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Ion Exchange Processing of AN-107 Hanford Tank Waste through Crystalline Silicotitanate in a Staged 2- then 3-Column System

August 2024

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Summary

The Hanford Site stores an estimated 56 million gallons of mixed radioactive and chemically hazardous waste in large underground tanks. In support of the Direct Feed Low-Activity Waste (DFLAW) Program for expediting Hanford tank waste supernate treatment, laboratory-scale ion exchange processing using prototypic unit operations was conducted on AN-107 tank waste at the Pacific Northwest National Laboratory Radiochemical Processing Laboratory.

This report describes the small-scale ion exchange testing with 13.7 L of diluted and filtered supernate from Tank 241-AN-107 (hereafter referred to as AN-107) at 16 °C (62 °F). One of the waste acceptance criteria (WAC) for the Waste Treatment Plant (WTP) Low-Activity Waste Facility is that the waste must contain less than 3.18×10^{-5} Ci ^{137}Cs per mole of Na.¹ For the AN-107 tank waste to meet this criterion, only 0.147% of the influent ^{137}Cs concentration may be delivered to the WTP; this requires a Cs decontamination factor of 678. Testing with AN-107 matched current Tank Side Cesium Removal (TSCR) facility prototypic operations where a lead-lag configuration was used until the lag column reached the WAC limit, then a polish column was brought online for continued processing in a lead-lag-polish column configuration. Feed was processed at 1.9 bed volumes (BVs) per hour; the flowrate, in terms of contact time with the crystalline silicotitanate (CST) bed, matched the expected flowrate at TSCR. The Cs-decontaminated product was retained for vitrification testing (to be reported separately).

The lead column reached 40% Cs breakthrough after processing ~1700 BVs of feed; the 50% Cs breakthrough was extrapolated from the breakthrough data to occur at 1873 BVs. Testing compared to previous AP-101 and AP-107 testing at 16 °C showed ~300 BV increases in volume processed to reach the WAC limit for both lead and lag columns. The increase in capacity was determined to be due to the significantly lower K concentration in the AN-107 supernate compared to the other tank waste matrices. A comparison in breakthrough curves for the three tests indicated slightly slower kinetic behavior in the AN-107, with variations in feed matrices (high organic complexants) likely responsible for the deviation. The Cs effluent from the lag column reached the WAC limit after processing 1097 BVs. Anticipating this breakthrough point, the polish column was preemptively installed around 900 BVs. Cs breakthrough from the lag column began at 500 BVs, reaching 3.06×10^0 µCi/mL, or 2.6 % Cs breakthrough, after processing all 1700 BVs of feed. Table S.1 and Figure S.1 summarize the observed column performance and relevant Cs loading characteristics.

¹ 24590-WTP-ICD-MG-01-030, Rev. 1. 2021. *ICD 30 – Interface Control Document for DFLAW Feed*. Bechtel National, Inc. (River Protection Project Waste Treatment Plant), Richland, Washington.

Table S.1. AN-107 Column Performance Summary with CST at 16 °C

| Column | WAC Limit Breakthrough (BVs) | 50% Cs Breakthrough (BVs) | ¹³⁷ Cs Loaded (μCi) | Cs Loaded (mmoles Cs/g CST) |
|--------|------------------------------|---------------------------|--------------------------------|-----------------------------|
| Lead | 277 | 1873 ^(a) | 1.41E+06 | 0.0965 |
| Lag | 1097 | 3378 ^(a) | 2.32E+05 | 0.0159 |
| Polish | 2031 ^(a) | NA | 5.58E+03 | 0.0004 |

(a) Extrapolated value.

BV = bed volume, 8.0 mL

The time-weighted average flowrate was 1.94 BV/h.

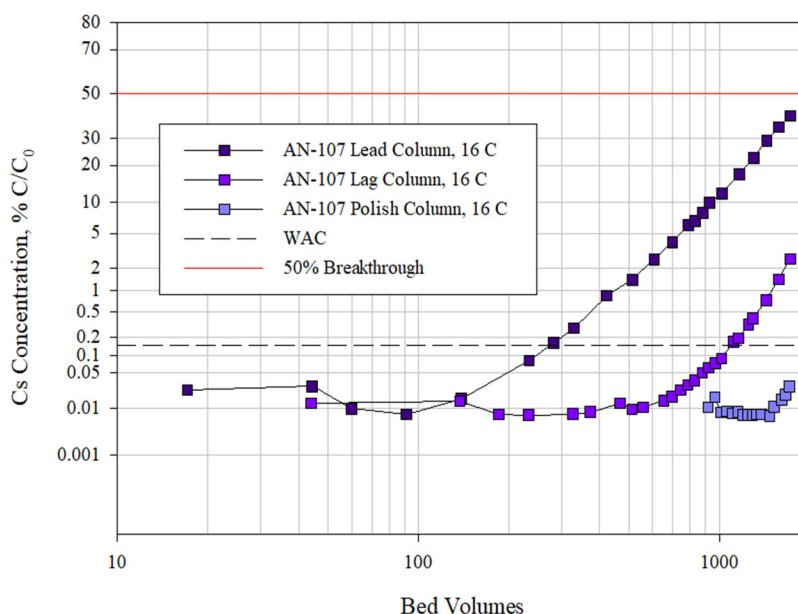


Figure S.1. Lead, Lag, and Polish Column Cs Load Profiles for AN-107 at 16 °C

The AN-107 composite feed and composite effluent were characterized to understand the fractionation of selected analytes and radionuclides. Concentrations and recoveries of the selected analytes are summarized in Table S.2. Notably no Sr was sorbed to the CST during waste processing, due to the complexant nature of the AN-107 waste stream.

Table S.2. Recoveries of Analytes of Interest in the AN-107 Effluent

| | | Feed Concentration (M) | Effluent Concentration (M) | Fraction in Effluent |
|-----------------------------|----------------------------------|------------------------------|----------------------------------|-------------------------|
| Metals / Non-metals | Al | 5.12E-02 | 8.17E-02 | 160% |
| | As | [1.5E-03] | [2.1E-03] | 139% |
| | Ba | 1.70E-05 | 2.42E-05 | 143% |
| | Ca | 8.33E-03 | 8.20E-03 | 99% |
| | Cd | 3.56E-04 | 3.73E-04 | 105% |
| | Cr | 1.24E-03 | 1.64E-03 | 133% |
| | Fe | 8.64E-03 | 1.41E-02 | 164% |
| | K | 2.73E-02 | 2.68E-02 | 98% |
| | Na | 5.53E+00 | 5.49E+00 | 100% |
| | Ni | 5.69E-03 | 5.64E-03 | 100% |
| | Pb | 7.99E-04 | [9.7E-04] | 123% |
| | Sr | 1.86E-05 | 1.81E-05 | 98% |
| | U | [1.1E-04] | [1.0E-04] | 91% |
| | Zn | 6.35E-04 | 6.92E-04 | 109% |
| Hot persulfate oxidation | Total organic C | 1.62E+00 | 1.68E+00 | 104% |
| | Total inorganic C ^(a) | 6.83E-01 | 7.42E-01 | 109% |
| ICP-MS | Sr-87 | 1.52E-04 | 1.39E-04 | 92% |
| | Sr-88 | 1.47E-05 | 1.57E-05 | 108% |
| | U-238 | 5.64E-05 | 4.96E-05 | 88% |
| Radioisotopes | Pb-206 | 7.50E-04 | 8.50E-04 | 114% |
| | Pb-207 | 7.57E-04 | 8.57E-04 | 114% |
| | Pb-208 | 7.43E-04 | 8.33E-04 | 113% |
| | U-238 | 5.64E-05 | 4.96E-05 | 88% |
| | ²⁴¹ Am | 1.34E-01 | 2.81E-01 | -- |
| | ¹³⁷ Cs | 1.12E+02 | 1.42E-02 | 0.013% |

Notes:

"<" values were < MDL, sample-specific MDL provided in Appendix B.

"--" indicates effluent recovery could not be calculated.

Values in brackets [] were ≥ MDL but < EQL, with errors likely to exceed ±15%.

MDL = method detection limit

EQL = estimated quantitation limit.

Batch contact tests were performed with the AN-107 tank waste at four Cs concentrations and four temperatures (16 °C, 20 °C, 25 °C, and 35 °C), each at a phase ratio of 200 (liquid volume to dry CST mass). The 16 °C distribution coefficient (K_d) at the equilibrium condition of 6.52E-5 M Cs (AN-107 feed condition) was 1858 mL AN-107/g CST. With a CST bed density of 1.00 g/mL (<30 mesh CST), this K_d corresponded to a predicted 50% Cs breakthrough of 1858 BVs. The predicted column performance 50% Cs breakthrough (1873 BVs) fell within 1% of the predicted performance from batch contacts (1858 BVs). The batch contact testing predicted a Cs load capacity of 0.121 mmol Cs/g dry CST at the equilibrium Cs concentration. The Cs breakthrough from the lead column at the 50% breakthrough point was used to determine full loading onto the CST at 100% C/C_0 and resulted in 0.122 mmol Cs/g CST — 100.9% of the maximum Cs loading at feed condition based on prediction from batch contact testing.

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Acronyms and Abbreviations

| | |
|---------|--|
| AMPS | advanced modular pretreatment system |
| ASO | Analytical Support Operations |
| ASR | Analytical Service Request |
| BV | bed volume |
| CST | crystalline silicotitanate |
| DF | decontamination factor |
| DFLAW | direct feed low-activity waste |
| DI | deionized |
| DOE ORP | Department of Energy Office of River Protection |
| EQL | estimated quantitation limit |
| erf | error function |
| FD | feed displacement |
| GEA | gamma energy analysis |
| IC | ion chromatography |
| ICP-MS | inductively coupled plasma mass spectrometry |
| ICP-OES | inductively coupled plasma optical emission spectroscopy |
| ID | identification |
| IX | ion exchange |
| LAW | low-activity waste |
| MDL | method detection limit |
| NA | not applicable |
| PNNL | Pacific Northwest National Laboratory |
| QA | quality assurance |
| R&D | research and development |
| SV | system volume |
| TIC | total inorganic carbon |
| TOC | total organic carbon |
| TRU | transuranic |
| TSCR | Tank Side Cesium Removal |
| WAC | waste acceptance criteria |
| WRPS | Washington River Protection Solutions, LLC |
| WTP | Hanford Waste Treatment and Immobilization Plant |

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1.0 Introduction

Washington River Protection Solutions (WRPS) is the Tank Operating Contractor for the U.S. Department of Energy-Office of River Protection (DOE-ORP) on the Hanford Site. The Hanford Site stores an estimated 56 million gallons of mixed radioactive and chemically hazardous waste in large underground tanks. In support of the Direct Feed Low-Activity Waste (DFLAW) Program, the U.S. Department of Energy deployed a strategy to pretreat supernate waste at tank farms and send it directly to Hanford's Waste Treatment and Immobilization Plant (WTP) Low-Activity Waste (LAW) facility for vitrification. To accommodate this strategy, DOE and WRPS developed a two-phased approach. The first phase consisted of the deployment of a Tank Side Cesium Removal (TSCR) system located at AP Farm as a part of the TSCR Demonstration Project, which began operations in January 2022. This system provides the initial feed for hot commissioning of the WTP-LAW facility. The second phase will consist of the deployment of a higher capacity pretreatment system called the Advanced Modular Pretreatment System (AMPS) that can deliver sufficient feed for two melters in the WTP-LAW facility. Decanted tank waste supernate will be pretreated using AMPS to meet the WTP LAW Facility waste acceptance criteria (WAC). Specific to ^{137}Cs , this requirement is $<3.18\text{E-}5 \text{ Ci } ^{137}\text{Cs}/\text{mole of Na}$.²

In support of flowsheet planning, laboratory-scale ion exchange processing using 13.7 L of AN-107 tank waste was conducted to help understand the impact of the high level of organics as well as assist in identifying the impact of the lack of ^{90}Sr retention on the CST. Although AN-107 is currently not identified as a direct feed to TSCR/AMPS, understanding the expected filtration and ion exchange performance is needed to assess processing viability, blending options, and other treatment strategies.

The primary objective of the work described in this report was to test Cs removal from AN-107 using the current TSCR prototypic hybrid column processing at an operating temperature of 16 °C and establish Cs load profiles. For this testing, a lead-lag column system was used initially, but once the lag column effluent reached the WAC limit, a polish column was added after the lag column and processing continued in a lead-lag-polish configuration. Additional objectives of the current study were as follows:

1. Conduct batch contact testing with CST at 16 °C, 20 °C, 25 °C, and 35 °C to determine the Cs load capacity of diluted and filtered AN-107.
2. Compare the 16 °C AN-107 Cs load profile to the previously reported 16 °C AP-107, AP-101 and AP-105 load curves (Westesen et al. 2021, 2022, and 2023).
3. Analyze the AN-107 ion exchange feed and effluent to derive the fates of key analytes and radionuclides.
4. Provide Cs-decontaminated AN-107 for vitrification (conducted in early 2024 and addressed in a separate report).

WRPS funded Pacific Northwest National Laboratory (PNNL) to conduct testing with AN-107 tank waste under the WRPS statement of work *Tank 241-AN-107 Large Volume Sample Collection to Support Platform Testing, Phase 2, FY23*, Rev. 0, Requisition 366862, dated June 29, 2023. There are no deviations from the statement of work.

² 24590-WTP-ICD-MG-01-030, Rev. 1. 2021. *ICD 30 – Interface Control Document for Direct LAW Feed*. Bechtel National, Inc., Richland, Washington.

2.0 Quality Assurance

This work was conducted with funding from WRPS under requisition 366862: Tank 241-AN-107 Large Volume Sample Collection to Support Platform Testing, Phase 2, FY23. This work was performed in accordance with the Pacific Northwest National Laboratory (PNNL) Nuclear Quality Assurance Program (NQAP). The NQAP complies with the United States Department of Energy Order 414.1D, Quality Assurance, and 10 CFR 830, Subpart A, Quality Assurance Requirements. The NQAP uses NQA-1-2012, Quality Assurance Requirements for Nuclear Facility Applications, as its consensus standard and NQA-1-2012, Subpart 4.2.1, as the basis for its graded approach to quality. The data associated with this report was collected under technology readiness level (TRL) 5, the highest level of applied research under NQAP.

3.0 Test Conditions

This section describes the CST media, AN-107 tank waste, column ion exchange conditions, sample analysis, and batch contact conditions. All testing was conducted in accordance with a task plan prepared by PNNL and approved by WRPS.³

3.1 CST Media

The CST used in this testing was procured by WRPS as ten 5-gallon buckets (149 kg total) of IONSIV R9140-B,⁴ lot number 2002009604, from Honeywell UOP, LLC. The CST was transferred to PNNL for use in laboratory testing described herein. Details of the procurement and material properties can be found elsewhere (Fiskum et al. 2019a). Before use in column and batch contact testing, the CST was sieved to <30-mesh and pretreated by contacting with 0.1 M NaOH successively until fines were no longer observed. The <30-mesh CST sieve cut has been shown to provide appropriate performance scaling to a full-height TSCR column (Westesen et al. 2020).

3.2 AN-107 Tank Waste Sample

WRPS collected multiple samples (36 at nominally 250 mL each) from the AN-107 Hanford tank in August 2023. The first and last samples collected, 7AN-23-01 and 7AN-23-36, were subsampled for a limited analysis suite to confirm density, total inorganic carbon (TIC), total organic carbon (TOC), ion chromatography (IC), and Cs concentrations. The density was measured in a PNNL hot cell using a 10-mL volumetric flask. Analytical results are provided in Table 3.1. The results of the two samples agreed well, indicating the 36 samples were likely homogenous.

Table 3.1. Characterization of Samples 7AN-23-01 and 7AN-23-36 Collected from Hanford Tank AN-107

| Analyte | 7AN-23-01 Result | 7AN-23-36 Result | Result Units | Analysis Method |
|-------------------------------|----------------------|----------------------|--------------|------------------|
| TIC | 0.975 | 0.902 | M | Hot pursulfate |
| TOC | 1.908 | 1.747 | M | Hot pursulfate |
| Cl ⁻ | 0.032 | 0.030 | M | IC |
| NO ₃ ⁻ | 1.887 | 1.790 | M | IC |
| NO ₂ ⁻ | 0.976 | 0.933 | M | IC |
| PO ₄ ³⁻ | 0.015 | 0.014 | M | IC |
| SO ₄ ²⁻ | 0.060 | 0.056 | M | IC |
| Total Cs | 1.06E-04 | 1.11E-04 | M | ICP-MS |
| ¹³⁷ Cs | 203.0 ^(a) | 195.1 ^(a) | μCi/mL | GEA |
| Density | 1.426 ^(b) | 1.424 ^(b) | g/mL | Volumetric flask |

(a) Reference date is October 13, 2023.
(b) Measured at 25.0 °C using a 10-mL volumetric flask.
Complete analytical reports are reported in Appendix B.
GEA = gamma energy analysis; ICP-MS = inductively coupled plasma mass spectrometry;
IC = ion chromatography

³ Westesen AM. 2023. Task Plan DFTP-TP-154, Rev. 0.0. *FY24 Cesium Ion Exchange Testing with AN-107 and AP-106 Tank Waste Using Crystalline Silicotitanate Media*. Pacific Northwest National Laboratory, Richland, Washington. Not publicly available.

⁴ R9140-B is provided in the sodium form by the vendor.

The Cs isotopic composition of the AN-107 samples was measured to determine the total Cs concentration in the AN-107 tank waste. Except for ^{133}Cs , direct analysis of AN-107 for the ^{135}Cs and ^{137}Cs isotopes can result in isobaric interferences. Therefore, subsamples (first and last AN-107 tank samples collected, 7AN-23-01 and 7AN-23-36) were processed to isolate Cs. Aliquots (1.5 mL) of AN-107 were batch contacted with 2 mL Na-form spherical resorcinol-formaldehyde (SRF) resin suspended in 8 mL 1 M NaOH. The slurries were mixed for ~24 hours on a shaker at room temperature. The aqueous phase was decanted and the SRF was washed three times with 6 mL 0.1 M NaOH, then rinsed three times with 6 mL deionized water. Cs was eluted from the SRF resin with 0.45 M HNO_3 . Quantitative recovery was not required because only the Cs isotope ratios were needed, and isotope fractionation does not occur in Cs uptake to, or elution from, SRF resin. The elution aliquots were measured by ICP-MS for Cs isotopic distribution; results are provided in Table 3.2. The total Cs concentration was calculated from the GEA-measured ^{137}Cs and the ICP-MS-measured isotopic composition. The calculated ^{133}Cs concentration agreed within 4% of the ICP-MS-measured ^{133}Cs concentration (shown in Table 3.2).

Table 3.2. 7AN-23-01 and 7AN-23-36 Average Cs Isotopic Composition (ASR 1861)

| Analyte ^(a) | 7AN-23-01 Results | 7AN-23-36 Results | Units |
|---|-------------------|-------------------|-----------------------|
| Cs isotopic mass ratio ^(a,b,c) | 66.7 | 68.2 | wt% ¹³³ Cs |
| | 17.2 | 16.5 | wt% ¹³⁵ Cs |
| | 16.1 | 15.4 | wt% ¹³⁷ Cs |
| Total Cs | 14.56 | | µg/mL Cs |
| (a) The Cs eluate samples (7AN-23-01-Cs and 7AN-23-36-Cs) were analyzed for the Cs isotopic mass distribution by ICP-MS per ASR 1861 samples 24-0071 and 24-0072, see Appendix B. | | | |
| (b) Reference date is November 13, 2023. | | | |
| (c) ¹³⁴ Cs, a fission product, was not detected by GEA; with a 2.065-year half-life, it was assumed to be decayed to extinction. | | | |

The AN-107 tank waste samples were composited and diluted to achieve a targeted 1.25 g/mL density and 5.50 M Na concentration as described in Allred et al. (2024). Nominally, 1 L of AN-107 tank waste was combined with 0.651 L of Columbia River process water. The AN-107 and water were mixed, and density was measured to verify the target dilution had been achieved. Density was measured via 10-mL Class A volumetric flask and an analytical balance and was recorded at 1.252 g/mL at an ambient cell temperature of 24.5 °C. The Na concentration was not measured after dilution but was measured after filtration (which should not affect Na concentration). The diluted AN-107 was chilled to 16 °C before being filtered with a media grade 5 filter (Allred et al. 2024). After filtration, 11 bottles of AN-107, containing nominally 1.2 L each, were made available for ion exchange testing.

The densities and ^{137}Cs concentrations of each of the 11 bottles of AN-107 were measured. The density average was 1.263 g/mL [0.65% relative standard deviation (RSD)] and the ^{137}Cs average was 119.3 μCi/mL (3.1% RSD; reference date January 2024). Therefore, AN-107 feeds in all containers were considered uniform. The total Cs concentration for the diluted waste was calculated from the ^{137}Cs concentration (in terms of μg/mL with unit conversion per the specific activity) and ^{137}Cs mass fraction (average 15.7 wt%). The total Cs concentration in the AN-107 was 8.73 μg/mL or 6.52E-5 M.

3.3 Ion Exchange Column Processing at 16 °C

This section describes the ion exchange column system AN-107 process conditions. The preparations and column testing were conducted in accordance with a test instruction.⁵

3.3.1 Ion Exchange Column System

Figure 3.1 provides a system schematic of the ion exchange process system used for the AN-107 column testing. The columns were housed in a 12-inch × 6-inch × 15-inch (W×D×H) insulated box, previously used and described in Westesen et al. (2022). Heat exchange was conducted with ethylene glycol from a chilled circulating bath flowing through copper tubing on the inner panels of the box. The internal temperature was monitored with a thermocouple seated inside a vial of water adjacent to the columns.

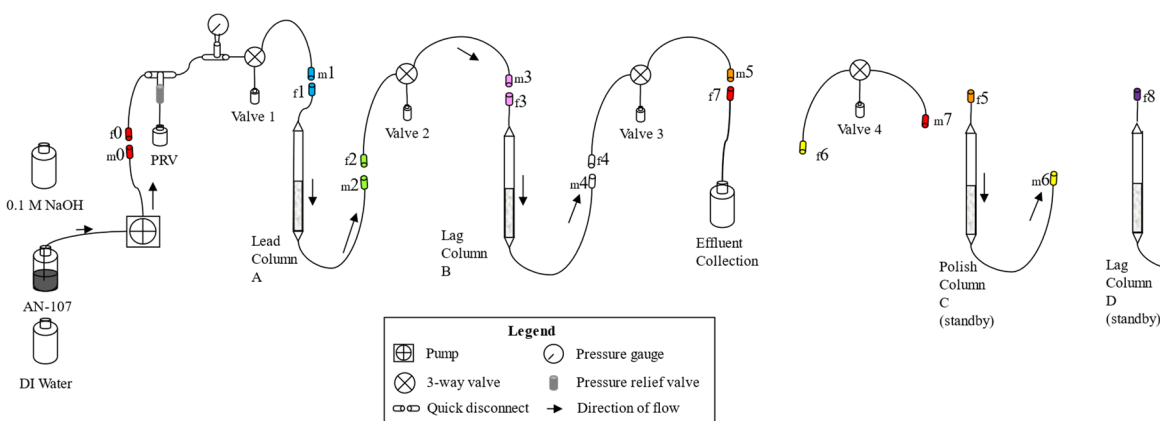


Figure 3.1. AN-107 Column System Schematic

Chromaflex column assemblies (previously described by Westesen et al. 2022) made of borosilicate glass measured 9 cm tall with an inside diameter of 1.5 cm (corresponding to a CST volume of 1.77 mL/cm) were used. The CST was supported by an in-house-constructed support consisting of a 200-mesh stainless steel screen tack welded onto a stainless-steel O-ring. The flared cavity at the bottom of each column was filled to the extent possible with 4-mm-diameter glass beads to minimize the mixing volume below the CST bed. An adhesive centimeter scale with 1-mm divisions (Oregon Rule Co., Oregon City, OR) was affixed to each column with the 0-point coincident with the top of the support screen.

Four Swagelok valves were installed on the valve manifold. Valve 1 was placed at the outlet of the pressure gauge and used to isolate the columns from the pump (when in the closed position) and purge the tubing from the inlet to valve 1 (when placed in the sampling position). Lead column A samples were collected at valve 2, the lag column B samples were collected at valve 3, and the polish column C samples were collected at valve 4. A fourth column D was prepared in the case that the polish column reached the waste acceptance criteria before all the waste was processed but was not needed in this testing. The gross AN-107 effluent, feed displacement (FD), water rinse, and flushed fluid were collected at the effluent line.

⁵ Westesen AM. 2023. Test Instruction DFTP-TI-155. *Reduced Temperature Cesium Removal from AN-107 Using Crystalline Silicotitanate in a Two- and Three-Column Format*. Pacific Northwest National Laboratory, Richland, Washington. Implemented December 2023. Not publicly available.

Aliquots of settled CST (pretreated, <30 mesh) were measured using a graduated cylinder and then quantitatively transferred to each individual column. Testing used 8.0-mL CST in each column. The CST was allowed to settle through the 0.1 M NaOH solution, thus mitigating gas bubble entrainment. The columns were tapped with a rubber bung until the CST height no longer changed. The CST bed volume (BV) corresponded to the settled CST media volume as measured in the graduated cylinder prior to transferring the media into the ion exchange column.

3.3.2 AN-107 Tank Waste Process Conditions

Once the ion exchange columns were installed within the chiller box, a flow of 0.1 M NaOH was used to verify system integrity and calibrate the pump. The diluted and filtered AN-107 contained in multiple 1.5-L polyethylene containers were used as the ion exchange feed. When the contents in a feed bottle decreased to ~300 mL, the next bottle in line was moved to the feed position and the residual contents were poured into the now primary feed bottle. The AN-107 feed was processed downflow through the ion exchange media beds, lead to lag. Effluent was collected in ~1.5-L increments. The lag column effluent Cs concentration was closely monitored. When the WAC limit was reached, the polish column was placed in-line and the run continued.

After the AN-107 processing (also “loading” in subsequent discussion) was completed, ~12 BVs (96 mL) of 0.1 M NaOH FD followed by ~12 BVs of deionized (DI) water were passed downflow through the system to rinse residual feed out of the columns and process lines. Twelve BVs is equivalent to ~1.7 times the fluid-filled system volume (SV).

Figure 3.2 provides daily temperature and flowrate profiles of the AN-107 processing as it went through the columns. Temperature was measured using a thermocouple placed inside a vial of water within the exchanger. The exchanger temperature averaged 16.4 °C throughout the testing, with min/max temperatures of 15.4 and 17.8 °C, respectively. The pump head stroke length was close to the minimum at which it could be set. The stroke rate was adjusted throughout testing to maintain the flowrate between 1.7 and 2.3 BV/h. Test parameters, including process volumes, flowrates, and CST contact times, are summarized in Table 3.3.

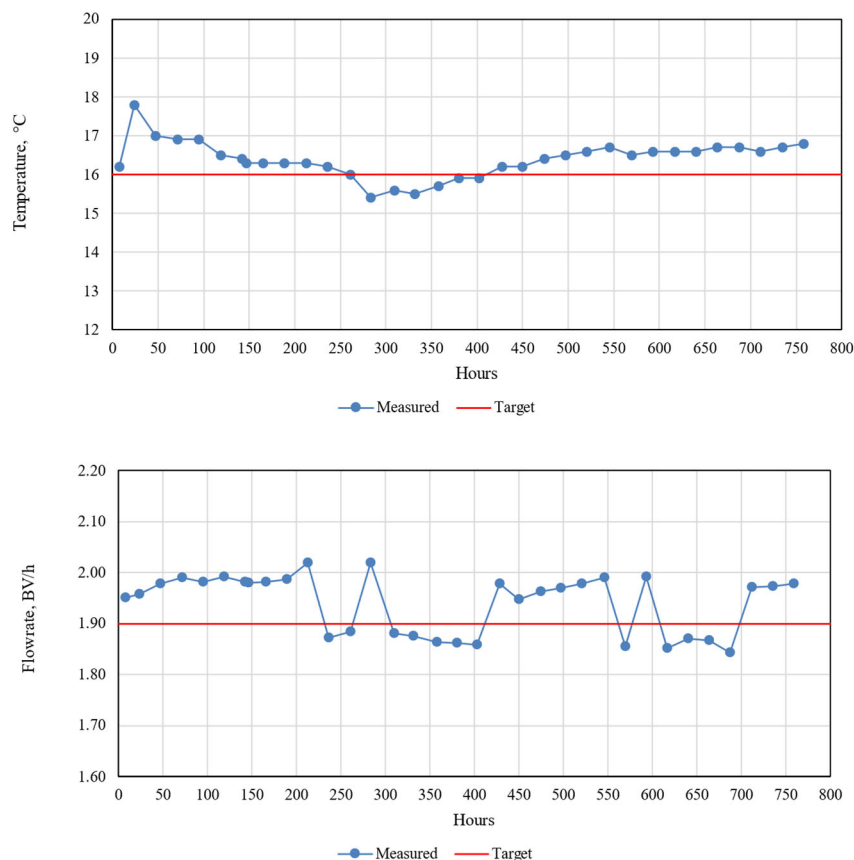


Figure 3.2. AN-107 Daily Column Temperature and Flowrate during Testing

Table 3.3. Experimental Conditions for AN-107 Column Processing at 16 °C, January 3 through February 12, 2024

| Process Step | Solution | Volume | | Flowrate | | Duration (h) |
|--------------------------------------|------------|--------|--------|----------|----------|-----------------|
| | | (BV) | (mL) | (BV/h) | (mL/min) | |
| Loading lead column | AN-107 | 1723.3 | 13787 | 1.94 | 0.324 | 890:31 |
| Loading lag column ^(a) | AN-107 | 1717.6 | 13741 | 1.94 | 0.324 | 890:31 |
| Loading polish column ^(b) | AN-107 | 793.7 | 6349.7 | 1.94 | 0.324 | 214:55 |
| Feed displacement | 0.1 M NaOH | 10.4 | 82.9 | 3.11 | 0.415 | 3:20 |
| Water rinse | DI water | 9.0 | 72.0 | 3.10 | 0.414 | 2:54 |
| Flush with compressed air | NA | 7.0 | 55.9 | NA | NA | NA |

(a) The feed volume through the lag column was reduced relative to that of the lead column because samples collected from the lead column did not enter the lag column.

(b) The feed volume through the polish column was lower relative to that of the lead and lag columns because it was placed in position after 875 BVs were processed.

BV = bed volume (8.0 mL as measured in graduated cylinder).

DI = deionized.

NA = not applicable.

The total cumulative volume of AN-107 processed was 13.8 L (1723 BVs). The process cycle mimicked, as best as possible, the process flow to be experienced at the TSCR facility in terms of Na concentration, BV/h (i.e., contact time), FD, and water rinse. It was understood that the feed linear flow velocity in this small-column configuration (0.17 cm/min) could not begin to match that of the full-height processing configuration (7.3 cm/min, Fiskum et al. 2019a). The objective was to match contact time in the bed.

During the loading phase, nominal 2-mL samples were collected from the lead, lag, and polish columns at the sample collection ports (see Figure 3.1, valves 2, 3, and 4). Sampling from the columns necessitated brief (~10-minute) interruptions of flow to the downstream columns. Samples were collected after the first 20 BVs were processed and again at nominal 15- to 150-BV increments. Only brief (~3-minute) interruptions were associated with changing the feed bottles.

The FD effluent was collected in bulk in a 125-mL polyethylene bottle. The water rinse was similarly collected. The fluid-filled volume was expelled with compressed air in ~4 minutes. The collected volume (55 mL) did include the interstitial fluid space between the CST beads but was not expected to include fluid in the CST pore space. Hours of additional gas flow were required to dry the CST enough to be free flowing.

3.4 Batch Contact Conditions

Batch contact experiments with the AN-107 effluent following ion exchange processing were conducted to evaluate Cs loading at four different temperatures. Stock solutions of 0.75 and 0.084 M CsNO₃ were prepared by dissolving the nitrate salt in a volumetric flask and diluting with DI water. Calculated volumes of Cs stock solutions were delivered to poly bottles and the mass of the spike was measured. The diluted AN-107 effluent was spiked with ¹³⁷Cs and nominally 120 mL of AN-107 was transferred into each poly bottle to achieve Cs concentrations of 1.5E-4, 3.8E-4, 7.6E-4, and 1.5E-2 M Cs. Solutions were prepared gravimetrically, and exact volumes were calculated from mass and density measurements.

Nominal 0.075-g (dry mass basis) aliquots of CST were measured into 20-mL vials. F-factor samples were collected in duplicate, bracketing batch contact aliquots, and used to determine the dry mass of the exchanger. The F-factor was measured at 105 °C with an average value of 0.928. The F-factor at 105 °C measured at the time of the experiment was used to calculate the dry mass of CST for the AN-107 batch contact tests.

Aliquots (15-mL) of the AN-107 Cs stock solutions were added to the appropriate vials (in duplicate) and the exact solution volume transferred was calculated from net solution mass and density. The solution-to-mass phase ratio averaged 200 ± 1.8 mL/g.

Two batch contact tests were conducted in series, where 16 °C and 25 °C were done concurrently, followed by 20 °C and 35 °C done concurrently. The colder temperature samples (16 °C and 20 °C) were contacted on a refrigerated/heated Benchmark (Sayreville, New Jersey) Incu-Shaker orbital shaker and the warmer temperatures (25 °C and 35 °C) were contacted on a Benchmark Incu-Shaker™ 10LR. All samples were contacted at 200 rpm. A vial of water co-located with each sample set was used to monitor the temperature over the ~ 240-hour contact time. The resulting temperature fluctuations are shown in Figure 3.3 with error bars representative of the 2.2 °C measurement uncertainty of a Type K thermocouple. The weighted mean temperature for each set of batch contacts is provided in Table 3.4.

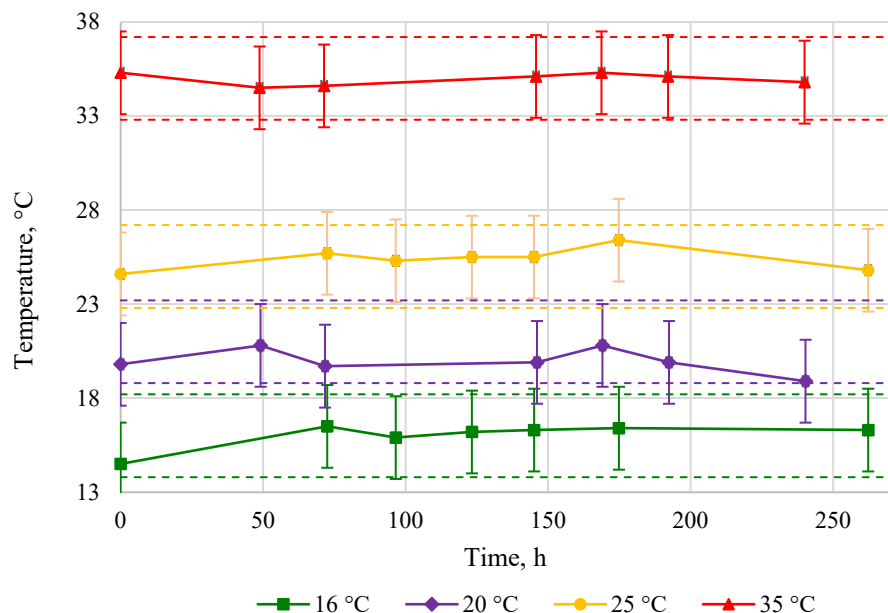


Figure 3.3. Temperature Profiles of Batch Contact Testing with AN-107 Tank Waste Supernate

Table 3.4. Average Contact Temperature

| Target Temperature (°C) | Weighted Mean Temperature (°C) |
|----------------------------|-----------------------------------|
| 16 | 16.1 |
| 20 | 20.0 |
| 25 | 25.5 |
| 35 | 34.9 |

After contact, 2 mL of the supernate was removed and filtered through a 0.45-micron pore size nylon syringe filter and transferred to a glass vial for GEA. The ^{137}Cs activity measured by GEA in pre- and post-contacted solutions was used to determine the total Cs exchange. Analysis and data reduction were conducted using the methods previously reported (Fiskum et al. 2019b). The isotherm data were fitted to a Freundlich/Langmuir hybrid equilibrium fit (Hamm et al. 2002).

The batch distribution coefficients were calculated according to Eq (3.1).

$$\frac{(A_0 - A_1)}{A_1} \times \frac{V}{M \times F} = K_d \quad (3.1)$$

where A_0 = initial ^{137}Cs concentration ($\mu\text{Ci/mL}$)

A_1 = final (equilibrium) ^{137}Cs concentration ($\mu\text{Ci/mL}$)

V = volume of the batch contact liquid (mL)

M = measured mass of CST (g)

F = F-factor, mass of the 105 °C dried CST divided by the mass of the undried CST

K_d = batch-distribution coefficient (mL/g)

Final (equilibrium) Cs concentrations (C_{Eq}) were calculated relative to the tracer recovered in the contacted samples (A_1) and the initial metal concentration (C_0) according to Eq. (3.2)

$$C_0 \times \left(\frac{A_1}{A_0} \right) = C_{Eq} \quad (3.2)$$

where C_0 = initial Cs concentration in solution ($\mu\text{g/mL}$ or M)
 C_{Eq} = equilibrium Cs concentration in solution ($\mu\text{g/mL}$ or M)

The equilibrium Cs concentrations loaded onto the CST (Q in units of mmoles Cs per gram of dry CST mass) were calculated according to Eq. (3.3)

$$\frac{C_0 \times V \times \left(1 - \frac{A_1}{A_0} \right)}{M \times F \times 1000 \times \text{FW}} = Q \quad (3.3)$$

where Q = equilibrium Cs concentration in the CST (mmole/g CST)
 1000 = conversion factor to convert μg to mg
 FW = Cs formula weight

3.5 Sample Analysis

Cesium load performance was determined from the ^{137}Cs measured in the collected samples relative to the native ^{137}Cs in the AN-107 feed. The collected samples were analyzed directly to determine the ^{137}Cs concentration using GEA. Cesium loading breakthrough curves for both the lead, lag and polish columns were generated based on the feed ^{137}Cs concentration (C_0) and the effluent Cs concentration (C) in terms of $\% C/C_0$.

A composite feed sample for the as-received and diluted AN-107 feed was prepared by collecting a pro-rated volume from each feed bottle and combining in a polyethylene vial; a composite effluent sample was similarly collected. Table 3.5 summarizes the specific sample collections and targeted analytes along with the cross-reference to the analytical sample identification (ID).

Analytical services were responsible for the preparation and analysis of appropriate analytical batch and instrument quality control samples and for providing any additional processing to the sub-samples that might be required (e.g., acid digestion, radiochemical separations, dilutions). All analyses were conducted according to the analytical services standard operating procedures, the QA Plan, and the Analytical Service Request (ASR). Samples were analyzed directly (no preparation) by GEA; longer count times were used to assess isotopes other than ^{137}Cs .

Table 3.5. Analytical Scope Supporting AN-107 Column Processing

| Sample ID | Analytical ID | Analysis Scope |
|-----------------------|--------------------------------|---|
| As-received AN-107 | ASO: 24-0069 through 24-0072 | GEA (^{241}Am , ^{137}Cs , ^{60}Co) ICP-MS (^{133}Cs , ^{135}Cs , ^{137}Cs) |
| | 331: 2310007-01 and -02 | IC anions (F^- , Cl^- , NO_2^- , NO_3^- , PO_4^{3-} , $\text{C}_2\text{O}_4^{2-}$, SO_4^{2-}) |
| AN-107 IX Feed | | GEA (^{241}Am , ^{137}Cs , ^{60}Co , ^{154}Eu) OH^- |
| | ASO: 24-0924 | ICP-OES (Al, As, Ba, Ca, Cd, Cr, Fe, K, Na, Ni, P, Pb, S, Sr, Ti, U, Zn, Zr) ICP-MS (Ba, Nb, Pb, Sr, U) |
| | 331: 2403005-01 and 2403003-01 | IC anions (F^- , Cl^- , NO_2^- , NO_3^- , PO_4^{3-} , $\text{C}_2\text{O}_4^{2-}$, SO_4^{2-}) TIC/TOC |
| | SwRI: 718822 | Total Alpha and ^{99}Tc |
| | | GEA (^{241}Am , ^{137}Cs , ^{60}Co , ^{154}Eu) OH^- |
| AN-107 IX Effluent | ASO: 24-0925 | ICP-OES (Al, As, Ba, Ca, Cd, Cr, Fe, K, Na, Ni, P, Pb, S, Sr, Ti, U, Zn, Zr) ICP-MS (Ba, Nb, Pb, Sr, U) |
| | 331: 2403005-02 and 2403003-02 | IC anions (F^- , Cl^- , NO_2^- , NO_3^- , PO_4^{3-} , $\text{C}_2\text{O}_4^{2-}$, SO_4^{2-}) TIC/TOC |
| | SwRI: 718821 | Total Alpha and ^{99}Tc |
| | | |

ICP-OES = inductively coupled plasma optical emission spectroscopy
ICP-MS = inductively coupled plasma mass spectroscopy
GEA = gamma energy analysis
IC = ion chromatography
TIC/TOC = total inorganic carbon/total organic carbon

4.0 Results

This section discusses the Cs exchange behavior during batch contact and column testing with AN-107 tank waste. Ion exchange process raw data are provided in Appendix A. Batch contact raw data are provided in Appendix C.

4.1 Ion Exchange Processing

The Cs load behavior for AN-107 tank waste was evaluated at 16 °C. This section discusses the Cs load behavior for the executed test.

4.1.1 Cs Load Results

The diluted and filtered AN-107 was processed at nominally 1.94 BV/h through the lead and lag columns for 875 BVs, at which time the lag column effluent approached the WAC limit. The polish column was then placed into position and processing continued for another ~800 BVs. Figure 4.1 shows the Cs breakthrough profiles for the AN-107 columns using a probability log scale plot. The C_0 value for ^{137}Cs was determined to be 119.3 $\mu\text{Ci/mL}$ (average of the eleven diluted and filtered IX feed bottles).

The Cs breakthrough from the lead column was observed to start at ~90 BVs and continued to 40% C/C_0 after processing 1723 BVs when the last sample was collected from the lead column. Similarly, the lag column Cs breakthrough appeared to start at ~500 BVs and increased to 2.5% breakthrough when the last sample was collected from the column. Breakthrough on the polish column appeared around 1500 BVs and reached 0.03% breakthrough after the 800 BVs processed through it. In addition to the 50% C/C_0 indication line, the WAC limit, set at 0.147% C/C_0 , is also apparent (dashed black line).⁶

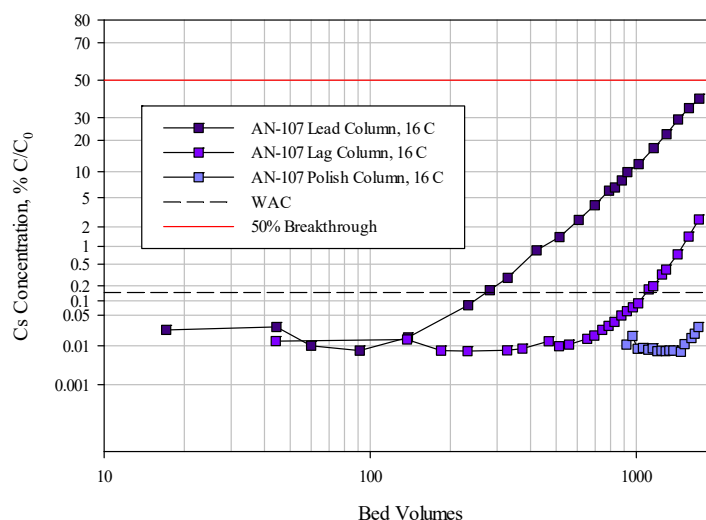


Figure 4.1. Lead, Lag, and Polish Column Cs Load Profiles of AN-107 at 1.9 BV/h

⁶ The WAC limit was derived from the allowed curies of ^{137}Cs per mole of Na in the effluent to support contact handling of the final vitrified waste form— $3.18\text{E-}5$ Ci $^{137}\text{Cs}/\text{mole Na}$. At 5.53 M Na and 119.3 $\mu\text{Ci } ^{137}\text{Cs/mL}$ in the AN-107 feed, the WAC limit is determined to be 0.147% C/C_0 .

The Cs breakthrough curves were modeled by the error function (erf) (Hougen and Marshall 1947; Klinkenberg 1948), as shown in Eq. (4.1):

$$\frac{C}{C_0} = \frac{1}{2} (1 + \operatorname{erf}(\sqrt{k_1 t} - \sqrt{k_2 z})) \quad (4.1)$$

where:

- k_1 and k_2 = parameters dependent on column conditions and ion exchange media performance
- t = time (or BVs processed)
- z = column length

Using this model, fits were generated to the AN-107 lead and lag column experimental data in Figure 4.2. The k_1 and k_2 values for AN-107 lead column were found to be 181.5 and 10.3, respectively and 142.9 and 23.6 for the lag column, respectively.

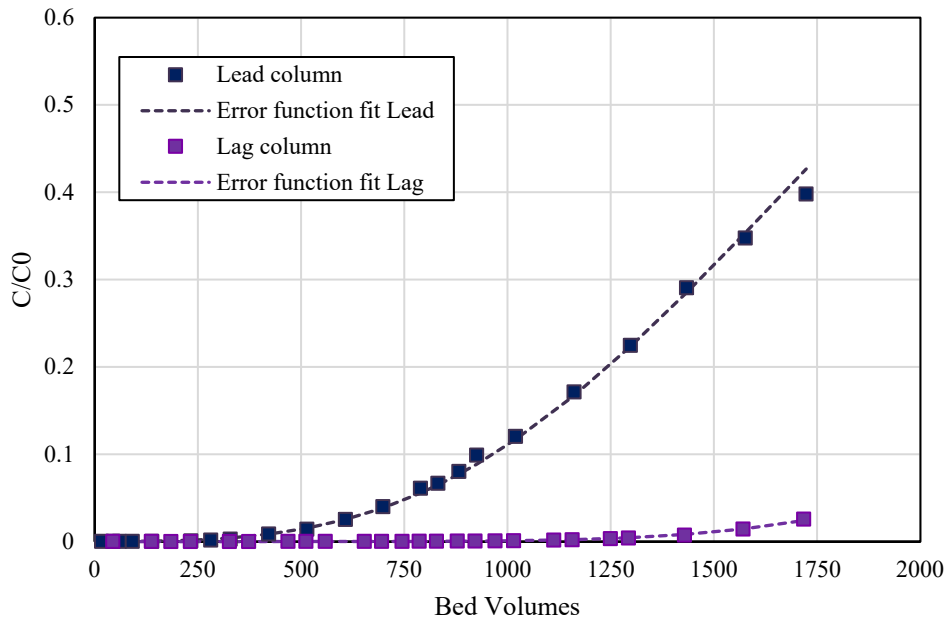


Figure 4.2. AN-107 Lead and Lag Column Cs Breakthrough with Error Function Fit

The 50% Cs breakthrough for the lead and lag columns were estimated from the error function fit at 1873 and 3378 BVs, respectively. The theoretical 50% Cs breakthrough on the ion exchange column (λ) can be predicted from the product of the K_d value and the ion exchanger bed density (ρ_b) according to Eq. (4.2) (Bray et al. 1993). The CST bed density is the dry CST mass divided by the volume in the column:

$$K_d \times \rho_b = \lambda \quad (4.2)$$

The lead column 50% Cs breakthrough value was within 1% of the Cs λ value predicted from the 16 °C batch contact studies (1858 BVs described in Section 4.2).

The WAC limit Cs breakthroughs were interpolated for each column by curve-fitting the BVs processed as a function of the log % C/C₀ values (see Figure 4.3). The curves were fitted to a second-order polynomial function ($R^2 \geq 0.98$) and the WAC limit breakthroughs were then calculated, resulting in the following:

- Lead column: 277 BVs
- Lag column: 1097 BVs
- Polish Column*: 2031 BVs (*=largely extrapolated)

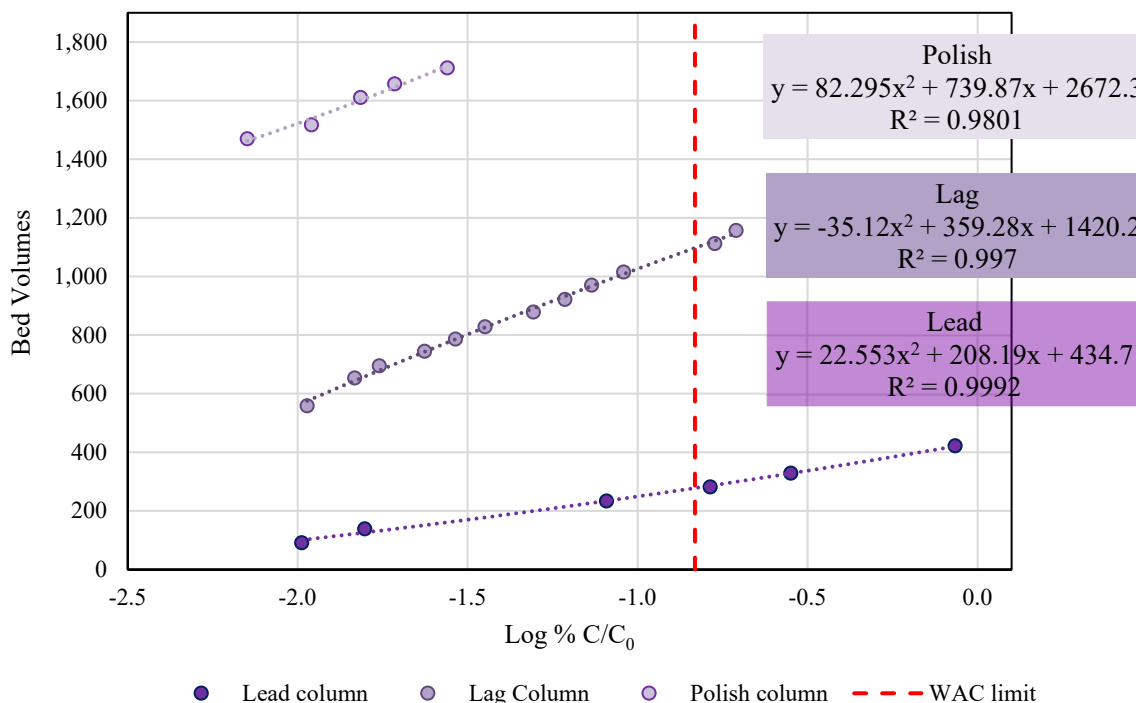


Figure 4.3. Curve Fits to Interpolate WAC Limit Breakthroughs from AN-107 Lead, Lag, and Polish Columns

4.1.2 Cesium Activity Balance

The Cs fractionations to the effluents and the columns were determined based on the input ¹³⁷Cs and the measured ¹³⁷Cs in the various effluent streams. The quantities of Cs loaded onto the lead, lag, and polish columns were determined by subtracting the Cs recovered in the samples and effluents from the Cs fed to each column. Table 4.1 summarizes the ¹³⁷Cs fractions found in the various effluents as well as the calculated ¹³⁷Cs column loadings. Approximately 85.6 % of the total Cs loaded onto the lead column, 14.1% loaded onto the lag column, and only 0.3% onto the polish column. Sample and effluent collection amounted to only ~0.004% of the input Cs.

Table 4.1. ^{137}Cs Activity Balance for AN-107

| Input | | |
|--|----------------|----------|
| | μCi | % |
| Feed Sample | 1.65E+06 | 100 |
| Output | | |
| Effluent-1 (0-137 BVs) | 0.09 | 5.31E-06 |
| Effluent-2 (137-279 BVs) | 10.54 | 6.38E-04 |
| Effluent-3 (279-418 BVs) | 10.53 | 6.37E-04 |
| Effluent-4 (418-556 BVs) | 12.90 | 7.81E-04 |
| Effluent-5 (556-692 BVs) | 17.91 | 1.08E-03 |
| Effluent-6 (692-825 BVs) | 34.7 | 2.10E-03 |
| Effluent-7 (825-966 BVs) | 28.43 | 1.72E-03 |
| Effluent-8 (966-1107 BVs) | 10.77 | 6.52E-04 |
| Effluent-9 (1107-1242 BVs) | 10.30 | 6.24E-04 |
| Effluent-10 (1242-1373 BVs) | 9.71 | 5.88E-04 |
| Effluent-11 (1373-1514 BVs) | 12.60 | 7.63E-04 |
| Effluent-12 (1514-1653 BVs) | 19.56 | 1.18E-03 |
| Effluent-13 (1653-1707 BVs) | 11.40 | 6.90E-04 |
| Load samples | 524 | 3.17E-02 |
| Feed displacement, water rinse and flush | 21.6 | 1.31E-03 |
| Total ^{137}Cs recovered in effluents | 735 | 4.45E-02 |
| Total ^{137}Cs column loading | | |
| Lead column Cs loading | 1.41E+06 | 85.6 |
| Middle column Cs loading | 2.32E+05 | 14.1 |
| Polish column Cs loading | 5.58E+03 | 0.3 |
| Column total | 1.65E+06 | 100.0 |

The total Cs loaded per g CST was calculated from the total Cs loaded onto the lead column and the dry CST mass loaded into the lead column according to Eq. (4.3):

$$\frac{A_{\text{Cs}} \times \text{CF}}{M} = C \quad (4.3)$$

where

- A_{Cs} = activity of ^{137}Cs , μCi on the lead column
- CF = conversion factor, mg Cs/ μCi ^{137}Cs
- M = mass of dry CST (8.0 g)
- C = capacity, mg Cs/g CST

A total of 12.92 mg Cs/g CST (0.0965 mmoles Cs/g CST) was loaded onto the lead column and was notably higher than previous AP-101, AP-107, and AP-105 testing at 16 °C (see Table 4.2) and is likely a direct result of decreased K concentration (described further in Sections 4.1.4 and 4.2.3). Since 50% breakthrough on the lead column was calculated per Eq. (4.2), the total load capacity was determined and was calculated to be 16.35 mg Cs/g CST (0.1220 mmoles Cs/g CST). This represented 100.9% of the predicted Cs load capacity found from batch contact testing (see Section 4.2.1) and shows excellent agreement between batch contacts and column flowthrough measurements. The documented safety analysis developed for TSCR limits a single column curie loading to 141,600 Ci, which equates to 0.10 mmole Cs/g CST. The total load capacity determined for the column testing represented 121% of this

limit and indicates that if processing occurs ≤ 16 °C, the curie limit on the lead column will be reached before the WAC limit on the polish column.

Table 4.2. AN-107 Cs CST Column Loading Comparison

| Test | Sieve Fraction | CST Cs loading (mg Cs/g CST) | Reference |
|---------------|----------------|---------------------------------|------------------------|
| AN-107, 16 °C | <30 mesh | 12.92 | Current report |
| AP-105, 16 °C | <30 mesh | 7.38 | Westesen et al. (2023) |
| AP-101, 16 °C | <30 mesh | 7.31 | Westesen et al. (2022) |
| AP-107, 16 °C | <30 mesh | 7.08 | Westesen et al. (2021) |

4.1.3 AN-107 Performance Comparison

Figure 4.4 provides the AN-107 and previously processed AP-101 (Westesen et al. 2022), and AP-107 (Westesen et al. 2021) column load profiles on one graph for direct comparison. Testing parameters for the three tank wastes are shown in Table 4.3. The Cs exchange associated with AN-107 resulted in a later Cs breakthrough to the lag column WAC by nominally 32%. This is likely due to the decrease in K concentration in the AN-107 waste by nearly 70%, which increases the capacity for Cs onto the CST. Additionally, the kinetics for the AN-107 test appear slightly slower than AP-101 and AP-107, based on a lower slope in the load curves. This may be due to differences in waste chemistry attributed to the higher organic concentration in AN-107.

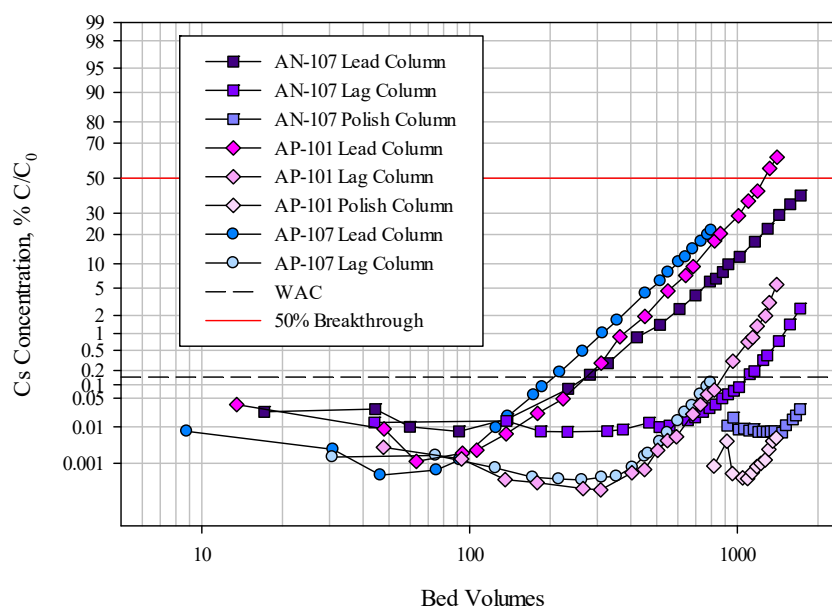


Figure 4.4. Comparative Cs Breakthrough Performance for AN-107, AP-101 and AP-107, Probability-Log Plot

Table 4.3. AN-107, AP-107 and AP-101 at 16 °C Testing Parameters

| Testing Condition | AN-107 (Current) | AP-101 (FY22) | AP-107 (FY21) |
|------------------------------|---------------------|------------------|------------------|
| Configuration | Lead-Lag-Polish | Lead-Lag-Polish | Lead-Lag |
| Flowrate, BV/h | 1.94 | 1.90 | 1.92 |
| Process Temp. °C | 16.0 | 16.0 | 16.0 |
| Density, g/mL | 1.263 | 1.259 | 1.271 |
| WAC limit, %C/C ₀ | 0.147 | 0.144 | 0.114 |
| Lag column BVs to WAC | 1097 | 875 | 791 |
| Cs, M | 6.52E-05 | 4.64E-05 | 6.99E-05 |
| Na, M | 5.53 | 5.20 | 6.20 |
| K, M | 0.03 | 0.098 | 0.10 |

4.1.4 Metals and Radionuclide Analysis

The AN-107 composite feed and composite effluent samples underwent extensive characterization to better define waste characteristics and assess analyte fractionation to the CST.

Table 4.4 summarizes the feed and effluent radionuclide concentrations and fractionations to the effluent. Partitioning to the effluent was only determined for GEA and alpha energy analysis (AEA) radionuclides ¹³⁷Cs, ²⁴³⁺²⁴⁴Cm, and ²³⁷Np due to higher concentrations measured in the effluent compared to the feed. It appears the feed analysis on the AN-107 may have been impacted by interferences in the waste due to the high organic complexant concentrations. The metals, anions, free hydroxide, inorganic and organic carbon concentrations are provided in Table 4.5. Analytical reports along with result uncertainties and quality control discussions are provided in Appendix B.

By inference, the analytes present in the feed and not found in the effluent were assumed to be retained on the CST. Analyte fractionation was calculated as the ratio of the total analyte measured in the feed processed through the columns and the total analyte collected in the Cs-decontaminated effluent according to Eq. (4.4):

$$\frac{C_{Da} \times V_D}{C_{Fa} \times V_F} = F_{Da} \quad (4.4)$$

where:

- C_{Da} = concentration of analyte *a* in the Cs-decontaminated effluent
- V_D = volume of Cs-decontaminated effluent
- C_{Fa} = concentration of analyte *a* in the AN-107 feed
- V_F = volume of AN-107 feed
- F_{Da} = fraction of analyte *a* in the Cs-decontaminated effluent

The analyte results shown in brackets indicate the result was less than the instrument estimated quantitation limit (EQL) but greater than or equal to the method detection limit (MDL); the associated analytical uncertainty could be higher than ±15%. The fractionation result was placed in brackets, where it was calculated with one or more bracketed analytical values to highlight the higher uncertainty.

Table 4.4. AN-107 Feed and Effluent Radionuclide Concentrations and Fractionations

| Analysis Method | Radionuclide | Feed Conc. TI126-Comp-Feed ($\mu\text{Ci/mL}$) | Effluent Conc. TI126-Comp-Eff ($\mu\text{Ci/mL}$) | Fraction in Effluent (%) |
|---|-----------------------|--|---|-----------------------------|
| Gamma energy analysis (GEA) ^(a) | ⁶⁰ Co | 2.90E-03 | 3.19E-03 | -- |
| | ¹³⁷ Cs | 1.12E+02 | 1.42E-02 | 0.013% |
| | ¹⁵² Eu | 8.60E-04 | 1.07E-03 | -- |
| | ¹⁵⁴ Eu | 2.33E-02 | 3.12E-02 | -- |
| | ²⁴¹ Am | 1.34E-01 | 2.81E-01 | -- |
| Separations/ Alpha energy analysis (AEA) ^(b) | ²⁴¹ Am | 2.11E-01 | 3.19E-01 | -- |
| | ²⁴² Cm | 3.54E-04 | 1.97E-03 | -- |
| | ²⁴³⁺²⁴⁴ Cm | 5.34E-03 | 3.90E-03 | 73% |
| | ²³⁷ Np | 1.14E-04 | 4.95E-05 | 44% |
| | ²³⁸ Pu | 4.41E-03 | 6.80E-03 | -- |
| | ²³⁹⁺²⁴⁰ Pu | 2.05E-02 | 3.62E-02 | -- |

(a) Reference date is February 2024.

(b) Reference date is April 2024.

--" = not applicable; value not reported, or fractionation cannot be calculated with a less-than value.

The recovered fractions are calculated with values containing more significant figures than shown; using listed values may result in a slight difference due to rounding.

Table 4.5. AN-107 Feed & Effluent Concentrations and Fractionations

| Analysis Method | Analyte | Feed Conc. TI155-Feed-Comp (M) | Effluent Conc. TI155-EFF-Comp (M) | Fraction in Effluent (%) |
|-----------------------------------|----------------------------------|--------------------------------------|---|--------------------------------|
| ICP-OES Metals / Non-metals | Al | 5.12E-02 | 8.17E-02 | 160% |
| | As | [1.5E-03] | [2.1E-03] | 139% |
| | Ba | 1.70E-05 | 2.42E-05 | 143% |
| | Ca | 8.33E-03 | 8.20E-03 | 99% |
| | Cd | 3.56E-04 | 3.73E-04 | 105% |
| | Cr | 1.24E-03 | 1.64E-03 | 133% |
| | Fe | 8.64E-03 | 1.41E-02 | 164% |
| | K | 2.73E-02 | 2.68E-02 | 98% |
| | Na | 5.53E+00 | 5.49E+00 | 100% |
| | Ni | 5.69E-03 | 5.64E-03 | 100% |
| | Pb | 7.99E-04 | [9.7E-04] | 123% |
| | Sr | 1.86E-05 | 1.81E-05 | 98% |
| | U | [1.1E-04] | [1.0E-04] | 91% |
| | Zn | 6.35E-04 | 6.92E-04 | 109% |
| Ion Chromatography Anions | F ⁻ | 6.84E-03 | 7.58E-03 | 111% |
| | Cl ⁻ | 3.10E-02 | 3.10E-02 | 100% |
| | NO ₂ ⁻ | 9.65E-01 | 9.72E-01 | 101% |
| | NO ₃ ⁻ | 1.81E+00 | 1.81E+00 | 100% |
| | PO ₄ ³⁻ | 1.25E-02 | 1.17E-02 | 94% |
| | SO ₄ ²⁻ | 5.33E-02 | 5.31E-02 | 100% |
| Titration | Free Hydroxide | 1.28E+00 | 1.29E+00 | 101% |
| Hot persulfate oxidation | Total organic C | 1.62E+00 | 1.68E+00 | 104% |
| | Total inorganic C ^(a) | 6.83E-01 | 7.42E-01 | 109% |
| ICP-MS | Sr-87 | 1.52E-04 | 1.39E-04 | 92% |
| | Sr-88 | 1.47E-05 | 1.57E-05 | 108% |
| | Ba-137 | 1.43E-04 | 1.05E-04 | 74% |
| | Ba-138 | 1.22E-05 | 1.88E-05 | 155% |
| | Pb-206 | 7.50E-04 | 8.50E-04 | 114% |
| | Pb-207 | 7.57E-04 | 8.57E-04 | 114% |
| | Pb-208 | 7.43E-04 | 8.33E-04 | 113% |
| | U-238 | 5.64E-05 | 4.96E-05 | 88% |
| | Nb-93 | 1.48E-05 | 5.37E-05 | 365% |
| | Tc-99 | 6.18E-06 | 5.70E-06 | 93% |

Bracketed values indicate the associated sample results were less than the EQL but greater than or equal to the MDL. Analytical uncertainty for these analytes was > ±15%.

(a) Assumed to be carbonate.

The ICP-OES results for the feed and effluent composite showed nearly all major analytes remained in the effluent. The Al, As, Ba, Cr, Fe, and Pb showed over recoveries in the effluent and are likely due to interferences in the waste matrix during analysis. All anions showed negligible partitioning to the CST with nearly 100% recovery for all passing passively through the system.

In contrast to previously tested tank waste matrices, the CST removed negligible amounts of Sr. The reduced removal seen by ICP-MS is due to the organic complexants in the waste holding on to the Sr allowing it to pass through the CST bed with very little removal.

4.2 Batch Contact Results

This section provides the K_d and isotherm curves for AN-107 tank waste at the four test temperatures, and a comparison of the data with AP-105, AP-107 and AP-101 temperature-dependent isotherm results. Input data supporting the various isotherms and figures are provided in Appendix C.

4.2.1 K_d and Isotherm Results for AN-107

Figure 4.5 shows the K_d dependence on Cs concentration at target temperatures of 16 °C, 20 °C, 25 °C, and 35 °C. The K_d increased with decreasing temperature, consistent with previous AP-105, AP-107 and AP-101 tank waste batch contact testing (Westesen et al. 2023, Fiskum et al. 2021b). There is negligible change in the K_d for the three lowest Cs concentrations (1.5E-4 M, 3.8E-4 M, 7.6E-4 M) measured. This behavior has also been observed for AP-107 and AP-101 and suggests the K_d is unimpacted with small changes in Cs concentrations of $<10^{-3}$ M Cs.

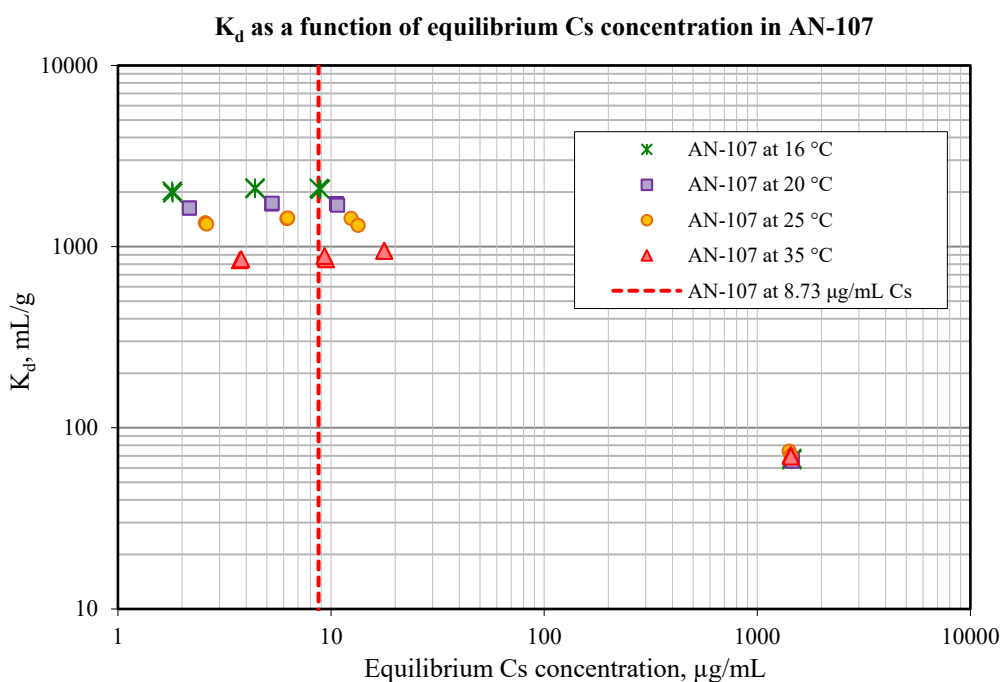


Figure 4.5. Cs K_d vs. Cs Concentration, AN-107 Tank Waste, Four Temperatures

Figure 4.6 shows the corresponding isotherms and Q (mmoles Cs/g dry CST) values vs. Cs molarity at all four test temperatures with AN-107 tank waste. It is important to note that the α_i , or total capacity in the matrix, was set to 0.68 mmoles Cs/g CST for this evolution of testing. Also provided are the curve fits to the Freundlich/Langmuir hybrid equilibrium model as given in Eq. (4.1) (Hamm et al. 2002).

$$Q = \frac{\alpha_i \times [Cs]}{(\beta + [Cs])} \quad (4.1)$$

where

- [Cs] = equilibrium Cs concentration, mmol/mL or M
- Q = equilibrium Cs loading on the CST, mmole Cs per g CST
- α_i = isotherm parameter constant (mmol/g), equivalent to total capacity in the matrix
- β = isotherm parameter constant (mmol/mL or M), selectivity coefficient, dependent on matrix and temperature; the larger the value, the less selective the CST is for Cs (Hamm et al. 2002)

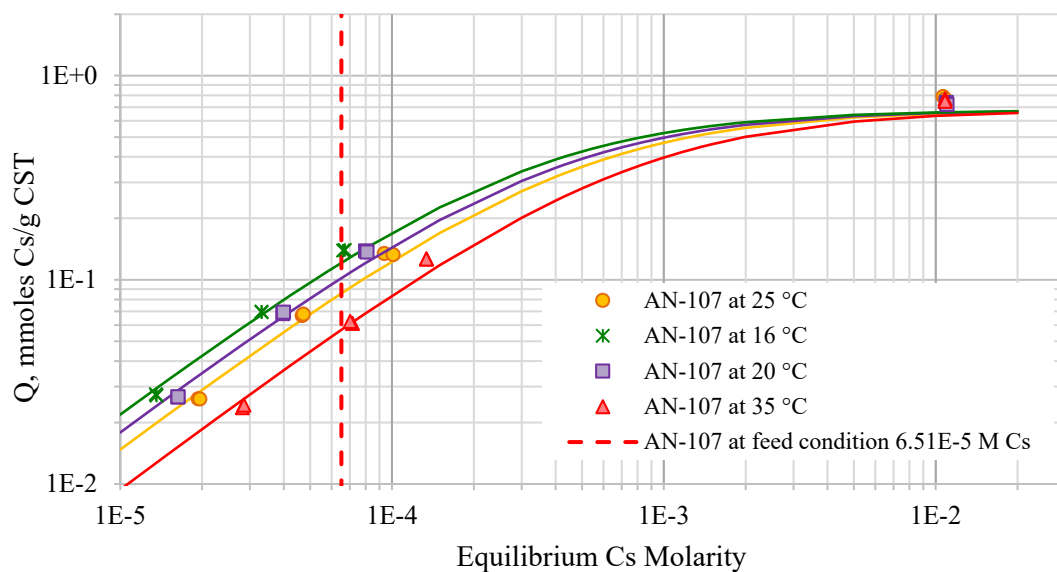


Figure 4.6. Q vs. Cs Equilibrium Concentration, AN-107 Tank Waste with Freundlich/Langmuir Hybrid Equilibrium Fits, Four Temperatures. The dashed red line represents the Cs concentration ($6.51\text{E-}5$ M) in AN-107 feed adjusted to 5.6 M Na.

A plot of Q (mmol Cs/g CST) vs. temperature (Figure 4.7) indicates that the loading decreases linearly as temperature increases. This is consistent with the data collected for previous tank waste matrices (Westesen et al. 2023).

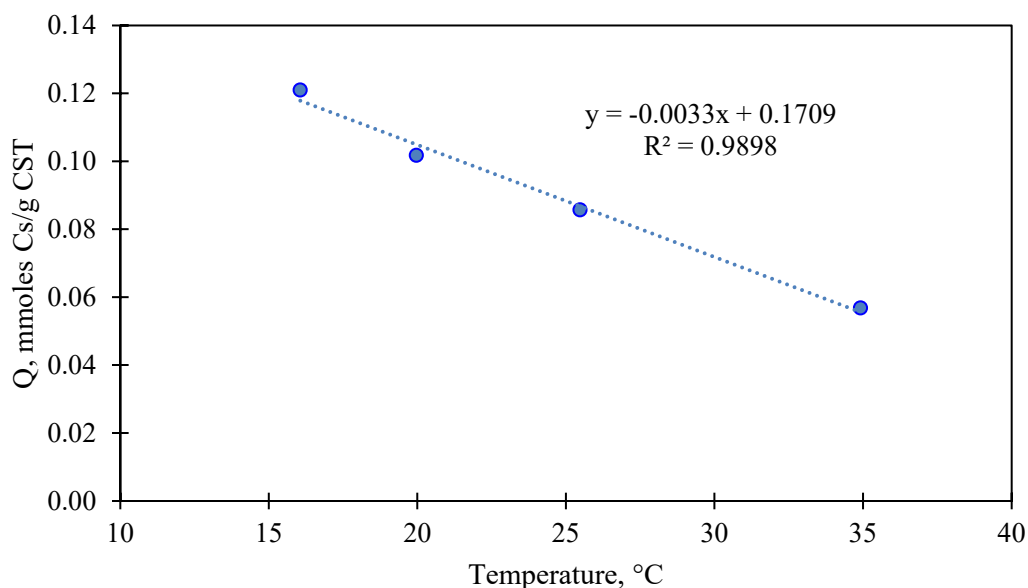


Figure 4.7. Q Dependence on Temperature for AN-107 Tank Waste

The experimental data for Cs loading (Q) at the three Cs concentrations (1.5E-4 M, 3.8E-4 M, 7.6E-4 M) bracketing Cs near the feed condition are better represented by a linear Freundlich isotherm fit as shown in Figure 4.8. A comparison of the loading calculated using the Freundlich/Langmuir hybrid model and the linear Freundlich approach is shown in Table 4.6. Conditions observed to challenge the current TSCR documented safety analysis (DSA) (upper limit of Q = 0.10 mmoles Cs/g CST and $K_d = 1400$ mL/g) occur at temperatures below 21.5 °C using the fit from Figure 4.7.

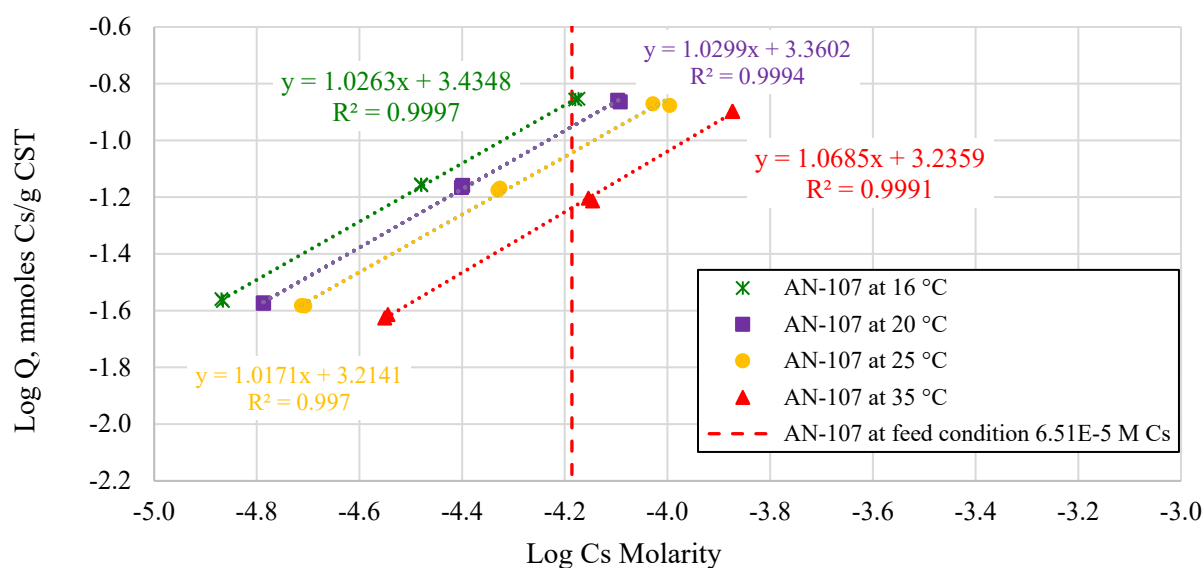


Figure 4.8. Linear Fits for Log Q vs. Log [Cs] for AN-107 at Four Test Temperatures

Table 4.6. Cs loading (Q, mmoles Cs/g CST) for the Freundlich/Langmuir Hybrid and Linear Freundlich Isotherm Model at AN-107 Feed Condition of 6.51E-5 M Cs

| Process Temperature (°C) | Q (mmoles Cs/g) F/L Hybrid model | Q (mmoles Cs/g) Linear Freundlich model |
|--------------------------|----------------------------------|---|
| 16.1 | 0.121 | 0.138 |
| 20.0 | 0.102 | 0.112 |
| 25.5 | 0.086 | 0.090 |
| 34.9 | 0.057 | 0.058 |

4.2.2 Tank Waste Comparisons

The alpha parameter in the Freundlich/Langmuir hybrid model represents the maximum Cs loading that can be achieved under the corresponding matrix conditions. To compare the data across tank wastes, α_i (maximum Cs loading) was set to 0.68 mmoles Cs/g CST and Excel Solver was used to calculate the β parameters using a generalized reduced gradient nonlinear method. The calculated β parameters for AP-107, AP-101, AP-105, and AN-107 are shown in Table 4.7 and graphed in Figure 4.9. The β values, or selectivity coefficient, can be used to compare Cs selectivity in the different tank waste matrices. The β values linearly increased with temperature, which is expected as increasing temperature inhibits Cs loading. The smaller the β value, the more favorable the exchange. The β values for AN-107 were the smallest of the waste series measured, which coincides with the ion exchange performance.

Table 4.7. Freundlich/Langmuir Hybrid Equilibrium β Parameter Summary for AP-107, AP-105, AP-101, and AN-107 Tank Waste and Calculated Q and K_d

| Matrix | Process Temperature (°C) | β , (Cs M) | K_d (mL/g) | Q (mmoles Cs/g CST) |
|-------------------------------|--------------------------|------------------|--------------|---------------------|
| AP-107 Tank Waste | 15.9 | 4.76E-04 | 1249 | 0.086 |
| | 21.0 | 5.28E-04 | 1138 | 0.079 |
| | 34.5 | 9.29E-04 | 681 | 0.047 |
| AP-101 Tank Waste | 15.7 | 4.43E-04 | 1391 | 0.0645 |
| | 21.7 | 5.03E-04 | 1237 | 0.0574 |
| | 34.3 | 9.74E-04 | 666 | 0.0309 |
| AP-105 Tank Waste | 15.9 | 6.11E-04 | 1019 | 0.058 |
| | 21.0 | 6.54E-04 | 956 | 0.054 |
| | 34.5 | 1.28E-03 | 510 | 0.029 |
| AN-107 Tank Waste (this work) | 16.1 | 3.01E-04 | 1858 | 0.1210 |
| | 20.0 | 3.70E-04 | 1563 | 0.1018 |
| | 25.5 | 4.51E-04 | 1316 | 0.0857 |
| | 34.9 | 7.14E-04 | 873 | 0.0568 |

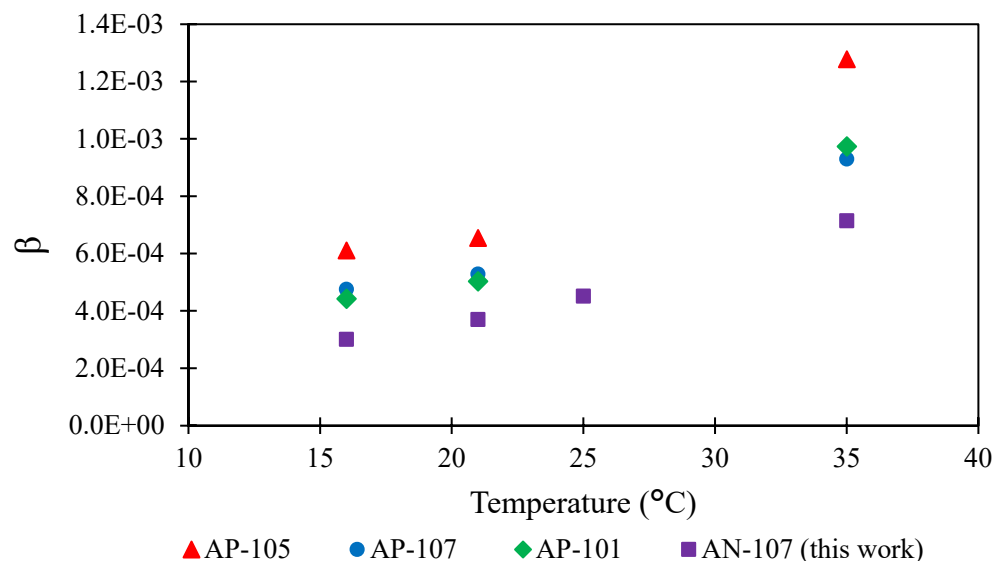


Figure 4.9. β values vs. Temperature for AP-107, AP-105, AP-101, and AN-107 Tank Waste

Figure 4.10 compares the previous batch contact results from AP-107, AP-101, AP-105, and AN-107 Q loading vs. temperature. Q is related to the initial Cs concentration, and while the trend across temperatures is the same for all wastes analyzed, AP-105 from FY20 and AP-101 had notably the lowest Cs loading (Q) possibly due to specific matrix effects reducing the specificity for Cs exchange at the feed condition. The Cs loading for AN-107 was notably higher than the other wastes and is likely attributed to the significantly lower K concentration in the waste (0.025 M K vs 0.1 M K seen in previous tank waste samples). Included on the graph is the loading from the AN-107 column breakthrough, which show excellent agreement with the batch contact results.

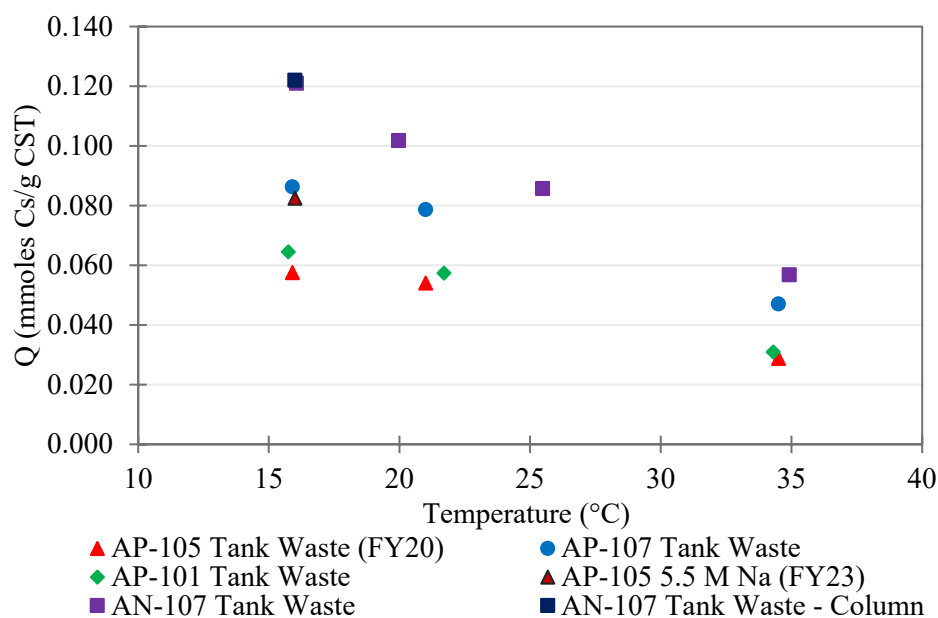


Figure 4.10. Q vs. Temperature for AP-107, AP-105, AP-101, and AP-106 Tank Waste at Corresponding Feed Conditions

4.2.3 Potassium Batch Contact Assessment

An assessment of the K concentration impact to the Cs loading was conducted with AN-107 to determine if the increased loading performance seen in the batch contact results were due to the lower K concentration in this waste compared to previous tank waste samples. Seven concentrations of K, nominally 0.05 M, 0.1 M, 0.2 M, 0.3 M, 0.5 M, 0.75 M and 1.0 M, were prepared and tested in a batch contact format at 25 °C to develop an isotherm for Cs in the presence of varying K concentrations.

Table 4.8 provides the results of batch contacts, showing the dry CST mass (relative to the F-factor determined at 105 °C), AN-107 volume, initial K and Cs concentrations, and Cs distribution loading onto CST (K_d , mL/g). The K concentration in each feed solution was measured by ICP-OES. The experimental data were fit to the Freundlich/Langmuir hybrid equilibrium model at a feed condition of 6.52E-05 M Cs with a total capacity value set to 0.68 mmols Cs/g CST. This information was used to generate the curve shown in Figure 4.11 (including the batch contact point for the AN-107 K concentration of 0.03 M K at 25 °C from Section 4.2.2). As can be seen from this data, there is a significant decrease in capacity for Cs with a small increase from 0.03 to 0.05 M K^+ . There is additional decrease in the loss of capacity as the potassium increases, but by the time the total potassium reaches 0.50 M, the decrease in going to 1 M potassium is significantly less. At a K concentration of 0.1 M, the K_d for AN-107 is 1035 mL/g and agrees within 5% of K_d values determined for AP-107 and AP-101 at 0.1 M K (1095 and 1081 mL/g, respectively). This shows that the performance deviation between AN-107 and the previously tested AP-101 and AP-107 is in direct relation to the differing K concentrations. A lower K concentration favors Cs exchange, so at 0.03 M K, AN-107 is expected to demonstrate a greater number of BVs processed before reaching the WAC limit compared to 0.1 M K seen in AP-101 and AP-107. The calculated parameters for this K batch contact testing are shown in Table 4.9. The effect of potassium concentration on the Cs K_d value is consistent with modeling documented in Hamm et. al., 2002.

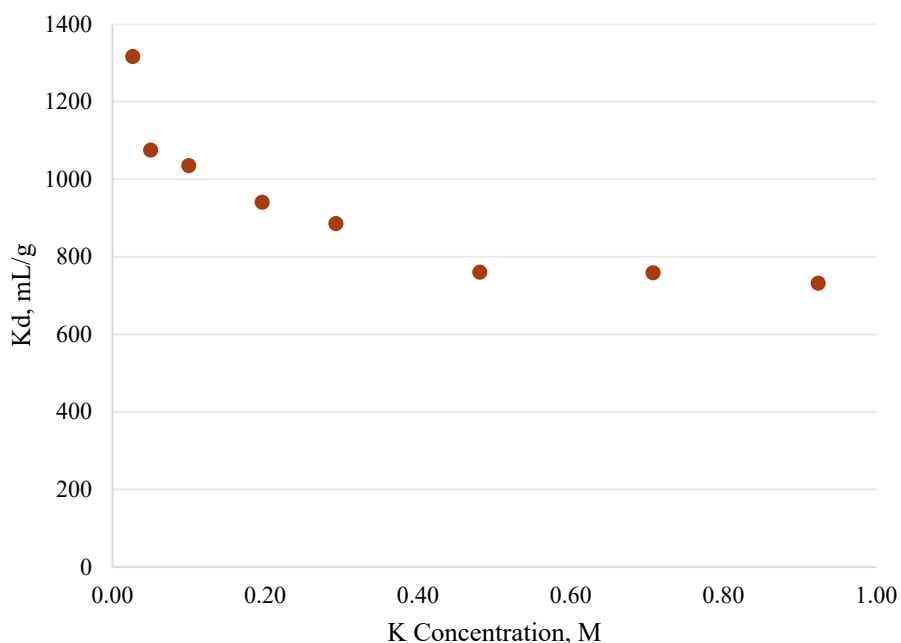


Figure 4.11. K_d values vs. K concentration for AN-107 Tank Waste

Table 4.8. K Batch Contact Results at 25 °C in AN-107

| Sample ID ^(a) | Dry CST Mass, g ^(b) | AN-107 Vol. ^(c) , mL | Initial K Conc., M | Initial Cs Conc., M | Average K _d , mL/g |
|--------------------------|--------------------------------|---------------------------------|--------------------|-----------------------|-------------------------------|
| CST-A-S1 | 0.0822 | 15.2521 | 0.05 | 1.32×10 ⁻⁴ | 1030 |
| CST-A-S1-d | 0.0826 | 15.1825 | | | |
| CST-A-S2 | 0.0767 | 15.2852 | | | |
| CST-A-S2-d | 0.0794 | 15.2006 | | | |
| CST-A-S3 | 0.0753 | 15.2867 | | | |
| CST-A-S3-d | 0.0799 | 15.1872 | | 7.60×10 ⁻⁴ | 1182 |
| CST-B-S1 | 0.0781 | 15.3673 | 0.11 | 1.33×10 ⁻⁴ | 1020 |
| CST-B-S1d | 0.0760 | 15.2341 | | | |
| CST-B-S2 | 0.0810 | 15.3859 | | | |
| CST-B-S2d | 0.0802 | 15.0704 | | | |
| CST-B-S3 | 0.0786 | 15.3325 | | | |
| CST-B-S3d | 0.0814 | 15.0053 | | 7.54×10 ⁻⁴ | 1064 |
| CST-C-S1 | 0.0782 | 15.3493 | 0.21 | 1.33×10 ⁻⁴ | 928 |
| CST-C-S1d | 0.0813 | 14.9823 | | | |
| CST-C-S2 | 0.0795 | 15.4297 | | | |
| CST-C-S2d | 0.0751 | 14.9956 | | | |
| CST-C-S3 | 0.0759 | 15.4414 | | | |
| CST-C-S3d | 0.0803 | 15.0008 | | 7.48×10 ⁻⁴ | 935 |
| CST-D-S1 | 0.0755 | 15.4838 | 0.32 | 1.33×10 ⁻⁴ | 903 |
| CST-D-S1d | 0.0799 | 15.2745 | | | |
| CST-D-S2 | 0.0793 | 15.5005 | | | |
| CST-D-S2d | 0.0743 | 15.3417 | | | |
| CST-D-S3 | 0.0793 | 15.4660 | | | |
| CST-D-S3d | 0.0772 | 15.1885 | | 7.65×10 ⁻⁴ | 857 |
| CST-E-S1 | 0.0770 | 15.4990 | 0.50 | 1.31×10 ⁻⁴ | 716 |
| CST-E-S1d | 0.0790 | 14.9799 | | | |
| CST-E-S2 | 0.0783 | 15.4960 | | | |
| CST-E-S2d | 0.0781 | 15.0955 | | | |
| CST-E-S3 | 0.0752 | 15.5623 | | | |
| CST-E-S3d | 0.0759 | 15.4394 | | 7.68×10 ⁻⁴ | 884 |
| CST-F-S1 | 0.0784 | 15.6775 | 0.78 | 1.32×10 ⁻⁴ | 779 |
| CST-F-S1d | 0.0783 | 15.3528 | | | |
| CST-F-S2 | 0.0791 | 15.7120 | | | |
| CST-F-S2d | 0.0788 | 15.2682 | | | |
| CST-F-S3 | 0.0784 | 15.5924 | | | |
| CST-F-S3d | 0.0780 | 15.3863 | | 7.69×10 ⁻⁴ | 651 |
| CST-G-S1 | 0.0772 | 15.6732 | 0.99 | 1.33×10 ⁻⁴ | 774 |
| CST-G-S1d | 0.0751 | 15.5591 | | | |
| CST-G-S2 | 0.0783 | 15.7851 | | | |
| CST-G-S2d | 0.0780 | 15.6907 | | | |
| CST-G-S3 | 0.0759 | 15.7176 | | | |
| CST-G-S3d | 0.0768 | 15.4997 | | 7.65×10 ⁻⁴ | 635 |

(a) The “-d” suffix designates a duplicate sample.

(b) F-factor at 105 °C = 0.933, 0.925 (average = 0.929)

(c) Volume was calculated from measured solution mass and density.

Table 4.9. Freundlich/Langmuir Hybrid Equilibrium β Parameter Summary for AN-107 Tank Waste with added K and Calculated Q and K_d

| Matrix | K Concentration, M | β , (Cs M) | K_d (mL/g) | Q (mmoles Cs/g CST) |
|--------------------------------------|--------------------|---------------------|-----------------|---------------------------|
| AN-107 Tank Waste with added K | 0.05 | 5.67E-04 | 1075.1 | 7.00E-02 |
| | 0.11 | 5.92E-04 | 1034.9 | 6.74E-02 |
| | 0.21 | 6.58E-04 | 940.7 | 6.12E-02 |
| | 0.32 | 7.03E-04 | 885.7 | 5.77E-02 |
| | 0.50 | 8.29E-04 | 760.2 | 4.95E-02 |
| | 0.78 | 8.31E-04 | 758.6 | 4.94E-02 |
| | 0.99 | 8.64E-04 | 731.9 | 4.76E-02 |

5.0 Conclusions

Cesium ion exchange column testing was conducted with CST Lot 2002009604 sieved to <30 mesh to assess Cs ion exchange performance with AN-107 tank waste at 16 °C. Column testing was conducted at a small scale in PNNL's Radiochemical Processing Laboratory (RPL) hot cells to accommodate the high radiological dose rate of the Hanford tank waste matrix. The results summary is provided below.

5.1 Column Testing

AN-107 tank waste was processed through two columns sequentially positioned in a lead-lag format; after processing 875 BVs, a polish column was placed in line. Each column was filled with 8.0 mL of CST ion exchanger. A total of 13.7 L of AN-107 tank waste, consisting of 5.5 M Na and 119 $\mu\text{Ci/mL}$ ^{137}Cs , was processed through the Cs ion exchange system at 1.94 BV/h and 16 °C. Effluent samples were collected periodically from each column during the load process and measured for ^{137}Cs to establish the Cs load curves. The flowrate was increased to 3.0 BV/h to process 12.0 BVs each of 0.1 M NaOH feed displacement solution and water rinse. The following conclusions were drawn from the results of this work:

1. Testing showed that at 16 °C, 1873 BVs of AN-107 tank waste, processed at 1.94 BV/h, was calculated to be treated before reaching 50% Cs breakthrough on the lead column. The WAC limit was reached on the lag column when 1097 BVs of AN-107 feed was processed. A polish column was installed and reached 0.03% breakthrough after processing ~800 BVs of feed.
2. The WTP LAW WAC limit for the AN-107 lag column was reached nearly 300 BVs later than respective lag column breakthrough with AP-101 and AP-107 at 16 °C (Westesen et al. 2022 and 2021b). Variations in feed matrices (namely K concentration) has shown to be responsible for the deviation in reaching the WAC limit.
3. The total Cs loading onto the lead column (12.92 mg Cs/g CST) was notably higher to that seen in previous AP-101 and AP-107 testing (7.31 and 7.08 mg Cs/g CST) at the same processing flowrate and temperature and is likely due to increased Cs loading capacity due to the notably lower K concentration.
4. Analyte fractionation on to the CST was determined on the AN-107 feed and effluent composite samples. All major metal and anion components partitioned exclusively to the effluent. There was nearly no removal of Sr by the CST due to the organic complexants in the AN-107 tank waste.

5.2 Batch Contact Testing

Cs isotherms were developed for AN-107 tank waste at 16 °C, 20 °C, 25 °C, and 35 °C with Cs concentrations of 1.5E-4 M, 3.8E-4 M, 7.6E-4 M, and 1.5E-2 M Cs. Batch contacts were conducted in duplicate with 0.075 g dry CST (lot 2002009604) per 15 mL of solution and agitated in a temperature-controlled box for ~240 hours. The isotherm data were fit to the Freundlich/Langmuir hybrid equilibrium model and the linear Freundlich model to calculate K_d and Q values at AN-107 feed condition of 6.51E-5 M. Results of AN-107 batch contact testing were compared to AP-107, AP-105, and AP-101 temperature studies. The following conclusions were made from this testing:

1. The Freundlich/Langmuir hybrid model accurately predicts the loading for all Cs concentrations chosen to bound the AN-107 feed condition. To further explore fidelity of the fit, the linear

Freundlich isotherm was also determined to predict loading with $R^2 > 0.99$ for the four Cs concentrations at all temperatures.

2. Conditions observed to challenge the current TSCR documented safety analysis (DSA) (upper limit of $Q = 0.10$ mmol Cs/g CST and $K_d = 1400$ mL/g) will occur at processing temperatures below 21.5 °C and recommend a volume limitation be set on the AN-107 processing to avoid exceeding the curie limitation on the lead column.
3. The β values for AN-107 were smaller than AP-107 and AP-101, meaning the matrix is more favorable for Cs uptake than the former two tanks. This is due to the 70% reduction in K concentration found in the AN-107 tank waste compared to AP-107 and AP-101.
4. The increased capacity performance for AN-107 compared to AP-101 and AP-107 was attributed to the lower K concentration. An evaluation of K batch contacts on Cs distribution evaluated the Cs uptake performance at 0.1 M K and found loading agreed within 5% of the AP-101 and AP-107 batch contact results at the same K concentration.

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Appendix A – Column Load Data

The AN-107 lead, lag, and polish column loading raw data are provided in Table A.1. The raw data include the processed bed volumes (BVs) and corresponding ^{137}Cs concentration in the collected sample, % C/C₀, and the Cs decontamination factor (DF).

Table A.1. Lead, Lag, and Polish Column Cs Breakthrough Results with AN-107

| Lead Column | | | | Lag Column | | | | Polish Column | | | |
|-------------|---|--------------------|---------|------------|---|--------------------|---------|---------------|---|--------------------|---------|
| BV | $\mu\text{Ci } ^{137}\text{Cs}/\text{mL}$ | % C/C ₀ | DF | BV | $\mu\text{Ci } ^{137}\text{Cs}/\text{mL}$ | % C/C ₀ | DF | BV | $\mu\text{Ci } ^{137}\text{Cs}/\text{mL}$ | % C/C ₀ | DF |
| 17 | 2.82E-2 | 2.36E-2 | 4.24E+3 | 44 | 1.54E-2 | 1.29E-2 | 7.76E+3 | 918 | 1.27E-02 | 1.07E-2 | 9.39E+3 |
| 44 | 3.29E-2 | 2.75E-2 | 3.63E+3 | 137 | 1.69E-2 | 1.41E-2 | 7.08E+3 | 966 | 2.04E-02 | 1.71E-2 | 5.86E+3 |
| 60 | 1.20E-2 | 1.00E-2 | 9.96E+3 | 185 | 9.08E-3 | 7.61E-3 | 1.31E+4 | 1011 | 1.01E-02 | 8.50E-3 | 1.18E+4 |
| 91 | 1.23E-2 | 1.03E-2 | 9.73E+3 | 232 | 8.87E-3 | 7.43E-3 | 1.35E+4 | 1058 | 1.06E-02 | 8.92E-3 | 1.12E+4 |
| 139 | 1.88E-2 | 1.58E-2 | 6.35E+3 | 327 | 9.25E-3 | 7.75E-3 | 1.29E+4 | 1108 | 9.55E-03 | 8.00E-3 | 1.25E+4 |
| 233 | 9.67E-2 | 8.10E-2 | 1.23E+3 | 373 | 1.01E-2 | 8.51E-3 | 1.18E+4 | 1152 | 1.04E-02 | 8.70E-3 | 1.15E+4 |
| 281 | 1.95E-1 | 1.64E-1 | 6.11E+2 | 468 | 1.53E-2 | 1.28E-2 | 7.80E+3 | 1199 | 8.84E-03 | 7.41E-3 | 1.35E+4 |
| 329 | 3.37E-1 | 2.82E-1 | 3.54E+2 | 512 | 1.17E-2 | 9.80E-3 | 1.02E+4 | 1244 | 9.02E-03 | 7.56E-3 | 1.32E+4 |
| 422 | 1.03E+0 | 8.60E-1 | 1.16E+2 | 559 | 1.27E-2 | 1.07E-2 | 9.37E+3 | 1288 | 8.83E-03 | 7.40E-3 | 1.35E+4 |
| 514 | 1.68E+0 | 1.41E+0 | 7.11E+1 | 653 | 1.76E-2 | 1.47E-2 | 6.79E+3 | 1331 | 9.09E-03 | 7.62E-3 | 1.31E+4 |
| 608 | 3.02E+0 | 2.53E+0 | 3.95E+1 | 695 | 2.07E-2 | 1.74E-2 | 5.75E+3 | 1376 | 9.14E-03 | 7.66E-3 | 1.30E+4 |
| 698 | 4.77E+0 | 4.00E+0 | 2.50E+1 | 745 | 2.82E-2 | 2.36E-2 | 4.23E+3 | 1470 | 8.48E-03 | 7.11E-3 | 1.41E+4 |
| 790 | 7.29E+0 | 6.11E+0 | 1.64E+1 | 786 | 3.48E-2 | 2.91E-2 | 3.43E+3 | 1517 | 1.31E-02 | 1.10E-2 | 9.11E+3 |
| 832 | 7.95E+0 | 4.00E+0 | 2.50E+1 | 828 | 4.25E-2 | 3.56E-2 | 2.81E+3 | 1611 | 1.83E-02 | 1.53E-2 | 6.53E+3 |
| 882 | 9.57E+0 | 8.02E+0 | 1.25E+1 | 879 | 5.89E-2 | 4.94E-2 | 2.03E+3 | 1657 | 2.30E-02 | 1.93E-2 | 5.18E+3 |
| 926 | 1.18E+1 | 9.90E+0 | 1.01E+1 | 921 | 7.30E-2 | 6.11E-2 | 1.64E+3 | 1711 | 3.29E-02 | 2.75E-2 | 3.63E+3 |
| 1019 | 1.44E+1 | 1.20E+1 | 8.31E+0 | 970 | 8.75E-2 | 7.33E-2 | 1.36E+3 | | | | |
| 1162 | 2.04E+1 | 1.71E+1 | 5.84E+0 | 1015 | 1.09E-1 | 9.10E-2 | 1.10E+3 | | | | |
| 1298 | 2.68E+1 | 2.25E+1 | 4.45E+0 | 1112 | 2.01E-1 | 1.69E-1 | 5.93E+2 | | | | |
| 1434 | 3.47E+1 | 2.91E+1 | 3.44E+0 | 1157 | 2.33E-1 | 1.95E-1 | 5.13E+2 | | | | |
| 1576 | 4.15E+1 | 3.48E+1 | 2.88E+0 | 1249 | 3.88E-1 | 3.25E-1 | 3.08E+2 | | | | |
| 1723 | 4.75E+1 | 3.98E+1 | 2.51E+0 | 1293 | 4.78E-1 | 4.00E-1 | 2.50E+2 | | | | |
| | | | | 1429 | 8.84E-1 | 7.41E-1 | 1.35E+2 | | | | |
| | | | | 1571 | 1.71E+0 | 1.43E+0 | 6.99E+1 | | | | |
| | | | | 1718 | 3.06E+0 | 2.56E+0 | 3.90E+1 | | | | |

BV = bed volume, 8 mL/BV

DF = decontamination factor

C₀ = 119.3 $\mu\text{Ci } ^{137}\text{Cs}/\text{mL}$ (reference date January 2024)

Appendix B – Analytical Reports

This appendix includes analytical reports provided by Pacific Northwest National Laboratory’s Analytical Support Operations (ASO) laboratory, 331 Analytical services and Southwest Research Institute. In addition to the analyte results, these reports define the procedures used for chemical separations and analysis, as well as quality control sample results, observations during analysis, and overall estimated uncertainties. The analyses are grouped according to analytical request or task order number. Cross-references of sample IDs to test description are provided in the body of the report (see Table 3.5 of the main report).

Appendix B Table of Contents

AN-107 Ion Exchange Feed and Effluent Analysis Samples

ASO Analytical Service Request (ASR) 1965

- ASR 1965 Rev. 0 B.1
- GEA B.3
- ICP-OES, Metals B.4
- ICP-MS, Ba, Nb, Pb, Sr, U B.10
- OH- B.16

331 Analytical request 2403003 and 2403005

- 331 Analytical Service Request B.18
- IC, Anions B.21
- TIC/TOC B.22

Southwest Research Institute Task Order 733437

- Task Order 733437 B.23
- DFTP-PSTF-002 B.26
- Alpha Spec Report B.32
- Tc-99 Report B.273

David L Jr Blanchard Digitally signed by David L Jr Blanchard
Date: 2024.02.16 15:25:20 -08'00'

Analytical Service Request (ASR)
(REQUEST PAGE ----- Information Specific to Individual Samples)

| ASO Staff Use Only | Provide Analytes of Interest and Required Detection limits - <input type="checkbox"/> Below <input type="checkbox"/> Attached | | | ASO Staff Use Only | |
|--------------------|--|---|---|--------------------|---------|
| RPL Number | Customer Sample ID | Sample Description (& Matrix, if it varies) | Analysis Requested | Test | Library |
| 24-0924 | TI155-Feed-Comp | AN-107 Tank waste | 1) GEA- All samples (Cs-137, Co-60, Am-241 and Eu-154 and any other observed gamma emitting isotopes) | | |
| 24-0925 | TI155-EFF-Comp | | 2) OH | | |
| | | | 3) Acid Digestion-128 Prep Lab | | |
| | | | 4) ICP/OES- Al, As, Ba, Ca, Cd, Cr, Fe, K, Na, Ni, P, Pb, S, Sr, Ti, U, Zn, Zr | | |
| | | | 5) ICP-MS – Ba, Nb, Pb, Sr, U-238 | | |
| 24-0926 | TI155-A-1-A | AN-107 Tank waste | 1) Acid Digestion-128 Prep Lab | | |
| 24-0927 | TI155-A-4-A | | 2) ICP/OES- Al, As, Ba, Ca, Cd, Cr, Fe, K, Na, Ni, P, Pb, S, Sr, Ti, U, Zn, Zr | | |
| 24-0928 | TI155-A-6-A | | 3) ICP-MS – Ba, Nb, Pb, Sr, U-238 | | |
| 24-0929 | TI155-A-8-A | | | | |
| 24-0930 | TI155-A-10-A | | | | |
| 24-0931 | TI155-A-12-A | | | | |
| 24-0932 | TI155-A-14-A | | | | |
| 24-0933 | TI155-A-16-A | | | | |
| 24-0934 | TI155-A-18-A | | | | |
| 24-0935 | TI155-A-20-A | | | | |
| 24-0936 | TI155-A-22-A | | | | |
| 24-0937 | TI155-B-1-A | | | | |
| 24-0938 | TI155-B-6-A | | | | |
| 24-0939 | TI155-B-15-A | | | | |
| 24-0940 | TI155-B-21-A | | | | |
| 24-0941 | TI155-B-25-A | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

Pacific Northwest National Laboratory
Richland, WA
Nuclear Chemistry and Engineering

Filename: 24-0924 WestesenAN107
2/19/2024

Client: A Westesen
ASR: 1965

Project: 82508
Charge code: NR1600

Analyst: Truc Trang-Le
Digitally signed by Truc Trang-Le
Date: 2024.02.20 08:38:48 -08'00'

Concur: Lawrence R Greenwood
Digitally signed by Lawrence R Greenwood
Date: 2024.02.20 08:45:28 -08'00'

Procedure: Activity #8693- Gamma Energy Analysis (GEA) and Low-Energy Photon Spectrometry (LEPS)
M & TE: Detectors G,T
Count date: February 16, 2024

| Measured Activity, $\mu\text{Ci/sample} \pm 1s$ | | | | |
|---|-----------------------|--------------|-----------------------|-------------|
| RPL ID: | 24-0924 | | 24-0925 | |
| Sample ID: | TI155-Feed-Comp | | TI155-Eff-Comp | |
| Reference Date | 2/16/2024 | | 2/16/2024 | |
| Isotope | $\mu\text{Ci/sample}$ | +/- | $\mu\text{Ci/sample}$ | +/- |
| Co-60 | 5.80E-03 | $\pm 3.6\%$ | 6.38E-03 | $\pm 2.0\%$ |
| Cs-137 | 2.24E+02 | $\pm 2.0\%$ | 2.84E-02 | $\pm 2.0\%$ |
| Eu-152 | 1.72E-03 | $\pm 38.5\%$ | 2.13E-03 | $\pm 3.5\%$ |
| Eu-154 | 4.65E-02 | $\pm 2.8\%$ | 6.23E-02 | $\pm 2.0\%$ |
| Eu-155 | <4.34E-02 | | 1.21E-02 | $\pm 6.5\%$ |
| Am241 | 2.67E-01 | $\pm 16.3\%$ | 5.62E-01 | $\pm 2.0\%$ |

Battelle PNNL/RPL/Inorganic Analysis ... ICP-OES Analysis Report
PO Box 999, Richland, Washington 99352

Project / WP#: 82508 / NR1600
ASR#: 1965
Client: A. Westesen
Total Samples: 2 (liquids)

| ASO Sample ID | Client Sample ID | Client Sample Description |
|---|------------------|---------------------------|
| 24-0924 | TI155-Feed-Comp | AN-107 Tank Waste |
| 24-0925 | TI155-EFF-Comp | |
| | | |
| | | |
| | | |
| | | |
| | | |
| Sample Preparation: Simple dilution of “as received” samples in 5% v/v HNO ₃ performed by C. Perez and J. Waller. | | |

| | | | | | |
|---|-------------------------------------|----------------------------|-----------------|------------------|-------|
| Procedure: <u>RPG-CMC-211, Rev. 4, “Determination of Elemental Composition by Inductively Coupled Argon Plasma Optical Emission Spectrometry (ICP-OES).”</u> | | | | | |
| Analyst: | C. Perez | Analysis Date: | 4/3/2024 | ICP File: | C0931 |
| See Chemical Measurement Center 98620 file: <u>ICP-325-405-3</u> (Calibration and Maintenance Records) | | | | | |
| M&TE: | <input checked="" type="checkbox"/> | PerkinElmer 5300DV ICP-OES | SN: 077N5122002 | | |
| | <input type="checkbox"/> | Sartorius ME414S Balance | SN: 21308482 | | |
| | <input checked="" type="checkbox"/> | Mettler AT400 Balance | SN: 1113162654 | | |
| | <input type="checkbox"/> | Sartorius R200D Balance | SN: 39080042 | | |
| | <input type="checkbox"/> | Mettler AT201 Balance | SN: 192720-92 | | |
| | <input checked="" type="checkbox"/> | Ohaus Pioneer PA224C | SN: B725287790 | | |
| | <input type="checkbox"/> | SAL Cell 2 Balance | SN: 8033311209 | | |

Christian Perez Digitally signed by Christian Perez
Date: 2024.04.26 09:32:14 -07'00'

| | |
|------------------------|--|
| Report Preparer | Date |
| Steven Baum | Digitally signed by Steven Baum Date: 2024.04.26 09:37:46 -07'00' |
| Review and Concurrence | Date |

Battelle PNNL/RPL/Inorganic Analysis ... ICP-OES Analysis Report

Two liquid samples were submitted under Analytical Service Request (ASR) 1965 and were analyzed by ICP-OES. The samples had an acid digestion performed by the Radiochemistry team.

All sample results are reported on a mass per mass basis ($\mu\text{g/g}$) for each detected analyte. The data have been adjusted for instrument dilutions.

Analytes of interest (AOI) were specified in the ASR and are listed in the highlighted section of the attached ICP-OES Data Report. The quality control (QC) results for the AOI have been evaluated and are presented below. The current AOI for this run (C0931) are: Aluminum, Arsenic, Barium, Calcium, Cadmium, Chromium, Iron, Potassium, Sodium, Nickel, Lead, Strontium, Uranium and Zinc.

Samples were prepared by radiochemistry team by first digesting in aqua regia to fully digest the organic material and taken to soft dryness. Following this, samples were converted to 2% HNO_3 and again taken to soft dryness.

Limited Data:

Bismuth and Selenium data is not usable due to a failed calibration of those two analytes.

Calibration of the ICP-OES was done following the manufacturer's recommended calibration procedure using multi-analyte custom standard solutions traceable to the National Institute of Standards and Technology (NIST). Midrange calibration verification standards (MCVA and MCVB) were used to verify acceptance of the two-point calibration curves obtained for each analyte and for continuing calibration verification.

The controlling documents were procedures RPG-CMC-211, Rev 4, *Determination of Elemental Composition by Inductively Coupled Argon Plasma Optical Emission Spectrometry (ICP-OES)*, and ASO-QAP-001, Rev. 11, *Analytical Support Operations (ASO) Quality Assurance Plan*. Instrument calibrations, QC checks and blanks (e.g., ICV/ICB, CCV/CCB, LLS, ICS), post-digestion spikes, duplicate, blank spike, and serial dilution were conducted during the analysis run.

Preparation Blank (PB):

A preparation blank was supplied with the samples by the radiochemistry team. All AOI were within the acceptance criteria of <EQL (estimated quantitation level), <50% regulatory decision level, or less than $\leq 5\%$ of the concentration in the sample.

Blank Spike (BS)/Laboratory Control Sample (LCS):

A 50:50 mixture of the MCVA and MCVB solutions was analyzed as the blank spike. Recovery values are listed for all analytes included in the BS that were measured at or above the EQL. All AOI meeting this requirement were within the acceptance criteria of 80% to 120%.

For 24-0925 BS-A @10x, all AOI included in spike-A were within the acceptance criteria, except for Sodium that failed bias high.

Battelle PNNL/RPL/Inorganic Analysis ... ICP-OES Analysis Report

For 24-0925 BS-B @10x, Arsenic passed within the acceptance criteria.

Duplicate/Replicate Relative Percent Difference (RPD):

A duplicate of sample 24-0925 Dup @10x was prepared and analyzed. RPD are listed for all analytes that were measured at or above the EQL. All AOI detected were within the acceptance criterion of $\leq 20\%$ for liquid samples, except for Aluminum which failed by a large margin. This may have been an issue caused by the acid digestion process on that analyte.

Matrix-Spike (MS) Sample:

A matrix spike sample was created during sample preparation beforehand by the radiochemistry team.

For 24-0925 MS-A @10x, Aluminum failed with a low recovery, and Sodium failed with high recovery. All other AOI passed and were in between 75-125% recovery. These failures may have been an issue caused by the acid digestion process.

For 24-0925 MS-B @10x, Arsenic passed within the acceptance criteria of 75-125% recovery.

Initial/Continuing Calibration Verification (ICV/CCV):

MCVA and MCVB solutions were analyzed immediately after calibration, after each group of not more than ten samples, and at the end of the analytical run. All AOI except for Sulfur were within the acceptance criteria of 90% to 110%.

Initial/Continuing Calibration Blank (ICB/CCB):

The ICB/CCB solution (5% v/v HNO₃) was analyzed immediately after the ICV solutions and after the CCV solutions (after each group of not more than ten samples and at the end of the analytical run). All AOI passed on the ICB/CCBs.

Low-Level Standard (LLS):

The LLS solution was analyzed immediately after the first CCB solution. All AOI were within the acceptance criteria of 70% to 130%.

Interference Check Standard (ICS/SST):

The ICS solution was analyzed immediately after the first LLS solution and immediately prior to analyzing the final CCV solutions. Recovery values are listed for all analytes included in the SST that were measured at or above the EQL. All AOI were within the acceptance criteria of 80% to 120%.

Serial Dilution (SD):

Battelle PNNL/RPL/Inorganic Analysis ... ICP-OES Analysis Report

Five-fold serial dilution was conducted on sample 24-0924 @125x. The percent difference (%D) for all AOI were within the acceptance criteria of $\leq 10\%$.

Post-Digestion Spike (PS-A) - Sample (A Component):

A post-digestion spike (A Component) was conducted on sample 24-0924 @25x. All AOI were within the acceptance criterion of 80% to 120%.

Post-Digestion Spike (PS-B) - Sample (B Component):

A post-digestion spike (B Component) was conducted on sample 24-0925 @25x. All AOI were within the acceptance criterion of 80% to 120%.

Other QC:

All other instrument-related QC tests for the AOI passed within their respective acceptance criteria.

Comments:

- 1) The "Final Results" have been corrected for all laboratory dilutions performed on the samples during processing and analysis, unless specifically noted.
- 2) Instrument detection limits (IDL) and estimated quantitation limits (EQL) shown are for acidified water and/or fusion flux matrices as applicable. Method detection limits (MDL) for individual samples can be estimated by multiplying the IDL by the "Process Factor" for that individual sample. The estimated quantitation limit (EQL) for each concentration value can be obtained by multiplying the EQL by the "Process Factor".
- 3) Routine precision and bias is typically $\pm 15\%$ or better for samples in dilute, acidified water (e.g. 5% v/v HNO₃ or less) at analyte concentrations > EQL up to the upper calibration level. This also presumes that the total dissolved solids concentration in the sample is less than 5000 $\mu\text{g/mL}$ (0.5 per cent by weight). Note that bracketed values listed in the data report are within the MDL and the EQL, and have potential uncertainties greater than 15%. Concentration values < MDL are listed as "-". Note, that calibration and QC standard samples are validated to a precision of $\pm 10\%$.
- 4) Analytes included in the spike MCVA component (for the AS/PS) are; Ag, Al, As, B, Ba, Be, Bi, Ca, Cd, Co, Cr, Cu, Eu, Fe, K, Li, Mg, Mn, Mo, Na, Ni, P, Pb, Sb, Se, Si, Sm, Sn, Sr, Ta, Ti, Tl, V, W, Y, Zn, and Zr. Analytes included in the spike MCVB component are; Ce, Dy, Eu, La, Nd, Pd, Rh, Ru, S, Te, Th, and U.

Battelle PNNL/RPG/Inorganic Analysis ... ICPOES Data Report

Page 1 of 2

| | | Run Date > | 4/3/2024 | 4/3/2024 | 4/3/2024 | 4/3/2024 | 4/3/2024 | 4/3/2024 | 4/3/2024 | 4/3/2024 | 4/3/2024 | 4/3/2024 | 4/3/2024 |
|-------------------------|-------------------------|------------------|----------------|-------------|-----------------|-----------------|-----------------|----------------|----------------|----------------|------------------|------------------|-------------------|
| | | Process Factor > | 1.0 | 1.0 | 158.8 | 397.1 | 1914.1 | 159.1 | 406.0 | 2010.2 | 155.1 | 396.1 | 1938.0 |
| | | | 24-0925 PB @1x | 405 Diluent | 24-0924 @10x | 24-0924 @25x | 24-0924 @125x | 24-0925 @10x | 24-0925 @25x | 24-0925 @125x | 24-0925 Dup @10x | 24-0925 Dup @25x | 24-0925 Dup @125x |
| Instr. Det. Limit (IDL) | Est. Quant. Limit (EQL) | Client ID > | | | Ti155-Feed-Comp | Ti155-Feed-Comp | Ti155-Feed-Comp | Ti155-EFF-Comp | Ti155-EFF-Comp | Ti155-EFF-Comp | Ti155-EFF-Comp | Ti155-EFF-Comp | Ti155-EFF-Comp |
| µg/g | µg/g | (Analyte) | µg/g | µg/g | µg/g | µg/g | µg/g | µg/g | µg/g | µg/g | µg/g | µg/g | µg/g |
| 0.0101 | 0.101 | Al | 0.530 | -- | 1,100 | 1,100 | 1,080 | 2,160 | 2,160 | 2,200 | 1,320 | 1,350 | 1,340 |
| 0.0619 | 0.619 | As | [0.091] | -- | -- | [47] | [130] | -- | -- | [220] | -- | [27.0] | -- |
| 0.0001 | 0.001 | Ba | 0.0019 | -- | 1.88 | 1.87 | [1.8] | 2.63 | 2.71 | 2.80 | 2.68 | 2.71 | 2.32 |
| 0.0056 | 0.056 | Ca | 0.0999 | -- | 279 | 273 | 241 | 272 | 277 | 240 | 273 | 273 | 234 |
| 0.0014 | 0.014 | Cd | [0.0030] | [0.0016] | 33.3 | 32.3 | 29.5 | 31.8 | 33.6 | 30.7 | 32.2 | 34.6 | 37.1 |
| 0.0020 | 0.020 | Cr | [0.0025] | -- | 50.9 | 50.9 | 51.6 | 65.7 | 67.7 | 70.7 | 65.8 | 67.4 | 70.7 |
| 0.0014 | 0.014 | Fe | 0.0586 | -- | 384 | 384 | 378 | 612 | 631 | 635 | 620 | 637 | 636 |
| 0.0312 | 0.312 | K | 0.652 | -- | 936 | 853 | 750 | 895 | 851 | 744 | 890 | 843 | 780 |
| 0.0073 | 0.073 | Na | 3.46 | -- | 98,100 | 102,000 | 102,000 | 98,900 | 99,400 | 102,000 | 96,600 | 102,000 | 104,000 |
| 0.0022 | 0.022 | Ni | [0.0027] | -- | 264 | 264 | 265 | 256 | 268 | 276 | 258 | 265 | 259 |
| 0.0269 | 0.269 | Pb | [0.045] | [0.029] | 129 | 133 | [180] | 143 | 153 | [200] | 145 | 143 | [180] |
| 0.0001 | 0.001 | Sr | [0.0009] | [0.0002] | 1.31 | 1.27 | [1.5] | 1.28 | 1.31 | [1.3] | 1.19 | 1.19 | [1.3] |
| 0.0410 | 0.410 | U | -- | -- | [22.0] | [21.0] | -- | [12.0] | [24.0] | -- | [12.0] | [30.0] | -- |
| 0.0027 | 0.027 | Zn | 0.0383 | -- | 12.3 | 18.3 | 68.0 | 14.5 | 22.3 | 69.8 | 14.2 | 23.6 | 71.6 |
| Other Analytes | | | | | | | | | | | | | |
| 0.0019 | 0.019 | Ag | -- | -- | [0.49] | -- | -- | [0.35] | -- | -- | [0.50] | [0.82] | -- |
| 0.0060 | 0.060 | B | 0.455 | [0.018] | 72.0 | 75.3 | [100] | 46.2 | 50.3 | [68.0] | 41.5 | 44.6 | [56.0] |
| 0.0001 | 0.001 | Be | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 0.0245 | 0.245 | Bi | -- | -- | [6.0] | [12] | -- | [4.8] | [17.0] | -- | [4.5] | [13.0] | -- |
| 0.0103 | 0.103 | Ce | -- | -- | [11.0] | [13.0] | -- | [14] | [13] | -- | [15.0] | [15] | -- |
| 0.0043 | 0.043 | Co | -- | -- | [1.8] | [2.9] | -- | [2.2] | [1.8] | -- | [2.9] | [3.3] | -- |
| 0.0023 | 0.023 | Cu | [0.0032] | -- | 17.9 | 17.6 | [16.0] | 17.4 | 17.9 | [17.0] | 17.3 | 17.6 | [16.0] |
| 0.0023 | 0.023 | Dy | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 0.0006 | 0.006 | Eu | -- | -- | [0.66] | [0.48] | -- | [0.32] | [0.68] | -- | [0.34] | [0.46] | -- |
| 0.0019 | 0.019 | La | -- | -- | 9.30 | 9.31 | [9.9] | 10.8 | 11.3 | [12.0] | 11.0 | 11.0 | [11.0] |
| 0.0007 | 0.007 | Li | [0.0031] | -- | [0.74] | [0.39] | -- | [0.38] | [0.86] | -- | [0.40] | [0.60] | -- |
| 0.0018 | 0.018 | Mg | 0.0185 | -- | 3.26 | [2.6] | [3.6] | [2.4] | [3.9] | -- | [2.3] | [3.1] | -- |
| 0.0002 | 0.002 | Mn | [0.0006] | -- | 82.2 | 82.1 | 80.7 | 126 | 130 | 130 | 125 | 128 | 128 |
| 0.0044 | 0.044 | Mo | -- | -- | 18.2 | [17] | [20.0] | 16.2 | 19.5 | [15.0] | 16.6 | 19.1 | [19.0] |
| 0.0088 | 0.088 | Nd | -- | -- | 22.6 | [25] | [19] | 29.2 | [32.0] | [18.0] | 29.3 | [33] | [34.0] |
| 0.0905 | 0.905 | P | -- | -- | 324 | [310] | [220] | 308 | [300] | [370] | 309 | [330] | [320] |
| 0.0054 | 0.054 | Pd | -- | -- | [2.5] | [3.0] | -- | [1.1] | -- | -- | -- | -- | -- |
| 0.0211 | 0.211 | Rh | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 0.0063 | 0.063 | Ru | -- | -- | 15.3 | [14.0] | [18.0] | 14.3 | [17.0] | -- | 13.8 | [14.0] | [14.0] |
| 0.1262 | 1.262 | S | -- | -- | 1,450 | 1,430 | [1,500] | 1,390 | 1,410 | [1,900] | 1,390 | 1,500 | [1,400] |
| 0.0598 | 0.598 | Sb | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 0.1656 | 1.656 | Se | -- | [0.17] | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 0.0086 | 0.086 | Si | [0.066] | [0.010] | 42.1 | 40.3 | [72] | 23.6 | [32.0] | [35.0] | 30.5 | 37.1 | [35.0] |
| 0.0291 | 0.291 | Sn | -- | -- | [11.0] | -- | [56] | -- | -- | -- | -- | -- | -- |
| 0.0246 | 0.246 | Ta | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 0.0197 | 0.197 | Te | [0.030] | -- | [5.5] | -- | -- | [4.7] | -- | -- | -- | -- | -- |
| 0.0071 | 0.071 | Th | -- | [0.0084] | [9.0] | [10.0] | [19.0] | [7.4] | [11] | -- | [6.8] | [10.0] | [19.0] |
| 0.0006 | 0.006 | Ti | [0.0031] | -- | [0.39] | [0.29] | -- | 1.83 | [2.0] | [1.4] | 1.71 | [1.7] | [2.2] |
| 0.0814 | 0.814 | Tl | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 0.0013 | 0.013 | V | [0.0031] | -- | [0.68] | [0.63] | -- | [0.60] | [0.96] | -- | [0.53] | [1.1] | -- |
| 0.0161 | 0.161 | W | [0.055] | -- | 71.3 | 76.1 | [110] | 70.4 | 70.2 | [96] | 70.8 | 79.4 | [110] |
| 0.0006 | 0.006 | Y | -- | -- | 2.79 | 2.87 | [3.0] | 3.07 | 3.27 | [3.4] | 3.13 | 3.22 | [3.0] |
| 0.0014 | 0.014 | Zr | [0.0030] | -- | 11.4 | 11.2 | [12.0] | 12.2 | 12.3 | [13.0] | 12.3 | 12.7 | [15.0] |

1) "--" indicates the value is < MDL. The method detection limit (MDL) = IDL times the "multiplier"

near the top of each column. The estimated sample quantitation limit = EQL (in Column 2)

times the "multiplier". Overall error for values ≥ EQL is estimated to be within ±15%.

2) Values in brackets [] are ≥ MDL but < EQL, with errors likely to exceed 15%.

na = not applicable; KOH flux and Ni crucible or Na₂O₂ flux and Zr crucible for fusion preparations, or Si for HF assisted digests.

Battelle PNNL/RPG/Inorganic Analysis ... ICPOES Data Report

Page 2 of 2

QC Performance 4/3/2024

| Criteria > | ≤ 20% | 80%-120% | 80%-120% | 75%-125% | 80%-120% | 80%-120% | ≤ 10% |
|------------|------------------------|----------------------|------------------------------|-----------------------|---------------------------|---------------------------|--|
| QC ID > | 24-0925 @10x Dup | Instrument LCS/BS | BS-24-0925 @10x LCS/BS | 24-0925 @10x MS | 24-0924 @25x + PS-A | 24-0925 @25x + AS-B | 24-0924 @125x 5-fold Serial Dil |
| Analytes | RPD (%) | %Rec | %Rec | %Rec | %Rec | %Rec | %Diff |
| Al | 46.0 | 102 | 114 | 51 | 102 | | 1.1 |
| As | | 95 | 115 | 101 | 96 | | |
| Ba | 4.3 | 104 | 111 | 88 | 97 | | |
| Ca | 3.0 | 102 | 112 | 92 | 100 | | 8.6 |
| Cd | 3.9 | 99 | 111 | 97 | 101 | | 5.3 |
| Cr | 2.8 | 96 | 108 | 94 | 97 | | 5.1 |
| Fe | 3.7 | 99 | 111 | nr | 98 | | 2.2 |
| K | 2.0 | 99 | 109 | 99 | 100 | | 8.8 |
| Na | 0.2 | 98 | 130 | 144 | 103 | | 4.2 |
| Ni | 3.4 | 99 | 109 | 98 | 98 | | 3.9 |
| Pb | 3.9 | 96 | 109 | 92 | 96 | | |
| Sr | 4.5 | 100 | 114 | 89 | 101 | | |
| U | | 96 | 105 | 84 | | 96 | |
| Zn | 0.1 | 96 | 120 | 90 | 102 | | 285.8 |

Other Analytes

| | | | | | | | |
|----|------|-----|-----|-----|-----|----|-----|
| Ag | | 99 | 17 | 57 | 96 | | |
| B | 8.0 | 103 | | | 101 | | |
| Be | | 94 | 106 | 83 | 92 | | |
| Bi | | 138 | 167 | 123 | 141 | | |
| Ce | | 93 | 102 | 86 | | 93 | |
| Co | | 98 | | | 97 | | |
| Cu | 2.0 | 105 | 113 | 98 | 103 | | |
| Dy | | 92 | | | | 90 | |
| Eu | | 91 | | | | 90 | |
| La | 4.7 | 91 | 98 | 83 | | 90 | |
| Li | | 106 | 115 | 98 | 104 | | |
| Mg | | 100 | 111 | 88 | 98 | | |
| Mn | 1.5 | 105 | 115 | 88 | 102 | | 1.9 |
| Mo | 4.7 | 101 | | | 100 | | |
| Nd | 2.8 | 90 | 97 | 81 | | 89 | |
| P | 3.0 | 99 | | | 99 | | |
| Pd | | 88 | | | | 88 | |
| Rh | | 94 | | | | 92 | |
| Ru | 1.2 | 89 | | | | 91 | |
| S | 2.4 | 99 | | | | 99 | |
| Sb | | 92 | | | 94 | | |
| Se | | 119 | | | 124 | | |
| Si | 28.3 | 93 | | | 95 | | |
| Sn | | 91 | | | 91 | | |
| Ta | | 99 | | | 99 | | |
| Te | | 93 | | | | 94 | |
| Th | | 91 | 99 | 84 | | 89 | |
| Ti | 4.4 | 101 | | | 99 | | |
| Tl | | 94 | | | 93 | | |
| V | | 94 | 105 | 87 | 93 | | |
| W | 3.2 | 94 | | | 94 | | |
| Y | 4.2 | 95 | | | 93 | | |
| Zr | 3.6 | 102 | | | 101 | | |

Shaded results are outside the acceptance criteria.

nr = spike concentration less than 25% of sample concentration. Matrix effects can be assessed from the serial dilution.

na = not applicable; KOH flux and Ni crucible or Na₂O₂ flux and Zr crucible for fusion preparations, or Si for HF assisted digests.

Battelle PNNL/RPL/Inorganic Analysis ... ICP-MS Analysis Report
PO Box 999, Richland, Washington 99352

Project / WP#: 82508 / NR1600 **ASR#:** 1965
Client Name: A. Westesen **Total Samples:** 2 (liquids)
Client Sample Description: AN-107 Tank Waste

| ASO Sample ID | Client Sample ID |
|---------------|------------------|
| 24-0924 | TI155-Feed-Comp |
| 24-0925 | TI155-EFF-Comp |

Sample Preparation: Simple dilution of sample in 2% v/v HNO₃ was performed by J. Waller on 4/16/2024.

Procedure(s): Lab Assist Activity #4681 Version 1 "ICP-MS Operations"

RPG-CMC-292, Rev 1, *Determination of Elemental Composition by Inductively Coupled Argon Plasma Mass Spectrometry.*

Lab Assist Activity #6501, "Acid Extraction of Liquid Samples for Metals Analysis"

| | | | | | |
|--------------------|----------|-----------------------|-----------|------------------|-------|
| Analyst(s): | C. Perez | Analysis Date: | 4/16/2024 | ICP File: | M0339 |
|--------------------|----------|-----------------------|-----------|------------------|-------|

See Chemical Measurement Center 98620 file: ICP-MS-325-405-1
(Calibration and Maintenance Records)

| | | | |
|------------------|---|-----------------|------------|
| M&TE: | <input checked="" type="checkbox"/> PerkinElmer NexION™ 350X ICP-MS | SN: 85VN4070702 | RPL 405 |
| | <input checked="" type="checkbox"/> Ohaus PA224C Balance | SN: B725287790 | RPL 405 |
| | <input checked="" type="checkbox"/> Mettler AT400 Balance | SN: M19445 | RPL 405 FH |
| | <input type="checkbox"/> Mettler AT400 Balance | SN: 1113162654 | RPL 420 FH |
| | <input type="checkbox"/> Mettler AT400 Balance | SN: 1113292667 | RPL 420 FH |
| | <input type="checkbox"/> Sartorius R200D Balance | SN: 39080058 | RPL 525 FH |

Christian Perez Digitally signed by Christian Perez
Date: 2024.06.12 10:43:52 -07'00'

Report Preparer Date

David L Jr Blanchard Digitally signed by David L Jr Blanchard
Date: 2024.06.13 09:12:33 -07'00'

Review and Concurrence Date

Battelle PNNL/RPL/Inorganic Analysis ... ICP-MS Analysis Report

Two liquid samples were submitted under Analytical Service Request (ASR) 1965 and were analyzed by ICP-MS. The sample went through an acid digestion process and was then diluted prior to analysis.

Results are reported as ng/g for each detected analyte. The data has been adjusted for instrument dilutions and initial sample dissolution. Initial instrument data is read in ppb (parts per billion).

The concentrations shown assume a natural abundance of the isotopes, and that is not the case for many of those reported. To correct for the concentration of a particular isotope the reported value should be multiplied by the natural abundance of that isotope, as a fraction. For example, the natural abundance of Sr-88 is 82.58% (per the KAPL Chart of the Nuclides, 2009), so to get the concentration of Sr-88 in the samples the reported values for Sr-88 should be multiplied by 0.8258. Contact the ASO lead with any questions about this.

Calibration of the ICP-MS was done following the manufacturer's recommended calibration procedure using multi-analyte (natural abundance) custom standard solutions traceable to the National Institute of Standards and Technology (NIST). Midrange calibration verification standards were used to verify acceptance of the six-point calibration curves and for initial and continuing calibration verification (ICV/CCV). The calibration range for the instrument is 0.2 – 10 ppb. One high check was ran at a 100 ppb target and all came back within +/- 10% recovery except for Uranium which came back saturated and is assumed to be over 100 ppb. Uranium values were above the calibration range for the Blank spike and the Matrix Spike at multiple dilution levels. Lead values were above the calibration range on the Matrix Spike only at multiple dilution levels. Both Samples had Barium-137 levels that were higher than the calibration range.

The controlling document was procedure RPG-CMC-292, Rev 1, *Determination of Elemental Composition by Inductively Coupled Argon Plasma Mass Spectrometry (ICP-MS)*. Instrument calibrations, QC checks and blanks (e.g., ICV/ICB, CCV/CCB, LLS, ICS), post-digestion spikes, duplicates, and serial dilutions were conducted during the analysis run.

Internal Standard (IS):

All solutions (blanks, standards, QC checks, and samples) were mixed in-line with a solution containing 10 ppb each of Tb-159 and Bi-209 as the internal standard (IS). The AOI data were normalized to the Tb-159 IS and were within the acceptance criterion of 30% to 120% recovery.

Preparation Blank (PB):

A preparation (process) blank was analyzed at a 30x dilution to match the dilution of the sample. All AOIs in the prep blank were either less than EQL or less than 5% of the sample concentration.

Blank Spike (BS)/Laboratory Control Sample (LCS):

The blank spike at 4500x and 900x were analyzed and all AOI passed. Uranium – 238 passed but the raw data was above our calibration limit. Strontium-87 failed low on the blank spike at all dilution levels with % recoveries of 24.4 and 21.4%.

Duplicate/Replicate Relative Percent Difference (RPD)/Relative Standard Deviation (RSD):

A sample replicate of 24-0925 at 30x and 900x were analyzed, and the results were

Battelle PNNL/RPL/Inorganic Analysis ... ICP-MS Analysis Report

within the acceptance criterion of $\leq 20\%$ RPD for liquid samples.

Matrix-Spike (MS) Sample:

We are reporting all Matrix spike results from the 900x except for Uranium-238 due to it being above the calibration limit. Uranium-238 is reported from the 4500x dilution. All AOI are within the acceptance range.

Initial/Continuing Calibration Verification (ICV/CCV):

The ICV/CCV solutions (71A) were analyzed immediately after calibration, after each group of not more than ten samples, and at the end of the analytical run. The concentrations of all AOI that bracket the reported results were within the acceptance criteria of 90% to 110% recovery.

Initial/Continuing Calibration Blank (ICB/CCB):

The ICB/CCB solutions (2% v/v HNO₃) were analyzed immediately after each respective ICV solution and after each respective CCV solution (after each group of not more than ten samples and at the end of the analytical run). The concentration of all AOI were within the acceptance criteria of less than EQL.

Post-Digestion Spike (PS)/Analytical Spike (AS) - Sample (P1 Component):

Post-digestion spikes 71A and 71B were conducted on sample 24-0924 at 900x PSA / PSB. All AOIs were observed within the recovery limits.

Low-Level Standard (LLS):

The LLS solutions of 71A and 71B were analyzed immediately after the first CCB solution. The concentrations of all AOI were within the acceptance criteria of 75% to 125%.

Interference Check Standard (ICS):

The ICS solutions 71A and 71B were analyzed immediately after the first LLS solution and immediately prior to analyzing the final CCV solutions. The concentrations of all AOI were within the acceptance criteria of 80% to 120% recovery.

Serial Dilution (SD):

A five-fold serial dilution was conducted on both samples. Percent differences (%D) are listed for all analytes that had a concentration at or above 10X the EQL in the diluted sample. The %Ds for the AOI meeting this requirement were within the acceptance criterion of $\leq 10\%$.

Battelle PNNL/RPL/Inorganic Analysis ... ICP-MS Analysis Report

Other QC:

All other instrument-related QC tests for the AOI passed within their respective acceptance criteria.

Comments:

- 1) The "Final Results" have been corrected for all laboratory dilutions performed on the samples during processing and analysis, unless specifically noted.
- 2) Instrument detection limits (IDL) and estimated quantitation limits (EQL) shown are for acidified water and/or fusion flux matrices as applicable. Method detection limits (MDL) for individual samples can be estimated by multiplying the IDL by the "Process Factor" for that individual sample. The estimated quantitation limit (EQL) for each concentration value can be obtained by multiplying the EQL by the "Process Factor".
- 3) Routine precision and bias is typically $\pm 15\%$ or better for samples in dilute, acidified water (e.g. 2% v/v HNO₃ or less) at analyte concentrations > EQL up to the upper calibration level. This also presumes that the total dissolved solids concentration in the sample is less than 5000 $\mu\text{g/mL}$ (0.5 per cent by weight). Note that bracketed values listed in the data report are within the MDL and the EQL, and have potential uncertainties greater than 15%. Concentration values < MDL are listed as "-". Note, that calibration and QC standard samples are validated to a precision of $\pm 10\%$.
- 4) Analytes included in the spike 71A component (for the AS/PS) are; Ag, Al, As, B, Ba, Be, Ca, Cd, Ce, Co, Cr, Cs, Cu, Dy, Er, Eu, Fe, Ga, Gd, Ho, K, La, Lu, Mg, Mn, Na, Nd, Ni, P, Pb, Pr, Rb, S, Se, Sm, Sr, Th, Tl, Tm, U, V, Yb, and Zn. Analytes included in the spike 71B component are; Ge, Hf, Mo, Nb, Sb, Si, Sn, Ta, Te, Ti, W, and Zr. Analytes included in the spike 71C component are; Ir, Os, Pd, Pt, Re, Rh, and Ru. Analytes included in the spike 71D component are; Bi, In, Li, Sc, Tb, and Y. Analyte included in the spike Hg component is Hg.
- 5) Isotopic abundances values were obtained from Nuclides and Isotopes: Chart of the Nuclides. 16th Edition, Revised 2002. Ed Baum, Harold Knox, Tom Miller
- 6) Analytes included in P1 solution are Ag, Cd, In, Mo, Nb, Pd, Rh, Ru, Sn, Zr.

ASR-1965 Westesen
Samples 24-0924 & 24-0925 Set 71A

| | | Run Date > | 04/16/24 | 04/16/24 | 04/16/24 | 04/16/24 | 04/16/24 | 04/16/24 | 04/16/24 | 04/16/24 | 04/16/24 |
|-------------------------|-------------------------|----------------|-------------------|-----------------|-----------------|-----------------|-----------------|----------------|----------------|----------------|-----------------|
| | | Process Factor | 1.00 | 474 | 2145 | 14423 | 72155 | 475 | 2368 | 14331 | 71675 |
| Units: ng/g | | RPL/LAB > | Blank Avg. | 24-0924 (30x) | 24-0924 (150x) | 24-0924 (900x) | 24-0924 (4500x) | 24-0925 (30x) | 24-0925 (150x) | 24-0925 (900x) | 24-0925 (4500x) |
| Instr. Det. Limit (IDL) | Est. Quant. Limit (EQL) | Client ID > | 2% HNO3 Lab Blank | Tl155-Feed-Comp | Tl155-Feed-Comp | Tl155-Feed-Comp | Tl155-Feed-Comp | Tl155-EFF-Comp | Tl155-EFF-Comp | Tl155-EFF-Comp | Tl155-EFF-Comp |
| 0.002 | 0.025 | Sr 87 | 0.001 | 10438.40 | 10478.21 | | | 9388.11 | 9782.73 | | |
| 0.003 | 0.027 | Sr 88 | 0.000 | 977.20 | 1062.9 | | | 1008.0 | 1189.8 | | |
| 0.005 | 0.045 | Ba 137 | 0.003 | 15598.5 | 15490.8 | | | 11003.7 | 11898.5 | | |
| 0.002 | 0.016 | Ba 138 | 0.001 | 1259.3 | 1401.6 | | | 1887.9 | 2228.7 | | |
| 0.004 | 0.040 | Pb 206 | 0.001 | | | 120842.1 | 123613.7 | | | 137972.9 | 140557.0 |
| 0.005 | 0.052 | Pb 207 | 0.001 | | | 123387.9 | 124687.0 | | | 138151.0 | 144259.0 |
| 0.002 | 0.018 | Pb 208 | 0.001 | | | 122504.5 | 122306.8 | | | 136857.0 | 138837.6 |
| 0.002 | 0.020 | U 238 | 0.001 | 10842.9 | 10419.0 | | | 9182.3 | 9613.2 | | |

Internal Standard % Recovery

| Tb 159 (IS) | 102% | 109% | 108% | 103% | 103% | 104% | 105% | 104% | 102% |
|-------------|------|------|------|------|------|------|------|------|------|
|-------------|------|------|------|------|------|------|------|------|------|

1) "-" indicates the value is < MDL. The method detection limit (MDL) = IDL times the "multiplier" near the top of each column. The estimated sample quantitation limit = EQL times the "multiplier". Overall error for values ≥ EQL is estimated to be within ±15%.
IS = Internal Standard. The concentration of certain elements cannot be determined due to the presence of the IS in all solutions.

QC Performance 4/16/24

| Criteria > | ≤ 35% | 75%-125% | ≤ 10% | ≤ 10% | 75%-125% | 75%-125% | 75%-125% | 75%-125% |
|------------|------------------|-----------------------------------|--------------------------------|---------------------------------|-----------------|------------------|-----------------|------------------|
| QC ID > | 24-0925 Dup 900x | 24-0925 Post Spike ICPMS-71A 900x | 24-0924 5-fold Serial Dil 150x | 24-0924 5-fold Serial Dil 4500x | MS-24-0925 900x | MS-24-0925 4500x | BS-24-0925 900x | BS-24-0925 4500x |
| Analytes | RPD (%) | %Rec | %Diff | %Diff | %Rec | %Rec | %Rec | %Rec |
| Sr 87 | 2.8% | 104% | 2% | 1% | 114% | 124% | 21% | 24% |
| Sr 88 | 1.4% | 100% | 4% | 23% | 96% | 126% | 99% | 127% |
| Ba 137 | 0.7% | 102% | 2% | 5% | 102% | 105% | 105% | 109% |
| Ba 138 | 0.8% | 99% | 5% | 25% | 91% | 95% | 104% | 107% |
| Pb 206 | 1.6% | 112% | N/A | 0.4% | 122% | 126% | 105% | 109% |
| Pb 207 | 2.4% | 116% | N/A | 0.2% | 119% | 122% | 100% | 101% |
| Pb 208 | 0.6% | 118% | N/A | 0.04% | 117% | 121% | 101% | 101% |
| U 238 | 1.4% | 105% | 1% | 0.3% | N/A | 89% | N/A | 102% |

Internal Standard % Recovery

| Tb 159 (IS) | 102% | 103% | 108% | 103% | 107% | 100% | 102% | 104% |
|-------------|------|------|------|------|------|------|------|------|
|-------------|------|------|------|------|------|------|------|------|

nr = spike concentration less than 25% of sample concentration. Matrix effects can be assessed from the serial dilution.
na = not applicable; KOH flux and Ni crucible or Na2O2 flux and Zr crucible for fusion preparations, or Si for HF assisted digests
IS = Internal Standard. The concentration of certain elements cannot be determined due to the presence of the IS in all solutions.
NM = Not measured. The isotope was not measure due to method or molecular interference limitations.

ASR-1965 Westesen Samples 24-0924 & 24-0925 Set 71B

| | | | | | | |
|-------------------------|-------------------------|----------------|-------------------|-----------------|----------------|-------------------|
| Units = ng/g | | Run Date > | 04/16/24 | 04/16/24 | 04/16/24 | 04/16/24 |
| | | Process Factor | 1.00 | 477 | 477 | 469 |
| | | RPL/LAB > | Blank Avg. | 24-0924 (30x) | 24-0925 (30x) | 24-0925 (30x) Dup |
| | | Client ID > | 2% HNO3 Lab Blank | TI155-Feed-Comp | TI155-EFF-Comp | |
| Instr. Def. Limit (IDL) | Est. Quant. Limit (EQL) | Nb 93 | 0.000 | 1087.5 | 4007.4 | 3935.4 |

Internal Standard % Recovery

| | | | | |
|-------------|------|------|------|------|
| Tb 159 (IS) | 101% | 104% | 107% | 104% |
|-------------|------|------|------|------|

1) "-" indicates the value is < MDL. The method detection limit (MDL) = IDL times the "multiplier" near the top of each column. The estimated sample quantitation limit = EQL

times the "multiplier". Overall error for values \geq EQL is estimated to be within $\pm 15\%$.

IS = Internal Standard. The concentration of certain elements cannot be determined due to the presence of the IS in all solutions.

QC Performance 4/16/24

| | | | | | |
|------------|-----------------|----------------------------------|--------------------------------|------------------|------------------|
| Criteria > | $\leq 35\%$ | 75%-125% | $\leq 10\%$ | 75%-125% | 75%-125% |
| QC ID > | 24-0925 Dup 30x | 24-0924 Post Spike ICPMS 71B 30x | 24-0924 5-fold Serial Dil 150x | MS-24-0925 4500x | BS-24-0925 4500x |
| Analytes | RPD (%) | %Rec | %Diff | %Rec | %Rec |
| Nb 93 | 0.1% | 100.4% | 0.4% | 98.0% | 99.0% |

Internal Standard % Recovery

| | | | |
|-------------|-----|------|------|
| Tb 159 (IS) | 97% | 105% | 105% |
|-------------|-----|------|------|

nr = spike concentration less than 25% of sample concentration. Matrix effects can be assessed from the serial dilution.

na = not applicable; KOH flux and Ni crucible or Na2O2 flux and Zr crucible for fusion preparations, or Si for HF assisted digests

IS = Internal Standard. The concentration of certain elements cannot be determined due to the presence of the IS in all solutions.

NM = Not measured. The isotope was not measure due to method or molecular interference limitations.

**Pacific Northwest National Laboratory
Analytical Support Operations
Chemical Measurements Center**

**ASR: 1965
Client: A. Westesen
Report Date: June 12, 2024
Analysis Date: April 2 -3, 2024**

Hydroxide Analysis of Tank Waste Samples

Sample preparation and analysis

Hydroxide analysis was performed for aliquots of 2 aqueous samples (24-0924 and 24-0925). Samples were analyzed by manual titration for the hydroxide content following the lab assist activities 7897, "Measurement of pH in Aqueous Solutions", and 7898, "Determination of Hydroxyl and Alkalinity of Aqueous Solutions, Leachates, and Supernates."

The titration was performed with standardized 0.0552 ± 0.004 M HCl prepared 4/2/2024 and the spike used for the blank and matrix spike samples was standardized 0.04598 ± 0.00007 M NaOH. The pH was measured using a Thermo Scientific Orion Triode 3-in-1 pH/ATC Probe. The pH was calibrated using buffers pH 4, 7, and 10 with verification using an independent pH 7 buffer.

The samples analyzed were diluted with DI H₂O to a point where it was possible to immerse the probe in the solution (~2-3 mL) and a burette was used to add known quantities of the standardized 0.0552 M HCl solution while monitoring the pH. Each sample was titrated to at least the equivalence point of 7 to determine the hydroxide concentration. The samples analyzed included:

- 0.25 mL aliquot of 24-0924
- three 0.25 mL aliquots of 24-0925
- a matrix spike composed of 0.25 mL aliquot of 24-0925 spiked with 0.25 mL 0.04598 NaOH
- a blank spike composed of 0.1 mL 0.04598 M NaOH
- a process blank composed of DI H₂O

Sample Results

The HCl volume and corresponding pH were used to determine the inflection point for each sample indicating the equivalence point for the hydroxide neutralization.

| ASO Sample ID | Client Sample ID | Hydroxide Concentration (M) | Average Hydroxide Concentration (M) | pH at Inflection Point |
|--------------------|------------------|-----------------------------|-------------------------------------|------------------------|
| 24-0924 | TI155-Feed-Comp | 1.28 | | 8.17 |
| 24-0925 | TI155-EFF-Comp | 1.31 | $1.29 \pm 4.05\%$ | 8.08 |
| 24-0925 duplicate | | 1.33 | | 8.00 |
| 24-0925 triplicate | | 1.23 | | 8.74 |

Quality Control Results

Quality control samples included a matrix spike (sample with NaOH spike), a blank spike (NaOH spike), and a process blank (DI H₂O). The theoretical concentration of hydroxide in the spikes was compared to the measured concentration and the yield is provided below.

| ASO Sample ID | Yield (%) | Acceptance criteria for Yield (%) |
|----------------------|-----------|-----------------------------------|
| 24-0925 matrix spike | 77.0 | 75-125% |
| Blank spike | 80.5 | 80-120% |
| Process Blank | N/A | N/A |

Instrument Calibration Control

The pH meter was calibrated using 3 buffers, pH 4, 7 and 10 and the calibration verified using an independent pH 7 buffer.

Prepared by:

Leah M
Arrigo

Digitally signed by Leah M Arrigo
Date: 2024.06.13 09:58:05 -07'00'

Reviewed by:

Christian
Perez

Digitally signed by Christian Perez
Date: 2024.06.13 11:08:51 -07'00'

Pacific Northwest National Laboratory

submit to: esl.lab@pnnl.gov

Subsurface Science & Technology Group

SAMPLE ANALYSIS REQUEST - SERVICE CENTER

Customer: This form must be completed upon delivery of samples.

FY24 rates

Samples Relinquished By:

AM Westesen

Date Sample(s) Relinquished:

[MM/DD/YY]

Date Analysis Results Requested:

[10/27/23]

Client Sample Identification Number(s):

See "Names" tab

Client/Company:

PNNL

MSIN:

xx-xx

Phone:

(509) 371 7223

Fax:

(509) xxx-xxxx

Project Title/Number:

High Level Waste Test Bed (AN-107)/ 82508

WP Number:

NR1600

QC Requirements:

ESL

QA Program

ESL

QA Data Review: Enter 'Yes' or 'No':

Yes

LDRD Project: Enter 'Yes' or 'No':

No

Storage Requirements :

☒ NONE☐ Refrigerate☐ Other (specify):

Hazardous Waste Disposal Issues:

☐ NONE

or Listed Waste Code (circle):

F

K

P

U

WA State Code?

[TEXT HERE]

Type of Liquid Sample: (choose one)

☐ ACIDIFIED☐ FUSION☐ WATER☒ WASTE☐ Other:

[TEXT HERE]

Analyze within hold times?

☒ NO☐ YES**NOTE: Advance notice is required for analytes with <7 day hold times**

Have the Samples been filtered?

☒ NO☐ YES

If yes, list filter size (0.45 µm, etc):

RADIOACTIVE SAMPLES? If submitting radioactive samples, list any known isotopes, activities, or dose rates associated with the sample:

Yes- AN-107 tank waste.

Radioactive Material Tracking (RMT) Number:

[TEXT HERE]

ORDER DETAILS:

| ASO Service Center (331 Building) | # of Non-Rad Samples Submitted† | # of Rad Samples Submitted† | Base Rate (per sample) | Batch Setup Fee* | Unburdened Cost | Burdened Cost |
|--|---------------------------------|-----------------------------|------------------------|------------------|-----------------|---------------|
| Analysis | | | | | | |
| ICP-MS RCRA ³ | | | \$98 | | | |
| ICP-MS Tc/U/Th | | | \$98 | | | |
| ICP-MS Lanthanides ⁴ | | | \$98 | | | |
| ICP-MS Actinides ⁵ | | | \$98 | | | |
| ICP-MS I-127 (total) | | | \$98 | | | |
| ICP-MS I-129 (total) | | | \$98 | | | |
| ICP-MS I-/IO3- 127 Speciation ¹ | | | \$141 | | | |
| ICP-MS I-/IO3- 129 Speciation ¹ | | | \$141 | | | |
| ICP-MS Cr(III/IV) Speciation ¹ | | | \$141 | | | |
| ICP-OES Standard List ⁶ | | | \$98 | | | |
| ICP-OES/MS Other Analytes | | | \$98 | | | |
| IC Standard Anions List ⁷ | | 2 | \$98 | \$88 | \$284 | \$389 |
| Sample Prep ² | | | \$343 | | | |

¹Per QA plan, speciation analysis requires that a total analysis also be performed in order to validate speciation recovery.²Sample Prep may involve Acid Digestion or Flux Fusion techniques.[†]Environmentally Controlled Material (ECM) and Volumetrically Released Radioactive Material (VRRM) samples are considered Rad.

*Setup fee (\$88 + burdening) is charged for each multiple of 20 samples.

GRAND TOTAL ESTIMATE:

\$389

Analysis Type:

☐ Quantitative Analysis☐ Semi-Quantitative Analysis

[TEXT HERE]

Other requirement or information (pH, EC)?

☐ NONE

or

[TEXT HERE]

Additional Information / Notes:

See "Names" tab

³ICP-MS RCRA includes: Ag, As, Ba, Cd, Cr, Cs, Cu, Hg, Mo, Pb, Re, Ru, Sb, & Se⁴ICP-MS Lanthanides includes: Ce, Dy, Er, Eu, Gd, Ho, La, Lu, Nd, Pr, Sc, Sm, Tb, Tm, Y, & Yb⁵ICP-MS Actinides includes: Am, Np, Pu, Th, & U⁶ICP-OES Standard List includes: Ag, Al, As, B, Ba, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, Gd, K, Li, Mg, Mn, Mo, Na, Ni, P, Pb, Re, S, Sb, Se, Si, Sn, Sr, Ti, Tl, V, Zn, & Zr⁷IC Standard Anions List includes: Bromide (Br-), Chloride (Cl-), Fluoride (F-), Nitrate (NO3-), Nitrite (NO2-), Phosphate (PO4-), & Sulfate (SO4-)

| Sample ID's | Analysis |
|-----------------|---------------|
| TI155-Feed-Comp | IC and Carbon |
| TI155-Eff-Comp | IC and Carbon |

Pacific Northwest National Laboratory

submit to: esl.lab@pnnl.gov

Subsurface Science & Technology Group

SAMPLE ANALYSIS REQUEST - NON-SERVICE CENTER

Customer: This form must be completed upon delivery of samples. Provide a separate listing of sample IDs.

FY24 rates

Samples Relinquished By:

AM Westesen

Date Sample(s) Relinquished:

[MM/DD/YY]

Date Analysis Results Requested:

[10/27/23]

Client Sample Identification Number:

See "Names" tab

Client/Company:

PNNL

MSIN:

xx-xx

Phone:

(509) 371 7223

Fax:

(509) xxx-xxxx

Project Title/Number:

High Level Waste Test Bed (AN-107)/ 82508

WP Number:

NR1600

QC Requirements:

ESL

QA Program

ESL

LDRD Project: Enter 'Yes' or 'No':

no

Storage Requirements :

☐ NONE ☐ Refrigerate ☐ Other (specify):

Hazardous Waste Disposal Issues:

☐ NONE or Listed Waste Code (circle): ☒ F ☐ K ☐ P ☐ U WA State Code? [TEXT HERE]

Type of Liquid Sample: (chose one)

☐ ACIDIFIED ☐ FUSION ☐ WATER ☒ WASTE ☐ Other: [TEXT HERE]

Analyze within hold times?

☒ NO ☐ YES

NOTE: Advance notice is required for analytes with <7 day hold times

Have the Samples been filtered?

☒ NO ☐ YES

If yes, list filter size (0.45 µm, etc):

RADIOACTIVE SAMPLES? If submitting radioactive samples, list any known isotopes, activities, or dose rates associated with the sample:

Yes- AN-107 tank waste.

Radioactive Material Tracking (RMT) Number:

[TEXT HERE]

ORDER DETAILS:

| Analysis Requested | # of Non-Rad Samples Submitted† | # of Rad Samples Submitted† | Base Rate (per sample) | Sample Submission Fee* | | Total Estimated Cost: |
|--|---------------------------------|-----------------------------|------------------------|------------------------|------------------------------|-----------------------|
| Carbon, Total (liquid samples) | | 2 | \$200 | \$500 | | \$900 |
| Carbon, Organic (liquid samples) | | 2 | \$200 | \$500 | | \$900 |
| Carbon, Total (Solid samples) | | | \$200 | | | |
| Carbon, Inorganic (Solid samples) | | | \$200 | | | |
| †Environmentally Controlled Material (ECM) and Volumetrically Released Radioactive Material (VRRM) samples are disposed of as Rad Waste. | | | | | | |
| *Fee is based on number of samples for each analysis (1-5: \$500, 6-10: \$250, >10: \$0) | | | | | | |
| | | | | | GRAND TOTAL ESTIMATE: | \$1,800 |

Analysis Type:

☐ Quantitative Analysis ☐ Semi-Quantitative Analysis

[TEXT HERE]

Other requirement or information (pH, EC)?

☐ NONE or [TEXT HERE]

Additional Information / Notes:

See "Names" tab

SXDATA

| LabNumber | SampleName | Analyte | Result | Units | EQL | Analysis |
|--------------|-------------------|-----------|--------|-------|------|-----------------|
| 2403005-01 | : TI155-Feed-Comp | Bromide | ND | ug/mL | 8.60 | Anions by IC-NP |
| 2403005-01 | : TI155-Feed-Comp | Chloride | 1100 | ug/mL | 4.80 | Anions by IC-NP |
| 2403005-01 | : TI155-Feed-Comp | Fluoride | 130 | ug/mL | 4.60 | Anions by IC-NP |
| 2403005-01 | : TI155-Feed-Comp | Nitrate | 112000 | ug/mL | 1220 | Anions by IC-NP |
| 2403005-01 | : TI155-Feed-Comp | Nitrite | 44400 | ug/mL | 142 | Anions by IC-NP |
| 2403005-01 | : TI155-Feed-Comp | Phosphate | 1190 | ug/mL | 25.5 | Anions by IC-NP |
| 2403005-01 | : TI155-Feed-Comp | Sulfate | 5120 | ug/mL | 9.40 | Anions by IC-NP |
| 2403005-02 | : TI155-Eff-Comp | Bromide | ND | ug/mL | 8.60 | Anions by IC-NP |
| 2403005-02 | : TI155-Eff-Comp | Chloride | 1100 | ug/mL | 4.80 | Anions by IC-NP |
| 2403005-02 | : TI155-Eff-Comp | Fluoride | 144 | ug/mL | 4.60 | Anions by IC-NP |
| 2403005-02 | : TI155-Eff-Comp | Nitrate | 112000 | ug/mL | 1220 | Anions by IC-NP |
| 2403005-02 | : TI155-Eff-Comp | Nitrite | 44700 | ug/mL | 142 | Anions by IC-NP |
| 2403005-02 | : TI155-Eff-Comp | Phosphate | 1110 | ug/mL | 25.5 | Anions by IC-NP |
| 2403005-02 | : TI155-Eff-Comp | Sulfate | 5100 | ug/mL | 9.40 | Anions by IC-NP |
| | | | | | | |
| Reviewed by: | | | | | | |

Elsa Cordova/3K022 Digitally signed by Elsa Cordova/3K022
Date: 2024.04.18 14:34:36 -07'00'

SXDATA

| LabNumber | SampleName | Analyte | Result | Units | EQL | Analysis |
|--------------|--------------------------|----------------------|--------|-------|------|-------------------------|
| 2403003-01 | : TI163-Comp-EFF (pH>14) | Total Carbon | 7160 | ug/mL | 2000 | Total Carbon-NP |
| 2403003-01 | : TI163-Comp-EFF (pH>14) | Total Organic Carbon | 1650 | ug/mL | 1000 | Total Organic Carbon-NP |
| 2403005-01 | : TI155-Feed-Comp | Total Carbon | 27600 | ug/mL | 2000 | Total Carbon-NP |
| 2403005-01 | : TI155-Feed-Comp | Total Organic Carbon | 19400 | ug/mL | 2000 | Total Organic Carbon-NP |
| 2403005-02 | : TI155-Eff-Comp | Total Carbon | 29000 | ug/mL | 2000 | Total Carbon-NP |
| 2403005-02 | : TI155-Eff-Comp | Total Organic Carbon | 20100 | ug/mL | 2000 | Total Organic Carbon-NP |
| Reviewed by: | | | | | | |

Elsa
Cordova/3K022

Digitally signed by Elsa
Cordova/3K022
Date: 2024.04.18 14:31:35 -07'00'



Battelle Memorial Institute, Pacific Northwest Division
Acting Under Prime Contract DE-AC05-76RL01830
With the U.S. Department of Energy
Operating the Pacific Northwest National Laboratory (PNNL) (www.pnnl.gov)

| | |
|--|---|
| BATTELLE MEMORIAL INSTITUTE, PACIFIC NORTHWEST DIVISION'S MASTER TASK AGREEMENT NUMBER 660825, TASK ORDER NUMBER 733437 PNNL REFERENCE NUMBER 733437 MODIFICATION 1 | |
| Issued By: Battelle Memorial Institute, Pacific Northwest Division 902 Battelle Boulevard Richland, WA 99352 | Contractor: Southwest Research Institute Accounts Receivable, Bldg 160 6220 Culebra Road San Antonio, TX 78238-5166 USA |
| Contracts Specialist: Name: Heather N. Mayfield Telephone Number: 509/371-7841 Email: heather.mayfield@pnnl.gov | Contractor's Point of Contact: Name: Crystal Chudej Telephone Number: 210-552-6067 Email: crystal.chudej@swri.org SHIP SAMPLES TO: Southwest Research Institute Attn: Jackie Ranger, Division 01 9503 W Commerce San Antonio, TX 78227-1301 |
| Payment Terms: Net 30 | Task Order Type: Fixed Unit Price-Flexible Qty. |
| Task Order Period of Performance: March 12, 2024, through May 31, 2024 | Task Order Total: \$18,868.00 |
| Submit Invoices and Invoice/Payment Inquiries To ap.invoices@pnnl.gov . Note: Invoices must list location(s) of service (U.S.: City, State; Foreign: Country). | |

| | |
|---|---|
| Battelle Memorial Institute, Pacific Northwest Division | Contractor shall sign and return a copy of this document |
| Signature of person authorized to sign  Heather N Mayfield Date: 2024.04.23 15:03:30 -07'00' | Signature of person authorized to sign |
| Name | Name |
| Heather N. Mayfield | |
| Title | Title |
| Contracts Specialist | |
| Date | Date |

Note: Captions in this document and in Battelle's General Provisions are included for convenience of reference only and in no other way define or delineate any of the provisions hereof or otherwise affect their construction or effect.

Modification 1 was issued to update the dose rate, TRU sample information, price, and period of performance of all items. The total contract amount increased by \$9,434.00 for a revised total

Master Task Agreement Number: 660825, Task Order Number: 733437 Mod 1

of \$28,302.00 It is understood and agreed that all other terms and conditions of this Purchase Order shall remain unchanged.

1. SCOPE AND PRICING

Scope: Pursuant to Master Task Agreement (hereinafter referred to as "Agreement") Number 660825, the Contractor shall provide services in accordance with the attached Statement of Work.

Pricing:

| Item No. | Analysis | Turnaround Time | Dose Rate | TRU Samples | Number of Samples | Price |
|--------------|---|-----------------|------------|--|-------------------|--------------------|
| 1 | [Solutions] Np-237 via Alpha Spec (Line 43) | 30 days | ≥100 mR/hr | Total TRU (Pu, Am, Cm, etc.) >0.1 μCi/sample but <100 μCi/sample | 2 | \$3,408.00 |
| 2 | [Solutions] Am-241, Cm-242, and Cm-244 via Alpha Spec (Line 42) | 30 days | ≥100 mR/hr | Total TRU (Pu, Am, Cm, etc.) >0.1 μCi/sample but <100 μCi/sample | 2 | \$3,408.00 |
| 3 | [Solutions] Pu-238, Pu-239/240, and Pu-244 via Alpha Spec (Line 44) | 30 days | ≥100 mR/hr | Total TRU (Pu, Am, Cm, etc.) >0.1 μCi/sample but <100 μCi/sample | 18 | \$17,040.00 |
| 4 | [Solutions] ICP-MS for Tc (Line 37) | 30 days | ≥100 mR/hr | Total TRU (Pu, Am, Cm, etc.) >0.1 μCi/sample but <100 μCi/sample | 2 | \$4,446.00 |
| Total | | | | | | \$28,302.00 |

2. PERIOD OF PERFORMANCE/DELIVERY

Period of Performance: The period of performance will be as shown on page 1.

3. AGREEMENT REQUIREMENTS/INFORMATION

Additional Requirements:

Services to be completed in compliance with DOEAP-AP and HASQARD compliant quality program.

Analytical Services (cl QA-176 - December 2013)

The Contractor shall have and maintain a Quality program that provides control of activities affecting the quality of the services specified in the statement of work to an extent consistent with its importance and any applicable standard (e.g. ISO 9001:2008, ISO/IEC 17025:2005, etc.). Such program shall be documented by written policies, procedures, or instructions and shall

be carried out by the Contractor in accordance with those policies, procedures, or instructions. Records shall be readily retrievable by the Contractor and shall be made available for inspection by Battelle.

Pre-Award Evaluation Requirement A pre-award evaluation of the Contractor's documented Quality program/system including the Contractor's capability to deliver the technical and quality assurance services required by Battelle will be conducted.

4. **CONTRACT ADMINISTRATION**

Technical Oversight Representative: All technical questions should be directed to the Technical Oversight Representative (TOR), Cassie A. Martin at 509/375-3805 or via email at cassie.martin@pnnl.gov. The TOR cannot modify this Task Order.

Battelle Contracts Specialist: The Battelle Contracts Specialist, Heather N. Mayfield, is the sole point of contact for any contractual/administrative communications or questions regarding this acquisition. Contact information is on Page 1.

5. **TERMS AND CONDITIONS**

The terms and conditions of Master Task Agreement Number 660825, including all supplements thereto, and all terms and conditions set forth above are applicable to this Task Order.

Order of Precedence: Any inconsistencies in this Task Order shall be resolved by giving precedence in the following order:

1. Task Order Modifications/Documents
2. Task Order
3. Master Task Agreement 660825 Modifications/Documents
4. Master Task Agreement 660825
5. Representations and Certifications
6. Other documents, exhibits, and attachments

6. **CONTRACT ATTACHMENTS**

In addition to the above, the Task Order consists of:

- Master Task Agreement 660825
- Statement of Work - dated February 23, 2024

7. **ENTIRE AGREEMENT**

This Task Order contains the entire understanding between the parties, and there are no understanding or representations not set forth or incorporated by reference herein. No subsequent modifications to this Task Order shall be of any force or effect unless in writing signed by the part claimed to be bound thereby. No communication, written or oral, by other than a Battelle Contracts Specialist shall be effective to modify or otherwise affect the provisions of the Task Order.

Page 1 of 2

Shipment 1 of 3

Project Sample Transfer Form (PSTF)

Page 2 of 2

0311

| | | | |
|---|----------------------|--|--|
| Final Sample Disposition: Dispose on-site | | If samples are to be preserved, identify requirements here. | |
| Project Approval | | | |
| Date | Approved by | Digitally signed by Reid A Peterson Date: 2024.03.18 11:23:08 -07'00' | |
| | Reid A Peterson | | |
| Receipt Acknowledgement | | | |
| Date | Received by | | |
| 04.04.24 | Daniel Marier / SWRI | | |

Client: Battelle Memorial Institute PNNL
SRR # 70993
Project # 27927.13.001
Case: 733437
VTSR: 04/04/24
Sample(s) Received: Intact
Temperature: 21.9°C SN # 029926

Page 1 of 2

Shipment 2 of 3

Project Sample Transfer Form (PSTF)

Page 2 of 2 0322

| | | | |
|---|----------------------|---|--|
| Final Sample Disposition: Dispose on-site | | If samples are to be preserved, identify requirements here. | |
| Project Approval | | | |
| Date | Approved by | | |
| | Reid A Peterson | | Digitally signed by Reid A Peterson Date: 2024.03.18 11:23:08 -07'00' |
| Receipt Acknowledgement | | | |
| Date | Received by | | |
| 04.04.24 | Daniel Haines / SWKI | | |

Client: Battelle Memorial Institute PNNL
SRR # 70993
Project # 27927.13.001
Case: 733437
VTSR: 04/04/24
Sample(s) Received: Intact
Temperature: 21.9°C SN # 029926

Project Sample Transfer Form (PSTF)

Page 2 of 2

| | | |
|---|---|--|
| Final Sample Disposition: Dispose on-site | | If samples are to be preserved, identify requirements here. |
| Project Approval | | |
| <small>Date</small> Reid | <small>Approved by</small> A Peterson | Digitally signed by Reid A Peterson Date: 2024.03.18 11:23:08 -07'00' |
| Receipt Acknowledgement | | |
| <small>Date</small> 04.04.24 | <small>Received by</small> Doel H. Davis / SWKI | |

Client: Battelle Memorial Institute PNNL
SRR # 70993
Project # 27927.13.001
Case: 733437
VTSR: 04/04/24
Sample(s) Received: Intact
Temperature: 21.9°C SN # 029926



May 22, 2024

Test Report

SwRI Project #: 27927.13.001
SwRI SDG: 718819
SwRI Task Order: 240405-6
SwRI Sample Receipt: 70993
Date Received: 04/04/2024

P.O.# 660825 R1/TON 733437

Prepared by:

*Southwest Research Institute®
Department of Analytical and Environmental Chemistry
6220 Culebra Road
San Antonio, Texas 78238*

Prepared for:

*Battelle Memorial Institute - PNNL
902 Battelle Boulevard
P.O. Box 999
Richland, WA 99354
Attn: MS. Amy Westesen*

Radonna Spies

Digitally signed by Radonna
Spies
Date: 2024.05.22 17:39:04 -05'00'

*Authorized for Release
05/22/2024 5:00PM
Jackie Ranger, Project Manager
jacqueline.ranger@swri.org
210-522-3320*

Digitally signed by
mdammann
Date: 2024.05.22
17:33:32 -05'00'

*Mike Dammann
Laboratory Director*



"I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed within this report. This report shall not be reproduced except in full without the written approval of SwRI."

Results relate only to the items tested and the samples/materials received by the laboratory.

SOUTHWEST RESEARCH INSTITUTE

CLIENT: Battelle Memorial Institute PNNL

SwRI Project #: 27927.13.001

SwRI Task Order #: 240405-6

SDG #: 718819

TON #: 733437

Case Narrative

CLIENT: Battelle Memorial Institute - PNNL
SwRI Project Number: 27927.13.001
SwRI Sample Receipt Number: 70993
PO 660825 R1, TO 733437
Page #: 1

Sample Index

1. Eighteen overall samples were received for various analyses. See the table below for the sixteen (18) samples and required tests reported here:

| SwRI ID | Sample Number | Analysis |
|---------|-----------------|--------------------|
| 718819 | TI155-A-2-A | Iso Pu |
| 718820 | TI155-B-10-A | Iso Pu |
| 718821 | TI155-EFF-Comp | Am, Cm, Np, Iso Pu |
| 718822 | TI155-Feed-Comp | Am, Cm, Np, Iso Pu |
| 718825 | TI155-A-11-A | Iso Pu |
| 718826 | TI155-A-17-A | Iso Pu |
| 718827 | TI155-A-21-A | Iso Pu |
| 718828 | TI155-B-22-A | Iso Pu |
| 718829 | TI155-B-24-A | Iso Pu |
| 718830 | TI155-A-9-A | Iso Pu |
| 718852 | TI155-A-13-A | Iso Pu |
| 718853 | TI155-A-15-A | Iso Pu |
| 718854 | TI155-A-19-A | Iso Pu |
| 718855 | TI155-A-5-A | Iso Pu |
| 718856 | TI155-A-7-A | Iso Pu |
| 718857 | TI155-B-18-A | Iso Pu |
| 718858 | TI155-B-2-A | Iso Pu |
| 718859 | TI155-B-5-A | Iso Pu |

Client: Battelle Memorial Institute PNNL
SDG: 718819
SwRI Project Number: 27927.13.001
SwRI Task Order Number: 240405-6

RADIOLOGICAL ANALYSIS

The sample SDG 718819 consisted of eighteen liquid samples received for radiological analysis. The samples for radiological analysis were reported on an “as received” volume basis. The recommended sample holding time of six months was met. Only two of the eighteen samples were analyzed for americium, curium, and neptunium.

The sample was analyzed for the following:

| Matrix | Analysis | Method |
|--------|--|---------------------------|
| Liquid | ²³⁹ Neptunium Alpha/Beta analysis | Gas Proportional Counting |
| Liquid | ²⁴¹ Americium | Alpha Spectroscopy |
| Liquid | ²⁴² Curium, ^{243/244} Curium | Alpha Spectroscopy |
| Liquid | ²³⁸ Plutonium, ^{239/240} Pu, ²⁴⁴ Pu | Alpha Spectroscopy |
| Liquid | ²³⁷ Neptunium | Alpha Spectroscopy |

Note:

A coverage factor of k=2 was applied to the TPU of all analytes. TPU was calculated using 1 sigma counting error.

The reported MDAs are sample-specific.

Sample Preparation and Digestion

0.5 milliliters of each liquid was digested with 1 M nitric acid in centrifuge tubes. Once digested, the samples were brought to a final volume of 50ml with deionized water. Aliquots were taken from the digestion for americium, curium, plutonium, and neptunium analyses. The aliquots were evaporated to dryness and nitrated a couple times. The sample aliquots were then transferred with 10 milliliters of a 3M nitric acid / 1M aluminum nitrate solution. A preparation blank, laboratory control sample, and a duplicate sample were also processed with the sample aliquots. Tracers and spikes were added to the sample aliquots prior to evaporation and nitration of the sample aliquots.

Gas Flow Proportional Counting

Daily instrument checks were within control limits and the weekly four hour background was within date and control limits.

²³⁹Neptunium tracer

The ²³⁷Neptunium samples were counted in the GPC for 30 minutes each for Gross Alpha/Beta analysis prior to counting by alpha spectroscopy. ²³⁹Neptunium is used as a tracer for ²³⁷Neptunium analysis. ²⁴³Americium is added to the samples and ²³⁹Neptunium which is in secular equilibrium is separated from the samples. GPC results were corrected to pCi using calibration standards to determine the efficiency.

Client: Battelle Memorial Institute PNNL
SDG: 718819
SwRI Project Number: 27927.13.001
SwRI Task Order Number: 240405-6

Alpha Spectroscopy (Am, Cm, Pu, Np)

For all alpha analysis, daily pulser checks were within control limits. The weekly secondary or monthly primary calibration check standards were within date and control limits. The monthly alpha detector background was within date.

The samples were counted for 500 minutes.

²⁴¹Americium

²⁴³Americium was used as a tracer to follow chemical separation efficiency and losses. Tracer FWHM were within control limits of 100keV. All reported results for the tracers were within the control limits of 30-110%. The result for the preparation blank was less than 3 times the TPU, the MDA, and the RL. The result for the laboratory control sample was within the control limits of 75-125% recovery. SwRI sample ID 718821 was analyzed in duplicate and the duplicate evaluation ratio was less than three.

²⁴²Curium, ^{243/244}Curium

²⁴²Curium and ^{243/244}Curium were separated, precipitated, and analyzed from the same aliquot as ²⁴¹Americium. ²⁴¹Americium was used as the spiking solution in the laboratory control samples and ²⁴³Americium was used to determine tracer recovery. ²⁴³Americium was used as a tracer to follow chemical separation efficiency and losses. Tracer FWHM were within control limits of 100keV. All reported results for the tracers were within the control limits of 30-110%. The results for the preparation blank were less than 3 times the TPU, the MDA, and the RL for both ²⁴²Curium and ^{243/244}Curium. The result for the laboratory control sample were within the control limits of 75-125% recovery. SwRI laboratory sample ID SwRI sample ID 718821 was analyzed in duplicate and the sample duplicate evaluation ratios were less than three for both isotopes.

²³⁸Plutonium, ^{239/240}Plutonium, ²⁴⁴Plutonium

²⁴²Plutonium was used as a tracer to follow chemical separation efficiency and losses. All tracer FWHM were within the control limits of 100keV. All reported results for the tracers were within the control limits of 30-110%. The results for the preparation blank for ²³⁸Pu, ^{239/240}Pu, and ²⁴⁴Pu were less than 3 times the TPU, the MDA, and the RL. The result for the laboratory control sample was within the control limits of 75-125% recovery. SwRI laboratory sample ID 718821 was analyzed in duplicate and the sample duplicate evaluation ratios for ²³⁸Pu and ²⁴⁴Pu were less than three. ^{239/240}Pu had a duplicate evaluation ratio of 4.1. Homogeneity of the sample may have been an issue.

Client: Battelle Memorial Institute PNNL
SDG: 718819
SwRI Project Number: 27927.13.001
SwRI Task Order Number: 240405-6

²³⁷Neptunium

²³⁹Neptunium was used as a tracer to follow chemical separation efficiency and losses. The ²³⁹Np was spiked in using high activity ²⁴³Am in secular equilibrium with its ²³⁹Np daughter. The neptunium was separated and the decay of the ²³⁹Np was calculated from the end of separation. The samples were then precipitated and the filters analyzed by beta GPC to determine the ²³⁹Np recovery. The samples were then analyzed by alpha spectroscopy using the tracer recovery from the GPC. The results for the tracers were within the control limits of 30-110%. The result for the preparation blank was less than 3 times the TPU, the MDA, and the RL. The result for the laboratory control sample was within the control limits of 75-125% recovery. SwRI laboratory sample ID 718821 was analyzed in duplicate and the sample duplicate evaluation ratio was less than three.

Warren A Naegeli
Digitally signed by
Warren A Naegeli[®]
Date: 2024.05.21
19:56:03 -05'00'

Prepared by

SOUTHWEST RESEARCH INSTITUTE

CLIENT: Battelle Memorial Institute PNNL

SwRI Project #: 27927.13.001

SwRI Task Order #: 240405-6

SDG #: 718819

TON #: 733437

Alpha Spec Results

SOUTHWEST RESEARCH INSTITUTE

ALPHA SPECTROMETRY ANALYSIS DATA SHEET

Lab Name: Southwest Research Institute

Client: Battelle Memorial Institute - PNNL

Lab Code: SwRI

Project No.: 27927.13.001

Matrix: Liquid

Date Received: 04/04/24

SRR #: 70993

TON: 733437

Task Order #: 240405-6

SDG: 718819

| AMERICIUM-241, CURIUM-242, 243/244 | | | | | | | | | |
|------------------------------------|---------------|-----------------------|-----------------|---|------------------|-------------|---------------------|-------------------------------|---------------|
| Sample ID | Lab System ID | Analyte | Results (pCi/g) | Q | TPU (2s) (pCi/g) | MDA (pCi/g) | Counting Error (2s) | ²⁴³ Am Tracer Rec. | Date Analyzed |
| Prep Blank | pb24e14ke2 | ²⁴¹ Am | 4.79E+01 | U | 1.52E+02 | 4.16E+02 | 1.51E+02 | 88.4% | 05/16/24 |
| | pb24e14ke2 | ²⁴² Cm | 0.00E+00 | U | 1.35E+02 | 3.65E+02 | 1.35E+02 | 88.4% | 05/16/24 |
| | pb24e14ke2 | ^{243/244} Cm | 0.00E+00 | U | 1.34E+02 | 3.62E+02 | 1.34E+02 | 88.4% | 05/16/24 |
| Lab Control | lcs24e14jt1 | ²⁴¹ Am | 2.55E+04 | | 4.73E+03 | 4.84E+02 | 2.23E+03 | 92.0% | 05/16/24 |
| | lcs24e14jt1 | ²⁴² Cm | 0.00E+00 | U | 1.37E+02 | 3.70E+02 | 1.37E+02 | 92.0% | 05/16/24 |
| | lcs24e14jt1 | ^{243/244} Cm | 0.00E+00 | U | 1.36E+02 | 3.67E+02 | 1.36E+02 | 92.0% | 05/16/24 |
| True Value | ----- | ²⁴¹ Am | 2.44E+04 | | ----- | ----- | ----- | ----- | ----- |
| | ----- | ²⁴² Cm | ----- | | ----- | ----- | ----- | ----- | ----- |
| | ----- | ^{243/244} Cm | ----- | | ----- | ----- | ----- | ----- | ----- |
| Recovery | ----- | ²⁴¹ Am | 104.4% | | ----- | ----- | ----- | ----- | ----- |
| | ----- | ²⁴² Cm | ----- | | ----- | ----- | ----- | ----- | ----- |
| | ----- | ^{243/244} Cm | ----- | | ----- | ----- | ----- | ----- | ----- |
| TI155-EFF-Comp | 718821 | ²⁴¹ Am | 2.52E+05 | | 4.16E+04 | 3.89E+02 | 6.71E+03 | 95.0% | 05/16/24 |
| | 718821 | ²⁴² Cm | 1.83E+03 | | 6.95E+02 | 3.72E+02 | 6.28E+02 | 95.0% | 05/16/24 |
| | 718821 | ^{243/244} Cm | 2.82E+03 | | 8.48E+02 | 3.12E+02 | 7.12E+02 | 95.0% | 05/16/24 |
| Duplicate result | 718821D | ²⁴¹ Am | 2.55E+05 | | 4.25E+04 | 3.48E+02 | 7.10E+03 | 88.5% | 05/16/24 |
| | 718821D | ²⁴² Cm | 1.31E+03 | | 6.04E+02 | 4.11E+02 | 5.64E+02 | 88.5% | 05/16/24 |
| | 718821D | ^{243/244} Cm | 3.38E+03 | | 9.94E+02 | 4.26E+02 | 8.24E+02 | 88.5% | 05/16/24 |
| Dup Evaluation | ----- | ²⁴¹ Am | 0.1 | | ----- | ----- | ----- | ----- | ----- |
| | ----- | ²⁴² Cm | 1.1 | | ----- | ----- | ----- | ----- | ----- |
| | ----- | ^{243/244} Cm | 0.9 | | ----- | ----- | ----- | ----- | ----- |
| TI155-Feed-Comp | 718822 | ²⁴¹ Am | 1.67E+05 | | 3.00E+04 | 1.67E+03 | 1.26E+04 | 88.0% | 05/16/24 |
| | 718822 | ²⁴² Cm | 2.80E+02 | U | 7.94E+02 | 2.14E+03 | 7.92E+02 | 88.0% | 05/16/24 |
| | 718822 | ^{243/244} Cm | 4.23E+03 | | 2.16E+03 | 1.80E+03 | 2.05E+03 | 88.0% | 05/16/24 |

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SOUTHWEST RESEARCH INSTITUTE

ALPHA SPECTROMETRY ANALYSIS DATA SHEET

Lab Name: Southwest Research Institute

Client: Battelle Memorial Institute - PNNL

Lab Code: SwRI

Project No.: 27927.13.001

Matrix: Liquid

Date Received: 04/04/24

SRR #: 70993

TON: 733437

Task Order #: 240405-6

SDG: 718819

| NEPTUNIUM-237 | | | | | | | | | |
|------------------|---------------|-------------------|-----------------|---|------------------|-------------|---------------------|-------------------------------|---------------|
| Sample ID | Lab System ID | Analyte | Results (pCi/g) | Q | TPU (2s) (pCi/g) | MDA (pCi/g) | Counting Error (2s) | ²³⁹ Np Tracer Rec. | Date Analyzed |
| Prep Blank | pb24e14ke2 | ²³⁷ Np | -2.69E+00 | U | 1.20E+01 | 3.78E+01 | 1.20E+01 | 81.6% | 05/16/24 |
| Lab Control | lcs24e14jt2 | ²³⁷ Np | 2.69E+03 | | 3.87E+02 | 3.59E+01 | 2.25E+02 | 93.5% | 05/16/24 |
| True Value | ----- | ²³⁷ Np | 2.74E+03 | | ----- | ----- | ----- | ----- | ----- |
| Recovery | ----- | ²³⁷ Np | 98.2% | | ----- | ----- | ----- | ----- | ----- |
| TI155-EFF-Comp | 718821 | ²³⁷ Np | 5.79E+01 | | 3.40E+01 | 3.41E+01 | 3.33E+01 | 97.8% | 05/16/24 |
| Duplicate result | 718821D | ²³⁷ Np | 2.09E+01 | U | 2.38E+01 | 4.62E+01 | 2.37E+01 | 105.2% | 05/16/24 |
| Dup Evaluation | ----- | ²³⁷ Np | 1.8 | | ----- | ----- | ----- | ----- | ----- |
| TI155-Feed-Comp | 718822 | ²³⁷ Np | 9.03E+01 | | 4.30E+01 | 3.25E+01 | 4.17E+01 | 97.2% | 05/16/24 |

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SOUTHWEST RESEARCH INSTITUTE

ALPHA SPECTROMETRY ANALYSIS DATA SHEET

Lab Name: Southwest Research Institute

Client: Battelle Memorial Institute - PNNL

Lab Code: SwRI

Project No.: 27927.13.001

Matrix: Liquid

Date Received: 04/04/24

SRR #: 70993

TON: 733437

Task Order #: 240405-6

SDG: 718819

| PLUTONIUM-238, 239/240, 244 | | | | | | | | | |
|-----------------------------|---------------|-----------------------|-----------------|---|------------------|-------------|---------------------|-------------------------------|---------------|
| Sample ID | Lab System ID | Analyte | Results (pCi/g) | Q | TPU (2s) (pCi/g) | MDA (pCi/g) | Counting Error (2s) | ²⁴² Pu Tracer Rec. | Date Analyzed |
| Prep Blank | pb24e14ke2 | ²³⁸ Pu | -5.10E+01 | U | 1.25E+02 | 4.43E+02 | 1.25E+02 | 81.9% | 05/15/24 |
| | pb24e14ke2 | ^{239/240} Pu | 1.53E+02 | U | 2.05E+02 | 3.90E+02 | 2.04E+02 | 81.9% | 05/15/24 |
| | pb24e14ke2 | ²⁴⁴ Pu | 2.04E+02 | U | 2.30E+02 | 3.90E+02 | 2.28E+02 | 81.9% | 05/15/24 |
| Lab Control | lcs24e14jt1 | ²³⁸ Pu | 3.10E+01 | U | 1.39E+02 | 4.35E+02 | 1.38E+02 | 71.2% | 05/15/24 |
| | lcs24e14jt1 | ^{239/240} Pu | 2.94E+04 | | 4.94E+03 | 4.74E+02 | 2.70E+03 | 71.2% | 05/15/24 |
| | lcs24e14jt1 | ²⁴⁴ Pu | -3.10E+01 | U | 1.39E+02 | 4.35E+02 | 1.38E+02 | 71.2% | 05/15/24 |
| True Value | ----- | ²³⁸ Pu | ----- | | ----- | ----- | ----- | ----- | ----- |
| | ----- | ^{239/240} Pu | 2.50E+04 | | ----- | ----- | ----- | ----- | ----- |
| | ----- | ²⁴⁴ Pu | ----- | | ----- | ----- | ----- | ----- | ----- |
| Recovery | ----- | ²³⁸ Pu | ----- | | ----- | ----- | ----- | ----- | ----- |
| | ----- | ^{239/240} Pu | 117.6% | | ----- | ----- | ----- | ----- | ----- |
| | ----- | ²⁴⁴ Pu | ----- | | ----- | ----- | ----- | ----- | ----- |
| TI155-A-2-A | 718819 | ²³⁸ Pu | 5.45E+03 | | 2.23E+03 | 1.39E+03 | 2.11E+03 | 84.9% | 05/15/24 |
| | 718819 | ^{239/240} Pu | 1.89E+04 | | 4.66E+03 | 1.39E+03 | 3.89E+03 | 84.9% | 05/15/24 |
| | 718819 | ²⁴⁴ Pu | 1.98E+02 | U | 5.60E+02 | 1.51E+03 | 5.60E+02 | 84.9% | 05/15/24 |
| TI155-B-10-A | 718820 | ²³⁸ Pu | 4.48E+03 | | 2.16E+03 | 1.61E+03 | 2.07E+03 | 75.4% | 05/15/24 |
| | 718820 | ^{239/240} Pu | 2.43E+04 | | 5.83E+03 | 1.76E+03 | 4.75E+03 | 75.4% | 05/15/24 |
| | 718820 | ²⁴⁴ Pu | -1.15E+02 | U | 5.13E+02 | 1.61E+03 | 5.13E+02 | 75.4% | 05/15/24 |
| TI155-EFF-Comp | 718821 | ²³⁸ Pu | 5.06E+03 | | 1.23E+03 | 3.61E+02 | 1.02E+03 | 80.3% | 05/15/24 |
| | 718821 | ^{239/240} Pu | 2.20E+04 | | 3.68E+03 | 3.93E+02 | 2.13E+03 | 80.3% | 05/15/24 |
| | 718821 | ²⁴⁴ Pu | 5.13E+01 | U | 1.45E+02 | 3.92E+02 | 1.45E+02 | 80.3% | 05/15/24 |
| Duplicate result | 718821D | ²³⁸ Pu | 5.76E+03 | | 1.33E+03 | 3.53E+02 | 1.08E+03 | 83.5% | 05/15/24 |
| | 718821D | ^{239/240} Pu | 3.56E+04 | | 5.54E+03 | 3.85E+02 | 2.68E+03 | 83.5% | 05/15/24 |
| | 718821D | ²⁴⁴ Pu | 1.00E+02 | U | 1.75E+02 | 3.84E+02 | 1.74E+02 | 83.5% | 05/15/24 |
| Dup Evaluation | ----- | ²³⁸ Pu | 0.8 | | ----- | ----- | ----- | ----- | ----- |
| | ----- | ^{239/240} Pu | 4.1 | | ----- | ----- | ----- | ----- | ----- |
| | ----- | ²⁴⁴ Pu | 0.4 | | ----- | ----- | ----- | ----- | ----- |
| TI155-Feed-Comp | 718822 | ²³⁸ Pu | 3.49E+03 | | 2.09E+03 | 1.96E+03 | 2.03E+03 | 75.2% | 05/15/24 |
| | 718822 | ^{239/240} Pu | 1.62E+04 | | 4.84E+03 | 2.14E+03 | 4.29E+03 | 75.2% | 05/15/24 |
| | 718822 | ²⁴⁴ Pu | 0.00E+00 | U | 7.89E+02 | 2.13E+03 | 7.89E+02 | 75.2% | 05/15/24 |

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Alpha Page 3 of 5

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SOUTHWEST RESEARCH INSTITUTE

ALPHA SPECTROMETRY ANALYSIS DATA SHEET

Lab Name: Southwest Research Institute

Client: Battelle Memorial Institute - PNNL

Lab Code: SwRI

Project No.: 27927.13.001

Matrix: Liquid

Date Received: 04/04/24

SRR #: 70993

TON: 733437

Task Order #: 240405-6

SDG: 718819

| PLUTONIUM-238, 239/240, 244 | | | | | | | | | |
|-----------------------------|---------------|-----------------------|-----------------|---|------------------|-------------|---------------------|-------------------------------|---------------|
| Sample ID | Lab System ID | Analyte | Results (pCi/g) | Q | TPU (2s) (pCi/g) | MDA (pCi/g) | Counting Error (2s) | ²⁴² Pu Tracer Rec. | Date Analyzed |
| TI155-A-11-A | 718825 | ²³⁸ Pu | 6.12E+03 | | 2.36E+03 | 1.36E+03 | 2.21E+03 | 85.8% | 05/15/24 |
| | 718825 | ^{239/240} Pu | 2.25E+04 | | 5.20E+03 | 1.49E+03 | 4.20E+03 | 85.8% | 05/15/24 |
| | 718825 | ²⁴⁴ Pu | 1.94E+02 | U | 5.49E+02 | 1.48E+03 | 5.49E+02 | 85.8% | 05/15/24 |
| TI155-A-17-A | 718826 | ²³⁸ Pu | 5.06E+03 | | 2.19E+03 | 1.76E+03 | 2.08E+03 | 83.2% | 05/15/24 |
| | 718826 | ^{239/240} Pu | 2.20E+04 | | 5.18E+03 | 1.42E+03 | 4.23E+03 | 83.2% | 05/15/24 |
| | 718826 | ²⁴⁴ Pu | 0.00E+00 | U | 5.72E+02 | 1.55E+03 | 5.72E+02 | 83.2% | 05/15/24 |
| TI155-A-21-A | 718827 | ²³⁸ Pu | 6.72E+03 | | 2.86E+03 | 2.25E+03 | 2.71E+03 | 83.3% | 05/15/24 |
| | 718827 | ^{239/240} Pu | 1.91E+04 | | 5.20E+03 | 2.25E+03 | 4.49E+03 | 83.3% | 05/15/24 |
| | 718827 | ²⁴⁴ Pu | 2.58E+02 | U | 7.31E+02 | 1.98E+03 | 7.30E+02 | 83.3% | 05/15/24 |
| TI155-B-22-A | 718828 | ²³⁸ Pu | 2.79E+03 | | 1.53E+03 | 1.42E+03 | 1.49E+03 | 88.1% | 05/15/24 |
| | 718828 | ^{239/240} Pu | 2.40E+04 | | 5.33E+03 | 1.42E+03 | 4.24E+03 | 88.1% | 05/15/24 |
| | 718828 | ²⁴⁴ Pu | 1.86E+02 | U | 5.26E+02 | 1.42E+03 | 5.25E+02 | 88.1% | 05/15/24 |
| TI155-B-24-A | 718829 | ²³⁸ Pu | 4.23E+03 | | 1.93E+03 | 1.47E+03 | 1.84E+03 | 87.6% | 05/15/24 |
| | 718829 | ^{239/240} Pu | 2.26E+04 | | 5.18E+03 | 1.35E+03 | 4.18E+03 | 87.6% | 05/15/24 |
| | 718829 | ²⁴⁴ Pu | 0.00E+00 | U | 5.44E+02 | 1.47E+03 | 5.44E+02 | 87.6% | 05/15/24 |
| TI155-A-9-A | 718830 | ²³⁸ Pu | 4.71E+03 | | 2.07E+03 | 1.41E+03 | 1.97E+03 | 84.8% | 05/15/24 |
| | 718830 | ^{239/240} Pu | 2.10E+04 | | 5.02E+03 | 1.53E+03 | 4.13E+03 | 84.8% | 05/15/24 |
| | 718830 | ²⁴⁴ Pu | 0.00E+00 | U | 5.67E+02 | 1.53E+03 | 5.67E+02 | 84.8% | 05/15/24 |
| TI155-A-13-A | 718852 | ²³⁸ Pu | 5.52E+03 | | 2.23E+03 | 1.66E+03 | 2.10E+03 | 84.6% | 05/15/24 |
| | 718852 | ^{239/240} Pu | 2.30E+04 | | 5.24E+03 | 1.66E+03 | 4.22E+03 | 84.6% | 05/15/24 |
| | 718852 | ²⁴⁴ Pu | 9.51E+01 | U | 4.26E+02 | 1.34E+03 | 4.25E+02 | 84.6% | 05/15/24 |
| TI155-A-15-A | 718853 | ²³⁸ Pu | 6.03E+03 | | 2.45E+03 | 2.22E+03 | 2.31E+03 | 81.4% | 05/15/24 |
| | 718853 | ^{239/240} Pu | 2.17E+04 | | 5.13E+03 | 1.54E+03 | 4.20E+03 | 81.4% | 05/15/24 |
| | 718853 | ²⁴⁴ Pu | 0.00E+00 | U | 5.69E+02 | 1.54E+03 | 5.69E+02 | 81.4% | 05/15/24 |
| TI155-A-19-A | 718854 | ²³⁸ Pu | 7.74E+03 | | 3.39E+03 | 3.69E+03 | 3.22E+03 | 73.1% | 05/15/24 |
| | 718854 | ^{239/240} Pu | 2.18E+04 | | 5.87E+03 | 2.19E+03 | 5.03E+03 | 73.1% | 05/15/24 |
| | 718854 | ²⁴⁴ Pu | 0.00E+00 | U | 8.11E+02 | 2.19E+03 | 8.11E+02 | 73.1% | 05/15/24 |
| TI155-A-5-A | 718855 | ²³⁸ Pu | 5.35E+03 | | 2.16E+03 | 1.60E+03 | 2.04E+03 | 91.4% | 05/15/24 |
| | 718855 | ^{239/240} Pu | 1.79E+04 | | 4.38E+03 | 1.60E+03 | 3.66E+03 | 91.4% | 05/15/24 |
| | 718855 | ²⁴⁴ Pu | 9.22E+01 | U | 4.12E+02 | 1.30E+03 | 4.12E+02 | 91.4% | 05/15/24 |

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Alpha Page 4 of 5

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SOUTHWEST RESEARCH INSTITUTE

ALPHA SPECTROMETRY ANALYSIS DATA SHEET

Lab Name: Southwest Research Institute

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Lab Code: SwRI

Project No.: 27927.13.001

Matrix: Liquid

Date Received: 04/04/24

SRR #: 70993

TON: 733437

Task Order #: 240405-6

SDG: 718819

| PLUTONIUM-238, 239/240, 244 | | | | | | | | | |
|-----------------------------|---------------|-----------------------|-----------------|---|------------------|-------------|---------------------|-------------------------------|---------------|
| Sample ID | Lab System ID | Analyte | Results (pCi/g) | Q | TPU (2s) (pCi/g) | MDA (pCi/g) | Counting Error (2s) | ²⁴² Pu Tracer Rec. | Date Analyzed |
| TI155-A-7-A | 718856 | ²³⁸ Pu | 7.01E+03 | | 2.79E+03 | 1.67E+03 | 2.61E+03 | 70.7% | 05/15/24 |
| | 718856 | ^{239/240} Pu | 2.21E+04 | | 5.54E+03 | 1.82E+03 | 4.61E+03 | 70.7% | 05/15/24 |
| | 718856 | ²⁴⁴ Pu | -1.19E+02 | U | 5.31E+02 | 1.67E+03 | 5.31E+02 | 70.7% | 05/15/24 |
| TI155-B-18-A | 718857 | ²³⁸ Pu | 5.47E+03 | | 2.31E+03 | 1.61E+03 | 2.19E+03 | 80.2% | 05/15/24 |
| | 718857 | ^{239/240} Pu | 2.00E+04 | | 4.95E+03 | 1.61E+03 | 4.12E+03 | 80.2% | 05/15/24 |
| | 718857 | ²⁴⁴ Pu | 4.20E+02 | U | 7.31E+02 | 1.61E+03 | 7.28E+02 | 80.2% | 05/15/24 |
| TI155-B-2-A | 718858 | ²³⁸ Pu | 5.76E+03 | | 2.21E+03 | 1.38E+03 | 2.07E+03 | 88.8% | 05/15/24 |
| | 718858 | ^{239/240} Pu | 2.27E+04 | | 5.07E+03 | 1.38E+03 | 4.06E+03 | 88.8% | 05/15/24 |
| | 718858 | ²⁴⁴ Pu | 0.00E+00 | U | 5.09E+02 | 1.38E+03 | 5.09E+02 | 88.8% | 05/15/24 |
| TI155-B-5-A | 718859 | ²³⁸ Pu | 4.30E+03 | | 2.06E+03 | 1.65E+03 | 1.97E+03 | 78.6% | 05/15/24 |
| | 718859 | ^{239/240} Pu | 2.35E+04 | | 5.55E+03 | 1.65E+03 | 4.52E+03 | 78.6% | 05/15/24 |
| | 718859 | ²⁴⁴ Pu | 1.08E+02 | U | 4.81E+02 | 1.51E+03 | 4.81E+02 | 78.6% | 05/15/24 |

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SOUTHWEST RESEARCH INSTITUTE

CLIENT: Battelle Memorial Institute PNNL

SwRI Project #: 27927.13.001

SwRI Task Order #: 240405-6

SDG #: 718819

TON #: 733437

Raw Data

SOUTHWEST RESEARCH INSTITUTE

CLIENT: Battelle Memorial Institute PNNL

SwRI Project #: 27927.13.001

SwRI Task Order #: 240405-6

SDG #: 718819

TON #: 733437

Alpha Spec
Raw Data

Southwest Research Institute, Division 1, Radiochemistry
Alpha Spectroscopy Bench Sheet
Americium 241, Curium 242,244 (2 sig)

Client: Battelle Memorial Institute PNNL

Task Order: 240405-6

Prep Batch: 20240514-P005

Prep Date: 14-May-24

Project #: 27927.13.001

SRR: 70993

Units: ml

RL: 750 pCi/ml Am241

750 pCi/ml Cm242

750 pCi/ml Cm244

TPU sig factor: 2

2nd Review

EW 5/17/24

Notes:

| Prep Information | | A | B | B1 | C | D1 | D2 | D3 | D | E | F |
|------------------|-------------|----------------------------|-----------------------------|----------|---------|----------------------------------|-------------------------------|------------------------------|----------------------|------------------------------|----------|
| Item | Lab Id | Initial Sample Amount (ml) | Digestion Final Volume (ml) | % Solids | (ml/ml) | Amount used for Column Sep. (ml) | Amount after Column Sep. (ml) | Amount taken for precip (ml) | Equivalent used (mL) | Sample aliquot analyzed (ml) | Total DF |
| 1 | PB24E14KE2 | 0.50 | 50.0 | 100% | 0.0100 | 0.010 | 23 | 23 | 0.010 | 0.00010 | 10000.0 |
| 2 | LCS24E14JT1 | 0.50 | 50.0 | 100% | 0.0100 | 0.010 | 23 | 23 | 0.010 | 0.00010 | 10000.0 |
| 3 | 718821 | 0.50 | 50.0 | 100% | 0.0100 | 0.010 | 23 | 23 | 0.010 | 0.00010 | 10000.0 |
| 4 | 718821D | 0.50 | 50.0 | 100% | 0.0100 | 0.010 | 23 | 23 | 0.010 | 0.00010 | 10000.0 |
| 5 | 718822 | 0.50 | 50.0 | 100% | 0.0100 | 0.0020 | 23 | 23 | 0.002 | 0.00002 | 50000.0 |

Sample Calculations:

$C = (A / B * B1)$

$D = D3 * (D1 / D2)$

$E = (C * D)$

$F = (1 / E)$

$F = 1 / ((A / B * B1) * D)$

Southwest Research Institute, Division 1, Radiochemistry

Alpha Spectroscopy Bench Sheet
Americium 241, Curium 242,244 (2 sig)

| Laboratory Control Sample Information | | Spike Information | |
|---------------------------------------|---------------|-------------------|--|
| Analyte: Am241 | Am241 RL: 750 | | |
| Standard ID: 058RadSol4 | CM242 RL: 750 | | |
| Activity (pCi/ml): 50.1006 | CM244 RL: 750 | | |
| Half-Life (yrs): 432.2 | | | |
| Reference Date: 17-Aug-07 | | | |
| Analysis Date: 5/16/2024 | | | |
| Decay Corrected TV: 48.7727 | | | |
| Volume Used (ml): 0.050 | | | |

| LCS Duplicate Evaluation | |
|--------------------------|----------------|
| RPD | Dup Eval 1 sig |
| N/A | N/A |
| Am241 | |

| Item | Lab Id | Date Analyzed | TRACER | | FWHM | Nuclide | Raw pCi/planchet | | Corrected Activity | Report pCi/ml | | TV | %r | Relative Bias |
|------|-------------|---------------|------------------|-------|------|---------|------------------|----------|--------------------|---------------|----------|----------|----------|---------------|
| | | | Nuclide | Rec % | | | Act | TPU | | Act | TPU (2s) | | | |
| 1 | PB24E14KE2 | 5/16/24 22:39 | Am243 106RadSol4 | 88.4 | 30.2 | AM-241 | 4.79E-03 | 7.58E-03 | 4.16E-02 | 7.57E-03 | 4.79E-03 | 1.52E+02 | 4.16E+02 | 1.51E+02 |
| | | | | | | CM-242 | 0.00E+00 | 6.75E-03 | 3.65E-02 | 6.75E-03 | 0.00E+00 | 1.35E+02 | 3.65E+02 | 1.35E+02 |
| | | | | | | CM-244 | 0.00E+00 | 6.69E-03 | 3.62E-02 | 6.69E-03 | 0.00E+00 | 1.34E+02 | 3.62E+02 | 1.34E+02 |
| 2 | LCS24E14JT1 | 5/16/24 22:39 | Am243 106RadSol4 | 92.0 | 29.7 | AM-241 | 2.55E+00 | 2.37E-01 | 4.84E-02 | 1.11E-01 | 2.55E+00 | 4.73E+03 | 4.84E+02 | 2.23E+03 |
| | | | | | | CM-242 | 0.00E+00 | 6.85E-03 | 3.70E-02 | 6.85E-03 | 0.00E+00 | 1.37E+02 | 3.70E+02 | 1.37E+02 |
| | | | | | | CM-244 | 0.00E+00 | 6.78E-03 | 3.67E-02 | 6.78E-03 | 0.00E+00 | 1.36E+02 | 3.67E+02 | 1.36E+02 |
| 3 | 718821 | 5/16/24 22:39 | Am243 106RadSol4 | 95.0 | 30.0 | AM-241 | 2.52E+01 | 2.08E+00 | 3.89E-02 | 3.36E-01 | 2.52E+01 | 4.16E+04 | 3.89E+02 | 6.71E+03 |
| | | | | | | CM-242 | 1.83E-01 | 3.48E-02 | 3.72E-02 | 3.14E-02 | 1.83E-01 | 6.95E+02 | 3.72E+02 | 6.28E+02 |
| | | | | | | CM-244 | 2.82E-01 | 4.24E-02 | 3.12E-02 | 3.56E-02 | 2.82E-01 | 8.48E+02 | 3.12E+02 | 7.12E+02 |
| 4 | 718821D | 5/16/24 22:39 | Am243 106RadSol4 | 88.5 | 22.7 | AM-241 | 2.55E+01 | 2.12E+00 | 3.48E-02 | 3.55E-01 | 2.55E+01 | 4.25E+04 | 3.48E+02 | 7.10E+03 |
| | | | | | | CM-242 | 1.31E-01 | 3.02E-02 | 4.11E-02 | 2.82E-02 | 1.31E-01 | 6.04E+02 | 4.11E+02 | 5.64E+02 |
| | | | | | | CM-244 | 3.38E-01 | 4.97E-02 | 4.26E-02 | 4.12E-02 | 3.38E-01 | 9.94E+02 | 4.26E+02 | 8.24E+02 |
| 5 | 718822 | 5/16/24 22:39 | Am243 106RadSol4 | 88.0 | 39.7 | AM-241 | 3.33E+00 | 3.00E-01 | 3.33E-02 | 1.26E-01 | 3.33E+00 | 3.00E+04 | 1.67E+03 | 1.26E+04 |
| | | | | | | CM-242 | 5.60E-03 | 7.94E-03 | 4.29E-02 | 7.92E-03 | 5.60E-03 | 7.94E+02 | 2.14E+03 | 7.92E+02 |
| | | | | | | CM-244 | 8.46E-02 | 2.16E-02 | 3.60E-02 | 2.05E-02 | 8.46E-02 | 2.16E+03 | 1.80E+03 | 2.05E+03 |

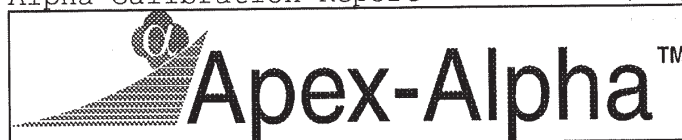
Sample Calculations
G, H, I, J results from Alpha Spec printouts
Duplicate Evaluation =

Am241 G = Planchet Result - Tracer Correction
CM244 G = Planchet Result - Tracer Correction
(Sample-Duplicate) / sqrt ((TPUsample*2) + (TPUdup*2)) ≤ 3

K = G * F
L = H * F * 0.5
M = I * F
N = J * F * 0.5

Alpha Calibration Report

5/17/2024 1:52:09 PM



Battelle Memorial Institute PNNL
OHDO1.13
T0#2404056
20240514-P005
WATN 05/17/24

Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272953.cnf
Detector Name: ALPHA 001
Chamber Serial Number: 05010114A
Detector Serial Number: 91232
Geometry Description: Shelf 2

Energy Calibration: 7/5/2023 3:04:56 PM by Administrator
Shape Calibration: 7/5/2023 3:04:56 PM by Administrator
Efficiency Calibration: 7/5/2023 3:04:57 PM by Administrator
Certificate Name: In8615 - primary

ENERGY / SHAPE CALIBRATION

Version: Alpha Encal v1.1
Energy = 3.428 MeV + 3.0064E-003*ch
FWHM = 2.9876E-002 MeV
Low Tail = 4.2352E-003 MeV

| Energy (MeV) | Centroid Channel | Centroid error | FWHM (ch) | FWHM error | TAIL (ch) | TAIL error |
|--------------|------------------|----------------|-----------|------------|-----------|------------|
| 4.184 | 251.97 | 0.1711 | 8.61 | 0.3911 | 1.17 | 0.1225 |
| 4.761 | 444.45 | 0.2514 | 8.81 | 0.5631 | 1.06 | 0.1533 |
| 5.148 | 571.40 | 0.1490 | 10.34 | 0.3732 | 2.33 | 0.2170 |
| 5.479 | 682.94 | 0.2033 | 12.57 | 0.5325 | 3.77 | 0.4660 |

EFFICIENCY CALIBRATION

Version: Alpha Efcal v1.0
Avg Efficiency: 0.2157
Uncertainty: +/- 0.0026

| Energy (MeV) | Efficiency | Error |
|--------------|-------------|-----------|
| 4.184 | 2.2056E-001 | 5.14E-003 |
| 4.761 | 2.1136E-001 | 4.95E-003 |
| 5.148 | 2.1092E-001 | 5.35E-003 |
| 5.479 | 2.1995E-001 | 5.17E-003 |

Alpha Analysis Report
Page 2 of 4

5/17/2024 1:52:09 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272953.cnf
Batch Identification: 240516AM
Sample Identification: PB24E14KE2
Sample Geometry: Shelf 2
Procedure Description: AmCm - 500min

Detector Name: ALPHA_001
Chamber Serial Number: 05010114A
Detector Serial Number: 91232
Env. Background: System Bkgd 247613
Reagent Blank: <not performed>

Sample Size: 1.000 +/- 0.0000 unit
Sample Date/Time: 5/14/2024 10:30:13 PM
Acquisition Date/Time: 5/16/2024 10:39:20 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

Tracer Certificate: Am243 106RadSol4
Tracer Quantity: 0.100 mL
Effective Efficiency: 0.1906 +/- 0.0111
Counting Efficiency: 0.2157 +/- 0.0026 on 7/5/2023 3:04:57 PM
Chem. Recovery Factor: 0.8838 +/- 0.0527

Peak Match Tolerance: 0.400 MeV

----- PEAK Location REPORT -----

| Nuclide | Left Channel | Channel Width | Right Channel | Left Energy Marker | Right Energy Marker |
|----------|--------------|---------------|---------------|--------------------|---------------------|
| AM-241 | 647 | 66 | 712 | 5372.9 | 5568.3 |
| CM-242 | 848 | 58 | 905 | 5977.2 | 6148.6 |
| AM-243 T | 497 | 149 | 645 | 4921.9 | 5366.9 |
| CM-244 | 752 | 51 | 802 | 5688.6 | 5838.9 |

----- PEAK AREA REPORT -----

| Nuclide | Energy (MeV) | Net Pk Area | Pk Area Error % | Ambient Backgnd | Reagent Backgnd | FWHM (keV) |
|----------|--------------|-------------|-----------------|-----------------|-----------------|------------|
| AM-241 | 5.484 | 1.00 | 158.11 | 1.00 | 0.00E+000 | 3.0 |
| CM-242 | 6.061 | 0.00 | 1000.0 | 0.00 | 0.00E+000 | 0.0 |
| AM-243 T | 5.240 | 1088.00 | 3.03 | 0.00 | 0.00E+000 | 30.2 |
| CM-244 | 5.764 | 0.00 | 1000.0 | 0.00 | 0.00E+000 | 0.0 |

Alpha Analysis Report
Page 3 of 4

5/17/2024 1:52:09 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272953.cnf
Batch Identification: 240516AM
Sample Identification: PB24E14KE2
Sample Geometry: Shelf 2
Procedure Description: AmCm - 500min

Detector Name: ALPHA_001
Chamber Serial Number: 05010114A
Detector Serial Number: 91232

Sample Size: 1.000 unit
Sample Date/Time: 5/14/2024 10:30:13 PM
Acquisition Date/Time: 5/16/2024 10:39:20 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ACTIVITY REPORT

| Nuclide | Energy (MeV) | Activity (pCi/unit) | Activity Error % | MDA (pCi/unit) | MDA Error % |
|---------|-----------------|-------------------------|---------------------|--------------------|----------------|
| AM-241 | | 4.7855E-003 | 158.33 | 4.1610E-002 | 8.19 |
| | 5.479 | 4.7855E-003 | 158.33 | | |
| CM-242 | | 0.0000E+000 | 0.00 | 3.6492E-002 | 8.19 |
| | 6.091 | 0.0000E+000 | 0.00 | | |
| AM-243 | | 5.2171E+000 | 8.19 | 3.6683E-002 | 8.19 |
| | 5.270 | 5.2171E+000 | 8.19 | | |
| CM-244 | | 0.0000E+000 | 0.00 | 3.6162E-002 | 8.19 |
| | 5.795 | 0.0000E+000 | 0.00 | | |

Errors quoted at 1.000 sigma

Alpha NID Report
Page 4 of 4

5/17/2024 1:52:09 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272953.cnf
Batch Identification: 240516AM
Sample Identification: PB24E14KE2
Sample Geometry: Shelf 2
Procedure Description: AmCm - 500min

Detector Name: ALPHA_001
Chamber Serial Number: 05010114A
Detector Serial Number: 91232

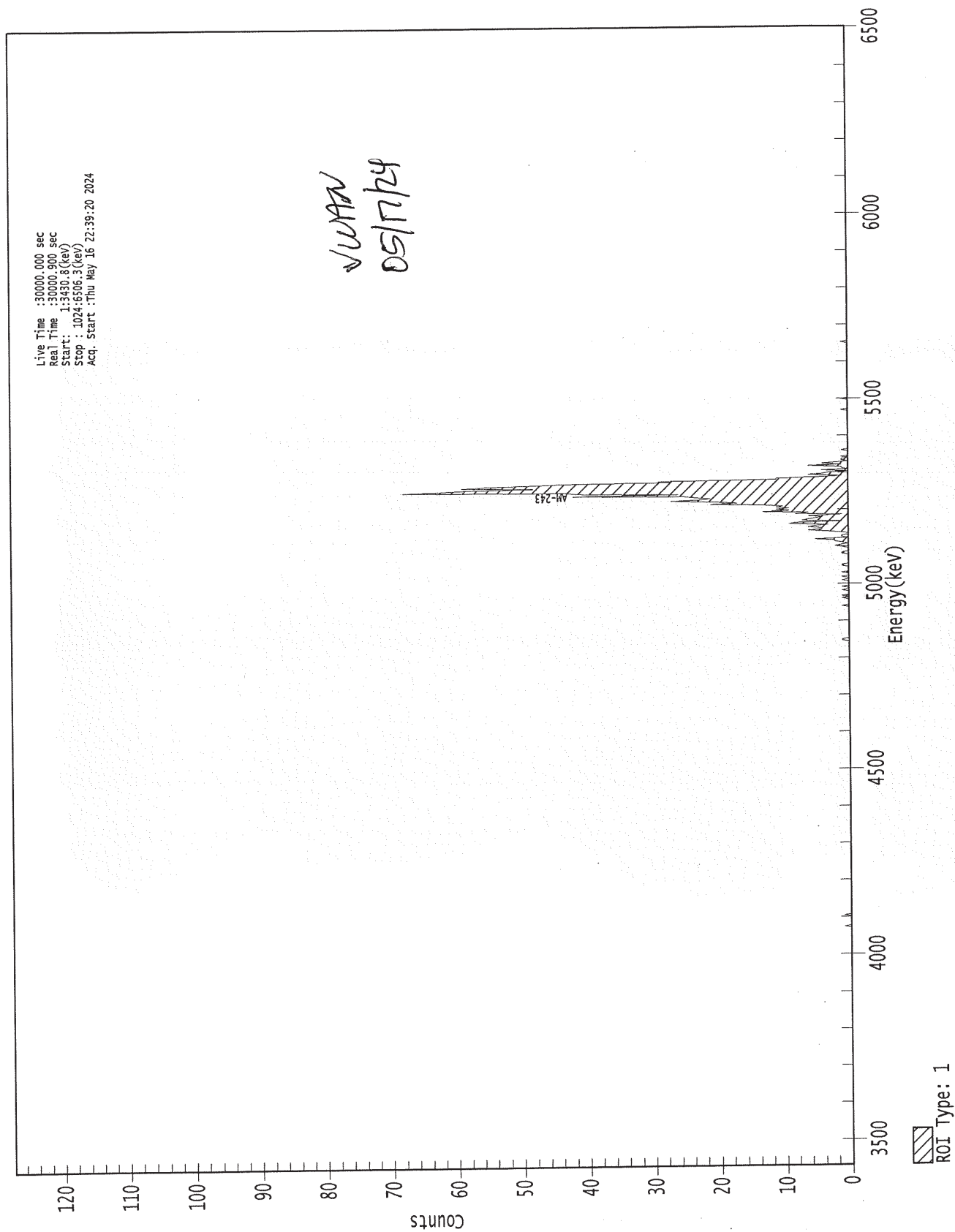
Sample Size: 1.000 unit
Sample Date/Time: 5/14/2024 10:30:13 PM
Acquisition Date/Time: 5/16/2024 10:39:20 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ANALYSIS RESULTS

| Nuclide Name | Id Conf. | Energy (keV) | Activity (pCi/unit) | MDA (pCi/unit) |
|--------------|----------|--------------|---------------------------|---------------------------|
| AM-241 | 1.000 | 5479.10* | 4.785E-003 +/- 7.577E-003 | 4.161E-002 +/- 3.410E-003 |
| CM-242 | 0.999 | 6091.30* | 0.000E+000 +/- 6.752E-003 | 3.649E-002 +/- 2.990E-003 |
| AM-243 | 0.999 | 5270.00* | 5.217E+000 +/- 4.275E-001 | 3.668E-002 +/- 3.006E-003 |
| CM-244 | 0.999 | 5795.00* | 0.000E+000 +/- 6.691E-003 | 3.616E-002 +/- 2.963E-003 |

Activity reported as of : 5/16/24 10:39:20 PM

0000272953.CNF



Alpha Calibration Report

5/17/2024 1:53:06 PM



Sample Description:

Spectrum File: \\V79W-7\AlphaRoot\Data\0000272954.cnf
Detector Name: ALPHA 002
Chamber Serial Number: 05010114B
Detector Serial Number: 91233
Geometry Description: Shelf 2

Energy Calibration: 8/11/2022 3:27:51 PM by Administrator
Shape Calibration: 8/11/2022 3:27:51 PM by Administrator
Efficiency Calibration: 8/11/2022 3:27:52 PM by Administrator
Certificate Name: In7861 - primary

ENERGY / SHAPE CALIBRATION

Version: Alpha Encal v1.1
Energy = 3.456 MeV + 3.0198E-003*ch
FWHM = 3.1654E-002 MeV
Low Tail = 5.0862E-003 MeV

| Energy (MeV) | Centroid Channel | Centroid error | FWHM (ch) | FWHM error | TAIL (ch) | TAIL error |
|-----------------|---------------------|-------------------|--------------|---------------|--------------|---------------|
| 4.184 | 241.80 | 0.2028 | 9.31 | 0.4704 | 1.41 | 0.1672 |
| 4.761 | 433.32 | 0.2847 | 9.08 | 0.6471 | 1.19 | 0.1929 |
| 5.148 | 559.23 | 0.1617 | 10.45 | 0.4025 | 2.24 | 0.2195 |
| 5.479 | 670.59 | 0.1952 | 12.74 | 0.5037 | 3.78 | 0.4275 |

EFFICIENCY CALIBRATION

Version: Alpha Efcad v1.0
Avg Efficiency: 0.2044
Uncertainty: +/- 0.0025

| Energy (MeV) | Efficiency | Error |
|-----------------|-------------|-----------|
| 4.184 | 1.9530E-001 | 4.93E-003 |
| 4.761 | 2.0175E-001 | 4.98E-003 |
| 5.148 | 2.1125E-001 | 5.19E-003 |
| 5.479 | 2.1055E-001 | 5.21E-003 |

Alpha Analysis Report
Page 2 of 4

5/17/2024 1:53:07 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272954.cnf
Batch Identification: 240516AM
Sample Identification: LCS24E14JT1
Sample Geometry: Shelf 2
Procedure Description: AmCm - 500min

Detector Name: ALPHA_002
Chamber Serial Number: 05010114B
Detector Serial Number: 91233
Env. Background: System Bkgd 247614
Reagent Blank: <not performed>

Sample Size: 1.000 +/- 0.0000 unit
Sample Date/Time: 5/14/2024 10:30:13 PM
Acquisition Date/Time: 5/16/2024 10:39:22 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

Tracer Certificate: Am243 106RadSol4
Tracer Quantity: 0.100 mL
Effective Efficiency: 0.1880 +/- 0.0110
Counting Efficiency: 0.2044 +/- 0.0025 on 8/11/2022 3:27:52 PM
Chem. Recovery Factor: 0.9197 +/- 0.0551

Control Certificate Name: Am241 058RadSol4
Chem. Recov. of Control: 1.0436
Peak Match Tolerance: 0.400 MeV

----- PEAK Location REPORT -----

| Nuclide | Left Channel | Channel Width | Right Channel | Left Energy Marker | Right Energy Marker |
|----------|--------------|---------------|---------------|--------------------|---------------------|
| AM-241 | 623 | 78 | 700 | 5337.4 | 5570.0 |
| CM-242 | 835 | 58 | 892 | 5977.6 | 6149.8 |
| AM-243 T | 509 | 115 | 623 | 4993.2 | 5337.4 |
| CM-244 | 739 | 51 | 789 | 5687.7 | 5838.7 |

----- PEAK AREA REPORT -----

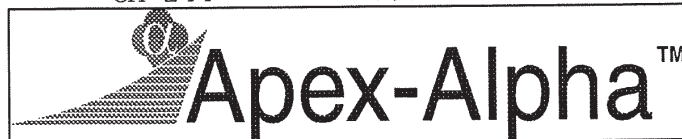
| Nuclide | Energy (MeV) | Net Pk Area | Pk Area Error % | Ambient Backgnd | Reagent Backgnd | FWHM (keV) |
|----------|--------------|-------------|-----------------|-----------------|-----------------|------------|
| AM-241 | 5.440 | 524.50 | 4.38 | 1.50 | 0.00E+000 | 17.5 |
| CM-242 | 6.062 | 0.00 | 1000.0 | 0.00 | 0.00E+000 | 0.0 |
| AM-243 T | 5.229 | 1073.00 | 3.05 | 1.00 | 0.00E+000 | 29.7 |

Alpha Analysis Report

5/17/2024 1:53:07 PM

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CM-244 5.763 0.00 1000.0 0.00 0.00E+000 0.0



Sample Description:

Spectrum File: \\V79W-7\AlphaRoot\Data\0000272954.cnf
Batch Identification: 240516AM
Sample Identification: LCS24E14JT1
Sample Geometry: Shelf 2
Procedure Description: AmCm - 500min

Detector Name: ALPHA 002
Chamber Serial Number: 05010114B
Detector Serial Number: 91233

Sample Size: 1.000 unit
Sample Date/Time: 5/14/2024 10:30:13 PM
Acquisition Date/Time: 5/16/2024 10:39:22 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ACTIVITY REPORT

| Nuclide | Energy (MeV) | Activity (pCi/unit) | Activity Error % | MDA (pCi/unit) | MDA Error % |
|---------|-----------------|-------------------------|---------------------|--------------------|----------------|
| AM-241 | | 2.5451E+000 | 9.30 | 4.8402E-002 | 8.20 |
| | 5.479 | 2.5451E+000 | 9.30 | | |
| CM-242 | | 0.0000E+000 | 0.00 | 3.7002E-002 | 8.20 |
| | 6.091 | 0.0000E+000 | 0.00 | | |
| AM-243 | | 5.2171E+000 | 8.20 | 4.2277E-002 | 8.20 |
| | 5.270 | 5.2171E+000 | 8.20 | | |
| CM-244 | | 0.0000E+000 | 0.00 | 3.6668E-002 | 8.20 |
| | 5.795 | 0.0000E+000 | 0.00 | | |

Errors quoted at 1.000 sigma

Alpha NID Report
Page 4 of 4

5/17/2024 1:53:07 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272954.cnf
Batch Identification: 240516AM
Sample Identification: LCS24E14JT1
Sample Geometry: Shelf 2
Procedure Description: AmCm - 500min

Detector Name: ALPHA_002
Chamber Serial Number: 05010114B
Detector Serial Number: 91233

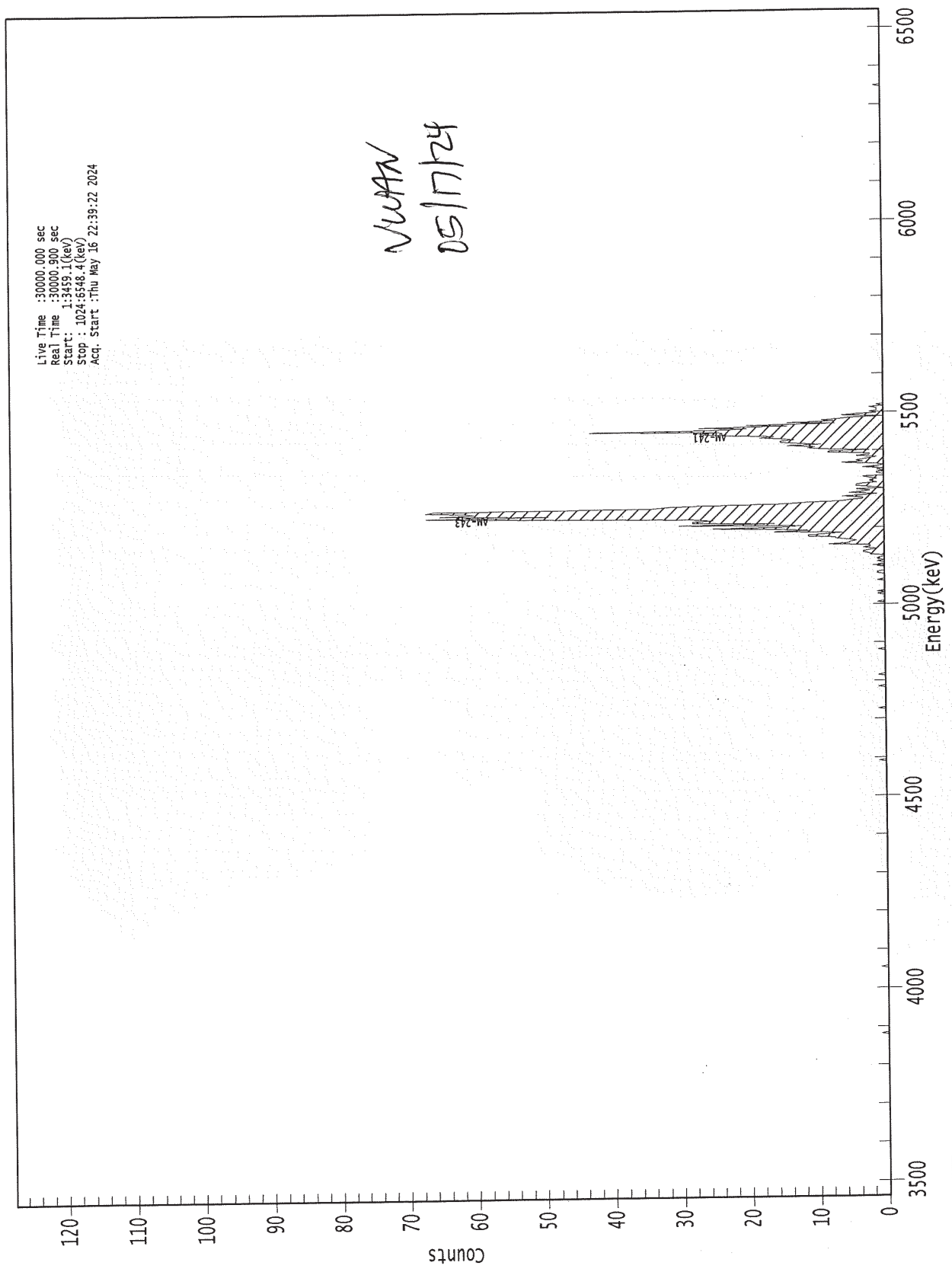
Sample Size: 1.000 unit
Sample Date/Time: 5/14/2024 10:30:13 PM
Acquisition Date/Time: 5/16/2024 10:39:22 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ANALYSIS RESULTS

| Nuclide Name | Id Conf. | Energy (keV) | Activity (pCi/unit) | MDA (pCi/unit) |
|--------------|----------|--------------|---------------------------|---------------------------|
| AM-241 | 0.998 | 5479.10* | 2.545E+000 +/- 2.366E-001 | 4.840E-002 +/- 3.970E-003 |
| CM-242 | 0.999 | 6091.30* | 0.000E+000 +/- 6.846E-003 | 3.700E-002 +/- 3.035E-003 |
| AM-243 | 0.998 | 5270.00* | 5.217E+000 +/- 4.279E-001 | 4.228E-002 +/- 3.468E-003 |
| CM-244 | 0.999 | 5795.00* | 0.000E+000 +/- 6.784E-003 | 3.667E-002 +/- 3.008E-003 |

Activity reported as of : 5/16/24 10:39:22 PM

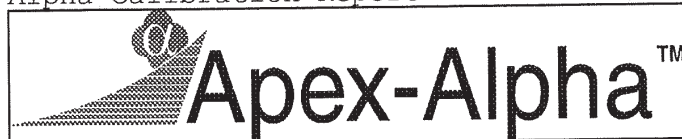
0000272954.CNF



ROI Type: 1

Alpha Calibration Report

5/17/2024 1:54:03 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272955.cnf
Detector Name: ALPHA 003
Chamber Serial Number: 02068349A
Detector Serial Number: 165822
Geometry Description: Shelf 2

Energy Calibration: 8/26/2023 12:34:42 AM by Administrator
Shape Calibration: 8/26/2023 12:34:42 AM by Administrator
Efficiency Calibration: 8/26/2023 12:34:43 AM by Administrator
Certificate Name: In8615 - primary

ENERGY / SHAPE CALIBRATION

Version: Alpha Encal v1.1
Energy = 3.401 MeV + 2.9952E-003*ch
FWHM = 2.4989E-002 MeV
Low Tail = 3.2158E-003 MeV

| Energy (MeV) | Centroid Channel | Centroid error | FWHM (ch) | FWHM error | TAIL (ch) | TAIL error |
|-----------------|---------------------|-------------------|--------------|---------------|--------------|---------------|
| 4.184 | 261.32 | 0.1620 | 7.74 | 0.3689 | 1.04 | 0.1132 |
| 4.761 | 455.55 | 0.2121 | 7.04 | 0.4626 | 0.67 | 0.0963 |
| 5.148 | 582.82 | 0.1039 | 8.32 | 0.2509 | 1.56 | 0.1154 |
| 5.479 | 694.45 | 0.2233 | 12.06 | 0.5849 | 3.58 | 0.5028 |

EFFICIENCY CALIBRATION

Version: Alpha Efcad v1.0
Avg Efficiency: 0.2146
Uncertainty: +/- 0.0026

| Energy (MeV) | Efficiency | Error |
|-----------------|-------------|-----------|
| 4.184 | 2.1477E-001 | 5.04E-003 |
| 4.761 | 2.1253E-001 | 4.97E-003 |
| 5.148 | 2.1390E-001 | 5.41E-003 |
| 5.479 | 2.1711E-001 | 5.12E-003 |

Alpha Analysis Report
Page 2 of 4

5/17/2024 1:54:03 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272955.cnf
Batch Identification: 240516AM
Sample Identification: 718821
Sample Geometry: Shelf 2
Procedure Description: AmCm - 500min

Detector Name: ALPHA_003
Chamber Serial Number: 02068349A
Detector Serial Number: 165822
Env. Background: System Bkgd 247615
Reagent Blank: <not performed>

Sample Size: 1.000 +/- 0.0000 unit
Sample Date/Time: 4/4/2024 10:30:13 PM
Acquisition Date/Time: 5/16/2024 10:39:24 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

Tracer Certificate: Am243 106RadSol4
Tracer Quantity: 0.100 mL
Effective Efficiency: 0.2038 +/- 0.0118
Counting Efficiency: 0.2146 +/- 0.0026 on 8/26/2023 12:34:43 AM
Chem. Recovery Factor: 0.9497 +/- 0.0562

Peak Match Tolerance: 0.400 MeV

PEAK Location REPORT

| Nuclide | Left Channel | Channel Width | Right Channel | Left Energy Marker | Right Energy Marker |
|---------|--------------|---------------|---------------|--------------------|---------------------|
| AM-241 | 637 | 88 | 724 | 5308.9 | 5569.5 |
| CM-242 | 861 | 57 | 917 | 5979.8 | 6147.5 |
| AM-243 | T 539 | 100 | 638 | 5015.4 | 5311.9 |
| CM-244 | 764 | 51 | 814 | 5689.3 | 5839.0 |

PEAK AREA REPORT

| Nuclide | Energy (MeV) | Net Pk Area | Pk Area Error % | Ambient Backgnd | Reagent Backgnd | FWHM (keV) |
|---------|--------------|-------------|-----------------|-----------------|-----------------|------------|
| AM-241 | 5.469 | 5621.00 | 1.33 | 1.00 | 0.00E+000 | 32.0 |
| CM-242 | 6.104 | 34.50 | 17.21 | 0.50 | 0.00E+000 | 4.4 |
| AM-243 | T 5.249 | 1163.00 | 2.93 | 1.00 | 0.00E+000 | 30.0 |
| CM-244 | 5.779 | 63.50 | 12.62 | 0.50 | 0.00E+000 | 6.0 |

Alpha Analysis Report
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5/17/2024 1:54:03 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272955.cnf
Batch Identification: 240516AM
Sample Identification: 718821
Sample Geometry: Shelf 2
Procedure Description: AmCm - 500min

Detector Name: ALPHA_003
Chamber Serial Number: 02068349A
Detector Serial Number: 165822

Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 10:30:13 PM
Acquisition Date/Time: 5/16/2024 10:39:24 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ACTIVITY REPORT

| Nuclide | Energy (MeV) | Activity (pCi/unit) | Activity Error % | MDA (pCi/unit) | MDA Error % |
|---------|-----------------|-------------------------|---------------------|--------------------|----------------|
| AM-241 | | 2.5169E+001 | 8.27 | 3.8933E-002 | 8.16 |
| | 5.479 | 2.5169E+001 | 8.27 | | |
| CM-242 | | 1.8254E-001 | 19.05 | 3.7180E-002 | 8.16 |
| | 6.091 | 1.8254E-001 | 19.05 | | |
| AM-243 | | 5.2172E+000 | 8.16 | 3.9006E-002 | 8.16 |
| | 5.270 | 5.2172E+000 | 8.16 | | |
| CM-244 | | 2.8199E-001 | 15.03 | 3.1206E-002 | 8.16 |
| | 5.795 | 2.8199E-001 | 15.03 | | |

Errors quoted at 1.000 sigma

Alpha NID Report
Page 4 of 4

5/17/2024 1:54:03 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272955.cnf
Batch Identification: 240516AM
Sample Identification: 718821
Sample Geometry: Shelf 2
Procedure Description: AmCm - 500min

Detector Name: ALPHA_003
Chamber Serial Number: 02068349A
Detector Serial Number: 165822

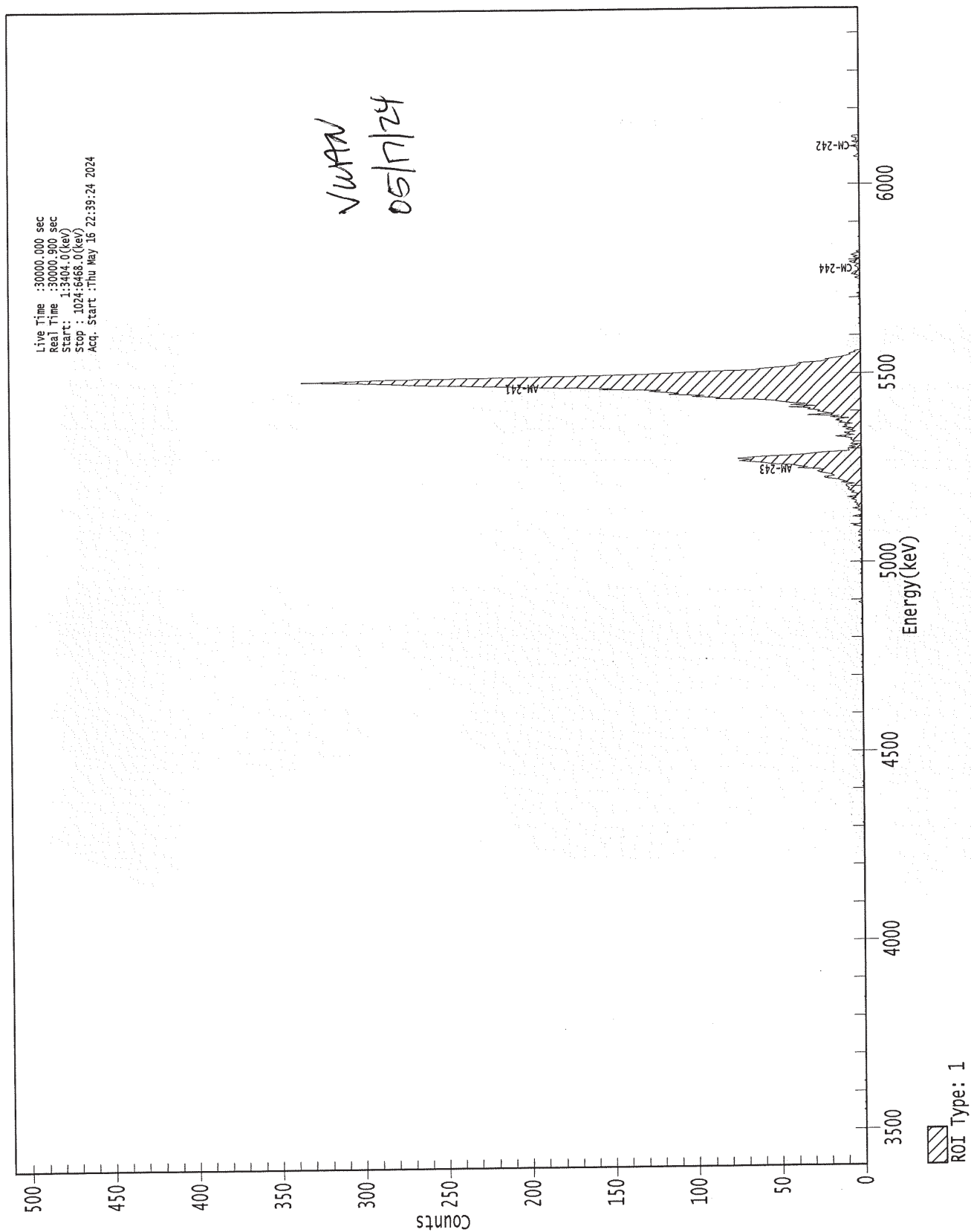
Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 10:30:13 PM
Acquisition Date/Time: 5/16/2024 10:39:24 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ANALYSIS RESULTS

| Nuclide Name | Id Conf. | Energy (keV) | Activity (pCi/unit) | MDA (pCi/unit) |
|-----------------|-------------|-----------------|---------------------------|---------------------------|
| AM-241 | 1.000 | 5479.10* | 2.517E+001 +/- 2.081E+000 | 3.893E-002 +/- 3.176E-003 |
| CM-242 | 1.000 | 6091.30* | 1.825E-001 +/- 3.477E-002 | 3.718E-002 +/- 3.033E-003 |
| AM-243 | 1.000 | 5270.00* | 5.217E+000 +/- 4.256E-001 | 3.901E-002 +/- 3.182E-003 |
| CM-244 | 1.000 | 5795.00* | 2.820E-001 +/- 4.238E-002 | 3.121E-002 +/- 2.546E-003 |

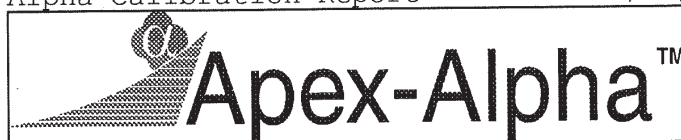
Activity reported as of : 5/16/24 10:39:24 PM

0000272955.CNF



Alpha Calibration Report

5/17/2024 1:54:51 PM



Sample Description:

Spectrum File: \\V79W-7\AlphaRoot\Data\0000272956.cnf
Detector Name: ALPHA 004
Chamber Serial Number: 02068349B
Detector Serial Number: 165823
Geometry Description: Shelf 2

Energy Calibration: 8/26/2023 12:34:53 AM by Administrator
Shape Calibration: 8/26/2023 12:34:53 AM by Administrator
Efficiency Calibration: 8/26/2023 12:34:54 AM by Administrator
Certificate Name: In7861 - primary

ENERGY / SHAPE CALIBRATION

Version: Alpha Encal v1.1
Energy = 3.391 MeV + 2.9913E-003*ch
FWHM = 2.5552E-002 MeV
Low Tail = 3.3199E-003 MeV

| Energy (MeV) | Centroid Channel | Centroid error | FWHM (ch) | FWHM error | TAIL (ch) | TAIL error |
|-----------------|---------------------|-------------------|--------------|---------------|--------------|---------------|
| 4.184 | 264.90 | 0.2033 | 8.27 | 0.4687 | 1.20 | 0.1580 |
| 4.761 | 459.47 | 0.2055 | 7.02 | 0.4497 | 0.71 | 0.1003 |
| 5.148 | 586.62 | 0.1193 | 8.15 | 0.2853 | 1.44 | 0.1214 |
| 5.479 | 698.59 | 0.1904 | 11.86 | 0.4946 | 3.39 | 0.4041 |

EFFICIENCY CALIBRATION

Version: Alpha Efcal v1.0
Avg Efficiency: 0.2084
Uncertainty: +/- 0.0026

| Energy (MeV) | Efficiency | Error |
|-----------------|-------------|-----------|
| 4.184 | 2.0576E-001 | 5.13E-003 |
| 4.761 | 2.0777E-001 | 5.08E-003 |
| 5.148 | 2.0847E-001 | 5.14E-003 |
| 5.479 | 2.1191E-001 | 5.24E-003 |

Alpha Analysis Report
Page 2 of 4

5/17/2024 1:54:51 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272956.cnf
Batch Identification: 240516AM
Sample Identification: 718821D
Sample Geometry: Shelf 2
Procedure Description: AmCm - 500min

Detector Name: ALPHA_004
Chamber Serial Number: 02068349B
Detector Serial Number: 165823
Env. Background: System Bkgd 247616
Reagent Blank: <not performed>

Sample Size: 1.000 +/- 0.0000 unit
Sample Date/Time: 4/4/2024 10:30:13 PM
Acquisition Date/Time: 5/16/2024 10:39:26 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

Tracer Certificate: Am243 106RadSol4
Tracer Quantity: 0.100 mL
Effective Efficiency: 0.1845 +/- 0.0108
Counting Efficiency: 0.2084 +/- 0.0026 on 8/26/2023 12:34:54 AM
Chem. Recovery Factor: 0.8851 +/- 0.0531

Peak Match Tolerance: 0.400 MeV

PEAK Location REPORT

| Nuclide | Left Channel | Channel Width | Right Channel | Left Energy Marker | Right Energy Marker |
|----------|--------------|---------------|---------------|--------------------|---------------------|
| AM-241 | 643 | 86 | 728 | 5314.6 | 5568.8 |
| CM-242 | 865 | 58 | 922 | 5978.6 | 6149.2 |
| AM-243 T | 526 | 118 | 643 | 4964.6 | 5314.6 |
| CM-244 | 768 | 51 | 818 | 5688.5 | 5838.1 |

PEAK AREA REPORT

| Nuclide | Energy (MeV) | Net Pk Area | Pk Area Error % | Ambient Backgnd | Reagent Backgnd | FWHM (keV) |
|----------|--------------|-------------|-----------------|-----------------|-----------------|------------|
| AM-241 | 5.471 | 5154.50 | 1.39 | 0.50 | 0.00E+000 | 31.7 |
| CM-242 | 6.097 | 22.50 | 21.43 | 0.50 | 0.00E+000 | 8.0 |
| AM-243 T | 5.255 | 1053.00 | 3.09 | 2.00 | 0.00E+000 | 22.7 |
| CM-244 | 5.784 | 69.00 | 12.17 | 1.00 | 0.00E+000 | 4.5 |

Alpha Analysis Report
Page 3 of 4

5/17/2024 1:54:51 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272956.cnf
Batch Identification: 240516AM
Sample Identification: 718821D
Sample Geometry: Shelf 2
Procedure Description: AmCm - 500min

Detector Name: ALPHA_004
Chamber Serial Number: 02068349B
Detector Serial Number: 165823

Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 10:30:13 PM
Acquisition Date/Time: 5/16/2024 10:39:26 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ACTIVITY REPORT

| Nuclide | Energy (MeV) | Activity (pCi/unit) | Activity Error % | MDA (pCi/unit) | MDA Error % |
|---------|-----------------|-------------------------|---------------------|--------------------|----------------|
| AM-241 | | 2.5491E+001 | 8.33 | 3.4751E-002 | 8.21 |
| | 5.479 | 2.5491E+001 | 8.33 | | |
| CM-242 | | 1.3149E-001 | 22.95 | 4.1065E-002 | 8.21 |
| | 6.091 | 1.3149E-001 | 22.95 | | |
| AM-243 | | 5.2172E+000 | 8.21 | 5.4768E-002 | 8.21 |
| | 5.270 | 5.2172E+000 | 8.21 | | |
| CM-244 | | 3.3843E-001 | 14.68 | 4.2647E-002 | 8.21 |
| | 5.795 | 3.3843E-001 | 14.68 | | |

Errors quoted at 1.000 sigma

Alpha NID Report
Page 4 of 4

5/17/2024 1:54:52 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272956.cnf
Batch Identification: 240516AM
Sample Identification: 718821D
Sample Geometry: Shelf 2
Procedure Description: AmCm - 500min

Detector Name: ALPHA 004
Chamber Serial Number: 02068349B
Detector Serial Number: 165823

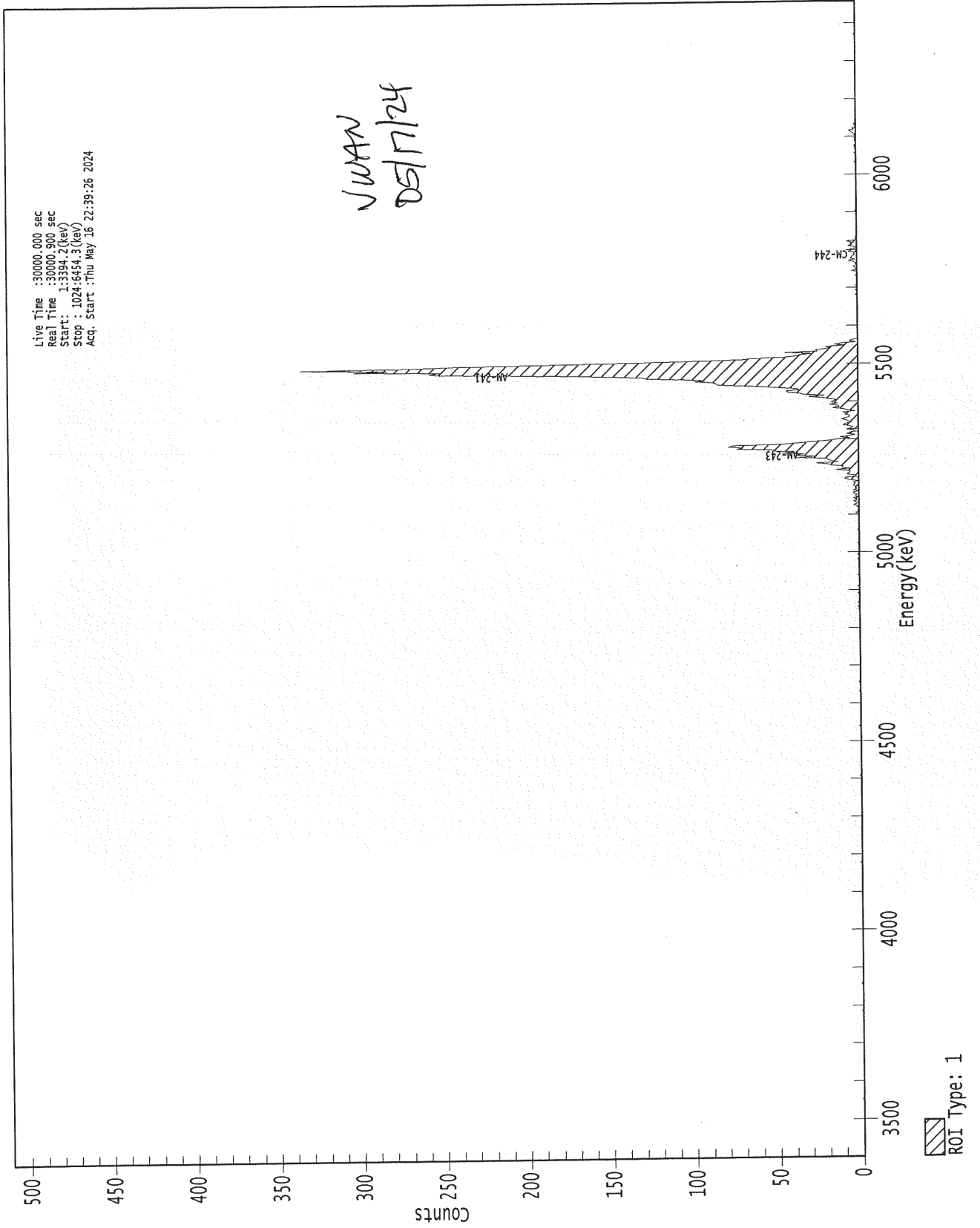
Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 10:30:13 PM
Acquisition Date/Time: 5/16/2024 10:39:26 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ANALYSIS RESULTS

| Nuclide Name | Id Conf. | Energy (keV) | Activity (pCi/unit) | MDA (pCi/unit) | |
|--------------|----------|--------------|---------------------------|-----------------|----------------|
| AM-241 | 1.000 | 5479.10* | 2.549E+001 +/- 2.124E+000 | 3.475E-002 | +/- 2.855E-003 |
| CM-242 | 1.000 | 6091.30* | 1.315E-001 +/- 3.018E-002 | 4.106E-002 | +/- 3.373E-003 |
| AM-243 | 1.000 | 5270.00* | 5.217E+000 +/- 4.285E-001 | 5.477E-002 | +/- 4.499E-003 |
| CM-244 | 1.000 | 5795.00* | 3.384E-001 +/- 4.969E-002 | 4.265E-002 | +/- 3.503E-003 |

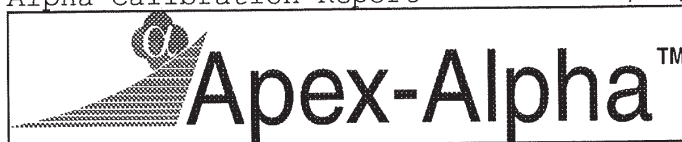
Activity reported as of : 5/16/24 10:39:26 PM

0000272956.CNF



Alpha Calibration Report

5/17/2024 1:55:38 PM



Sample Description:

Spectrum File: \\V79W-7\AlphaRoot\Data\0000272957.cnf
Detector Name: ALPHA 005
Chamber Serial Number: 05010224A
Detector Serial Number: 159381
Geometry Description: Shelf 2

Energy Calibration: 2/8/2023 9:17:28 PM by Administrator
Shape Calibration: 2/8/2023 9:17:28 PM by Administrator
Efficiency Calibration: 2/8/2023 9:17:29 PM by Administrator
Certificate Name: In8615 - primary

ENERGY / SHAPE CALIBRATION

Version: Alpha Encal v1.1
Energy = 3.440 MeV + 3.0066E-003*ch
FWHM = 2.8672E-002 MeV
Low Tail = 3.4417E-003 MeV

| Energy (MeV) | Centroid Channel | Centroid error | FWHM (ch) | FWHM error | TAIL (ch) | TAIL error |
|-----------------|---------------------|-------------------|--------------|---------------|--------------|---------------|
| 4.184 | 247.84 | 0.1662 | 8.01 | 0.3722 | 0.92 | 0.0953 |
| 4.761 | 440.30 | 0.2523 | 8.17 | 0.5551 | 0.87 | 0.1310 |
| 5.148 | 566.78 | 0.1636 | 10.29 | 0.3950 | 1.93 | 0.1816 |
| 5.479 | 678.82 | 0.2024 | 12.31 | 0.5113 | 2.94 | 0.3221 |

EFFICIENCY CALIBRATION

Version: Alpha Efcad v1.0
Avg Efficiency: 0.2188
Uncertainty: +/- 0.0026

| Energy (MeV) | Efficiency | Error |
|-----------------|-------------|-----------|
| 4.184 | 2.2169E-001 | 5.15E-003 |
| 4.761 | 2.1624E-001 | 5.03E-003 |
| 5.148 | 2.1413E-001 | 5.41E-003 |
| 5.479 | 2.2275E-001 | 5.21E-003 |

Alpha Analysis Report
Page 2 of 4

5/17/2024 1:55:38 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272957.cnf
Batch Identification: 240516AM
Sample Identification: 718822
Sample Geometry: Shelf 2
Procedure Description: AmCm - 500min

Detector Name: ALPHA_005
Chamber Serial Number: 05010224A
Detector Serial Number: 159381
Env. Background: System Bkgd 247617
Reagent Blank: <not performed>

Sample Size: 1.000 +/- 0.0000 unit
Sample Date/Time: 4/4/2024 10:30:13 PM
Acquisition Date/Time: 5/16/2024 10:39:28 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

Tracer Certificate: Am243 106RadSol4
Tracer Quantity: 0.100 mL
Effective Efficiency: 0.1925 +/- 0.0112
Counting Efficiency: 0.2188 +/- 0.0026 on 2/8/2023 9:17:29 PM
Chem. Recovery Factor: 0.8798 +/- 0.0524

Peak Match Tolerance: 0.400 MeV

PEAK Location REPORT

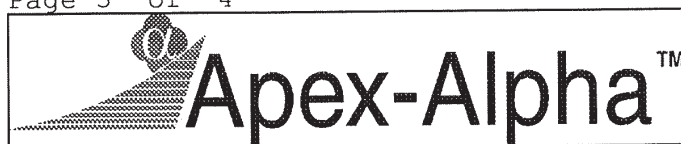
| Nuclide | Left Channel | Channel Width | Right Channel | Left Energy Marker | Right Energy Marker |
|----------|--------------|---------------|---------------|--------------------|---------------------|
| AM-241 | 637 | 72 | 708 | 5355.7 | 5569.2 |
| CM-242 | 844 | 58 | 901 | 5978.1 | 6149.4 |
| AM-243 T | 517 | 122 | 638 | 4994.9 | 5358.7 |
| CM-244 | 748 | 51 | 798 | 5689.4 | 5839.8 |

PEAK AREA REPORT

| Nuclide | Energy (MeV) | Net Pk Area | Pk Area Error % | Ambient Backgnd | Reagent Backgnd | FWHM (keV) |
|----------|--------------|-------------|-----------------|-----------------|-----------------|------------|
| AM-241 | 5.465 | 702.50 | 3.77 | 0.50 | 0.00E+000 | 33.2 |
| CM-242 | 6.107 | 1.00 | 141.42 | 0.00 | 0.00E+000 | 3.0 |
| AM-243 T | 5.249 | 1098.50 | 3.02 | 1.50 | 0.00E+000 | 39.7 |
| CM-244 | 5.774 | 18.00 | 24.22 | 0.00 | 0.00E+000 | 4.5 |

Alpha Analysis Report
Page 3 of 4

5/17/2024 1:55:38 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272957.cnf
Batch Identification: 240516AM
Sample Identification: 718822
Sample Geometry: Shelf 2
Procedure Description: AmCm - 500min

Detector Name: ALPHA_005
Chamber Serial Number: 05010224A
Detector Serial Number: 159381

Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 10:30:13 PM
Acquisition Date/Time: 5/16/2024 10:39:28 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ACTIVITY REPORT

| Nuclide | Energy (MeV) | Activity (pCi/unit) | Activity Error % | MDA (pCi/unit) | MDA Error % |
|---------|-----------------|-------------------------|---------------------|--------------------|----------------|
| AM-241 | | 3.3302E+000 | 9.02 | 3.3312E-002 | 8.19 |
| | 5.479 | 3.3302E+000 | 9.02 | | |
| CM-242 | | 5.6018E-003 | 141.66 | 4.2853E-002 | 8.19 |
| | 6.091 | 5.6018E-003 | 141.66 | | |
| AM-243 | | 5.2172E+000 | 8.19 | 4.7375E-002 | 8.19 |
| | 5.270 | 5.2172E+000 | 8.19 | | |
| CM-244 | | 8.4628E-002 | 25.56 | 3.5967E-002 | 8.19 |
| | 5.795 | 8.4628E-002 | 25.56 | | |

Errors quoted at 1.000 sigma

Alpha NID Report 5/17/2024 1:55:39 PM
Page 4 of 4



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272957.cnf
Batch Identification: 240516AM
Sample Identification: 718822
Sample Geometry: Shelf 2
Procedure Description: AmCm - 500min

Detector Name: ALPHA_005
Chamber Serial Number: 05010224A
Detector Serial Number: 159381

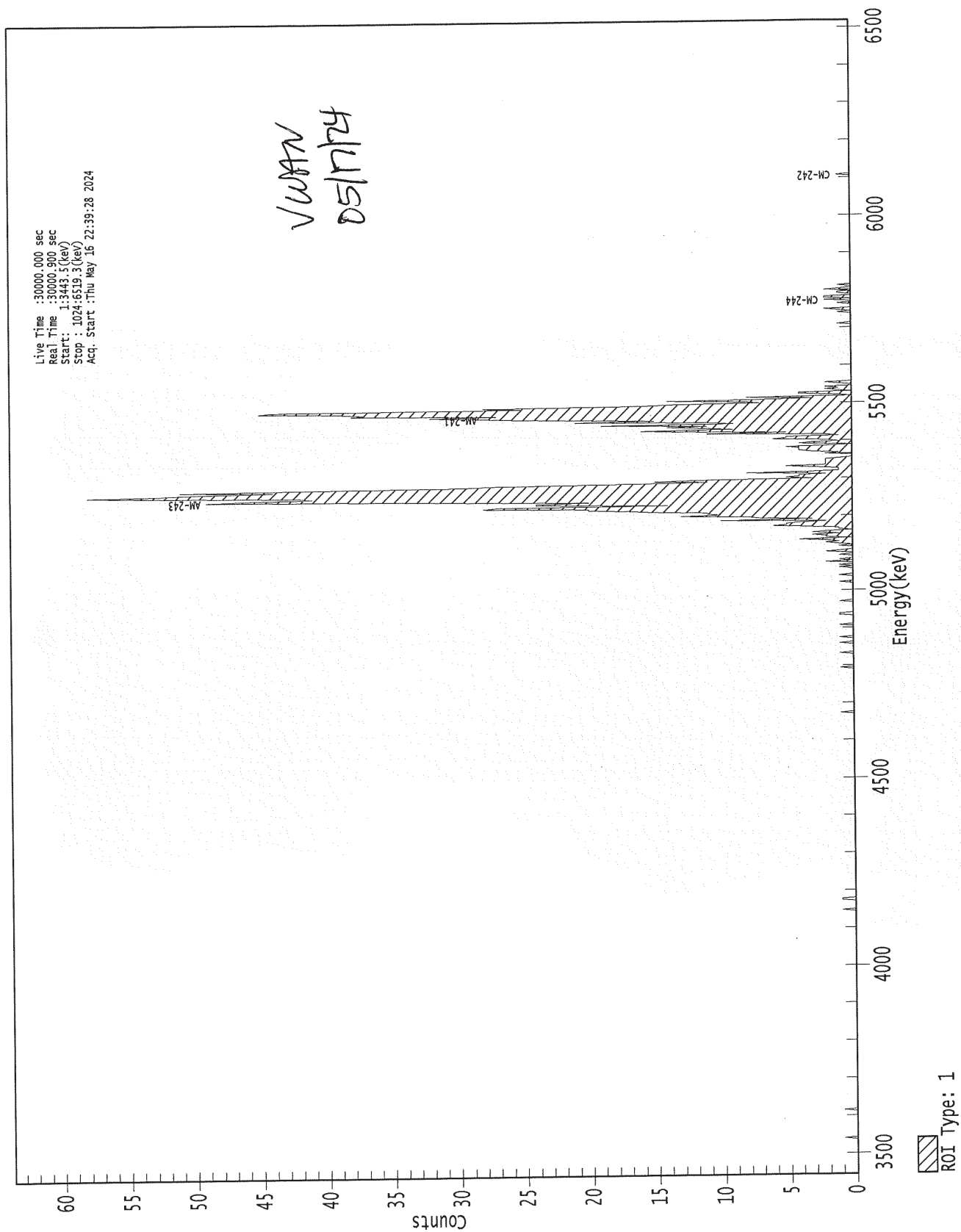
Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 10:30:13 PM
Acquisition Date/Time: 5/16/2024 10:39:28 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ANALYSIS RESULTS

| Nuclide Name | Id Conf. | Energy (keV) | Activity (pCi/unit) | MDA (pCi/unit) |
|-----------------|-------------|-----------------|---------------------------|---------------------------|
| AM-241 | 1.000 | 5479.10* | 3.330E+000 +/- 3.003E-001 | 3.331E-002 +/- 2.728E-003 |
| CM-242 | 0.999 | 6091.30* | 5.602E-003 +/- 7.935E-003 | 4.285E-002 +/- 3.510E-003 |
| AM-243 | 1.000 | 5270.00* | 5.217E+000 +/- 4.273E-001 | 4.737E-002 +/- 3.880E-003 |
| CM-244 | 1.000 | 5795.00* | 8.463E-002 +/- 2.163E-002 | 3.597E-002 +/- 2.946E-003 |

Activity reported as of : 5/16/24 10:39:28 PM

0000272957.CNF



Southwest Research Institute, Division 1, Radiochemistry
Alpha Spectroscopy Bench Sheet
Neptunium 237 (2 sig)

Client: Battelle Memorial Institute PNNL
Task Order: 240405-6
Prep Batch: 20240514-P006
Prep Date: 14-May-24
Separation: 5/16/24 14:12

Project #: 27927.13.001
SRR: 70993
Units: ml
RL: 75 pCi/ml
TPU sig factor: 2

2nd Review
EW 5/17/24

WAW 05/17/24

| Prep Information | | A | B | C | D1 | D2 | D3 | D | E | F |
|------------------|-------------|----------------------------|-----------------------------|------------------|----------------------------------|-------------------------------|------------------------------|----------------------|------------------------------|----------|
| Item | Lab Id | Initial Sample Amount (ml) | Digestion Final Volume (ml) | % Solids (ml/ml) | Amount used for Column Sep. (mL) | Amount after Column Sep. (mL) | Amount taken for precip (mL) | Equivalent used (mL) | Sample aliquot analyzed (ml) | Total DF |
| 1 | PB24E14KE2 | 0.50 | 50.0 | 100.0% | 0.01000 | 10.0 | 10.0 | 0.10 | 0.00100 | 1000 |
| 2 | LCS24E14JT2 | 0.50 | 50.0 | 100.0% | 0.01000 | 10.0 | 10.0 | 0.10 | 0.00100 | 1000 |
| 3 | 718821 | 0.50 | 50.0 | 100.0% | 0.01000 | 10.0 | 10.0 | 0.10 | 0.00100 | 1000 |
| 4 | 718821D | 0.50 | 50.0 | 100.0% | 0.01000 | 10.0 | 10.0 | 0.10 | 0.00100 | 1000 |
| 5 | 718822 | 0.50 | 50.0 | 100.0% | 0.01000 | 10.0 | 10.0 | 0.10 | 0.00100 | 1000 |

Sample Calculations:

$C = (A / B)$
 $D = D3 * (D1 / D2)$
 $E = (C * D)$
 $F = (1 / E)$
 $F = 1 / ((A / B) * D)$

Southwest Research Institute, Division 1, Radiochemistry

Alpha Spectroscopy Bench Sheet
Neptunium 237 (2 sig)

| Laboratory Control Sample Information | | Spike Information | |
|---------------------------------------|------------|-------------------|------|
| Analyte: | Np237 | | |
| Standard ID: | 090RadSol4 | | |
| Activity (pCi/ml): | 21.8983 | Np237 RL: | 75.0 |
| Half-Life (yrs): | 2140000 | | |
| Reference Date: | 1-Sep-12 | | |
| Analysis Date: | 5/16/2024 | | |
| Decay Corrected TV: | 21.898 | | |
| Volume Used (ml): | 0.125 | Volume Used (ml): | N/A |

| Item | Lab Id | Date Analyzed | TRACER | | | G | | | H | | | I | | | J | | | K | | | L | | | M | | | N | | |
|------|-------------|---------------|---------|--------|------|---------|------------------|----------|----------|---------------|-----------|----------|---------------|----------|----------|----------|----------------|---|--|--|---|--|--|---|--|--|---|--|--|
| | | | Nuclide | Rec % | FWHM | Nuclide | Raw pCi/planchet | | ERR | Report pCi/ml | | TV | Relative Bias | | | | | | | | | | | | | | | | |
| | | | | | | | Act | TPU | | MDC | Act | | | TPU (2s) | MDC | ERR (2s) | % | | | | | | | | | | | | |
| 1 | 1PB24E14KE2 | 5/16/24 22:39 | N/A | 81.6% | 0.0 | NP-237 | -2.69E-03 | 6.02E-03 | 3.78E-02 | 6.01E-03 | -2.69E+00 | 1.20E+01 | 3.78E+01 | 1.20E+01 | 2.25E+02 | 2737.3 | PB < 3*TPU | | | | | | | | | | | | |
| 2 | 1CS24E14JT2 | 5/16/24 22:39 | N/A | 93.5% | 0.0 | NP-237 | 2.69E+00 | 1.94E-01 | 3.59E-02 | 1.12E-01 | 2.69E+03 | 3.87E+02 | 3.59E+01 | 2.25E+02 | 3.33E+01 | RPD | Dup Eval 1 sig | | | | | | | | | | | | |
| 3 | 718821 | 5/16/24 22:39 | N/A | 97.8% | 0.0 | NP-237 | 5.79E-02 | 1.70E-02 | 3.41E-02 | 1.67E-02 | 5.79E+01 | 3.40E+01 | 3.41E+01 | 2.37E+01 | 93.8 | 1.8 | Pass | | | | | | | | | | | | |
| 4 | 718821D | 5/16/24 22:39 | N/A | 105.2% | 0.0 | NP-237 | 2.09E-02 | 1.19E-02 | 4.62E-02 | 1.18E-02 | 2.09E+01 | 2.38E+01 | 4.62E+01 | 2.37E+01 | 4.17E+01 | | | | | | | | | | | | | | |
| 5 | 718822 | 5/16/24 22:39 | N/A | 97.2% | 0.0 | NP-237 | 9.03E-02 | 2.15E-02 | 3.25E-02 | 2.08E-02 | 9.03E+01 | 4.30E+01 | 3.25E+01 | 4.17E+01 | | | | | | | | | | | | | | | |

Sample Calculations

G, H, I, J results from Alpha Spec printouts

Duplicate Evaluation =

$$F^*G=K$$

U
*
I
=

$$M^* = I$$

$$\mathbb{E}^* \cup \mathbb{N}$$

$$(\text{Sample-Duplicate}) / \sqrt{(\text{TPUsample}^2) + (\text{TPUdup}^2)} \leq 3$$

Southwest Research Institute, Division 1, Radiochemistry
Gas Flow Proportional Counting Bench Sheet
Np-239 Tracer 2 sig

Client: Battelle Memorial Institute PNNL
Task Order: 240405-6
Prep Batch: 20240514-P006
Prep Date: 14-May-24
Separation: 5/16/24 14:12

Project #: 27927.13.001
SRR: 70993
Units: ml
RL: 75 pCi/ml
TPU Sig Factor: 2

WAV 05/17/24

| Prep Info | | A | | B | B1 | C | D | E | F | | | Alpha to Beta x-talk | End of Sample Elution |
|-------------|-----------------------|-------------|-----------------------------|----------|---------|----------------------|------------------------------|-------------------|--------------------------|---------------------|----------------|----------------------|-----------------------|
| Lab Id | Initial Sample Amount | Sample (ml) | Digestion Final Volume (ml) | % Solids | (ml/ml) | Amount Separate (mL) | Sample Aliquot Analyzed (ml) | Total Prep Factor | Planchet Tare weight (g) | Planchet Sample (g) | Sample wt (mg) | Beta Eff | |
| PB24E14KE2 | 0.50 | | 50.0 | 100.0% | 0.01000 | 0.10 | 0.00100 | 1000.00 | 1.000 | 1.000 | 0.0 | 53.9% | 5/16/24 14:12 |
| LCS24E14JT2 | 0.50 | | 50.0 | 100.0% | 0.01000 | 0.10 | 0.00100 | 1000.00 | 1.000 | 1.000 | 0.0 | 53.9% | 5/16/24 14:12 |
| 718821 | 0.50 | | 50.0 | 100.0% | 0.01000 | 0.10 | 0.00100 | 1000.00 | 1.000 | 1.000 | 0.0 | 53.9% | 5/16/24 14:12 |
| 718821D | 0.50 | | 50.0 | 100.0% | 0.01000 | 0.10 | 0.00100 | 1000.00 | 1.000 | 1.000 | 0.0 | 53.9% | 5/16/24 14:12 |
| 718822 | 0.50 | | 50.0 | 100.0% | 0.01000 | 0.10 | 0.00100 | 1000.00 | 1.000 | 1.000 | 0.0 | 53.9% | 5/16/24 14:12 |
| | | | | | | | | | | | | | |

Sample Calculations:

$C = (A / B * B1)$ $E = (C * D)$ $F = (1 / E)$
 $F = 1 / ((A / B * B1) * D)$

Southwest Research Institute, Division 1, Radiochemistry
Gas Flow Proportional Counting Bench Sheet
Np-239 Tracer 2 sig

Client: Battelle Memorial Institute PNNL
Task Order: 240405-6
Prep Batch: 20240514-P006
Prep Date: 14-May-24
Separation: 5/16/24 14:12

Project #: 27927.13.001
SRR: 70993
Units: ml
RL: 75 pCi/ml
TPU Sig Factor: 2

| GPC Spec Results Beta | | | | | | | | | |
|-----------------------|-------------|--------|-------------------|------------|------------|-------------|-------------|-----------|----------|
| Analyzed | Lab Id | Matrix | Analysis Midpoint | G | | | H | | |
| | | | | Time (min) | Beta (cpm) | Error (cpm) | Alpha (cpm) | Beta Act | TPU (2s) |
| | PB24E14KE2 | Liquid | 5/16/24 19:19 | 30 | 38.454 | 1.132 | 1.033 | 31557.0 | 4256.34 |
| | LCS24E14JT2 | Liquid | 5/16/24 19:50 | 30 | 44.185 | 1.213 | 2.599 | 35951.5 | 4827.39 |
| | 718821 | Liquid | 5/16/24 20:20 | 30 | 45.518 | 1.232 | 1.333 | 37381.4 | 4960.76 |
| | 718821D | Liquid | 5/16/24 20:51 | 30 | 48.650 | 1.273 | 1.566 | 39938.8 | 5272.19 |
| | 718822 | Liquid | 5/16/24 21:21 | 30 | 44.618 | 1.219 | 1.066 | 36896.6 | 4870.57 |
| Report pCi/ml | | | | | | | | | |
| Tracer Recovery | | | | | | | | | |
| Decay Corr. Rec | | | | | | | | | |
| %r | | | | | | | | | |
| | | | | | | | | Corr. Act | %r |
| | | | | | | | | 33599.3 | 81.6% |
| | | | | | | | | 38521.3 | 93.5% |
| | | | | | | | | 40299.7 | 97.8% |
| | | | | | | | | 43330.2 | 105.2% |
| | | | | | | | | 40057.4 | 97.2% |

| Bkg | Bkg Date | Bkg Time | Beta Bkg | Beta Error | Alpha Bkg | Alpha Error |
|---------|----------|----------|----------|------------|-----------|-------------|
| 4hr Bkg | 5/1/24 | 240 | 0.367 | 0.039 | 0.029 | 0.011 |

| Tracer Information | |
|--------------------------|----------------|
| Analyte: Am243/Np239 | Np237 RL: 75.0 |
| Standard ID: 106RadSol4 | |
| Activity (pCi/ml): 51.49 | |
| Half-Life (days): 2.3565 | |
| Volume Used (ml): 0.80 | |

G, H, I results from GPC printouts
J - Activity pCi/g = (Beta cpm-avg bkg-(Net Alpha cpm*Alpha Cross Talk)/Beta Eff./2.22/Sample Amount
K - TPU pCi/g = Sqrt(Counting Error^2+CPM*TPU%^2) /Beta Eff/2.22/Sample Amount
L - MDC pCi/g = (4.65*SQRT((AVG(bkg cpm))/Time))/((Beta Eff*Sample Amt)/2.22+3/(Beta Eff * Sample Amt * Time)/ 2.22
RPD = | Sample - Duplicate | / Average (Sample,Duplicate) * 100
Duplicate Evaluation = (Sample-Duplicate) / sqrt ((TPUsample^2) + (TPUdup^2)) ≤ 3

| TPU Factors | % |
|---------------------|-------|
| Aliquot Amount | 2.00% |
| Standards | 5.00% |
| Recovery Stds Error | 2.50% |
| TPU of net Counts | 5.94% |

| | | Beta | | Alpha | | Net | |
|---------------------|------------|----------|-------|----------|-------|----------|--------|
| | | Activity | Error | Activity | Beta | Activity | %Eff |
| Cal std 1 | 084RadSol4 | 51.150 | 1.306 | 25.891 | 43.04 | 82.66 | 52.07% |
| Cal std 2 | 084RadSol4 | 55.681 | 1.362 | 26.091 | 47.51 | 85.13 | 55.81% |
| Average Efficiency: | | | | | | | 53.94% |

Alpha/Beta Count Results

Sample Activity Report

PIC IPC 650 - A

Battelle Memorial Institute PNL
27927.13.001
TO# 2404056
20240514-POD6
WAN 05/17/24

Addr: 0

Sample ID CAL1

Repeat 132

Np

Carrier No. 1

Batch ID 240516NP

Count Method Np Tracer - Gross Alpha/Beta

Detector Volts 1575

Sample Qty 1 Sample sd 0 Sample
Residual Wt 0 mg sd 0 mg

Count Began 5/16/2024 6:03:20 PM

Collection Date 1 1/1/1900

Half Life 0.00 days

Count Ended 5/16/2024 6:33:22 PM

Collection Date 2 1/1/1900

Decay Factor 1.000

Sample Count Time 30.01 mins Background Count Time .00 mins

| | Efficiency % | Attenuation Factor | Activity Divisor | Background cpm | Gross counts | Gross cpm | Net cpm |
|--------|--------------|--------------------|------------------|----------------|--------------|-----------|---------|
| Alpha | 0.000 | 0.000 | 1.000 | 0.000 | 777 | 25.891 | 25.891 |
| sd | 0.000 | | | 0.000 | 27.875 | 0.929 | 0.929 |
| A to B | 0.000 | 0.000 | | | | 0.000 | |
| sd | 0.000 | | | | | 0.000 | |
| Beta | 0.000 | 0.000 | 1.000 | 0.000 | 1,535 | 51.150 | 51.150 |
| sd | 0.000 | | | 0.000 | 39.179 | 1.306 | 1.306 |

| | Net Activity dpm | LLD dpm | MDC DPM | MPC DPM | Net Concentration * DPM | Conc / MPC Ratio |
|-------|------------------|---------|---------|---------|-------------------------|------------------|
| Alpha | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 ± 0.000 | 0.000 |
| sd | 0.000 | | | | 0.000 | |
| Beta | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 ± 0.000 | 0.000 |
| sd | 0.000 | | | | 0.000 | |

* Note: Decay Corrected

MDC Method Currie

Error = .00 x sd

Alpha/Beta Count Results

Sample Activity Report

PIC IPC 650 - A

Addr: 0

Sample ID CAL2

Repeat 82

Np

Carrier No. 2

Batch ID 240516NP

Count Method Np Tracer - Gross Alpha/Beta

Detector Volts 1575

Sample Qty 1 Sample sd 0 Sample
Residual Wt 0 mg sd 0 mg

Count Began 5/16/2024 6:33:53 PM

Collection Date 1 1/1/1900

Half Life 0.00 days

Count Ended 5/16/2024 7:03:55 PM

Collection Date 2 1/1/1900

Decay Factor 1.000

Sample Count Time 30.01 mins

Background Count Time .00 mins

| | Efficiency % | Attenuation Factor | Activity Divisor | Background cpm | Gross counts | Gross cpm | Net cpm |
|--------|--------------|--------------------|------------------|----------------|--------------|-----------|---------|
| Alpha | 0.000 | 0.000 | 1.000 | 0.000 | 783 | 26.091 | 26.091 |
| sd | 0.000 | | | 0.000 | 27.982 | 0.932 | 0.932 |
| A to B | 0.000 | 0.000 | | | | 0.000 | |
| sd | 0.000 | | | | | 0.000 | |
| Beta | 0.000 | 0.000 | 1.000 | 0.000 | 1,671 | 55.681 | 55.681 |
| sd | 0.000 | | | 0.000 | 40.878 | 1.362 | 1.362 |

| | Net Activity dpm | LLD dpm | MDC DPM | MPC DPM | Net Concentration * DPM | Conc / MPC Ratio |
|-------|------------------|---------|---------|---------|-------------------------|------------------|
| Alpha | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 ± 0.000 | 0.000 |
| sd | 0.000 | | | | 0.000 | |
| Beta | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 ± 0.000 | 0.000 |
| sd | 0.000 | | | | 0.000 | |

* Note: Decay Corrected

MDC Method Currie

Error = .00 x sd

Alpha/Beta Count Results

Sample Activity Report

PIC IPC 650 - A

Addr: 0

Sample ID PB24E14KE2

Repeat 1

Np

Carrier No. 4

Batch ID 240516NP

Count Method Np Tracer - Gross Alpha/Beta

Detector Volts 1575

Sample Qty 1 Sample sd 0 Sample
Residual Wt 0 mg sd 0 mg

Count Began 5/16/2024 7:04:26 PM

Collection Date 1 1/1/1900

Half Life 0.00 days

Count Ended 5/16/2024 7:34:28 PM

Collection Date 2 1/1/1900

Decay Factor 1.000

Sample Count Time 30.01 mins Background Count Time .00 mins

| | Efficiency % | Attenuation Factor | Activity Divisor | Background cpm | Gross counts | Gross cpm | Net cpm |
|--------|--------------|--------------------|------------------|----------------|--------------|-----------|---------|
| Alpha | 0.000 | 0.000 | 1.000 | 0.000 | 31 | 1.033 | 1.033 |
| sd | 0.000 | | | 0.000 | 5.568 | 0.186 | 0.186 |
| A to B | 0.000 | 0.000 | | | | 0.000 | |
| sd | 0.000 | | | | | 0.000 | |
| Beta | 0.000 | 0.000 | 1.000 | 0.000 | 1,154 | 38.454 | 38.454 |
| sd | 0.000 | | | 0.000 | 33.971 | 1.132 | 1.132 |

| | Net Activity dpm | LLD dpm | MDC DPM | MPC DPM | Net Concentration * DPM | Conc / MPC Ratio |
|-------|------------------|---------|---------|---------|-------------------------|------------------|
| Alpha | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 ± 0.000 | 0.000 |
| sd | 0.000 | | | | 0.000 | |
| Beta | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 ± 0.000 | 0.000 |
| sd | 0.000 | | | | 0.000 | |

* Note: Decay Corrected

MDC Method Currie

Error = .00 x sd

Alpha/Beta Count Results

Sample Activity Report

PIC IPC 650 - A

Addr: 0

Sample ID LCS24E14JT2

Repeat 1

Np

Carrier No. 5

Batch ID 240516NP

Count Method Np Tracer - Gross Alpha/Beta

Detector Volts 1575

Sample Qty 1 Sample sd 0 Sample

Residual Wt 0 mg sd 0 mg

Count Began 5/16/2024 7:34:58 PM

Collection Date 1 1/1/1900

Half Life 0.00 days

Count Ended 5/16/2024 8:05:01 PM

Collection Date 2 1/1/1900

Decay Factor 1.000

Sample Count Time 30.01 mins

Background Count Time .00 mins

| | Efficiency % | Attenuation Factor | Activity Divisor | Background cpm | Gross counts | Gross cpm | Net cpm |
|--------|--------------|--------------------|------------------|----------------|--------------|-----------|---------|
| Alpha | 0.000 | 0.000 | 1.000 | 0.000 | 78 | 2.599 | 2.599 |
| sd | 0.000 | | | 0.000 | 8.832 | 0.294 | 0.294 |
| A to B | 0.000 | 0.000 | | | | 0.000 | |
| sd | 0.000 | | | | | 0.000 | |
| Beta | 0.000 | 0.000 | 1.000 | 0.000 | 1,326 | 44.185 | 44.185 |
| sd | 0.000 | | | 0.000 | 36.414 | 1.213 | 1.213 |

| | Net Activity dpm | LLD dpm | MDC DPM | MPC DPM | Net Concentration * DPM | Conc / MPC Ratio |
|-------|------------------|---------|---------|---------|-------------------------|------------------|
| Alpha | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 ± 0.000 | 0.000 |
| sd | 0.000 | | | | 0.000 | |

| | | | | | | |
|------|-------|-------|-------|-------|---------------|-------|
| Beta | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 ± 0.000 | 0.000 |
| sd | 0.000 | | | | 0.000 | |

* Note: Decay Corrected

MDC Method Currie

Error = .00 x sd

Alpha/Beta Count Results

Sample Activity Report

PIC IPC 650 - A

Addr: 0

Sample ID 718821

Repeat 1

Np

Carrier No. 6

Batch ID 240516NP

Count Method Np Tracer - Gross Alpha/Beta

Detector Volts 1575

Sample Qty 1 Sample sd 0 Sample

Residual Wt 0 mg sd 0 mg

Count Began 5/16/2024 8:05:31 PM

Collection Date 1 1/1/1900

Half Life 0.00 days

Count Ended 5/16/2024 8:35:33 PM

Collection Date 2 1/1/1900

Decay Factor 1.000

Sample Count Time 30.01 mins

Background Count Time .00 mins

| | Efficiency % | Attenuation Factor | Activity Divisor | Background cpm | Gross counts | Gross cpm | Net cpm |
|--------|--------------|--------------------|------------------|----------------|--------------|-----------|---------|
| Alpha | 0.000 | 0.000 | 1.000 | 0.000 | 40 | 1.333 | 1.333 |
| sd | 0.000 | | | 0.000 | 6.325 | 0.211 | 0.211 |
| A to B | 0.000 | 0.000 | | | | 0.000 | |
| sd | 0.000 | | | | | 0.000 | |
| Beta | 0.000 | 0.000 | 1.000 | 0.000 | 1,366 | 45.518 | 45.518 |
| sd | 0.000 | | | 0.000 | 36.959 | 1.232 | 1.232 |

| | Net Activity dpm | LLD dpm | MDC DPM | MPC DPM | Net Concentration * DPM | Conc / MPC Ratio |
|-------|------------------|---------|---------|---------|-------------------------|------------------|
| Alpha | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 ± 0.000 | 0.000 |
| sd | 0.000 | | | | 0.000 | |
| Beta | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 ± 0.000 | 0.000 |
| sd | 0.000 | | | | 0.000 | |

* Note: Decay Corrected

MDC Method Currie

Error = .00 x sd

Alpha/Beta Count Results

Sample Activity Report

PIC IPC 650 - A

Addr: 0

Sample ID 718821D

Repeat 1

Np

Carrier No. 7

Batch ID 240516NP

Count Method Np Tracer - Gross Alpha/Beta

Detector Volts 1575

Sample Qty 1 Sample sd 0 Sample

Residual Wt 0 mg sd 0 mg

Count Began 5/16/2024 8:36:04 PM

Collection Date 1 1/1/1900

Half Life 0.00 days

Count Ended 5/16/2024 9:06:06 PM

Collection Date 2 1/1/1900

Decay Factor 1.000

Sample Count Time 30.01 mins

Background Count Time .00 mins

| | Efficiency % | Attenuation Factor | Activity Divisor | Background cpm | Gross counts | Gross cpm | Net cpm |
|--------|--------------|--------------------|------------------|----------------|--------------|-----------|---------|
| Alpha | 0.000 | 0.000 | 1.000 | 0.000 | 47 | 1.566 | 1.566 |
| sd | 0.000 | | | 0.000 | 6.856 | 0.228 | 0.228 |
| A to B | 0.000 | 0.000 | | | | 0.000 | |
| sd | 0.000 | | | | | 0.000 | |
| Beta | 0.000 | 0.000 | 1.000 | 0.000 | 1,460 | 48.650 | 48.650 |
| sd | 0.000 | | | 0.000 | 38.210 | 1.273 | 1.273 |

| | Net Activity dpm | LLD dpm | MDC DPM | MPC DPM | Net Concentration * DPM | Conc / MPC Ratio |
|-------|------------------|---------|---------|---------|-------------------------|------------------|
| Alpha | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 ± 0.000 | 0.000 |
| sd | 0.000 | | | | 0.000 | |

| | | | | | | |
|------|-------|-------|-------|-------|---------------|-------|
| Beta | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 ± 0.000 | 0.000 |
| sd | 0.000 | | | | 0.000 | |

* Note: Decay Corrected

MDC Method Currie

Error = .00 x sd

Alpha/Beta Count Results

Sample Activity Report

PIC IPC 650 - A

Addr: 0

| | | |
|---|----------------|------|
| Sample ID 718822 | Repeat | 1 |
| Np | Carrier No. | 8 |
| Batch ID 240516NP | | |
| Count Method Np Tracer - Gross Alpha/Beta | Detector Volts | 1575 |

Sample Qty 1 *Sample* sd 0 *Sample*
Residual Wt 0 *mg* sd 0 *mg*

Count Began 5/16/2024 9:06:37 PM Collection Date 1 1/1/1900 Half Life 0.00 *days*
Count Ended 5/16/2024 9:36:39 PM Collection Date 2 1/1/1900 Decay Factor 1.000

Sample Count Time 30.01 *mins* Background Count Time .00 *mins*

| | Efficiency % | Attenuation Factor | Activity Divisor | Background cpm | Gross counts | Gross cpm | Net cpm |
|--------|--------------|--------------------|------------------|----------------|--------------|-----------|---------|
| Alpha | 0.000 | 0.000 | 1.000 | 0.000 | 32 | 1.066 | 1.066 |
| sd | 0.000 | | | 0.000 | 5.657 | 0.188 | 0.188 |
| A to B | 0.000 | 0.000 | | | | 0.000 | |
| sd | 0.000 | | | | | 0.000 | |
| Beta | 0.000 | 0.000 | 1.000 | 0.000 | 1,339 | 44.618 | 44.618 |
| sd | 0.000 | | | 0.000 | 36.592 | 1.219 | 1.219 |

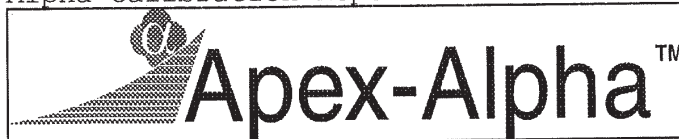
| | Net Activity dpm | LLD dpm | MDC DPM | MPC DPM | Net Concentration * DPM | Conc / MPC Ratio |
|-------|------------------|---------|---------|---------|-------------------------|------------------|
| Alpha | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 ± 0.000 | 0.000 |
| sd | 0.000 | | | | 0.000 | |

| | | | | | | |
|------|-------|-------|-------|-------|---------------|-------|
| Beta | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 ± 0.000 | 0.000 |
| sd | 0.000 | | | | 0.000 | |

* Note: Decay Corrected MDC Method Currie Error = .00 x sd

Alpha Calibration Report

5/17/2024 1:47:51 PM



Battelle Memorial Institute PNNL
21927.13.001
TO#2404056
20240514-P006
WAN 05/17/24

Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272948.cnf
Detector Name: ALPHA 006
Chamber Serial Number: 05010224B
Detector Serial Number: 159382
Geometry Description: Shelf 2

Energy Calibration: 6/6/2023 4:03:24 PM by Administrator
Shape Calibration: 6/6/2023 4:03:24 PM by Administrator
Efficiency Calibration: 6/6/2023 4:03:26 PM by Administrator
Certificate Name: In7861 - primary

ENERGY / SHAPE CALIBRATION

Version: Alpha Encal v1.1
Energy = 3.445 MeV + 3.0102E-003*ch
FWHM = 2.8236E-002 MeV
Low Tail = 3.7434E-003 MeV

| Energy (MeV) | Centroid Channel | Centroid error | FWHM (ch) | FWHM error | TAIL (ch) | TAIL error |
|--------------|------------------|----------------|-----------|------------|-----------|------------|
| 4.184 | 245.82 | 0.2457 | 9.27 | 0.5590 | 1.25 | 0.1727 |
| 4.761 | 438.80 | 0.2362 | 7.95 | 0.5219 | 0.82 | 0.1185 |
| 5.148 | 565.12 | 0.1355 | 9.20 | 0.3198 | 1.54 | 0.1280 |
| 5.479 | 676.70 | 0.2307 | 11.87 | 0.5818 | 2.80 | 0.3603 |

EFFICIENCY CALIBRATION

Version: Alpha Efcad v1.0
Avg Efficiency: 0.2148
Uncertainty: +/- 0.0026

| Energy (MeV) | Efficiency | Error |
|--------------|-------------|-----------|
| 4.184 | 2.1060E-001 | 5.22E-003 |
| 4.761 | 2.1959E-001 | 5.29E-003 |
| 5.148 | 2.1545E-001 | 5.27E-003 |
| 5.479 | 2.1354E-001 | 5.27E-003 |

Alpha Analysis Report
Page 2 of 4

5/17/2024 1:47:51 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272948.cnf
Batch Identification: 240516NP
Sample Identification: PB24E14KE2
Sample Geometry: Shelf 2
Procedure Description: Np - 500min

Detector Name: ALPHA_006
Chamber Serial Number: 05010224B
Detector Serial Number: 159382
Env. Background: System Bkgd 247618
Reagent Blank: <not performed>

Sample Size: 1.000 +/- 0.0000 unit
Sample Date/Time: 5/14/2024 10:33:52 PM
Acquisition Date/Time: 5/16/2024 10:39:30 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

Chem. Recovery Factor: 0.8160 +/- 0.0000
Counting Efficiency: 0.2148 +/- 0.0026 on 6/6/2023 4:03:26 PM
Effective Efficiency: 0.1752 +/- 0.0021

Peak Match Tolerance: 0.200 MeV

PEAK Location REPORT

| Nuclide | Left Channel | Channel Width | Right Channel | Left Energy Marker | Right Energy Marker |
|---------|--------------|---------------|---------------|--------------------|---------------------|
| NP-237 | 377 | 107 | 483 | 4579.4 | 4898.5 |

PEAK AREA REPORT

| Nuclide | Energy (MeV) | Net Pk Area | Pk Area Error % | Ambient Backgnd | Reagent Backgnd | FWHM (keV) |
|---------|--------------|-------------|-----------------|-----------------|-----------------|------------|
| NP-237 | 4.739 | -0.50 | 223.61 | 0.50 | 0.00E+000 | 0.0 |

Alpha Analysis Report
Page 3 of 4

5/17/2024 1:47:51 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272948.cnf
Batch Identification: 240516NP
Sample Identification: PB24E14KE2
Sample Geometry: Shelf 2
Procedure Description: Np - 500min

Detector Name: ALPHA_006
Chamber Serial Number: 05010224B
Detector Serial Number: 159382

Sample Size: 1.000 unit
Sample Date/Time: 5/14/2024 10:33:52 PM
Acquisition Date/Time: 5/16/2024 10:39:30 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

----- NUCLIDE ACTIVITY REPORT -----

| Nuclide | Energy (MeV) | Activity (pCi/unit) | Activity Error % | MDA (pCi/unit) | MDA Error % |
|---------|-----------------|-------------------------|---------------------|--------------------|----------------|
| NP-237 | | -2.6894E-003 | -223.6 | 3.7797E-002 | 5.87 |
| | 4.769 | -2.6894E-003 | -223.6 | | |

Errors quoted at 1.000 sigma

Alpha NID Report
Page 4 of 4

5/17/2024 1:47:51 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272948.cnf
Batch Identification: 240516NP
Sample Identification: PB24E14KE2
Sample Geometry: Shelf 2
Procedure Description: Np - 500min

Detector Name: ALPHA_006
Chamber Serial Number: 05010224B
Detector Serial Number: 159382

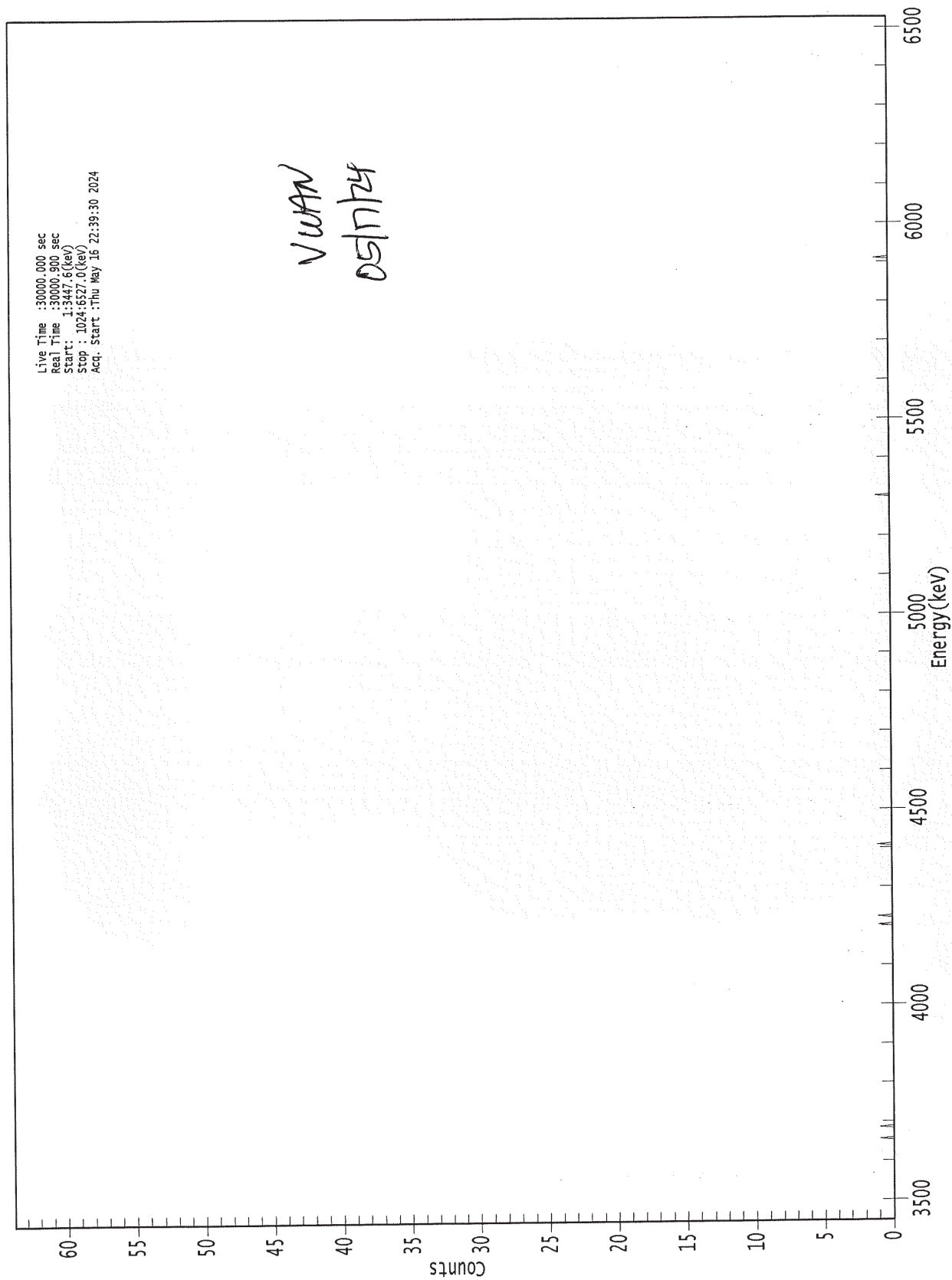
Sample Size: 1.000 unit
Sample Date/Time: 5/14/2024 10:33:52 PM
Acquisition Date/Time: 5/16/2024 10:39:30 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ANALYSIS RESULTS

| Nuclide Name | Id Conf. | Energy (keV) | Activity (pCi/unit) | MDA (pCi/unit) |
|-----------------|-------------|-----------------|----------------------------|---------------------------|
| NP-237 | 0.996 | 4768.80* | -2.689E-003 +/- 6.016E-003 | 3.780E-002 +/- 2.218E-003 |

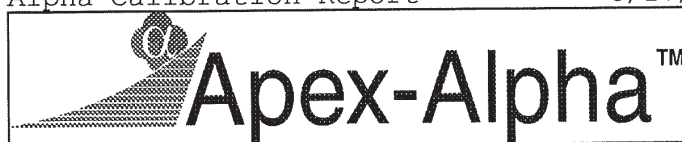
Activity reported as of : 5/16/24 10:39:30 PM

0000272948.CNF



Alpha Calibration Report

5/17/2024 1:48:52 PM



Sample Description:

Spectrum File: \\V79W-7\AlphaRoot\Data\0000272949.cnf
Detector Name: ALPHA 007
Chamber Serial Number: 05010225A
Detector Serial Number: 42347
Geometry Description: Shelf 2

Energy Calibration: 8/11/2022 8:35:03 PM by Administrator
Shape Calibration: 8/11/2022 8:35:03 PM by Administrator
Efficiency Calibration: 8/11/2022 8:35:05 PM by Administrator
Certificate Name: In8615 - primary

ENERGY / SHAPE CALIBRATION

Version: Alpha Encal v1.1
Energy = 3.454 MeV + 3.0107E-003*ch
FWHM = 3.2699E-002 MeV
Low Tail = 4.5379E-003 MeV

| Energy (MeV) | Centroid Channel | Centroid error | FWHM (ch) | FWHM error | TAIL (ch) | TAIL error |
|-----------------|---------------------|-------------------|--------------|---------------|--------------|---------------|
| 4.184 | 242.50 | 0.2095 | 10.17 | 0.4893 | 1.55 | 0.1754 |
| 4.761 | 435.31 | 0.2156 | 8.90 | 0.4787 | 1.00 | 0.1210 |
| 5.148 | 562.07 | 0.1357 | 10.09 | 0.3334 | 2.03 | 0.1675 |
| 5.479 | 673.05 | 0.1807 | 15.09 | 0.4801 | 5.06 | 0.5018 |

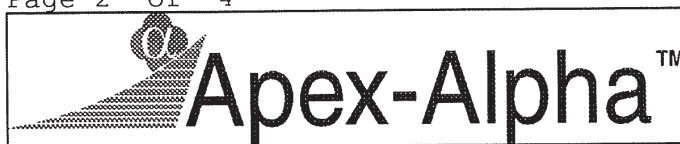
EFFICIENCY CALIBRATION

Version: Alpha Efcals v1.0
Avg Efficiency: 0.2149
Uncertainty: +/- 0.0026

| Energy (MeV) | Efficiency | Error |
|-----------------|-------------|-----------|
| 4.184 | 2.1363E-001 | 5.02E-003 |
| 4.761 | 2.1507E-001 | 5.01E-003 |
| 5.148 | 2.0950E-001 | 5.33E-003 |
| 5.479 | 2.2114E-001 | 5.19E-003 |

Alpha Analysis Report
Page 2 of 4

5/17/2024 1:48:52 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272949.cnf
Batch Identification: 240516NP
Sample Identification: LCS24E14JT2
Sample Geometry: Shelf 2
Procedure Description: Np - 500min

Detector Name: ALPHA_007
Chamber Serial Number: 05010225A
Detector Serial Number: 42347
Env. Background: System Bkgd 247619
Reagent Blank: <not performed>

Sample Size: 1.000 +/- 0.0000 unit
Sample Date/Time: 5/14/2024 10:33:52 PM
Acquisition Date/Time: 5/16/2024 10:39:32 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

Chem. Recovery Factor: 0.9350 +/- 0.0000
Counting Efficiency: 0.2149 +/- 0.0026 on 8/11/2022 8:35:05 PM
Effective Efficiency: 0.2009 +/- 0.0024

Control Certificate Name: Np237 090RadSol4
Chem. Recov. of Control: 0.9821
Peak Match Tolerance: 0.200 MeV

PEAK Location REPORT

| Nuclide | Left Channel | Channel Width | Right Channel | Left Energy Marker | Right Energy Marker |
|---------|--------------|---------------|---------------|--------------------|---------------------|
| NP-237 | 355 | 130 | 484 | 4522.7 | 4911.1 |

PEAK AREA REPORT

| Nuclide | Energy (MeV) | Net Pk Area | Pk Area Error % | Ambient Backgnd | Reagent Backgnd | FWHM (keV) |
|---------|--------------|-------------|-----------------|-----------------|-----------------|------------|
| NP-237 | 4.753 | 573.00 | 4.18 | 0.00 | 0.00E+000 | 17.2 |

Alpha Analysis Report
Page 3 of 4

5/17/2024 1:48:52 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272949.cnf
Batch Identification: 240516NP
Sample Identification: LCS24E14JT2
Sample Geometry: Shelf 2
Procedure Description: Np - 500min

Detector Name: ALPHA_007
Chamber Serial Number: 05010225A
Detector Serial Number: 42347

Sample Size: 1.000 unit
Sample Date/Time: 5/14/2024 10:33:52 PM
Acquisition Date/Time: 5/16/2024 10:39:32 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

----- NUCLIDE ACTIVITY REPORT -----

| Nuclide | Energy (MeV) | Activity (pCi/unit) | Activity Error % | MDA (pCi/unit) | MDA Error % |
|---------|-----------------|-------------------------|---------------------|--------------------|----------------|
| NP-237 | | 2.6883E+000 | 7.20 | 3.5890E-002 | 5.86 |
| | 4.769 | 2.6883E+000 | 7.20 | | |

Errors quoted at 1.000 sigma

Alpha NID Report
Page 4 of 4

5/17/2024 1:48:53 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272949.cnf
Batch Identification: 240516NP
Sample Identification: LCS24E14JT2
Sample Geometry: Shelf 2
Procedure Description: Np - 500min

Detector Name: ALPHA_007
Chamber Serial Number: 05010225A
Detector Serial Number: 42347

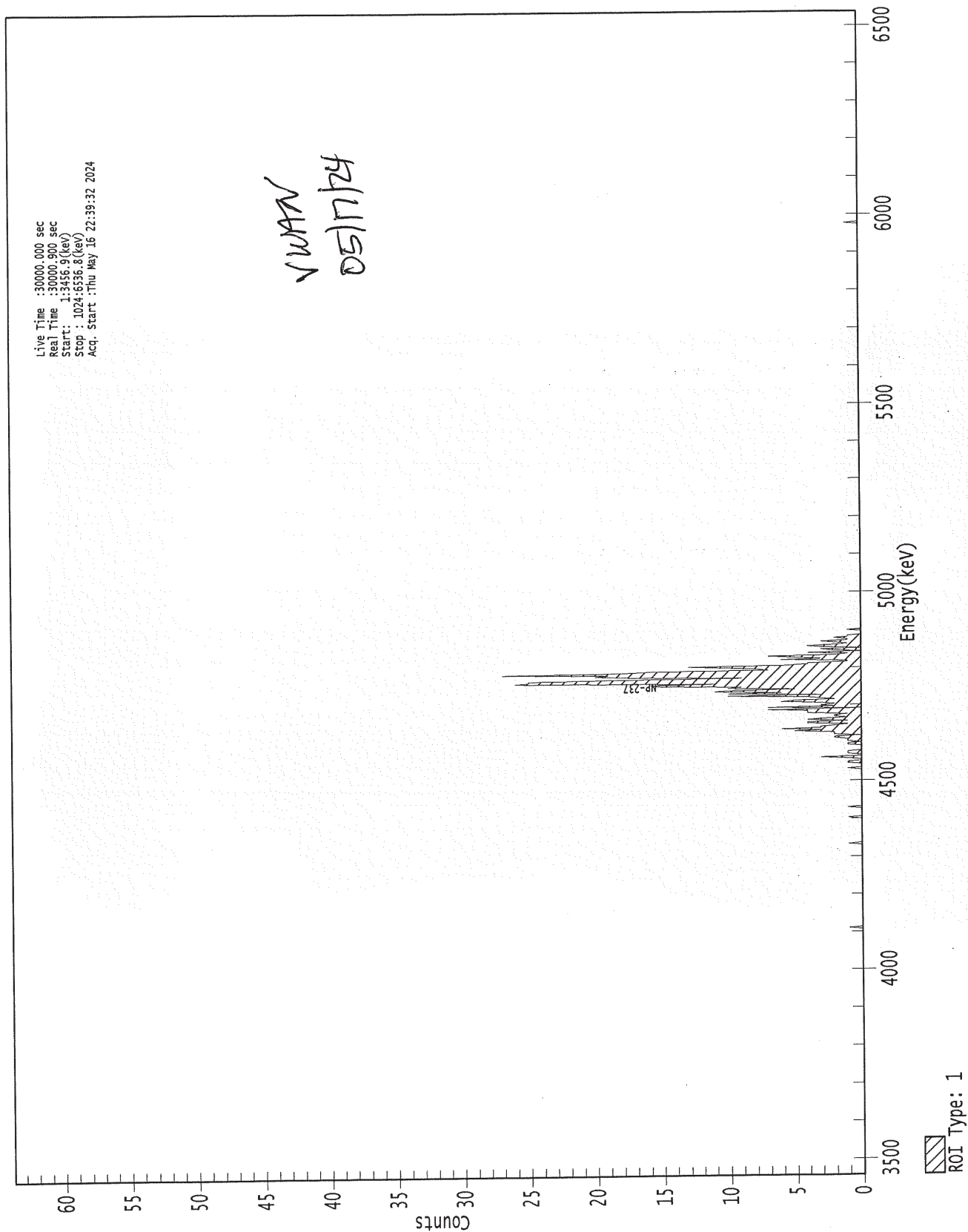
Sample Size: 1.000 unit
Sample Date/Time: 5/14/2024 10:33:52 PM
Acquisition Date/Time: 5/16/2024 10:39:32 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ANALYSIS RESULTS

| Nuclide Name | Id Conf. | Energy (keV) | Activity (pCi/unit) | MDA (pCi/unit) |
|-----------------|-------------|-----------------|---------------------------|---------------------------|
| NP-237 | 0.999 | 4768.80* | 2.688E+000 +/- 1.936E-001 | 3.589E-002 +/- 2.104E-003 |

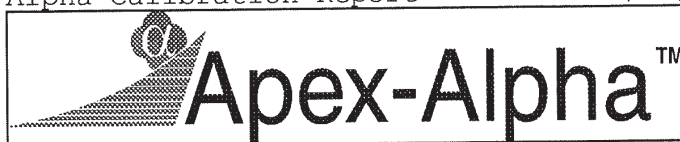
Activity reported as of : 5/16/24 10:39:32 PM

0000272949.CNF



Alpha Calibration Report

5/17/2024 1:49:37 PM



Sample Description:

Spectrum File: \\V79W-7\AlphaRoot\Data\0000272950.cnf
Detector Name: ALPHA 008
Chamber Serial Number: 05010225B
Detector Serial Number: 42348
Geometry Description: Shelf 2

Energy Calibration: 11/2/2022 4:26:18 PM by Administrator
Shape Calibration: 11/2/2022 4:26:18 PM by Administrator
Efficiency Calibration: 11/2/2022 4:26:19 PM by Administrator
Certificate Name: In7861 - primary

ENERGY / SHAPE CALIBRATION

Version: Alpha Encal v1.1
Energy = 3.443 MeV + 3.0161E-003*ch
FWHM = 2.5317E-002 MeV
Low Tail = 3.3054E-003 MeV

| Energy (MeV) | Centroid Channel | Centroid error | FWHM (ch) | FWHM error | TAIL (ch) | TAIL error |
|-----------------|---------------------|-------------------|--------------|---------------|--------------|---------------|
| 4.184 | 245.71 | 0.1730 | 8.59 | 0.3960 | 1.20 | 0.1277 |
| 4.761 | 437.74 | 0.2168 | 7.94 | 0.4802 | 0.86 | 0.1150 |
| 5.148 | 564.86 | 0.1201 | 7.74 | 0.2766 | 1.10 | 0.0908 |
| 5.479 | 675.48 | 0.2423 | 11.86 | 0.6128 | 2.91 | 0.4007 |

EFFICIENCY CALIBRATION

Version: Alpha Efcad v1.0
Avg Efficiency: 0.2165
Uncertainty: +/- 0.0026

| Energy (MeV) | Efficiency | Error |
|-----------------|-------------|-----------|
| 4.184 | 2.0888E-001 | 5.19E-003 |
| 4.761 | 2.2084E-001 | 5.31E-003 |
| 5.148 | 2.1982E-001 | 5.35E-003 |
| 5.479 | 2.1692E-001 | 5.33E-003 |

Alpha Analysis Report
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5/17/2024 1:49:37 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272950.cnf
Batch Identification: 240516NP
Sample Identification: 718821
Sample Geometry: Shelf 2
Procedure Description: Np - 500min

Detector Name: ALPHA_008
Chamber Serial Number: 05010225B
Detector Serial Number: 42348
Env. Background: System Bkgd 247620
Reagent Blank: <not performed>

Sample Size: 1.000 +/- 0.0000 unit
Sample Date/Time: 4/4/2024 10:33:52 PM
Acquisition Date/Time: 5/16/2024 10:39:34 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

Chem. Recovery Factor: 0.9780 +/- 0.0000
Counting Efficiency: 0.2165 +/- 0.0026 on 11/2/2022 4:26:19 PM
Effective Efficiency: 0.2117 +/- 0.0026

Peak Match Tolerance: 0.200 MeV

----- PEAK Location REPORT -----

| Nuclide | Left Channel | Channel Width | Right Channel | Left Energy Marker | Right Energy Marker |
|---------|-----------------|------------------|------------------|-----------------------|------------------------|
| NP-237 | 376 | 108 | 483 | 4577.2 | 4900.0 |

----- PEAK AREA REPORT -----

| Nuclide | Energy (MeV) | Net Pk Area | Pk Area Error % | Ambient Backgnd | Reagent Backgnd | FWHM (keV) |
|---------|-----------------|----------------|--------------------|--------------------|--------------------|---------------|
| NP-237 | 4.728 | 13.00 | 28.78 | 0.00 | 0.00E+000 | 3.0 |

Alpha Analysis Report
Page 3 of 4

5/17/2024 1:49:37 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272950.cnf
Batch Identification: 240516NP
Sample Identification: 718821
Sample Geometry: Shelf 2
Procedure Description: Np - 500min

Detector Name: ALPHA_008
Chamber Serial Number: 05010225B
Detector Serial Number: 42348

Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 10:33:52 PM
Acquisition Date/Time: 5/16/2024 10:39:34 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ACTIVITY REPORT

| Nuclide | Energy (MeV) | Activity (pCi/unit) | Activity Error % | MDA (pCi/unit) | MDA Error % |
|---------|-----------------|-------------------------|---------------------|--------------------|----------------|
| NP-237 | | 5.7873E-002 | 29.37 | 3.4056E-002 | 5.87 |
| | 4.769 | 5.7873E-002 | 29.37 | | |

Errors quoted at 1.000 sigma

Alpha NID Report
Page 4 of 4

5/17/2024 1:49:37 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272950.cnf
Batch Identification: 240516NP
Sample Identification: 718821
Sample Geometry: Shelf 2
Procedure Description: Np - 500min

Detector Name: ALPHA_008
Chamber Serial Number: 05010225B
Detector Serial Number: 42348

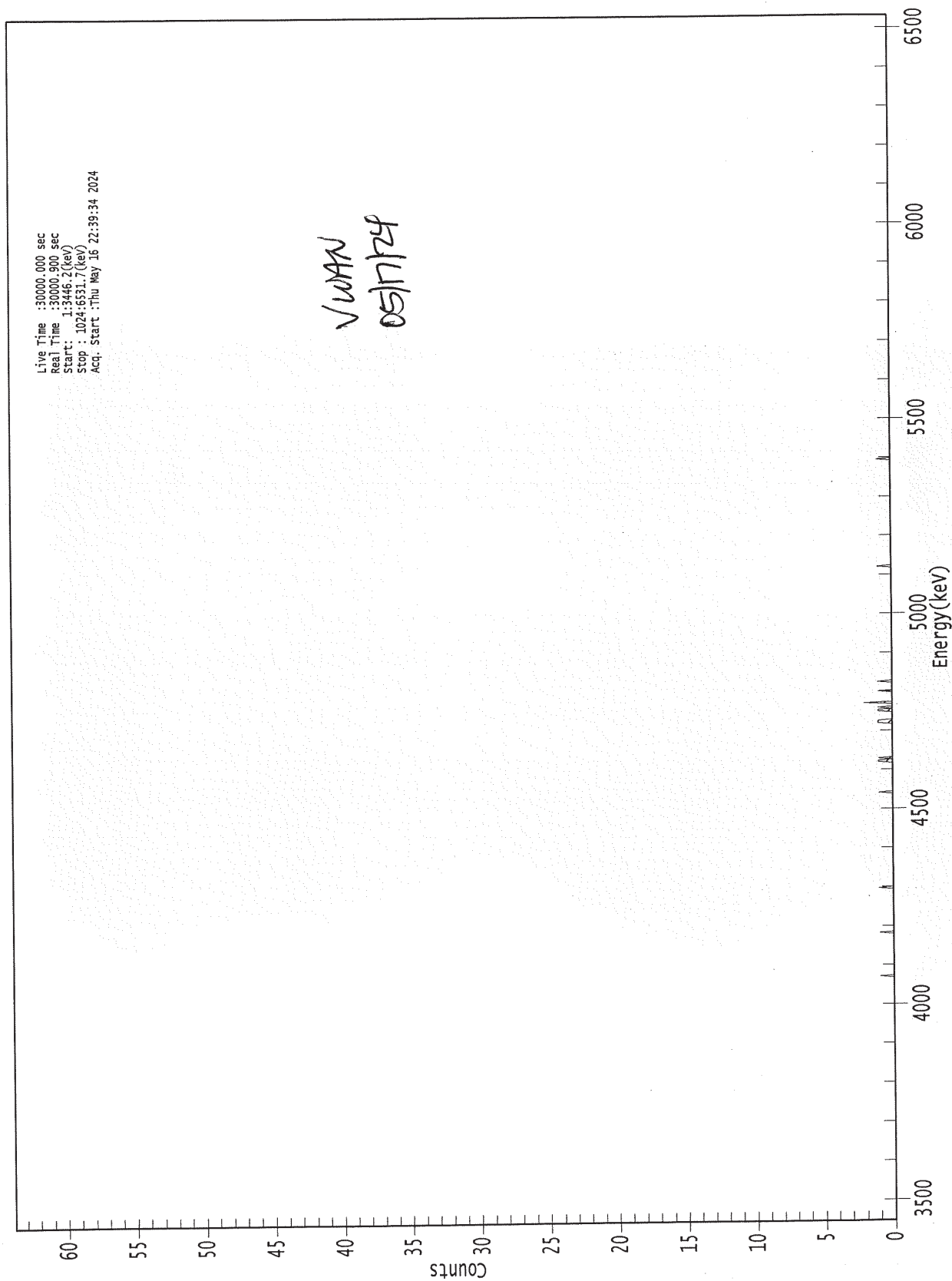
Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 10:33:52 PM
Acquisition Date/Time: 5/16/2024 10:39:34 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ANALYSIS RESULTS

| Nuclide Name | Id Conf. | Energy (keV) | Activity (pCi/unit) | MDA (pCi/unit) |
|-----------------|-------------|-----------------|---------------------------|---------------------------|
| NP-237 | 0.993 | 4768.80* | 5.787E-002 +/- 1.700E-002 | 3.406E-002 +/- 1.999E-003 |

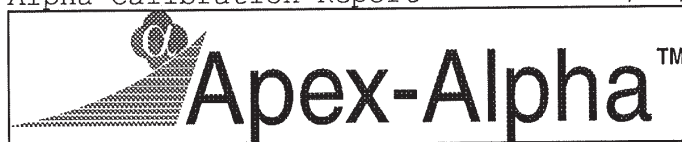
Activity reported as of : 5/16/24 10:39:34 PM

0000272950.CNF



Alpha Calibration Report

5/17/2024 1:50:16 PM



Sample Description:

Spectrum File: \\V79W-7\AlphaRoot\Data\0000272951.cnf
Detector Name: ALPHA 011
Chamber Serial Number: 13000554A
Detector Serial Number: 20314
Geometry Description: Shelf 2

Energy Calibration: 8/28/2023 10:44:32 AM by Administrator
Shape Calibration: 8/28/2023 10:44:32 AM by Administrator
Efficiency Calibration: 8/28/2023 10:44:33 AM by Administrator
Certificate Name: In8615 - primary

ENERGY / SHAPE CALIBRATION

Version: Alpha Encal v1.1
Energy = 3.604 MeV + 3.1310E-003*ch
FWHM = 2.7198E-002 MeV
Low Tail = 3.5003E-003 MeV

| Energy (MeV) | Centroid Channel | Centroid error | FWHM (ch) | FWHM error | TAIL (ch) | TAIL error |
|-----------------|---------------------|-------------------|--------------|---------------|--------------|---------------|
| 4.184 | 185.06 | 0.1912 | 7.41 | 0.4330 | 0.93 | 0.1227 |
| 4.761 | 370.34 | 0.1991 | 7.24 | 0.4399 | 0.80 | 0.1080 |
| 5.148 | 492.53 | 0.1237 | 8.57 | 0.3011 | 1.64 | 0.1413 |
| 5.479 | 599.06 | 0.1862 | 12.40 | 0.4876 | 3.77 | 0.4354 |

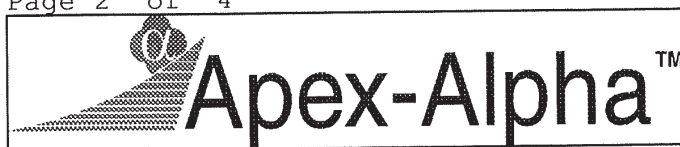
EFFICIENCY CALIBRATION

Version: Alpha Efcad v1.0
Avg Efficiency: 0.2142
Uncertainty: +/- 0.0026

| Energy (MeV) | Efficiency | Error |
|-----------------|-------------|-----------|
| 4.184 | 2.1730E-001 | 5.08E-003 |
| 4.761 | 2.1344E-001 | 4.98E-003 |
| 5.148 | 2.0410E-001 | 5.23E-003 |
| 5.479 | 2.2192E-001 | 5.20E-003 |

Alpha Analysis Report
Page 2 of 4

5/17/2024 1:50:16 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272951.cnf
Batch Identification: 240516NP
Sample Identification: 718821D
Sample Geometry: Shelf 2
Procedure Description: Np - 500min

Detector Name: ALPHA 011
Chamber Serial Number: 13000554A
Detector Serial Number: 20314
Env. Background: System Bkgd 247621
Reagent Blank: <not performed>

Sample Size: 1.000 +/- 0.0000 unit
Sample Date/Time: 4/4/2024 10:33:52 PM
Acquisition Date/Time: 5/16/2024 10:39:36 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

Chem. Recovery Factor: 1.0520 +/- 0.0000
Counting Efficiency: 0.2142 +/- 0.0026 on 8/28/2023 10:44:33 AM
Effective Efficiency: 0.2254 +/- 0.0027

Peak Match Tolerance: 0.200 MeV

----- PEAK Location REPORT -----

| Nuclide | Left Channel | Channel Width | Right Channel | Left Energy Marker | Right Energy Marker |
|---------|--------------|---------------|---------------|--------------------|---------------------|
| NP-237 | 311 | 103 | 413 | 4578.2 | 4897.5 |

----- PEAK AREA REPORT -----

| Nuclide | Energy (MeV) | Net Pk Area | Pk Area Error % | Ambient Backgnd | Reagent Backgnd | FWHM (keV) |
|---------|--------------|-------------|-----------------|-----------------|-----------------|------------|
| NP-237 | 4.732 | 5.00 | 56.57 | 2.00 | 0.00E+000 | 3.1 |

Alpha Analysis Report
Page 3 of 4

5/17/2024 1:50:16 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272951.cnf
Batch Identification: 240516NP
Sample Identification: 718821D
Sample Geometry: Shelf 2
Procedure Description: Np - 500min

Detector Name: ALPHA_011
Chamber Serial Number: 13000554A
Detector Serial Number: 20314

Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 10:33:52 PM
Acquisition Date/Time: 5/16/2024 10:39:36 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ACTIVITY REPORT

| Nuclide | Energy (MeV) | Activity (pCi/unit) | Activity Error % | MDA (pCi/unit) | MDA Error % |
|---------|-----------------|-------------------------|---------------------|--------------------|----------------|
| NP-237 | | 2.0912E-002 | 56.87 | 4.6233E-002 | 5.86 |
| | 4.769 | 2.0912E-002 | 56.87 | | |

Errors quoted at 1.000 sigma

Alpha NID Report
Page 4 of 4

5/17/2024 1:50:16 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272951.cnf
Batch Identification: 240516NP
Sample Identification: 718821D
Sample Geometry: Shelf 2
Procedure Description: Np - 500min

Detector Name: ALPHA_011
Chamber Serial Number: 13000554A
Detector Serial Number: 20314

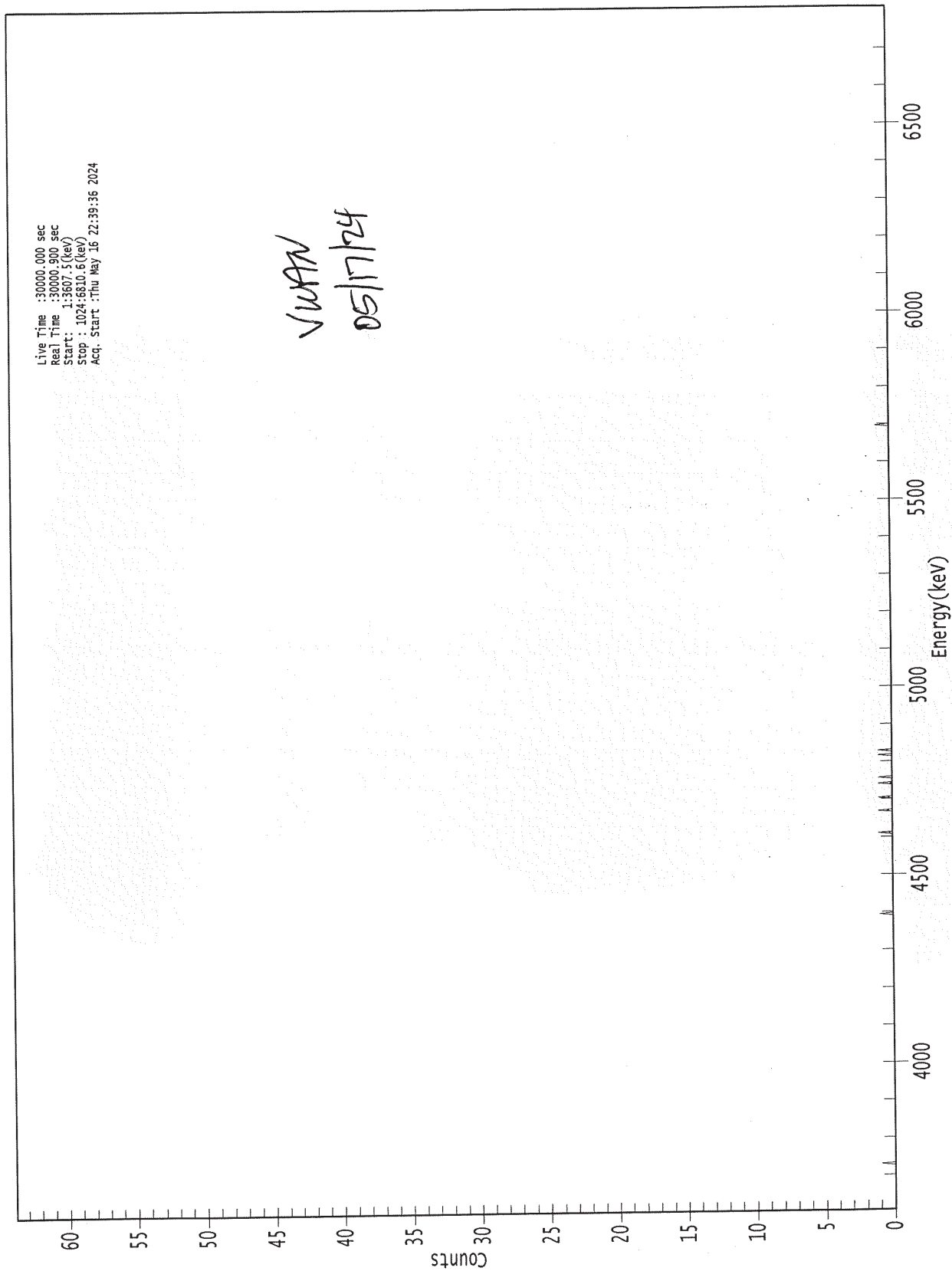
Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 10:33:52 PM
Acquisition Date/Time: 5/16/2024 10:39:36 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ANALYSIS RESULTS

| Nuclide Name | Id Conf. | Energy (keV) | Activity (pCi/unit) | MDA (pCi/unit) |
|-----------------|-------------|-----------------|---------------------------|---------------------------|
| NP-237 | 0.995 | 4768.80* | 2.091E-002 +/- 1.189E-002 | 4.623E-002 +/- 2.711E-003 |

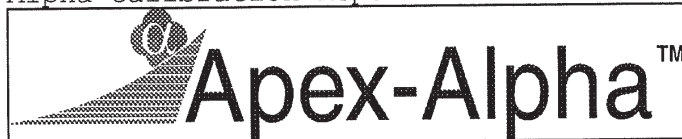
Activity reported as of : 5/16/24 10:39:36 PM

0000272951.CNF



Alpha Calibration Report

5/17/2024 1:50:57 PM



Sample Description:

Spectrum File: \\V79W-7\AlphaRoot\Data\0000272952.cnf
Detector Name: ALPHA 012
Chamber Serial Number: 13000554B
Detector Serial Number: 165851
Geometry Description: Shelf 2

Energy Calibration: 8/28/2023 10:44:42 AM by Administrator
Shape Calibration: 8/28/2023 10:44:42 AM by Administrator
Efficiency Calibration: 8/28/2023 10:44:43 AM by Administrator
Certificate Name: In7861 - primary

ENERGY / SHAPE CALIBRATION

Version: Alpha Encal v1.1
Energy = 3.620 MeV + 3.1261E-003*ch
FWHM = 2.6223E-002 MeV
Low Tail = 4.0003E-003 MeV

| Energy (MeV) | Centroid Channel | Centroid error | FWHM (ch) | FWHM error | TAIL (ch) | TAIL error |
|-----------------|---------------------|-------------------|--------------|---------------|--------------|---------------|
| 4.184 | 180.96 | 0.2226 | 8.22 | 0.5099 | 1.14 | 0.1625 |
| 4.761 | 366.37 | 0.2147 | 7.63 | 0.4823 | 0.97 | 0.1378 |
| 5.148 | 488.25 | 0.1122 | 8.08 | 0.2690 | 1.45 | 0.1164 |
| 5.479 | 595.69 | 0.2308 | 11.23 | 0.5900 | 2.87 | 0.4081 |

EFFICIENCY CALIBRATION

Version: Alpha Efcal v1.0
Avg Efficiency: 0.2095
Uncertainty: +/- 0.0026

| Energy (MeV) | Efficiency | Error |
|-----------------|-------------|-----------|
| 4.184 | 2.0365E-001 | 5.09E-003 |
| 4.761 | 2.0832E-001 | 5.09E-003 |
| 5.148 | 2.1752E-001 | 5.31E-003 |
| 5.479 | 2.0914E-001 | 5.18E-003 |

Alpha Analysis Report
Page 2 of 4

5/17/2024 1:50:57 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272952.cnf
Batch Identification: 240516NP
Sample Identification: 718822
Sample Geometry: Shelf 2
Procedure Description: Np - 500min

Detector Name: ALPHA 012
Chamber Serial Number: 13000554B
Detector Serial Number: 165851
Env. Background: System Bkgd 247622
Reagent Blank: <not performed>

Sample Size: 1.000 +/- 0.0000 unit
Sample Date/Time: 4/4/2024 10:33:52 PM
Acquisition Date/Time: 5/16/2024 10:39:38 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

Chem. Recovery Factor: 0.9720 +/- 0.0000
Counting Efficiency: 0.2095 +/- 0.0026 on 8/28/2023 10:44:43 AM
Effective Efficiency: 0.2036 +/- 0.0025

Peak Match Tolerance: 0.200 MeV

----- PEAK Location REPORT -----

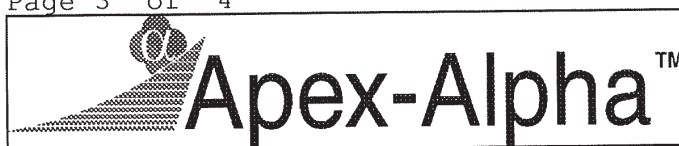
| Nuclide | Left Channel | Channel Width | Right Channel | Left Energy Marker | Right Energy Marker |
|---------|--------------|---------------|---------------|--------------------|---------------------|
| NP-237 | 307 | 103 | 409 | 4579.5 | 4898.4 |

----- PEAK AREA REPORT -----

| Nuclide | Energy (MeV) | Net Pk Area | Pk Area Error % | Ambient Backgnd | Reagent Backgnd | FWHM (keV) |
|---------|--------------|-------------|-----------------|-----------------|-----------------|------------|
| NP-237 | 4.744 | 19.50 | 23.08 | 0.50 | 0.00E+000 | 4.7 |

Alpha Analysis Report
Page 3 of 4

5/17/2024 1:50:57 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272952.cnf
Batch Identification: 240516NP
Sample Identification: 718822
Sample Geometry: Shelf 2
Procedure Description: Np - 500min

Detector Name: ALPHA_012
Chamber Serial Number: 13000554B
Detector Serial Number: 165851

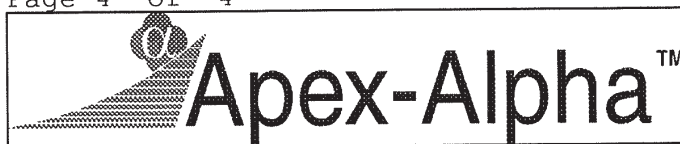
Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 10:33:52 PM
Acquisition Date/Time: 5/16/2024 10:39:38 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ACTIVITY REPORT

| Nuclide | Energy (MeV) | Activity (pCi/unit) | Activity Error % | MDA (pCi/unit) | MDA Error % |
|---------|-----------------|-------------------------|---------------------|--------------------|----------------|
| NP-237 | | 9.0267E-002 | 23.81 | 3.2529E-002 | 5.87 |
| | 4.769 | 9.0267E-002 | 23.81 | | |

Errors quoted at 1.000 sigma

Alpha NID Report 5/17/2024 1:50:58 PM
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Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272952.cnf
Batch Identification: 240516NP
Sample Identification: 718822
Sample Geometry: Shelf 2
Procedure Description: Np - 500min

Detector Name: ALPHA_012
Chamber Serial Number: 13000554B
Detector Serial Number: 165851

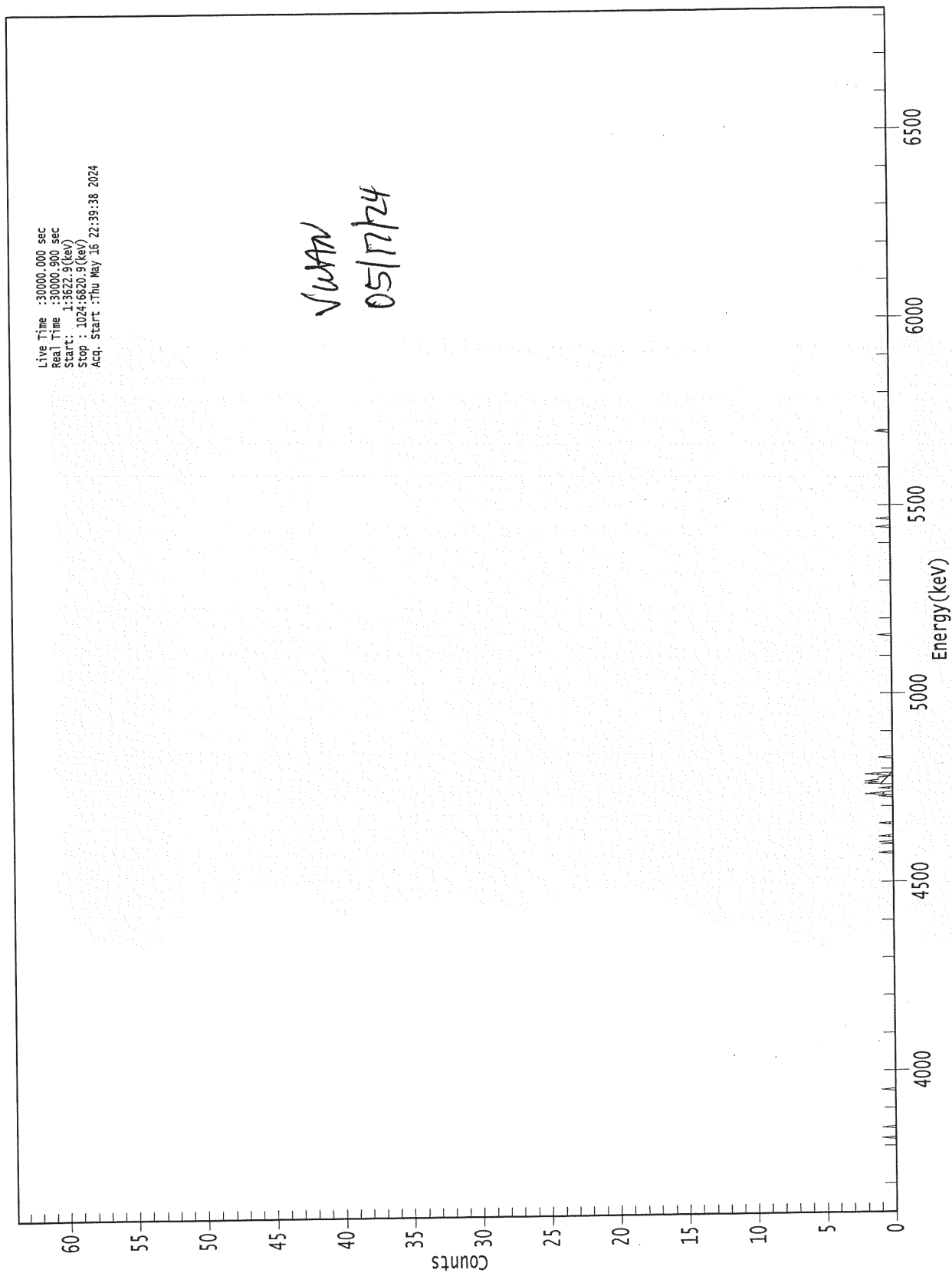
Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 10:33:52 PM
Acquisition Date/Time: 5/16/2024 10:39:38 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ANALYSIS RESULTS

| Nuclide Name | Id Conf. | Energy (keV) | Activity (pCi/unit) | MDA (pCi/unit) | |
|-----------------|-------------|-----------------|---------------------------|--------------------|----------------|
| NP-237 | 0.998 | 4768.80* | 9.027E-002 +/- 2.149E-002 | 3.253E-002 | +/- 1.910E-003 |

Activity reported as of : 5/16/24 10:39:38 PM

0000272952.CNF



Southwest Research Institute, Division 1, Radiochemistry
Alpha Spectroscopy Bench Sheet
Plutonium 238, 239/240, 242, 244 (2 sig)

Client: Battelle Memorial Institute PNNL
Task Order: 240405-6
Prep Batch: 20240514-P005
Prep Date: 14-May-24

Project #: 27927.13.001
SRR: 70993
Units: ml
RL: 750 pCi/ml Pu-238
750 pCi/ml Pu-239/240
750 pCi/ml Pu-244
TPU sig factor: 2

Review
5/22/24
WPN

WPN 05/21/24

| Prep Information | | A | B | B2 | C | D1 | D2 | D3 | D | E | F |
|------------------|---------------|----------------------------|-----------------------------|----------|---------|----------------------------------|-------------------------------|------------------------------|----------------------|------------------------------|----------|
| | Item | Initial Sample Amount (ml) | Digestion Final Volume (ml) | % Solids | (ml/ml) | Amount used for Column Sep. (mL) | Amount after Column Sep. (mL) | Amount taken for precip (mL) | Equivalent used (mL) | Sample aliquot analyzed (ml) | Total DF |
| | 1 PB24E14KE2 | 0.50 | 50.0 | 100.0% | 0.0100 | 0.010 | 15.0 | 15.0 | 0.0100 | 0.00010 | 10000.0 |
| | 2 LCS24E14JT1 | 0.50 | 50.0 | 100.0% | 0.0100 | 0.010 | 15.0 | 15.0 | 0.0100 | 0.00010 | 10000.0 |
| | 3 718819 | 0.50 | 50.0 | 100.0% | 0.0100 | 0.00250 | 15.0 | 15.0 | 0.0025 | 0.00003 | 40000.0 |
| | 4 718820 | 0.50 | 50.0 | 100.0% | 0.0100 | 0.00250 | 15.0 | 15.0 | 0.0025 | 0.00003 | 40000.0 |
| | 5 718821 | 0.50 | 50.0 | 100.0% | 0.0100 | 0.010 | 15.0 | 15.0 | 0.0100 | 0.00010 | 10000.0 |
| | 6 718821D | 0.50 | 50.0 | 100.0% | 0.0100 | 0.010 | 15.0 | 15.0 | 0.0100 | 0.00010 | 10000.0 |
| | 7 718822 | 0.50 | 50.0 | 100.0% | 0.0100 | 0.0020 | 15.0 | 15.0 | 0.0020 | 0.00002 | 50000.0 |
| | 8 718825 | 0.50 | 50.0 | 100.0% | 0.0100 | 0.00250 | 15.0 | 15.0 | 0.0025 | 0.00003 | 40000.0 |
| | 9 718826 | 0.50 | 50.0 | 100.0% | 0.0100 | 0.00250 | 15.0 | 15.0 | 0.0025 | 0.00003 | 40000.0 |
| | 10 718827 | 0.50 | 50.0 | 100.0% | 0.0100 | 0.0020 | 15.0 | 15.0 | 0.0020 | 0.00002 | 50000.0 |
| | 11 718828 | 0.50 | 50.0 | 100.0% | 0.0100 | 0.00250 | 15.0 | 15.0 | 0.0025 | 0.00003 | 40000.0 |
| | 12 718829 | 0.50 | 50.0 | 100.0% | 0.0100 | 0.00250 | 15.0 | 15.0 | 0.0025 | 0.00003 | 40000.0 |
| | 13 718830 | 0.50 | 50.0 | 100.0% | 0.0100 | 0.00250 | 15.0 | 15.0 | 0.0025 | 0.00003 | 40000.0 |
| | 14 718852 | 0.50 | 50.0 | 100.0% | 0.0100 | 0.00250 | 15.0 | 15.0 | 0.0025 | 0.00003 | 40000.0 |
| | 15 718853 | 0.50 | 50.0 | 100.0% | 0.0100 | 0.00250 | 15.0 | 15.0 | 0.0025 | 0.00003 | 40000.0 |
| | 16 718854 | 0.50 | 50.0 | 100.0% | 0.0100 | 0.0020 | 15.0 | 15.0 | 0.0020 | 0.00002 | 50000.0 |
| | 17 718855 | 0.50 | 50.0 | 100.0% | 0.0100 | 0.00250 | 15.0 | 15.0 | 0.0025 | 0.00003 | 40000.0 |
| | 18 718856 | 0.50 | 50.0 | 100.0% | 0.0100 | 0.00250 | 15.0 | 15.0 | 0.0025 | 0.00003 | 40000.0 |
| | 19 718857 | 0.50 | 50.0 | 100.0% | 0.0100 | 0.00250 | 15.0 | 15.0 | 0.0025 | 0.00003 | 40000.0 |
| | 20 718858 | 0.50 | 50.0 | 100.0% | 0.0100 | 0.00250 | 15.0 | 15.0 | 0.0025 | 0.00003 | 40000.0 |
| | 21 718859 | 0.50 | 50.0 | 100.0% | 0.0100 | 0.00250 | 15.0 | 15.0 | 0.0025 | 0.00003 | 40000.0 |

Sample Calculations:
C = (A / B * B2) E = (C * D) F = (1 / E)
D = D3 * (D1 / D2) F = 1 / ((A / B * B2) * D)

Southwest Research Institute, Division 1, Radiochemistry

Alpha Spectroscopy Bench Sheet
Plutonium 238, 239/240, 242, 244 (2 sig)

| Laboratory Control Sample Information | | Spike Information | |
|---------------------------------------|-----------------------|--------------------------|----------------|
| Analyte: Pu239 | | LCS Duplicate Evaluation | |
| Standard ID: 074RadSol4 | | RPD | Dup Eval 1 sig |
| Activity (pCi/ml): 49.992 | Pu238 RL: 750.0 | | |
| Half-Life (yrs): 24110 | Pu239 RL: 750.0 | | |
| Reference Date: 8-Jun-09 | Pu244 RL: 750.0 | | |
| Analysis Date: 5/15/2024 | | | |
| Decay Corrected TV: 49.971 | | | |
| Volume Used (ml): 0.050 | Volume Used (ml): N/A | | |

| Item | Lab Id | Date Analyzed | TRACER | | FWHM | Nuclide | Raw pCi/ planchet | | | Report pCi/ml | | | TV | %r | Relative Bias | |
|------|-------------|---------------|------------------|-------|------|-----------|-------------------|----------|----------|---------------|-----------|----------|----------|----------|------------------|------------|
| | | | Nuclide | Rec % | | | Act | TPU | MDC | ERR | Act | TPU | | | | MDC |
| 1 | PB24E14KE2 | 5/15/24 20:36 | Pu242 124RadSol4 | 81.9% | 25.7 | PU-238 | -5.10E-03 | 6.25E-03 | 4.43E-02 | -6.24E-03 | -5.10E+01 | 1.25E+02 | 4.43E+02 | 1.25E+02 | PB < 3*TPU | PB < 3*TPU |
| | | | | | | PU239/240 | 1.53E-02 | 1.03E-02 | 3.90E-02 | 1.02E-02 | 1.53E+02 | 2.05E+02 | 3.90E+02 | 2.04E+02 | | |
| | | | | | | PU-242 | 3.88E+00 | 2.65E-01 | 3.58E-02 | 1.41E-01 | 3.88E+04 | 5.29E+03 | 3.58E+02 | 2.81E+03 | | |
| | | | | | | PU-244 | 2.04E-02 | 1.15E-02 | 3.90E-02 | 1.14E-02 | 2.04E+02 | 2.30E+02 | 3.90E+02 | 2.28E+02 | | |
| 2 | LCS24E14JT1 | 5/15/24 20:36 | Pu242 124RadSol4 | 71.2% | 28.4 | PU-238 | 3.10E-03 | 6.93E-03 | 4.35E-02 | 6.92E-03 | 3.10E+01 | 1.39E+02 | 4.35E+02 | 1.38E+02 | PB < 3*TPU | PB < 3*TPU |
| | | | | | | PU239/240 | 2.94E+00 | 2.47E-01 | 4.74E-02 | 1.35E-01 | 2.94E+04 | 4.94E+03 | 4.74E+02 | 2.70E+03 | | |
| | | | | | | PU-242 | 3.88E+00 | 2.72E-01 | 5.38E-02 | 1.55E-01 | 3.88E+04 | 5.45E+03 | 5.38E+02 | 3.10E+03 | | |
| | | | | | | PU-244 | -3.10E-03 | 6.93E-03 | 4.35E-02 | -6.92E-03 | -3.10E+01 | 1.39E+02 | 4.35E+02 | 1.38E+02 | | |
| 3 | 718819 | 5/15/24 20:36 | Pu242 124RadSol4 | 84.9% | 30.3 | PU-238 | 1.36E-01 | 2.79E-02 | 3.48E-02 | 2.63E-02 | 5.45E+03 | 2.23E+03 | 1.39E+03 | 2.11E+03 | | |
| | | | | | | PU239/240 | 4.73E-01 | 5.83E-02 | 3.48E-02 | 4.86E-02 | 1.89E+04 | 4.66E+03 | 1.39E+03 | 3.89E+03 | | |
| | | | | | | PU-242 | 3.88E+00 | 2.63E-01 | 3.48E-02 | 1.39E-01 | 1.55E+05 | 2.11E+04 | 1.59E+03 | 1.11E+04 | | |
| | | | | | | PU-244 | 4.95E-03 | 7.00E-03 | 3.78E-02 | 7.00E-03 | 1.98E+02 | 5.60E+02 | 1.51E+03 | 5.60E+02 | | |
| 4 | 718820 | 5/15/24 20:36 | Pu242 124RadSol4 | 75.4% | 24.3 | PU-238 | 1.12E-01 | 2.70E-02 | 4.03E-02 | 2.58E-02 | 4.48E+02 | 2.16E+03 | 1.61E+03 | 2.07E+03 | | |
| | | | | | | PU239/240 | 6.08E-01 | 7.29E-02 | 4.39E-02 | 5.94E-02 | 2.43E+04 | 5.83E+03 | 1.76E+03 | 4.75E+03 | | |
| | | | | | | PU-242 | 3.88E+00 | 2.69E-01 | 4.99E-02 | 1.49E-01 | 1.55E+05 | 2.15E+04 | 1.99E+03 | 1.19E+04 | | |
| | | | | | | PU-244 | -2.87E-03 | 6.41E-03 | 4.03E-02 | -6.41E-03 | -1.15E+02 | 5.13E+02 | 1.61E+03 | 5.13E+02 | | |
| 5 | 718821 | 5/15/24 20:36 | Pu242 124RadSol4 | 80.3% | 30.1 | PU-238 | 5.06E-01 | 6.17E-02 | 3.61E-02 | 5.12E-02 | 5.06E+03 | 1.23E+03 | 3.61E+02 | 1.02E+03 | | |
| | | | | | | PU239/240 | 2.20E+00 | 1.84E-01 | 3.93E-02 | 1.06E-01 | 2.20E+04 | 3.68E+03 | 3.93E+02 | 2.13E+03 | | |
| | | | | | | PU-242 | 3.88E+00 | 2.65E-01 | 3.61E-02 | 1.41E-01 | 3.88E+04 | 5.30E+03 | 3.61E+02 | 2.82E+03 | | |
| | | | | | | PU-244 | 5.13E-03 | 7.26E-03 | 3.92E-02 | 7.26E-03 | 5.13E+01 | 1.45E+02 | 3.92E+02 | 1.45E+02 | | |
| 6 | 718821D | 5/15/24 20:36 | Pu242 124RadSol4 | 83.5% | 12.0 | PU-238 | 5.76E-01 | 6.67E-02 | 3.53E-02 | 5.40E-02 | 5.76E+03 | 1.33E+03 | 3.53E+02 | 1.08E+03 | Dup Eval (1 sig) | 0.8 |
| | | | | | | PU239/240 | 3.56E+00 | 2.77E-01 | 3.85E-02 | 1.34E-01 | 3.56E+04 | 5.54E+03 | 3.85E+02 | 2.68E+03 | | |
| | | | | | | PU-242 | 3.88E+00 | 2.64E-01 | 3.53E-02 | 1.40E-01 | 3.88E+04 | 5.28E+03 | 3.53E+02 | 2.79E+03 | | |
| | | | | | | PU-244 | 1.00E-02 | 8.73E-03 | 3.84E-02 | 8.70E-03 | 1.00E+02 | 1.75E+02 | 3.84E+02 | 1.74E+02 | | |
| 7 | 718822 | 5/15/24 20:36 | Pu242 124RadSol4 | 75.2% | 28.4 | PU-238 | 6.98E-02 | 2.09E-02 | 3.92E-02 | 2.03E-02 | 3.49E+03 | 2.09E+03 | 1.96E+03 | 2.03E+03 | | Pass |
| | | | | | | PU239/240 | 3.24E-01 | 4.84E-02 | 4.27E-02 | 4.29E-02 | 1.62E+04 | 4.84E+03 | 2.14E+03 | 4.29E+03 | | |
| | | | | | | PU-242 | 3.88E+00 | 2.68E-01 | 4.27E-02 | 1.47E-01 | 1.94E+05 | 2.68E+04 | 2.13E+03 | 1.47E+04 | | |
| | | | | | | PU-244 | 0.00E+00 | 7.89E-03 | 4.27E-02 | 7.89E-03 | 0.00E+00 | 7.89E+02 | 2.13E+03 | 7.89E+02 | | |
| 8 | 718825 | 5/15/24 20:36 | Pu242 124RadSol4 | 85.8% | 20.2 | PU-238 | 1.53E-01 | 2.95E-02 | 3.41E-02 | 2.76E-02 | 6.12E+03 | 2.36E+03 | 1.36E+03 | 2.21E+03 | | |
| | | | | | | PU239/240 | 5.63E-01 | 6.49E-02 | 3.71E-02 | 5.25E-02 | 2.25E+04 | 5.20E+03 | 1.49E+03 | 4.20E+03 | | |
| | | | | | | PU-242 | 3.88E+00 | 2.63E-01 | 3.71E-02 | 1.37E-01 | 1.55E+05 | 2.10E+04 | 1.48E+03 | 1.10E+04 | | |
| | | | | | | PU-244 | 4.85E-03 | 6.87E-03 | 3.71E-02 | 6.86E-03 | 1.94E+02 | 5.49E+02 | 1.48E+03 | 5.49E+02 | | |

Southwest Research Institute, Division 1, Radiochemistry
Alpha Spectroscopy Bench Sheet
Plutonium 238, 239/240, 242, 244 (2 sig)

| | | | | | | | | | | | | | | | | |
|----|--------|---------------|------------------|-------|------|-----------|-----------|----------|----------|-----------|-----------|----------|----------|----------|--|--|
| 9 | 718826 | 5/15/24 20:36 | Pu242 124RadSol4 | 83.2% | 36.0 | PU-238 | 1.26E-01 | 2.74E-02 | 4.40E-02 | 2.60E-02 | 5.06E+03 | 2.19E+03 | 1.76E+03 | 2.08E+03 | | |
| | | | | | | PU239/240 | 5.49E-01 | 6.48E-02 | 3.55E-02 | 5.29E-02 | 2.20E+04 | 5.18E+03 | 1.42E+03 | 4.23E+03 | | |
| | | | | | | PU-242 | 3.88E+00 | 2.64E-01 | 5.59E-02 | 1.40E-01 | 1.55E+05 | 2.11E+04 | 2.23E+03 | 1.12E+04 | | |
| | | | | | | PU-244 | 0.00E+00 | 7.15E-03 | 3.87E-02 | 7.15E-03 | 0.00E+00 | 5.72E+02 | 1.55E+03 | 5.72E+02 | | |
| 10 | 718827 | 5/15/24 20:36 | Pu242 124RadSol4 | 83.3% | 35.6 | PU-238 | 1.34E-01 | 2.86E-02 | 4.49E-02 | 2.71E-02 | 6.72E+03 | 2.86E+03 | 2.25E+03 | 2.71E+03 | | |
| | | | | | | PU239/240 | 3.83E-01 | 5.20E-02 | 4.50E-02 | 4.49E-02 | 1.91E+04 | 2.60E+03 | 2.25E+03 | 4.49E+03 | | |
| | | | | | | PU-242 | 3.88E+00 | 2.65E-01 | 3.63E-02 | 1.42E-01 | 1.94E+05 | 5.65E+04 | 1.81E+03 | 1.42E+04 | | |
| | | | | | | PU-244 | 5.16E-03 | 7.31E-03 | 3.95E-02 | 7.30E-03 | 2.58E+02 | 7.31E+02 | 1.98E+03 | 7.30E+02 | | |
| 11 | 718828 | 5/15/24 20:36 | Pu242 124RadSol4 | 88.1% | 22.8 | PU-238 | 6.97E-02 | 1.92E-02 | 3.55E-02 | 1.86E-02 | 2.79E+03 | 1.53E+03 | 1.42E+03 | 1.49E+03 | | |
| | | | | | | PU239/240 | 5.99E-01 | 6.66E-02 | 3.55E-02 | 5.30E-02 | 2.40E+04 | 5.33E+03 | 1.42E+03 | 4.24E+03 | | |
| | | | | | | PU-242 | 3.88E+00 | 2.61E-01 | 3.55E-02 | 1.34E-01 | 1.55E+05 | 2.09E+04 | 1.42E+03 | 1.07E+04 | | |
| | | | | | | PU-244 | 4.64E-03 | 6.57E-03 | 3.55E-02 | 6.56E-03 | 1.86E+02 | 5.26E+02 | 1.42E+03 | 5.25E+02 | | |
| 12 | 718829 | 5/15/24 20:36 | Pu242 124RadSol4 | 87.6% | 22.2 | PU-238 | 1.06E-01 | 2.41E-02 | 3.68E-02 | 2.31E-02 | 4.23E+03 | 1.93E+03 | 1.47E+03 | 1.84E+03 | | |
| | | | | | | PU239/240 | 5.65E-01 | 6.48E-02 | 3.38E-02 | 5.23E-02 | 2.26E+04 | 5.18E+03 | 1.35E+03 | 4.18E+03 | | |
| | | | | | | PU-242 | 3.88E+00 | 2.62E-01 | 3.67E-02 | 1.37E-01 | 1.55E+05 | 2.10E+04 | 1.47E+03 | 1.09E+04 | | |
| | | | | | | PU-244 | 0.00E+00 | 6.80E-03 | 3.67E-02 | 6.80E-03 | 0.00E+00 | 5.44E+02 | 1.47E+03 | 5.44E+02 | | |
| 13 | 718830 | 5/15/24 20:36 | Pu242 124RadSol4 | 84.8% | 19.7 | PU-238 | 1.18E-01 | 2.59E-02 | 3.52E-02 | 2.47E-02 | 4.71E+03 | 2.07E+03 | 1.41E+03 | 1.97E+03 | | |
| | | | | | | PU239/240 | 5.26E-01 | 6.28E-02 | 3.83E-02 | 5.16E-02 | 2.10E+04 | 5.02E+03 | 1.53E+03 | 4.13E+03 | | |
| | | | | | | PU-242 | 3.88E+00 | 2.64E-01 | 3.52E-02 | 1.39E-01 | 1.55E+05 | 2.11E+04 | 1.41E+03 | 1.11E+04 | | |
| | | | | | | PU-244 | 0.00E+00 | 7.08E-03 | 3.83E-02 | 7.08E-03 | 0.00E+00 | 5.67E+02 | 1.53E+03 | 5.67E+02 | | |
| 14 | 718852 | 5/15/24 20:36 | Pu242 124RadSol4 | 84.6% | 24.0 | PU-238 | 1.38E-01 | 2.79E-02 | 4.14E-02 | 2.63E-02 | 5.52E+03 | 2.23E+03 | 1.66E+03 | 2.10E+03 | | |
| | | | | | | PU239/240 | 5.76E-01 | 6.55E-02 | 4.14E-02 | 5.27E-02 | 2.30E+04 | 5.24E+03 | 1.66E+03 | 4.22E+03 | | |
| | | | | | | PU-242 | 3.88E+00 | 2.62E-01 | 3.64E-02 | 1.36E-01 | 1.55E+05 | 2.10E+04 | 1.46E+03 | 1.09E+04 | | |
| | | | | | | PU-244 | 2.38E-03 | 5.32E-03 | 3.34E-02 | 5.32E-03 | 9.51E+01 | 4.26E+02 | 1.34E+03 | 4.25E+02 | | |
| 15 | 718853 | 5/15/24 20:36 | Pu242 124RadSol4 | 81.4% | 13.6 | PU-238 | 1.51E-01 | 3.06E-02 | 5.56E-02 | 2.89E-02 | 6.03E+03 | 2.45E+03 | 2.22E+03 | 2.31E+03 | | |
| | | | | | | PU239/240 | 5.43E-01 | 6.42E-02 | 3.84E-02 | 5.25E-02 | 2.17E+04 | 5.13E+03 | 1.54E+03 | 4.20E+03 | | |
| | | | | | | PU-242 | 3.88E+00 | 2.64E-01 | 3.84E-02 | 1.40E-01 | 1.55E+05 | 2.11E+04 | 1.54E+03 | 1.12E+04 | | |
| | | | | | | PU-244 | 0.00E+00 | 7.11E-03 | 3.84E-02 | 7.11E-03 | 0.00E+00 | 5.69E+02 | 1.54E+03 | 5.69E+02 | | |
| 16 | 718854 | 5/15/24 20:36 | Pu242 124RadSol4 | 73.1% | 29.3 | PU-238 | 1.55E-01 | 3.39E-02 | 7.38E-02 | 3.22E-02 | 7.74E+03 | 3.39E+03 | 3.69E+03 | 3.22E+03 | | |
| | | | | | | PU239/240 | 4.36E-01 | 5.87E-02 | 4.39E-02 | 5.03E-02 | 2.18E+04 | 5.87E+03 | 2.19E+03 | 5.03E+03 | | |
| | | | | | | PU-242 | 3.88E+00 | 2.69E-01 | 4.03E-02 | 1.49E-01 | 1.94E+05 | 2.69E+04 | 2.01E+03 | 1.49E+04 | | |
| | | | | | | PU-244 | 0.00E+00 | 8.11E-03 | 4.38E-02 | 8.11E-03 | 0.00E+00 | 8.11E+02 | 2.19E+03 | 8.11E+02 | | |
| 17 | 718855 | 5/15/24 20:37 | Pu242 124RadSol4 | 91.4% | 30.3 | PU-238 | 1.34E-01 | 2.70E-02 | 4.01E-02 | 2.55E-02 | 5.35E+03 | 2.16E+03 | 1.60E+03 | 2.04E+03 | | |
| | | | | | | PU239/240 | 4.48E-01 | 5.48E-02 | 4.01E-02 | 4.58E-02 | 1.79E+04 | 4.38E+03 | 1.60E+03 | 3.66E+03 | | |
| | | | | | | PU-242 | 3.88E+00 | 2.61E-01 | 3.53E-02 | 1.34E-01 | 1.55E+05 | 2.09E+04 | 1.41E+03 | 1.07E+04 | | |
| | | | | | | PU-244 | 2.30E-03 | 5.16E-03 | 3.24E-02 | 5.15E-03 | 9.22E+01 | 4.12E+02 | 1.30E+03 | 4.12E+02 | | |
| 18 | 718856 | 5/15/24 20:37 | Pu242 124RadSol4 | 70.7% | 13.9 | PU-238 | 1.75E-01 | 3.49E-02 | 4.17E-02 | 3.27E-02 | 7.01E+03 | 2.79E+03 | 1.67E+03 | 2.61E+03 | | |
| | | | | | | PU239/240 | 5.52E-01 | 6.93E-02 | 4.54E-02 | 5.76E-02 | 2.21E+04 | 5.54E+03 | 1.82E+03 | 4.61E+03 | | |
| | | | | | | PU-242 | 3.88E+00 | 2.71E-01 | 4.17E-02 | 1.52E-01 | 1.55E+05 | 2.16E+04 | 1.67E+03 | 1.21E+04 | | |
| | | | | | | PU-244 | -2.97E-03 | 6.63E-03 | 4.17E-02 | -6.63E-03 | -1.19E+02 | 5.31E+02 | 1.67E+03 | 5.31E+02 | | |
| 19 | 718857 | 5/15/24 20:37 | Pu242 124RadSol4 | 80.2% | 23.5 | PU-238 | 1.37E-01 | 2.89E-02 | 4.02E-02 | 2.73E-02 | 5.47E+03 | 2.31E+03 | 1.67E+03 | 2.19E+03 | | |
| | | | | | | PU239/240 | 5.00E-01 | 6.19E-02 | 4.02E-02 | 5.15E-02 | 2.00E+04 | 4.95E+03 | 1.61E+03 | 4.12E+03 | | |
| | | | | | | PU-242 | 3.88E+00 | 2.66E-01 | 3.69E-02 | 1.43E-01 | 1.55E+05 | 2.13E+04 | 1.48E+03 | 1.14E+04 | | |
| | | | | | | PU-244 | 1.05E-02 | 9.13E-03 | 4.02E-02 | 9.10E-03 | 4.20E+02 | 7.31E+02 | 1.61E+03 | 7.28E+02 | | |

Southwest Research Institute, Division 1, Radiochemistry

Alpha Spectroscopy Bench Sheet
Plutonium 238, 239/240, 242, 244 (2 sig)

| | | | | | | | | | | | | | | | | | |
|----|--------|---------------|------------------|-------|------|-----------|----------|----------|----------|----------|----------|----------|----------|----------|--|--|--|
| 20 | 718858 | 5/15/24 20:37 | Pu242 124RadSol4 | 88.8% | 24.4 | PU-238 | 1.44E-01 | 2.76E-02 | 3.44E-02 | 2.59E-02 | 5.76E+03 | 2.21E+03 | 1.38E+03 | 2.07E+03 | | | |
| | | | | | | PU239/240 | 5.67E-01 | 6.34E-02 | 3.44E-02 | 5.07E-02 | 2.27E+04 | 5.07E+03 | 1.38E+03 | 4.06E+03 | | | |
| | | | | | | PU-242 | 3.88E+00 | 2.60E-01 | 3.44E-02 | 1.32E-01 | 1.55E+05 | 2.08E+04 | 1.38E+03 | 1.06E+04 | | | |
| | | | | | | PU-244 | 0.00E+00 | 6.36E-03 | 3.44E-02 | 6.36E-03 | 0.00E+00 | 5.09E+02 | 1.38E+03 | 5.09E+02 | | | |
| 21 | 718859 | 5/15/24 20:37 | Pu242 124RadSol4 | 78.6% | 29.2 | PU-238 | 1.08E-01 | 2.57E-02 | 4.12E-02 | 2.47E-02 | 4.30E+03 | 2.06E+03 | 1.65E+03 | 1.97E+03 | | | |
| | | | | | | PU239/240 | 5.87E-01 | 6.94E-02 | 4.12E-02 | 5.64E-02 | 2.35E+04 | 5.55E+03 | 1.65E+03 | 4.52E+03 | | | |
| | | | | | | PU-242 | 3.88E+00 | 2.67E-01 | 4.11E-02 | 1.44E-01 | 1.55E+05 | 2.13E+04 | 1.65E+03 | 1.16E+04 | | | |
| | | | | | | PU-244 | 2.69E-03 | 6.01E-03 | 3.78E-02 | 6.01E-03 | 1.08E+02 | 4.81E+02 | 1.51E+03 | 4.81E+02 | | | |

Sample Calculations
G, H, I, J results from Alpha Spec printouts
Duplicate Evaluation =

$$K = G * F$$

$$L = H * F$$

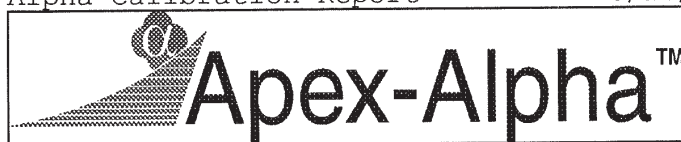
$$M = I * F$$

$$N = J * F$$

$$(\text{Sample-Duplicate}) / \text{sqrt}((\text{TPUsample}^2) + (\text{TPUdup}^2)) \leq 3$$

Alpha Calibration Report

5/16/2024 1:27:16 PM



Battelle Memorial Institute PNNL
27927.13.001
TO# 240405-6
202404514-P005
WAN 05/17/24
WAN 05/17/24 EE

Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272917.cnf
Detector Name: ALPHA_001
Chamber Serial Number: 05010114A
Detector Serial Number: 91232
Geometry Description: Shelf 2

Energy Calibration: 7/5/2023 3:04:56 PM by Administrator
Shape Calibration: 7/5/2023 3:04:56 PM by Administrator
Efficiency Calibration: 7/5/2023 3:04:57 PM by Administrator
Certificate Name: In8615 - primary

ENERGY / SHAPE CALIBRATION

Version: Alpha Encal v1.1
Energy = 3.428 MeV + 3.0064E-003*ch
FWHM = 2.9876E-002 MeV
Low Tail = 4.2352E-003 MeV

| Energy (MeV) | Centroid Channel | Centroid error | FWHM (ch) | FWHM error | TAIL (ch) | TAIL error |
|-----------------|---------------------|-------------------|--------------|---------------|--------------|---------------|
| 4.184 | 251.97 | 0.1711 | 8.61 | 0.3911 | 1.17 | 0.1225 |
| 4.761 | 444.45 | 0.2514 | 8.81 | 0.5631 | 1.06 | 0.1533 |
| 5.148 | 571.40 | 0.1490 | 10.34 | 0.3732 | 2.33 | 0.2170 |
| 5.479 | 682.94 | 0.2033 | 12.57 | 0.5325 | 3.77 | 0.4660 |

EFFICIENCY CALIBRATION

Version: Alpha Efcals v1.0
Avg Efficiency: 0.2157
Uncertainty: +/- 0.0026

| Energy (MeV) | Efficiency | Error |
|-----------------|-------------|-----------|
| 4.184 | 2.2056E-001 | 5.14E-003 |
| 4.761 | 2.1136E-001 | 4.95E-003 |
| 5.148 | 2.1092E-001 | 5.35E-003 |
| 5.479 | 2.1995E-001 | 5.17E-003 |

Alpha Analysis Report
Page 2 of 4

5/16/2024 1:27:16 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272917.cnf
Batch Identification: 240515PUX
Sample Identification: PB24E14KE2
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA_001
Chamber Serial Number: 05010114A
Detector Serial Number: 91232
Env. Background: System Bkgd 247613
Reagent Blank: <not performed>

Sample Size: 1.000 +/- 0.0000 unit
Sample Date/Time: 5/14/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:30 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

Tracer Certificate: Pu242 124RadSol4
Tracer Quantity: 0.100 mL
Effective Efficiency: 0.1768 +/- 0.0065
Counting Efficiency: 0.2157 +/- 0.0026 on 7/5/2023 3:04:57 PM
Chem. Recovery Factor: 0.8195 +/- 0.0318

Peak Match Tolerance: 0.200 MeV

----- PEAK Location REPORT -----

| Nuclide | Left Channel | Channel Width | Right Channel | Left Energy Marker | Right Energy Marker |
|----------|--------------|---------------|---------------|--------------------|---------------------|
| PU-238 | 663 | 32 | 694 | 5421.0 | 5514.2 |
| PU-239 | 524 | 60 | 583 | 5003.1 | 5180.5 |
| PU-242 T | 407 | 92 | 498 | 4651.4 | 4925.0 |
| PU-244 | 358 | 34 | 391 | 4504.1 | 4603.3 |

----- PEAK AREA REPORT -----

| Nuclide | Energy (MeV) | Net Pk Area | Pk Area Error % | Ambient Backgnd | Reagent Backgnd | FWHM (keV) |
|----------|--------------|-------------|-----------------|-----------------|-----------------|------------|
| PU-238 | 5.466 | -1.00 | 122.47 | 1.00 | 0.00E+000 | 0.0 |
| PU-239 | 5.111 | 3.00 | 66.67 | 0.00 | 0.00E+000 | 3.0 |
| PU-242 T | 4.859 | 760.50 | 3.63 | 0.50 | 0.00E+000 | 25.7 |
| PU-244 | 4.564 | 4.00 | 55.90 | 0.00 | 0.00E+000 | 3.0 |

Alpha Analysis Report
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5/16/2024 1:27:16 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272917.cnf
Batch Identification: 240515PUX
Sample Identification: PB24E14KE2
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA_001
Chamber Serial Number: 05010114A
Detector Serial Number: 91232

Sample Size: 1.000 unit
Sample Date/Time: 5/14/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:30 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

----- NUCLIDE ACTIVITY REPORT -----

| Nuclide | Energy (MeV) | Activity (pCi/unit) | Activity Error % | MDA (pCi/unit) | MDA Error % |
|---------|-----------------|-------------------------|---------------------|--------------------|----------------|
| PU-238 | | -5.0970E-003 | -122.6 | 4.4319E-002 | 6.82 |
| | 5.487 | -5.0970E-003 | -122.6 | | |
| PU-239 | | 1.5306E-002 | 67.02 | 3.9030E-002 | 6.82 |
| | 5.148 | 1.5306E-002 | 67.02 | | |
| PU-242 | | 3.8762E+000 | 6.82 | 3.5816E-002 | 6.82 |
| | 4.891 | 3.8762E+000 | 6.82 | | |
| PU-244 | | 2.0387E-002 | 56.32 | 3.8991E-002 | 6.82 |
| | 4.581 | 2.0387E-002 | 56.32 | | |

Errors quoted at 1.000 sigma

Alpha NID Report 5/16/2024 1:27:16 PM
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Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272917.cnf
Batch Identification: 240515PUX
Sample Identification: PB24E14KE2
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA_001
Chamber Serial Number: 05010114A
Detector Serial Number: 91232

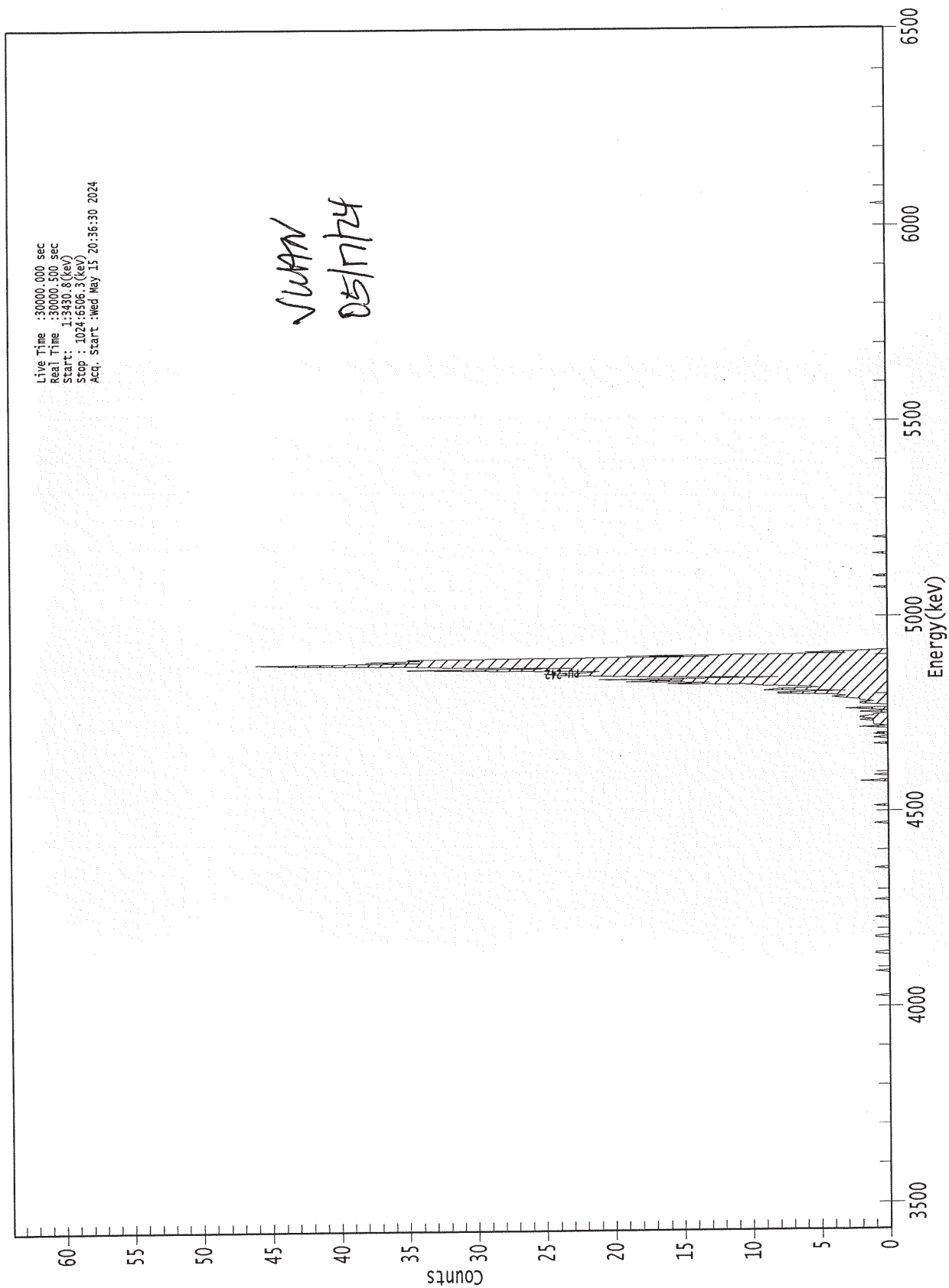
Sample Size: 1.000 unit
Sample Date/Time: 5/14/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:30 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ANALYSIS RESULTS

| Nuclide Name | Id Conf. | Energy (keV) | Activity (pCi/unit) | MDA (pCi/unit) |
|--------------|----------|--------------|----------------------------|---------------------------|
| PU-238 | 0.998 | 5487.10* | -5.097E-003 +/- 6.252E-003 | 4.432E-002 +/- 3.024E-003 |
| PU-239 | 0.995 | 5147.70* | 1.531E-002 +/- 1.026E-002 | 3.903E-002 +/- 2.664E-003 |
| PU-242 | 0.996 | 4890.70* | 3.876E+000 +/- 2.645E-001 | 3.582E-002 +/- 2.444E-003 |
| PU-244 | 0.999 | 4581.00* | 2.039E-002 +/- 1.148E-002 | 3.899E-002 +/- 2.661E-003 |

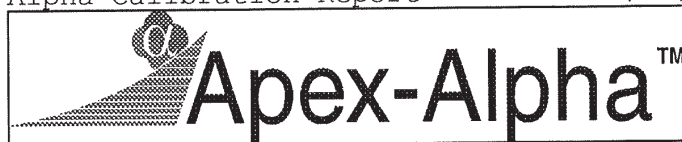
Activity reported as of : 5/15/24 8:36:30 PM

0000272917.CNF



Alpha Calibration Report

5/16/2024 1:29:10 PM



Sample Description:

Spectrum File: \\V79W-7\AlphaRoot\Data\0000272918.cnf
Detector Name: ALPHA_002
Chamber Serial Number: 05010114B
Detector Serial Number: 91233
Geometry Description: Shelf 2

Energy Calibration: 8/11/2022 3:27:51 PM by Administrator
Shape Calibration: 8/11/2022 3:27:51 PM by Administrator
Efficiency Calibration: 8/11/2022 3:27:52 PM by Administrator
Certificate Name: In7861 - primary

ENERGY / SHAPE CALIBRATION

Version: Alpha Encal v1.1
Energy = 3.456 MeV + 3.0198E-003*ch
FWHM = 3.1654E-002 MeV
Low Tail = 5.0862E-003 MeV

| Energy (MeV) | Centroid Channel | Centroid error | FWHM (ch) | FWHM error | TAIL (ch) | TAIL error |
|-----------------|---------------------|-------------------|--------------|---------------|--------------|---------------|
| 4.184 | 241.80 | 0.2028 | 9.31 | 0.4704 | 1.41 | 0.1672 |
| 4.761 | 433.32 | 0.2847 | 9.08 | 0.6471 | 1.19 | 0.1929 |
| 5.148 | 559.23 | 0.1617 | 10.45 | 0.4025 | 2.24 | 0.2195 |
| 5.479 | 670.59 | 0.1952 | 12.74 | 0.5037 | 3.78 | 0.4275 |

EFFICIENCY CALIBRATION

Version: Alpha Efcad v1.0
Avg Efficiency: 0.2044
Uncertainty: +/- 0.0025

| Energy (MeV) | Efficiency | Error |
|-----------------|-------------|-----------|
| 4.184 | 1.9530E-001 | 4.93E-003 |
| 4.761 | 2.0175E-001 | 4.98E-003 |
| 5.148 | 2.1125E-001 | 5.19E-003 |
| 5.479 | 2.1055E-001 | 5.21E-003 |

Alpha Analysis Report
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Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272918.cnf
Batch Identification: 240515PUX
Sample Identification: LCS24E14JT1
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA_002
Chamber Serial Number: 05010114B
Detector Serial Number: 91233
Env. Background: System Bkgd 247614
Reagent Blank: <not performed>

Sample Size: 1.000 +/- 0.0000 unit
Sample Date/Time: 5/14/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:32 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

Tracer Certificate: Pu242 124RadSol4
Tracer Quantity: 0.100 mL
Effective Efficiency: 0.1455 +/- 0.0059
Counting Efficiency: 0.2044 +/- 0.0025 on 8/11/2022 3:27:52 PM
Chem. Recovery Factor: 0.7118 +/- 0.0302

Control Certificate Name: Pu239 074-Rad-Sol4
Chem. Recov. of Control: 1.1759
Peak Match Tolerance: 0.200 MeV

PEAK Location REPORT

| Nuclide | Left Channel | Channel Width | Right Channel | Left Energy Marker | Right Energy Marker |
|----------|--------------|---------------|---------------|--------------------|---------------------|
| PU-238 | 651 | 31 | 681 | 5422.0 | 5512.6 |
| PU-239 | 493 | 79 | 571 | 4944.9 | 5180.4 |
| PU-242 T | 385 | 102 | 486 | 4618.7 | 4923.7 |
| PU-244 | 347 | 34 | 380 | 4504.0 | 4603.6 |

PEAK AREA REPORT

| Nuclide | Energy (MeV) | Net Pk Area | Pk Area Error % | Ambient Backgnd | Reagent Backgnd | FWHM (keV) |
|----------|--------------|-------------|-----------------|-----------------|-----------------|------------|
| PU-238 | 5.458 | 0.50 | 223.61 | 0.50 | 0.00E+000 | 3.0 |
| PU-239 | 5.100 | 474.00 | 4.60 | 0.00 | 0.00E+000 | 5.5 |
| PU-242 T | 4.842 | 626.00 | 4.00 | 1.00 | 0.00E+000 | 28.4 |

Alpha Analysis Report

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PU-244 4.552 -0.50 223.61 0.50 0.00E+000 0.0



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272918.cnf
Batch Identification: 240515PUX
Sample Identification: LCS24E14JT1
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA 002
Chamber Serial Number: 05010114B
Detector Serial Number: 91233

Sample Size: 1.000 unit
Sample Date/Time: 5/14/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:32 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

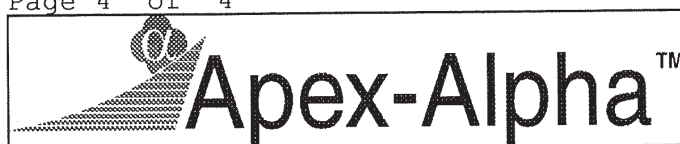
----- NUCLIDE ACTIVITY REPORT -----

| Nuclide | Energy (MeV) | Activity (pCi/unit) | Activity Error % | MDA (pCi/unit) | MDA Error % |
|---------|-----------------|-------------------------|---------------------|--------------------|----------------|
| PU-238 | | 3.0960E-003 | 223.72 | 4.3512E-002 | 7.03 |
| | 5.487 | 3.0960E-003 | 223.72 | | |
| PU-239 | | 2.9379E+000 | 8.40 | 4.7416E-002 | 7.03 |
| | 5.148 | 2.9379E+000 | 8.40 | | |
| PU-242 | | 3.8762E+000 | 7.03 | 5.3839E-002 | 7.03 |
| | 4.891 | 3.8762E+000 | 7.03 | | |
| PU-244 | | -3.0960E-003 | -223.7 | 4.3511E-002 | 7.03 |
| | 4.581 | -3.0960E-003 | -223.7 | | |

Errors quoted at 1.000 sigma

Alpha NID Report
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5/16/2024 1:29:10 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272918.cnf
Batch Identification: 240515PUX
Sample Identification: LCS24E14JT1
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA_002
Chamber Serial Number: 05010114B
Detector Serial Number: 91233

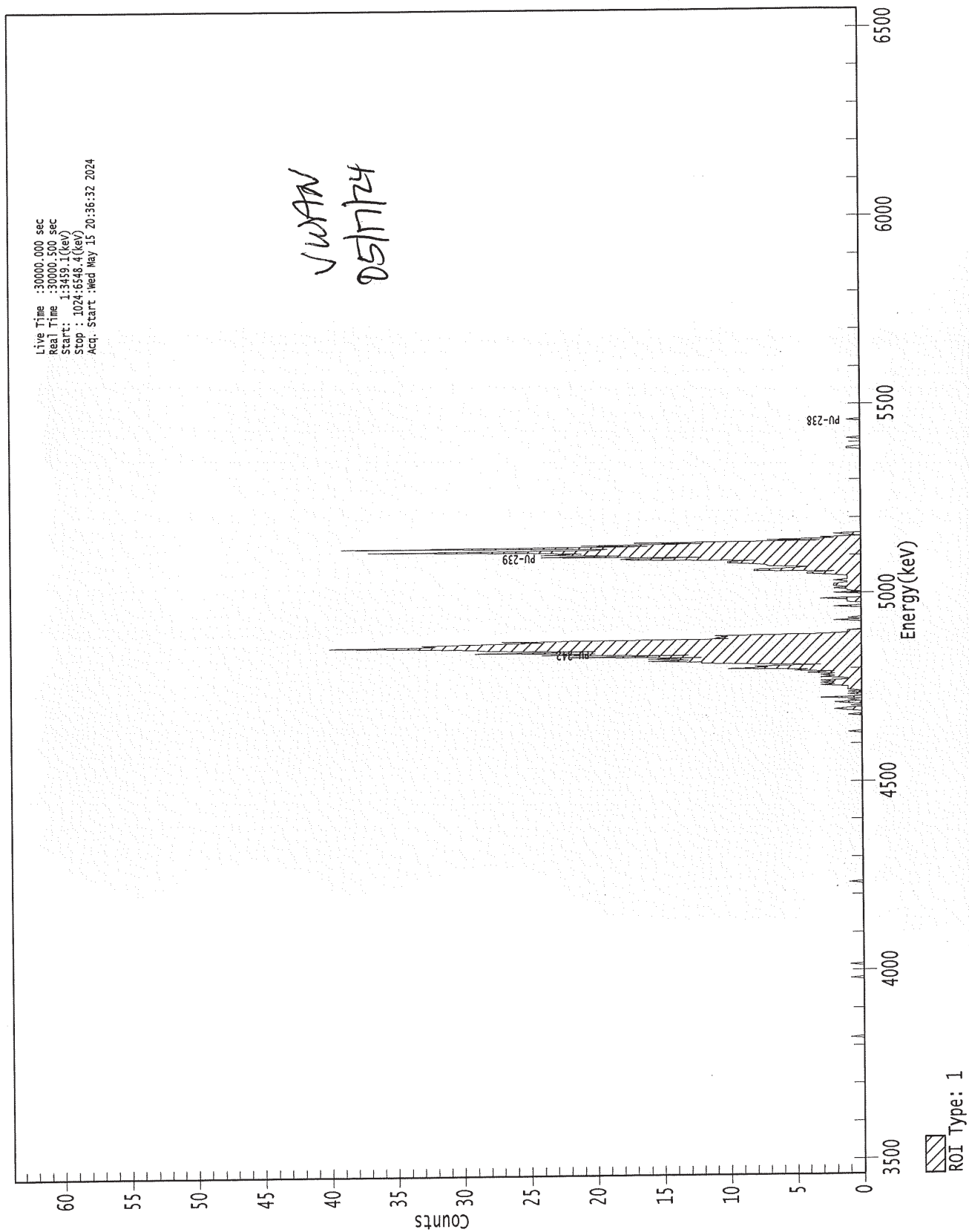
Sample Size: 1.000 unit
Sample Date/Time: 5/14/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:32 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ANALYSIS RESULTS

| Nuclide Name | Id Conf. | Energy (keV) | Activity (pCi/unit) | MDA (pCi/unit) |
|--------------|----------|--------------|----------------------------|---------------------------|
| PU-238 | 0.997 | 5487.10* | 3.096E-003 +/- 6.926E-003 | 4.351E-002 +/- 3.059E-003 |
| PU-239 | 0.991 | 5147.70* | 2.938E+000 +/- 2.468E-001 | 4.742E-002 +/- 3.333E-003 |
| PU-242 | 0.990 | 4890.70* | 3.876E+000 +/- 2.725E-001 | 5.384E-002 +/- 3.785E-003 |
| PU-244 | 0.997 | 4581.00* | -3.096E-003 +/- 6.926E-003 | 4.351E-002 +/- 3.059E-003 |

Activity reported as of : 5/15/24 8:36:32 PM

0000272918.CNF



Alpha Calibration Report

5/16/2024 1:30:22 PM



Sample Description:

Spectrum File: \\V79W-7\AlphaRoot\Data\0000272919.cnf
Detector Name: ALPHA_003
Chamber Serial Number: 02068349A
Detector Serial Number: 165822
Geometry Description: Shelf 2

Energy Calibration: 8/26/2023 12:34:42 AM by Administrator
Shape Calibration: 8/26/2023 12:34:42 AM by Administrator
Efficiency Calibration: 8/26/2023 12:34:43 AM by Administrator
Certificate Name: In8615 - primary

ENERGY / SHAPE CALIBRATION

Version: Alpha Encal v1.1
Energy = 3.401 MeV + 2.9952E-003*ch
FWHM = 2.4989E-002 MeV
Low Tail = 3.2158E-003 MeV

| Energy (MeV) | Centroid Channel | Centroid error | FWHM (ch) | FWHM error | TAIL (ch) | TAIL error |
|-----------------|---------------------|-------------------|--------------|---------------|--------------|---------------|
| 4.184 | 261.32 | 0.1620 | 7.74 | 0.3689 | 1.04 | 0.1132 |
| 4.761 | 455.55 | 0.2121 | 7.04 | 0.4626 | 0.67 | 0.0963 |
| 5.148 | 582.82 | 0.1039 | 8.32 | 0.2509 | 1.56 | 0.1154 |
| 5.479 | 694.45 | 0.2233 | 12.06 | 0.5849 | 3.58 | 0.5028 |

EFFICIENCY CALIBRATION

Version: Alpha Efcad v1.0
Avg Efficiency: 0.2146
Uncertainty: +/- 0.0026

| Energy (MeV) | Efficiency | Error |
|-----------------|-------------|-----------|
| 4.184 | 2.1477E-001 | 5.04E-003 |
| 4.761 | 2.1253E-001 | 4.97E-003 |
| 5.148 | 2.1390E-001 | 5.41E-003 |
| 5.479 | 2.1711E-001 | 5.12E-003 |

Alpha Analysis Report
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5/16/2024 1:30:22 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272919.cnf
Batch Identification: 240515PUX
Sample Identification: 718819
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA_003
Chamber Serial Number: 02068349A
Detector Serial Number: 165822
Env. Background: System Bkgd 247615
Reagent Blank: <not performed>

Sample Size: 1.000 +/- 0.0000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:33 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

Tracer Certificate: Pu242 124RadSol4
Tracer Quantity: 0.100 mL
Effective Efficiency: 0.1821 +/- 0.0066
Counting Efficiency: 0.2146 +/- 0.0026 on 8/26/2023 12:34:43 AM
Chem. Recovery Factor: 0.8487 +/- 0.0325

Peak Match Tolerance: 0.200 MeV

----- PEAK Location REPORT -----

| Nuclide | Left Channel | Channel Width | Right Channel | Left Energy Marker | Right Energy Marker |
|----------|--------------|---------------|---------------|--------------------|---------------------|
| PU-238 | 666 | 46 | 711 | 5395.8 | 5530.5 |
| PU-239 | 535 | 64 | 598 | 5003.4 | 5192.1 |
| PU-242 T | 421 | 93 | 513 | 4661.9 | 4937.5 |
| PU-244 | 368 | 35 | 402 | 4503.2 | 4605.0 |

----- PEAK AREA REPORT -----

| Nuclide | Energy (MeV) | Net Pk Area | Pk Area Error % | Ambient Backgnd | Reagent Backgnd | FWHM (keV) |
|----------|--------------|-------------|-----------------|-----------------|-----------------|------------|
| PU-238 | 5.479 | 27.50 | 19.33 | 0.50 | 0.00E+000 | 7.0 |
| PU-239 | 5.132 | 95.50 | 10.27 | 0.50 | 0.00E+000 | 6.5 |
| PU-242 T | 4.870 | 783.50 | 3.57 | 0.50 | 0.00E+000 | 30.3 |
| PU-244 | 4.527 | 1.00 | 141.42 | 0.00 | 0.00E+000 | 3.0 |

Alpha Analysis Report
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Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272919.cnf
Batch Identification: 240515PUX
Sample Identification: 718819
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA_003
Chamber Serial Number: 02068349A
Detector Serial Number: 165822

Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:33 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ACTIVITY REPORT

| Nuclide | Energy (MeV) | Activity (pCi/unit) | Activity Error % | MDA (pCi/unit) | MDA Error % |
|---------|-----------------|-------------------------|---------------------|--------------------|----------------|
| PU-238 | | 1.3617E-001 | 20.49 | 3.4795E-002 | 6.80 |
| | 5.487 | 1.3617E-001 | 20.49 | | |
| PU-239 | | 4.7294E-001 | 12.32 | 3.4799E-002 | 6.80 |
| | 5.148 | 4.7294E-001 | 12.32 | | |
| PU-242 | | 3.8762E+000 | 6.80 | 3.4764E-002 | 6.80 |
| | 4.891 | 3.8762E+000 | 6.80 | | |
| PU-244 | | 4.9472E-003 | 141.58 | 3.7846E-002 | 6.80 |
| | 4.581 | 4.9472E-003 | 141.58 | | |

Errors quoted at 1.000 sigma

Alpha NID Report 5/16/2024 1:30:22 PM
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Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272919.cnf
Batch Identification: 240515PUX
Sample Identification: 718819
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA_003
Chamber Serial Number: 02068349A
Detector Serial Number: 165822

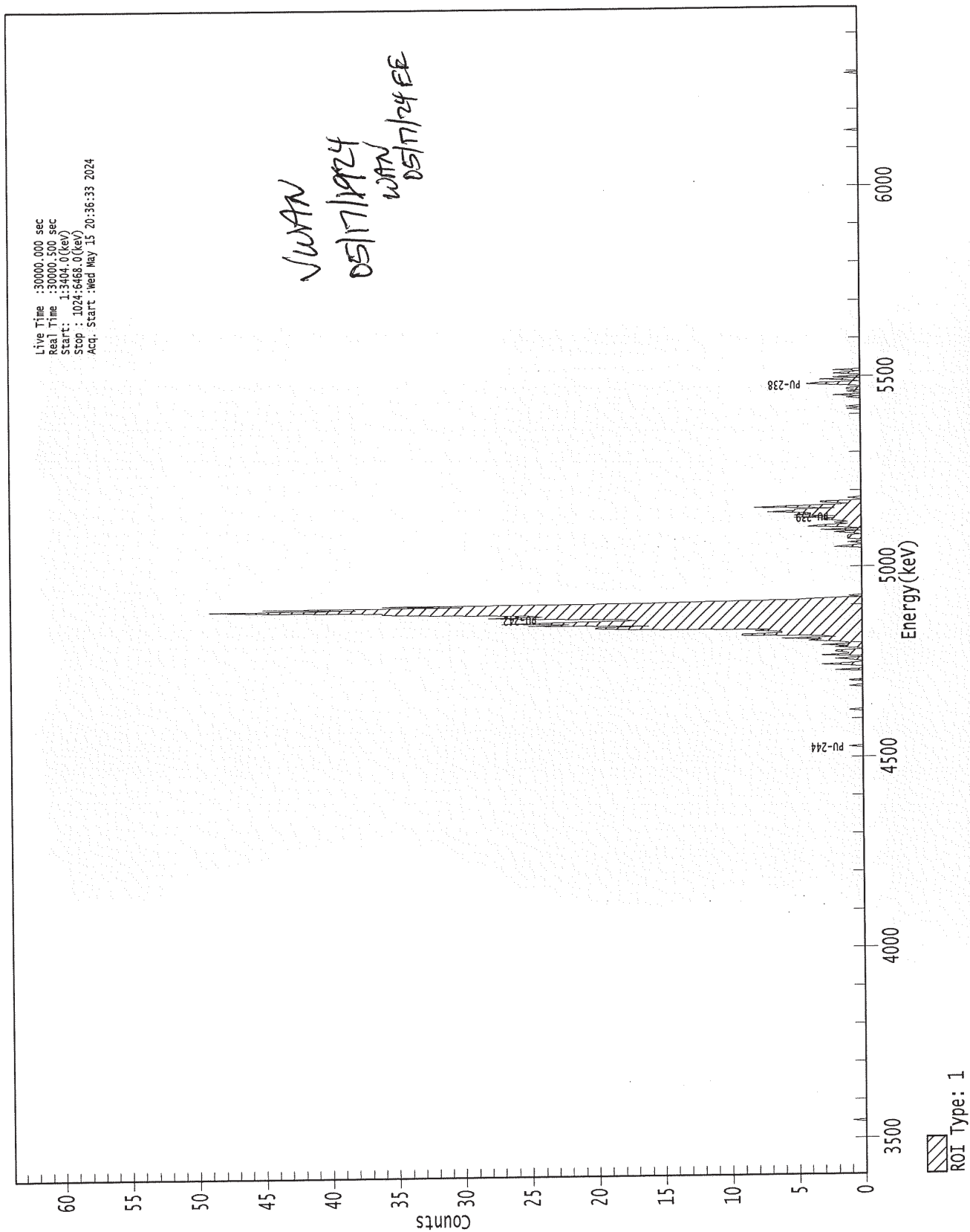
Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:33 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ANALYSIS RESULTS

| Nuclide Name | Id Conf. | Energy (keV) | Activity (pCi/unit) | MDA (pCi/unit) |
|--------------|----------|--------------|---------------------------|---------------------------|
| PU-238 | 1.000 | 5487.10* | 1.362E-001 +/- 2.790E-002 | 3.480E-002 +/- 2.365E-003 |
| PU-239 | 0.999 | 5147.70* | 4.729E-001 +/- 5.825E-002 | 3.480E-002 +/- 2.365E-003 |
| PU-242 | 0.998 | 4890.70* | 3.876E+000 +/- 2.634E-001 | 3.476E-002 +/- 2.363E-003 |
| PU-244 | 0.988 | 4581.00* | 4.947E-003 +/- 7.005E-003 | 3.785E-002 +/- 2.572E-003 |

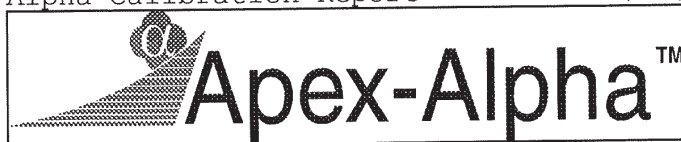
Activity reported as of : 5/15/24 8:36:33 PM

0000272919.CNF



Alpha Calibration Report

5/16/2024 1:31:29 PM



Sample Description:

Spectrum File: \\V79W-7\AlphaRoot\Data\0000272920.cnf
Detector Name: ALPHA_004
Chamber Serial Number: 02068349B
Detector Serial Number: 165823
Geometry Description: Shelf 2

Energy Calibration: 8/26/2023 12:34:53 AM by Administrator
Shape Calibration: 8/26/2023 12:34:53 AM by Administrator
Efficiency Calibration: 8/26/2023 12:34:54 AM by Administrator
Certificate Name: In7861 - primary

ENERGY / SHAPE CALIBRATION

Version: Alpha Encal v1.1
Energy = 3.391 MeV + 2.9913E-003*ch
FWHM = 2.5552E-002 MeV
Low Tail = 3.3199E-003 MeV

| Energy (MeV) | Centroid Channel | Centroid error | FWHM (ch) | FWHM error | TAIL (ch) | TAIL error |
|-----------------|---------------------|-------------------|--------------|---------------|--------------|---------------|
| 4.184 | 264.90 | 0.2033 | 8.27 | 0.4687 | 1.20 | 0.1580 |
| 4.761 | 459.47 | 0.2055 | 7.02 | 0.4497 | 0.71 | 0.1003 |
| 5.148 | 586.62 | 0.1193 | 8.15 | 0.2853 | 1.44 | 0.1214 |
| 5.479 | 698.59 | 0.1904 | 11.86 | 0.4946 | 3.39 | 0.4041 |

EFFICIENCY CALIBRATION

Version: Alpha Efcad v1.0
Avg Efficiency: 0.2084
Uncertainty: +/- 0.0026

| Energy (MeV) | Efficiency | Error |
|-----------------|-------------|-----------|
| 4.184 | 2.0576E-001 | 5.13E-003 |
| 4.761 | 2.0777E-001 | 5.08E-003 |
| 5.148 | 2.0847E-001 | 5.14E-003 |
| 5.479 | 2.1191E-001 | 5.24E-003 |

Alpha Analysis Report
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Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272920.cnf
Batch Identification: 240515PUX
Sample Identification: 718820
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA_004
Chamber Serial Number: 02068349B
Detector Serial Number: 165823
Env. Background: System Bkgd 247616
Reagent Blank: <not performed>

Sample Size: 1.000 +/- 0.0000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:35 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

Tracer Certificate: Pu242 124RadSol4
Tracer Quantity: 0.100 mL
Effective Efficiency: 0.1571 +/- 0.0061
Counting Efficiency: 0.2084 +/- 0.0026 on 8/26/2023 12:34:54 AM
Chem. Recovery Factor: 0.7538 +/- 0.0309

Peak Match Tolerance: 0.200 MeV

----- PEAK Location REPORT -----

| Nuclide | Left Channel | Channel Width | Right Channel | Left Energy Marker | Right Energy Marker |
|----------|--------------|---------------|---------------|--------------------|---------------------|
| PU-238 | 662 | 51 | 712 | 5371.4 | 5521.0 |
| PU-239 | 539 | 60 | 598 | 5003.5 | 5180.0 |
| PU-242 T | 412 | 105 | 516 | 4623.6 | 4934.7 |
| PU-244 | 372 | 35 | 406 | 4503.9 | 4605.6 |

----- PEAK AREA REPORT -----

| Nuclide | Energy (MeV) | Net Pk Area | Pk Area Error % | Ambient Backgnd | Reagent Backgnd | FWHM (keV) |
|----------|--------------|-------------|-----------------|-----------------|-----------------|------------|
| PU-238 | 5.469 | 19.50 | 23.08 | 0.50 | 0.00E+000 | 4.5 |
| PU-239 | 5.136 | 106.00 | 9.76 | 0.00 | 0.00E+000 | 8.5 |
| PU-242 T | 4.868 | 676.00 | 3.85 | 1.00 | 0.00E+000 | 24.3 |
| PU-244 | 4.555 | -0.50 | 223.61 | 0.50 | 0.00E+000 | 0.0 |

Alpha Analysis Report
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Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272920.cnf
Batch Identification: 240515PUX
Sample Identification: 718820
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA_004
Chamber Serial Number: 02068349B
Detector Serial Number: 165823

Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:35 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ACTIVITY REPORT

| Nuclide | Energy (MeV) | Activity (pCi/unit) | Activity Error % | MDA (pCi/unit) | MDA Error % |
|---------|-----------------|-------------------------|---------------------|--------------------|----------------|
| PU-238 | | 1.1191E-001 | 24.10 | 4.0329E-002 | 6.95 |
| | 5.487 | 1.1191E-001 | 24.10 | | |
| PU-239 | | 6.0841E-001 | 11.98 | 4.3909E-002 | 6.95 |
| | 5.148 | 6.0841E-001 | 11.98 | | |
| PU-242 | | 3.8762E+000 | 6.95 | 4.9857E-002 | 6.95 |
| | 4.891 | 3.8762E+000 | 6.95 | | |
| PU-244 | | -2.8670E-003 | -223.7 | 4.0293E-002 | 6.95 |
| | 4.581 | -2.8670E-003 | -223.7 | | |

Errors quoted at 1.000 sigma

Alpha NID Report
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Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272920.cnf
Batch Identification: 240515PUX
Sample Identification: 718820
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA_004
Chamber Serial Number: 02068349B
Detector Serial Number: 165823

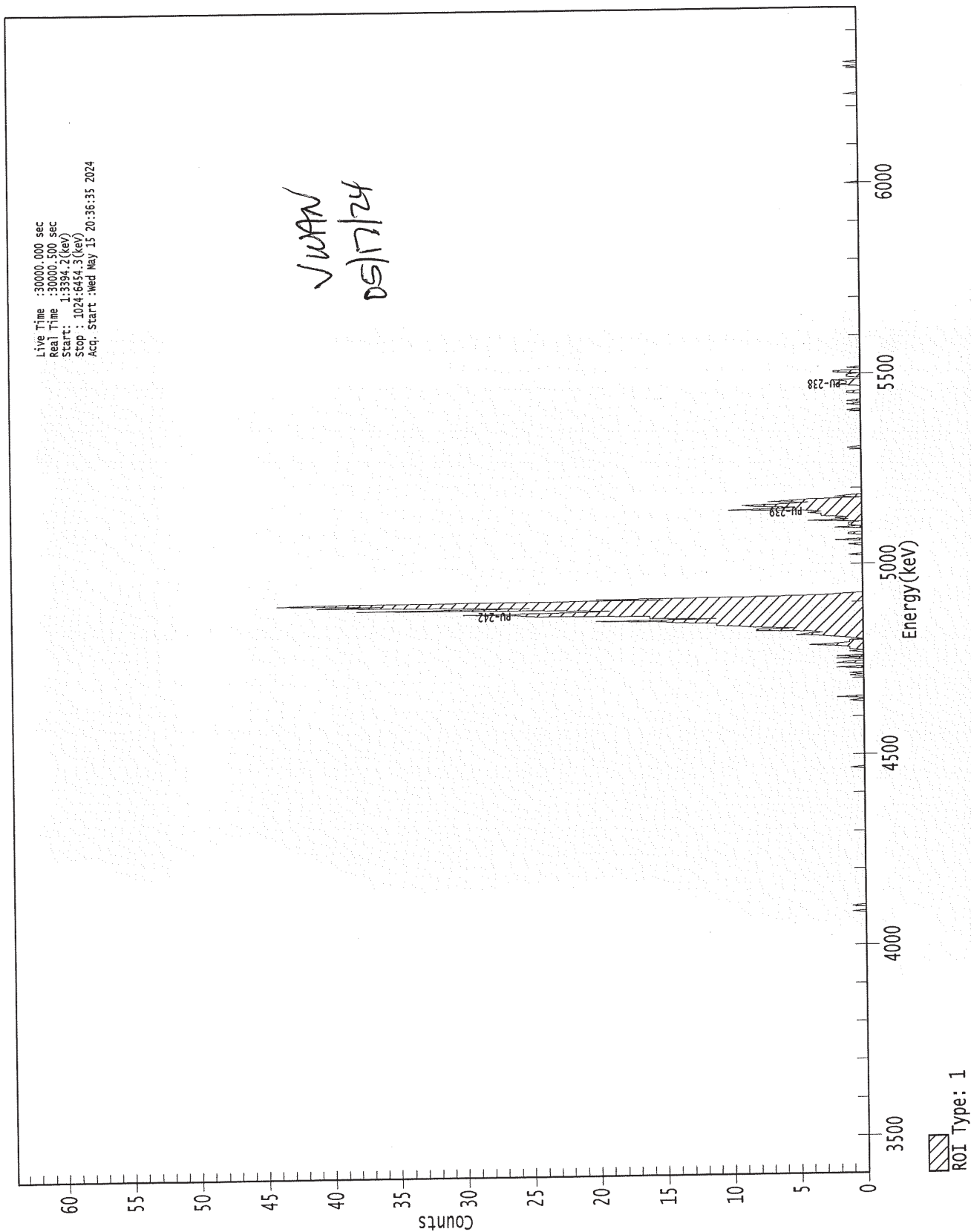
Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:35 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ANALYSIS RESULTS

| Nuclide Name | Id Conf. | Energy (keV) | Activity (pCi/unit) | MDA (pCi/unit) |
|-----------------|-------------|-----------------|----------------------------|---------------------------|
| PU-238 | 0.999 | 5487.10* | 1.119E-001 +/- 2.697E-002 | 4.033E-002 +/- 2.801E-003 |
| PU-239 | 0.999 | 5147.70* | 6.084E-001 +/- 7.287E-002 | 4.391E-002 +/- 3.050E-003 |
| PU-242 | 0.998 | 4890.70* | 3.876E+000 +/- 2.692E-001 | 4.986E-002 +/- 3.463E-003 |
| PU-244 | 0.997 | 4581.00* | -2.867E-003 +/- 6.414E-003 | 4.029E-002 +/- 2.798E-003 |

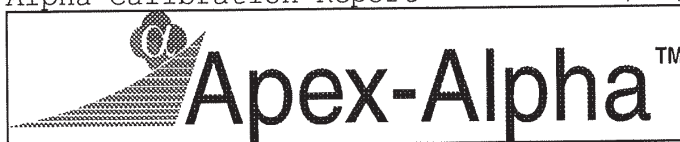
Activity reported as of : 5/15/24 8:36:35 PM

0000272920.CNF



Alpha Calibration Report

5/16/2024 1:32:42 PM



Sample Description:

Spectrum File: \\V79W-7\AlphaRoot\Data\0000272921.cnf
Detector Name: ALPHA_005
Chamber Serial Number: 05010224A
Detector Serial Number: 159381
Geometry Description: Shelf 2

Energy Calibration: 2/8/2023 9:17:28 PM by Administrator
Shape Calibration: 2/8/2023 9:17:28 PM by Administrator
Efficiency Calibration: 2/8/2023 9:17:29 PM by Administrator
Certificate Name: In8615 - primary

ENERGY / SHAPE CALIBRATION

Version: Alpha Encal v1.1
Energy = 3.440 MeV + 3.0066E-003*ch
FWHM = 2.8672E-002 MeV
Low Tail = 3.4417E-003 MeV

| Energy (MeV) | Centroid Channel | Centroid error | FWHM (ch) | FWHM error | TAIL (ch) | TAIL error |
|-----------------|---------------------|-------------------|--------------|---------------|--------------|---------------|
| 4.184 | 247.84 | 0.1662 | 8.01 | 0.3722 | 0.92 | 0.0953 |
| 4.761 | 440.30 | 0.2523 | 8.17 | 0.5551 | 0.87 | 0.1310 |
| 5.148 | 566.78 | 0.1636 | 10.29 | 0.3950 | 1.93 | 0.1816 |
| 5.479 | 678.82 | 0.2024 | 12.31 | 0.5113 | 2.94 | 0.3221 |

EFFICIENCY CALIBRATION

Version: Alpha Efcals v1.0
Avg Efficiency: 0.2188
Uncertainty: +/- 0.0026

| Energy (MeV) | Efficiency | Error |
|-----------------|-------------|-----------|
| 4.184 | 2.2169E-001 | 5.15E-003 |
| 4.761 | 2.1624E-001 | 5.03E-003 |
| 5.148 | 2.1413E-001 | 5.41E-003 |
| 5.479 | 2.2275E-001 | 5.21E-003 |

Alpha Analysis Report
Page 2 of 4

5/16/2024 1:32:42 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272921.cnf
Batch Identification: 240515PUX
Sample Identification: 718821
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA_005
Chamber Serial Number: 05010224A
Detector Serial Number: 159381
Env. Background: System Bkgd 247617
Reagent Blank: <not performed>

Sample Size: 1.000 +/- 0.0000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:37 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

Tracer Certificate: Pu242 124RadSol4
Tracer Quantity: 0.100 mL
Effective Efficiency: 0.1756 +/- 0.0065
Counting Efficiency: 0.2188 +/- 0.0026 on 2/8/2023 9:17:29 PM
Chem. Recovery Factor: 0.8027 +/- 0.0312

Peak Match Tolerance: 0.200 MeV

----- PEAK Location REPORT -----

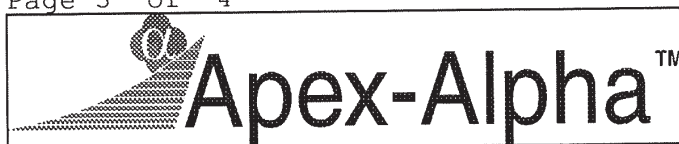
| Nuclide | Left Channel | Channel Width | Right Channel | Left Energy Marker | Right Energy Marker |
|----------|--------------|---------------|---------------|--------------------|---------------------|
| PU-238 | 640 | 56 | 695 | 5364.7 | 5530.1 |
| PU-239 | 505 | 80 | 584 | 4958.8 | 5196.3 |
| PU-242 T | 393 | 105 | 497 | 4622.1 | 4934.8 |
| PU-244 | 354 | 34 | 387 | 4504.8 | 4604.0 |

----- PEAK AREA REPORT -----

| Nuclide | Energy (MeV) | Net Pk Area | Pk Area Error % | Ambient Backgnd | Reagent Backgnd | FWHM (keV) |
|----------|--------------|-------------|-----------------|-----------------|-----------------|------------|
| PU-238 | 5.470 | 98.50 | 10.11 | 0.50 | 0.00E+000 | 16.5 |
| PU-239 | 5.123 | 428.00 | 4.84 | 0.00 | 0.00E+000 | 8.4 |
| PU-242 T | 4.861 | 755.50 | 3.64 | 0.50 | 0.00E+000 | 30.1 |
| PU-244 | 4.514 | 1.00 | 141.42 | 0.00 | 0.00E+000 | 3.0 |

Alpha Analysis Report
Page 3 of 4

5/16/2024 1:32:42 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272921.cnf
Batch Identification: 240515PUX
Sample Identification: 718821
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA_005
Chamber Serial Number: 05010224A
Detector Serial Number: 159381

Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:37 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ACTIVITY REPORT

| Nuclide | Energy (MeV) | Activity (pCi/unit) | Activity Error % | MDA (pCi/unit) | MDA Error % |
|---------|-----------------|-------------------------|---------------------|--------------------|----------------|
| PU-238 | | 5.0581E-001 | 12.20 | 3.6085E-002 | 6.83 |
| | 5.487 | 5.0581E-001 | 12.20 | | |
| PU-239 | | 2.1981E+000 | 8.37 | 3.9288E-002 | 6.83 |
| | 5.148 | 2.1981E+000 | 8.37 | | |
| PU-242 | | 3.8762E+000 | 6.83 | 3.6053E-002 | 6.83 |
| | 4.891 | 3.8762E+000 | 6.83 | | |
| PU-244 | | 5.1306E-003 | 141.59 | 3.9249E-002 | 6.83 |
| | 4.581 | 5.1306E-003 | 141.59 | | |

Errors quoted at 1.000 sigma

Alpha NID Report
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5/16/2024 1:32:42 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272921.cnf
Batch Identification: 240515PUX
Sample Identification: 718821
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA_005
Chamber Serial Number: 05010224A
Detector Serial Number: 159381

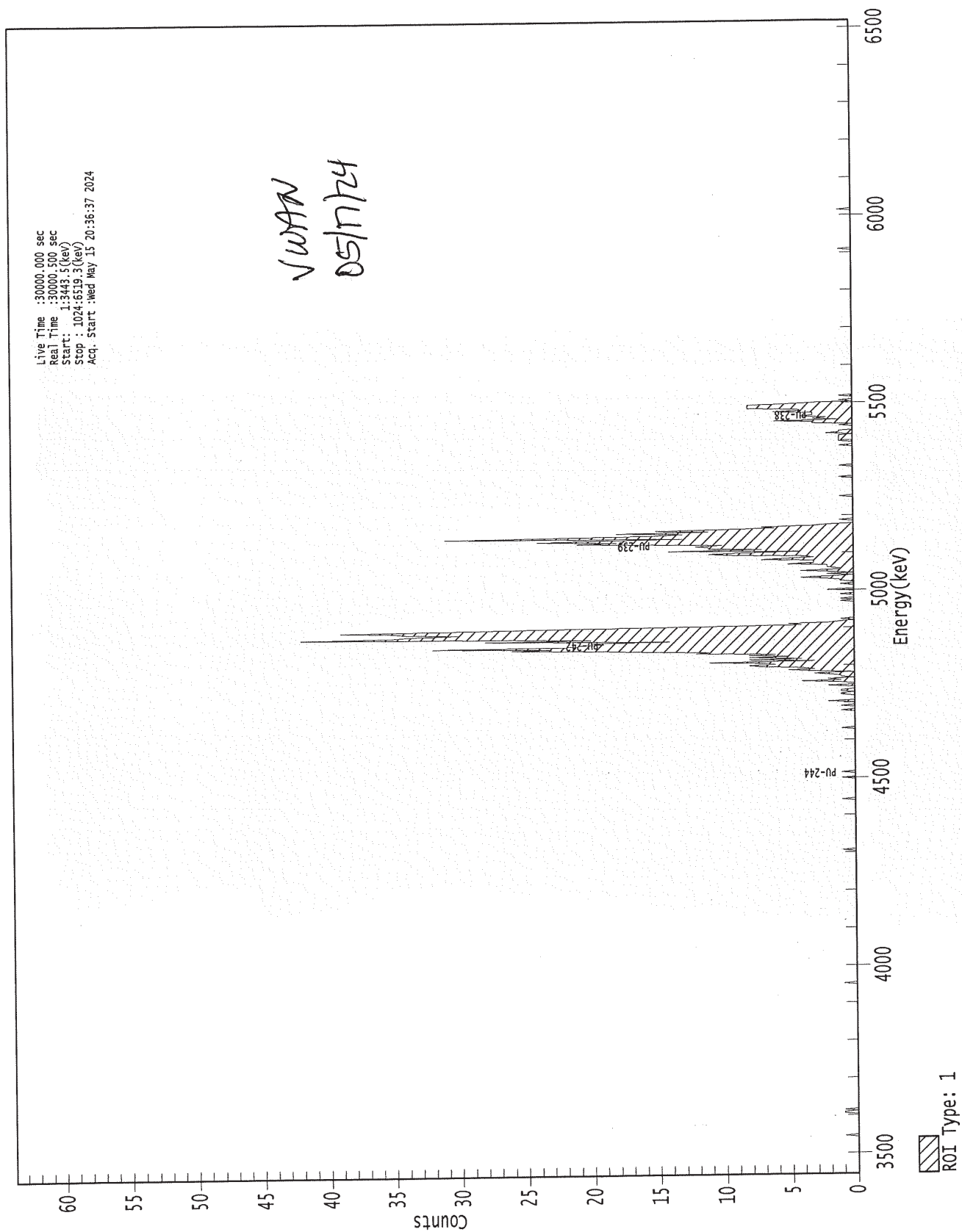
Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:37 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ANALYSIS RESULTS

| Nuclide Name | Id Conf. | Energy (keV) | Activity (pCi/unit) | MDA (pCi/unit) |
|-----------------|-------------|-----------------|---------------------------|---------------------------|
| PU-238 | 0.999 | 5487.10* | 5.058E-001 +/- 6.173E-002 | 3.608E-002 +/- 2.465E-003 |
| PU-239 | 0.998 | 5147.70* | 2.198E+000 +/- 1.840E-001 | 3.929E-002 +/- 2.684E-003 |
| PU-242 | 0.996 | 4890.70* | 3.876E+000 +/- 2.648E-001 | 3.605E-002 +/- 2.463E-003 |
| PU-244 | 0.982 | 4581.00* | 5.131E-003 +/- 7.264E-003 | 3.925E-002 +/- 2.681E-003 |

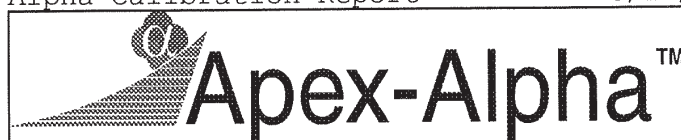
Activity reported as of : 5/15/24 8:36:37 PM

0000272921.CNF



Alpha Calibration Report

5/16/2024 1:34:45 PM



Sample Description:

Spectrum File: \\V79W-7\AlphaRoot\Data\0000272922.cnf
Detector Name: ALPHA_006
Chamber Serial Number: 05010224B
Detector Serial Number: 159382
Geometry Description: Shelf 2

Energy Calibration: 6/6/2023 4:03:24 PM by Administrator
Shape Calibration: 6/6/2023 4:03:24 PM by Administrator
Efficiency Calibration: 6/6/2023 4:03:26 PM by Administrator
Certificate Name: In7861 - primary

----- ENERGY / SHAPE CALIBRATION -----

Version: Alpha Encal v1.1
Energy = 3.445 MeV + 3.0102E-003*ch
FWHM = 2.8236E-002 MeV
Low Tail = 3.7434E-003 MeV

| Energy (MeV) | Centroid Channel | Centroid error | FWHM (ch) | FWHM error | TAIL (ch) | TAIL error |
|-----------------|---------------------|-------------------|--------------|---------------|--------------|---------------|
| 4.184 | 245.82 | 0.2457 | 9.27 | 0.5590 | 1.25 | 0.1727 |
| 4.761 | 438.80 | 0.2362 | 7.95 | 0.5219 | 0.82 | 0.1185 |
| 5.148 | 565.12 | 0.1355 | 9.20 | 0.3198 | 1.54 | 0.1280 |
| 5.479 | 676.70 | 0.2307 | 11.87 | 0.5818 | 2.80 | 0.3603 |

----- EFFICIENCY CALIBRATION -----

Version: Alpha Efcals v1.0
Avg Efficiency: 0.2148
Uncertainty: +/- 0.0026

| Energy (MeV) | Efficiency | Error |
|-----------------|-------------|-----------|
| 4.184 | 2.1060E-001 | 5.22E-003 |
| 4.761 | 2.1959E-001 | 5.29E-003 |
| 5.148 | 2.1545E-001 | 5.27E-003 |
| 5.479 | 2.1354E-001 | 5.27E-003 |

Alpha Analysis Report
Page 2 of 4

5/16/2024 1:34:45 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272922.cnf
Batch Identification: 240515PUX
Sample Identification: 718821D
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA_006
Chamber Serial Number: 05010224B
Detector Serial Number: 159382
Env. Background: System Bkgd 247618
Reagent Blank: <not performed>

Sample Size: 1.000 +/- 0.0000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:39 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

Tracer Certificate: Pu242 124RadSol4
Tracer Quantity: 0.100 mL
Effective Efficiency: 0.1793 +/- 0.0066
Counting Efficiency: 0.2148 +/- 0.0026 on 6/6/2023 4:03:26 PM
Chem. Recovery Factor: 0.8349 +/- 0.0323

Peak Match Tolerance: 0.200 MeV

PEAK Location REPORT

| Nuclide | Left Channel | Channel Width | Right Channel | Left Energy Marker | Right Energy Marker |
|----------|--------------|---------------|---------------|--------------------|---------------------|
| PU-238 | 636 | 57 | 692 | 5359.1 | 5527.6 |
| PU-239 | 504 | 78 | 581 | 4961.7 | 5193.5 |
| PU-242 T | 404 | 93 | 496 | 4660.7 | 4937.6 |
| PU-244 | 352 | 34 | 385 | 4504.2 | 4603.5 |

PEAK AREA REPORT

| Nuclide | Energy (MeV) | Net Pk Area | Pk Area Error % | Ambient Backgnd | Reagent Backgnd | FWHM (keV) |
|----------|--------------|-------------|-----------------|-----------------|-----------------|------------|
| PU-238 | 5.469 | 114.50 | 9.38 | 0.50 | 0.00E+000 | 4.4 |
| PU-239 | 5.128 | 708.00 | 3.76 | 0.00 | 0.00E+000 | 31.6 |
| PU-242 T | 4.867 | 771.50 | 3.60 | 0.50 | 0.00E+000 | 12.0 |
| PU-244 | 4.581 | 2.00 | 86.60 | 0.00 | 0.00E+000 | 3.0 |

Alpha Analysis Report
Page 3 of 4

5/16/2024 1:34:45 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272922.cnf
Batch Identification: 240515PUX
Sample Identification: 718821D
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA_006
Chamber Serial Number: 05010224B
Detector Serial Number: 159382

Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:39 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

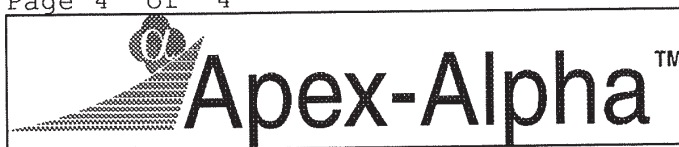
NUCLIDE ACTIVITY REPORT

| Nuclide | Energy (MeV) | Activity (pCi/unit) | Activity Error % | MDA (pCi/unit) | MDA Error % |
|---------|-----------------|-------------------------|---------------------|--------------------|----------------|
| PU-238 | | 5.7578E-001 | 11.59 | 3.5336E-002 | 6.81 |
| | 5.487 | 5.7578E-001 | 11.59 | | |
| PU-239 | | 3.5607E+000 | 7.78 | 3.8474E-002 | 6.81 |
| | 5.148 | 3.5607E+000 | 7.78 | | |
| PU-242 | | 3.8762E+000 | 6.81 | 3.5305E-002 | 6.81 |
| | 4.891 | 3.8762E+000 | 6.81 | | |
| PU-244 | | 1.0048E-002 | 86.87 | 3.8435E-002 | 6.81 |
| | 4.581 | 1.0048E-002 | 86.87 | | |

Errors quoted at 1.000 sigma

Alpha NID Report
Page 4 of 4

5/16/2024 1:34:46 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272922.cnf
Batch Identification: 240515PUX
Sample Identification: 718821D
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA 006
Chamber Serial Number: 05010224B
Detector Serial Number: 159382

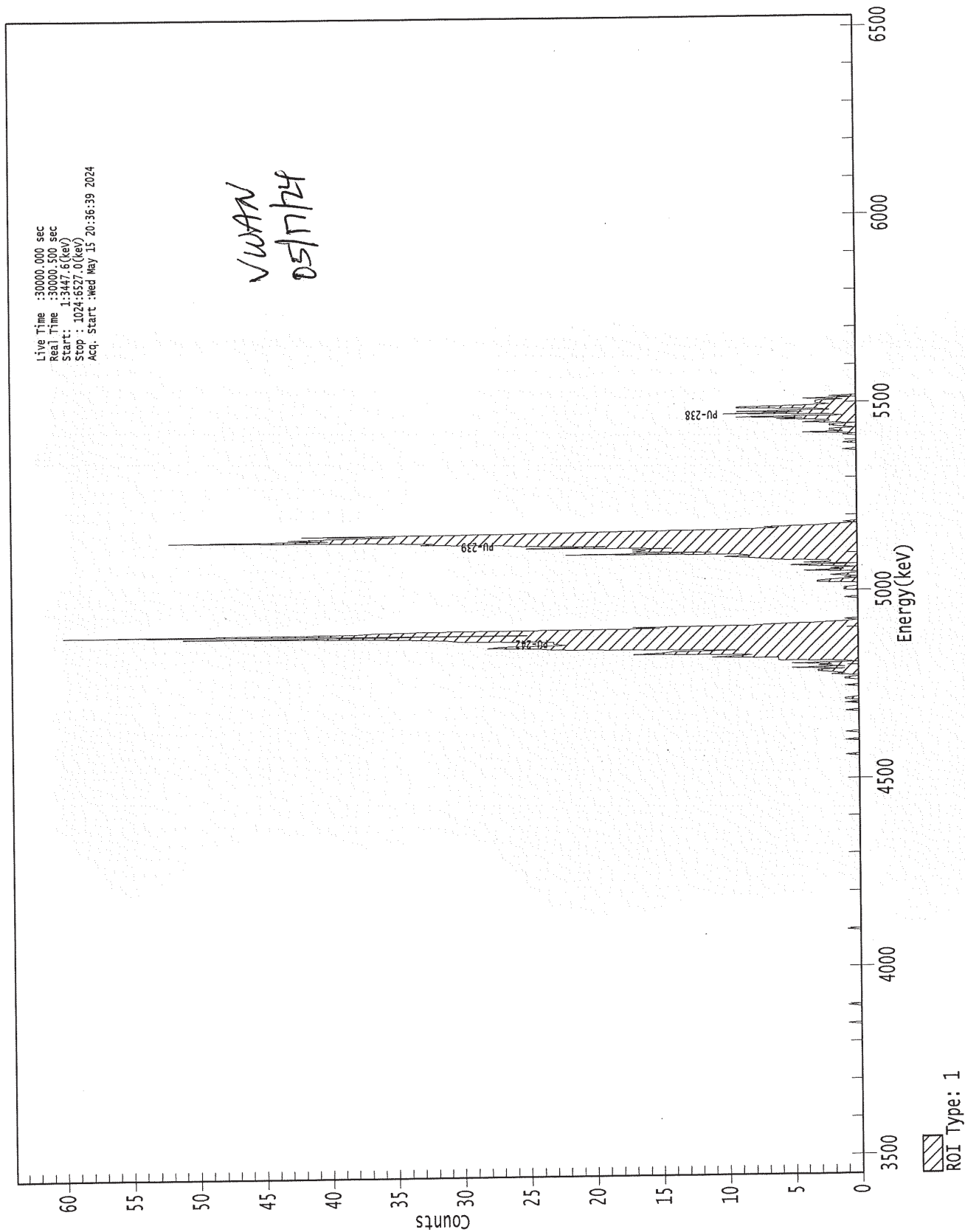
Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:39 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ANALYSIS RESULTS

| Nuclide Name | Id Conf. | Energy (keV) | Activity (pCi/unit) | MDA (pCi/unit) | |
|-----------------|-------------|-----------------|---------------------------|--------------------|----------------|
| PU-238 | 0.999 | 5487.10* | 5.758E-001 +/- 6.672E-002 | 3.534E-002 | +/- 2.407E-003 |
| PU-239 | 0.999 | 5147.70* | 3.561E+000 +/- 2.770E-001 | 3.847E-002 | +/- 2.620E-003 |
| PU-242 | 0.998 | 4890.70* | 3.876E+000 +/- 2.640E-001 | 3.531E-002 | +/- 2.404E-003 |
| PU-244 | 1.000 | 4581.00* | 1.005E-002 +/- 8.729E-003 | 3.844E-002 | +/- 2.618E-003 |

Activity reported as of : 5/15/24 8:36:39 PM

0000272922.CNF



Alpha Calibration Report

5/16/2024 1:35:44 PM



Sample Description:

Spectrum File: \\V79W-7\AlphaRoot\Data\0000272923.cnf
Detector Name: ALPHA 007
Chamber Serial Number: 05010225A
Detector Serial Number: 42347
Geometry Description: Shelf 2

Energy Calibration: 8/11/2022 8:35:03 PM by Administrator
Shape Calibration: 8/11/2022 8:35:03 PM by Administrator
Efficiency Calibration: 8/11/2022 8:35:05 PM by Administrator
Certificate Name: In8615 - primary

ENERGY / SHAPE CALIBRATION

Version: Alpha Encal v1.1
Energy = 3.454 MeV + 3.0107E-003*ch
FWHM = 3.2699E-002 MeV
Low Tail = 4.5379E-003 MeV

| Energy (MeV) | Centroid Channel | Centroid error | FWHM (ch) | FWHM error | TAIL (ch) | TAIL error |
|-----------------|---------------------|-------------------|--------------|---------------|--------------|---------------|
| 4.184 | 242.50 | 0.2095 | 10.17 | 0.4893 | 1.55 | 0.1754 |
| 4.761 | 435.31 | 0.2156 | 8.90 | 0.4787 | 1.00 | 0.1210 |
| 5.148 | 562.07 | 0.1357 | 10.09 | 0.3334 | 2.03 | 0.1675 |
| 5.479 | 673.05 | 0.1807 | 15.09 | 0.4801 | 5.06 | 0.5018 |

EFFICIENCY CALIBRATION

Version: Alpha Efcad v1.0
Avg Efficiency: 0.2149
Uncertainty: +/- 0.0026

| Energy (MeV) | Efficiency | Error |
|-----------------|-------------|-----------|
| 4.184 | 2.1363E-001 | 5.02E-003 |
| 4.761 | 2.1507E-001 | 5.01E-003 |
| 5.148 | 2.0950E-001 | 5.33E-003 |
| 5.479 | 2.2114E-001 | 5.19E-003 |

Alpha Analysis Report
Page 2 of 4

5/16/2024 1:35:45 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272923.cnf
Batch Identification: 240515PUX
Sample Identification: 718822
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA_007
Chamber Serial Number: 05010225A
Detector Serial Number: 42347
Env. Background: System Bkgd 247619
Reagent Blank: <not performed>

Sample Size: 1.000 +/- 0.0000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:41 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

Tracer Certificate: Pu242 124RadSol4
Tracer Quantity: 0.100 mL
Effective Efficiency: 0.1615 +/- 0.0062
Counting Efficiency: 0.2149 +/- 0.0026 on 8/11/2022 8:35:05 PM
Chem. Recovery Factor: 0.7517 +/- 0.0303

Peak Match Tolerance: 0.200 MeV

PEAK Location REPORT

| Nuclide | Left Channel | Channel Width | Right Channel | Left Energy Marker | Right Energy Marker |
|----------|--------------|---------------|---------------|--------------------|---------------------|
| PU-238 | 653 | 39 | 691 | 5419.9 | 5534.3 |
| PU-239 | 514 | 60 | 573 | 5001.4 | 5179.0 |
| PU-242 T | 395 | 97 | 491 | 4643.1 | 4932.1 |
| PU-244 | 349 | 34 | 382 | 4504.6 | 4604.0 |

PEAK AREA REPORT

| Nuclide | Energy (MeV) | Net Pk Area | Pk Area Error % | Ambient Backgnd | Reagent Backgnd | FWHM (keV) |
|----------|--------------|-------------|-----------------|-----------------|-----------------|------------|
| PU-238 | 5.485 | 12.50 | 29.12 | 0.50 | 0.00E+000 | 4.5 |
| PU-239 | 5.137 | 58.00 | 13.24 | 0.00 | 0.00E+000 | 4.7 |
| PU-242 T | 4.870 | 695.00 | 3.80 | 0.00 | 0.00E+000 | 28.4 |
| PU-244 | 4.553 | 0.00 | 1000.0 | 0.00 | 0.00E+000 | 0.0 |

Alpha Analysis Report
Page 3 of 4

5/16/2024 1:35:45 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272923.cnf
Batch Identification: 240515PUX
Sample Identification: 718822
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA_007
Chamber Serial Number: 05010225A
Detector Serial Number: 42347

Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:41 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

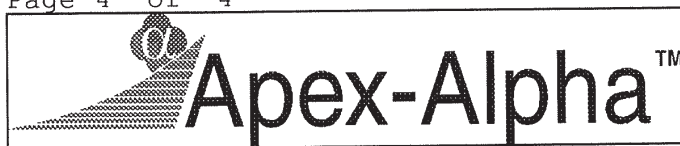
NUCLIDE ACTIVITY REPORT

| Nuclide | Energy (MeV) | Activity (pCi/unit) | Activity Error % | MDA (pCi/unit) | MDA Error % |
|---------|-----------------|-------------------------|---------------------|--------------------|----------------|
| PU-238 | | 6.9777E-002 | 29.93 | 3.9226E-002 | 6.92 |
| | 5.487 | 6.9777E-002 | 29.93 | | |
| PU-239 | | 3.2380E-001 | 14.94 | 4.2709E-002 | 6.92 |
| | 5.148 | 3.2380E-001 | 14.94 | | |
| PU-242 | | 3.8762E+000 | 6.92 | 4.2666E-002 | 6.92 |
| | 4.891 | 3.8762E+000 | 6.92 | | |
| PU-244 | | 0.0000E+000 | 0.00 | 4.2666E-002 | 6.92 |
| | 4.581 | 0.0000E+000 | 0.00 | | |

Errors quoted at 1.000 sigma

Alpha NID Report
Page 4 of 4

5/16/2024 1:35:45 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272923.cnf
Batch Identification: 240515PUX
Sample Identification: 718822
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA_007
Chamber Serial Number: 05010225A
Detector Serial Number: 42347

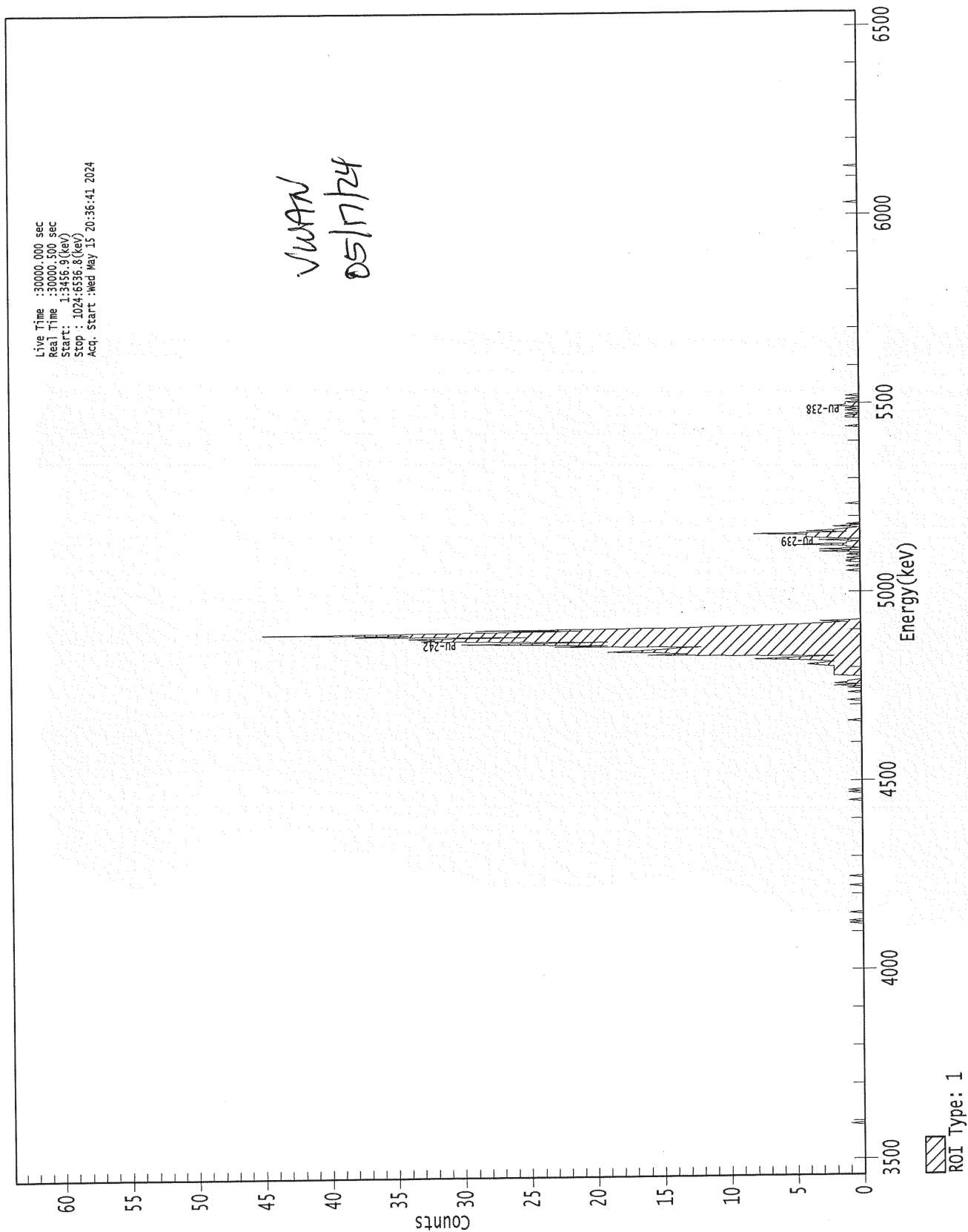
Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:41 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ANALYSIS RESULTS

| Nuclide Name | Id Conf. | Energy (keV) | Activity (pCi/unit) | MDA (pCi/unit) |
|--------------|----------|--------------|---------------------------|---------------------------|
| PU-238 | 1.000 | 5487.10* | 6.978E-002 +/- 2.088E-002 | 3.923E-002 +/- 2.713E-003 |
| PU-239 | 1.000 | 5147.70* | 3.238E-001 +/- 4.838E-002 | 4.271E-002 +/- 2.953E-003 |
| PU-242 | 0.998 | 4890.70* | 3.876E+000 +/- 2.680E-001 | 4.267E-002 +/- 2.950E-003 |
| PU-244 | 0.997 | 4581.00* | 0.000E+000 +/- 7.894E-003 | 4.267E-002 +/- 2.950E-003 |

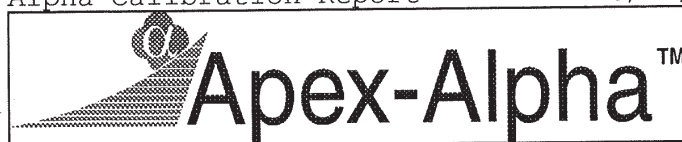
Activity reported as of : 5/15/24 8:36:41 PM

0000272923.CNF



Alpha Calibration Report

5/16/2024 1:36:51 PM



Sample Description:

Spectrum File: \\V79W-7\AlphaRoot\Data\0000272924.cnf
Detector Name: ALPHA_008
Chamber Serial Number: 05010225B
Detector Serial Number: 42348
Geometry Description: Shelf 2

Energy Calibration: 11/2/2022 4:26:18 PM by Administrator
Shape Calibration: 11/2/2022 4:26:18 PM by Administrator
Efficiency Calibration: 11/2/2022 4:26:19 PM by Administrator
Certificate Name: In7861 - primary

ENERGY / SHAPE CALIBRATION

Version: Alpha Encal v1.1
Energy = 3.443 MeV + 3.0161E-003*ch
FWHM = 2.5317E-002 MeV
Low Tail = 3.3054E-003 MeV

| Energy (MeV) | Centroid Channel | Centroid error | FWHM (ch) | FWHM error | TAIL (ch) | TAIL error |
|-----------------|---------------------|-------------------|--------------|---------------|--------------|---------------|
| 4.184 | 245.71 | 0.1730 | 8.59 | 0.3960 | 1.20 | 0.1277 |
| 4.761 | 437.74 | 0.2168 | 7.94 | 0.4802 | 0.86 | 0.1150 |
| 5.148 | 564.86 | 0.1201 | 7.74 | 0.2766 | 1.10 | 0.0908 |
| 5.479 | 675.48 | 0.2423 | 11.86 | 0.6128 | 2.91 | 0.4007 |

EFFICIENCY CALIBRATION

Version: Alpha Efcad v1.0
Avg Efficiency: 0.2165
Uncertainty: +/- 0.0026

| Energy (MeV) | Efficiency | Error |
|-----------------|-------------|-----------|
| 4.184 | 2.0888E-001 | 5.19E-003 |
| 4.761 | 2.2084E-001 | 5.31E-003 |
| 5.148 | 2.1982E-001 | 5.35E-003 |
| 5.479 | 2.1692E-001 | 5.33E-003 |

Alpha Analysis Report
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5/16/2024 1:36:51 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272924.cnf
Batch Identification: 240515PUX
Sample Identification: 718825
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA_008
Chamber Serial Number: 05010225B
Detector Serial Number: 42348
Env. Background: System Bkgd 247620
Reagent Blank: <not performed>

Sample Size: 1.000 +/- 0.0000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:43 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

Tracer Certificate: Pu242 124RadSol4
Tracer Quantity: 0.100 mL
Effective Efficiency: 0.1857 +/- 0.0067
Counting Efficiency: 0.2165 +/- 0.0026 on 11/2/2022 4:26:19 PM
Chem. Recovery Factor: 0.8577 +/- 0.0326

Peak Match Tolerance: 0.200 MeV

PEAK Location REPORT

| Nuclide | Left Channel | Channel Width | Right Channel | Left Energy Marker | Right Energy Marker |
|----------|--------------|---------------|---------------|--------------------|---------------------|
| PU-238 | 635 | 57 | 691 | 5358.4 | 5527.3 |
| PU-239 | 510 | 67 | 576 | 4981.4 | 5180.5 |
| PU-242 T | 392 | 106 | 497 | 4625.5 | 4942.2 |
| PU-244 | 352 | 34 | 385 | 4504.8 | 4604.4 |

PEAK AREA REPORT

| Nuclide | Energy (MeV) | Net Pk Area | Pk Area Error % | Ambient Backgnd | Reagent Backgnd | FWHM (keV) |
|----------|--------------|-------------|-----------------|-----------------|-----------------|------------|
| PU-238 | 5.464 | 31.50 | 18.03 | 0.50 | 0.00E+000 | 8.0 |
| PU-239 | 5.126 | 116.00 | 9.32 | 0.00 | 0.00E+000 | 5.1 |
| PU-242 T | 4.866 | 799.00 | 3.54 | 0.00 | 0.00E+000 | 20.2 |
| PU-244 | 4.505 | 1.00 | 141.42 | 0.00 | 0.00E+000 | 3.0 |

Alpha Analysis Report
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5/16/2024 1:36:51 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272924.cnf
Batch Identification: 240515PUX
Sample Identification: 718825
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA_008
Chamber Serial Number: 05010225B
Detector Serial Number: 42348

Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:43 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ACTIVITY REPORT

| Nuclide | Energy (MeV) | Activity (pCi/unit) | Activity Error % | MDA (pCi/unit) | MDA Error % |
|---------|-----------------|-------------------------|---------------------|--------------------|----------------|
| PU-238 | | 1.5295E-001 | 19.26 | 3.4120E-002 | 6.78 |
| | 5.487 | 1.5295E-001 | 19.26 | | |
| PU-239 | | 5.6331E-001 | 11.53 | 3.7150E-002 | 6.78 |
| | 5.148 | 5.6331E-001 | 11.53 | | |
| PU-242 | | 3.8762E+000 | 6.78 | 3.7112E-002 | 6.78 |
| | 4.891 | 3.8762E+000 | 6.78 | | |
| PU-244 | | 4.8513E-003 | 141.58 | 3.7112E-002 | 6.78 |
| | 4.581 | 4.8513E-003 | 141.58 | | |

Errors quoted at 1.000 sigma

Alpha NID Report 5/16/2024 1:36:52 PM
Page 4 of 4



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272924.cnf
Batch Identification: 240515PUX
Sample Identification: 718825
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA_008
Chamber Serial Number: 05010225B
Detector Serial Number: 42348

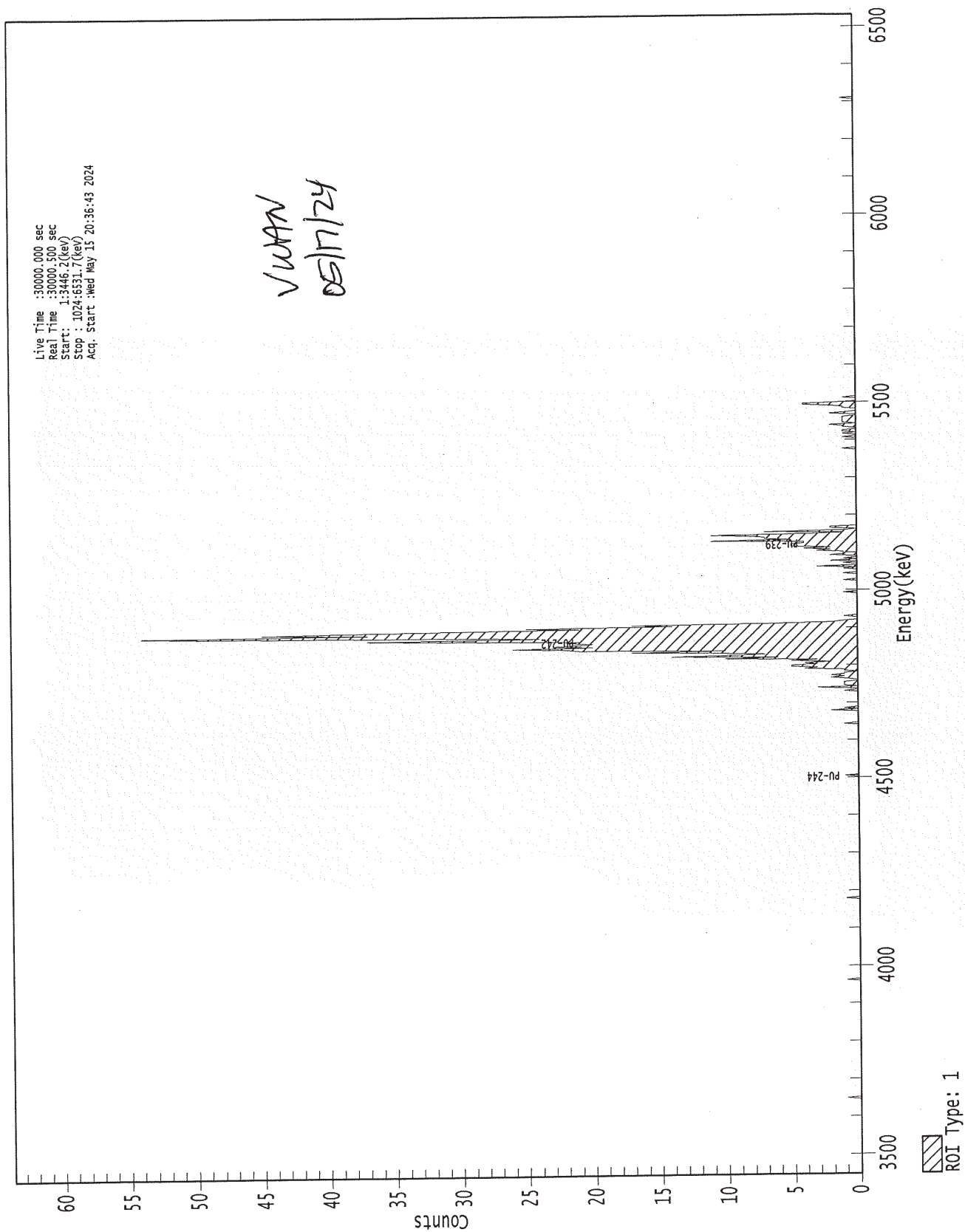
Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:43 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ANALYSIS RESULTS

| Nuclide Name | Id Conf. | Energy (keV) | Activity (pCi/unit) | MDA (pCi/unit) |
|--------------|----------|--------------|---------------------------|---------------------------|
| PU-238 | 0.998 | 5487.10* | 1.530E-001 +/- 2.946E-002 | 3.412E-002 +/- 2.313E-003 |
| PU-239 | 0.998 | 5147.70* | 5.633E-001 +/- 6.494E-002 | 3.715E-002 +/- 2.518E-003 |
| PU-242 | 0.998 | 4890.70* | 3.876E+000 +/- 2.627E-001 | 3.711E-002 +/- 2.515E-003 |
| PU-244 | 0.977 | 4581.00* | 4.851E-003 +/- 6.869E-003 | 3.711E-002 +/- 2.515E-003 |

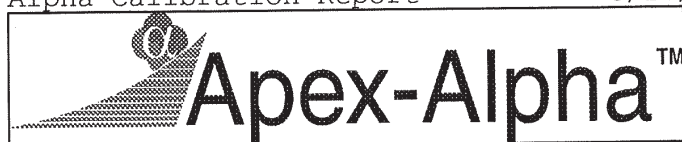
Activity reported as of : 5/15/24 8:36:43 PM

0000272924.CNF



Alpha Calibration Report

5/16/2024 1:37:56 PM



Sample Description:

Spectrum File: \\V79W-7\AlphaRoot\Data\0000272925.cnf
Detector Name: ALPHA_011
Chamber Serial Number: 13000554A
Detector Serial Number: 20314
Geometry Description: Shelf 2

Energy Calibration: 8/28/2023 10:44:32 AM by Administrator
Shape Calibration: 8/28/2023 10:44:32 AM by Administrator
Efficiency Calibration: 8/28/2023 10:44:33 AM by Administrator
Certificate Name: In8615 - primary

----- ENERGY / SHAPE CALIBRATION -----

Version: Alpha Encal v1.1
Energy = 3.604 MeV + 3.1310E-003*ch
FWHM = 2.7198E-002 MeV
Low Tail = 3.5003E-003 MeV

| Energy (MeV) | Centroid Channel | Centroid error | FWHM (ch) | FWHM error | TAIL (ch) | TAIL error |
|-----------------|---------------------|-------------------|--------------|---------------|--------------|---------------|
| 4.184 | 185.06 | 0.1912 | 7.41 | 0.4330 | 0.93 | 0.1227 |
| 4.761 | 370.34 | 0.1991 | 7.24 | 0.4399 | 0.80 | 0.1080 |
| 5.148 | 492.53 | 0.1237 | 8.57 | 0.3011 | 1.64 | 0.1413 |
| 5.479 | 599.06 | 0.1862 | 12.40 | 0.4876 | 3.77 | 0.4354 |

----- EFFICIENCY CALIBRATION -----

Version: Alpha Efcad v1.0
Avg Efficiency: 0.2142
Uncertainty: +/- 0.0026

| Energy (MeV) | Efficiency | Error |
|-----------------|-------------|-----------|
| 4.184 | 2.1730E-001 | 5.08E-003 |
| 4.761 | 2.1344E-001 | 4.98E-003 |
| 5.148 | 2.0410E-001 | 5.23E-003 |
| 5.479 | 2.2192E-001 | 5.20E-003 |

Alpha Analysis Report
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5/16/2024 1:37:56 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272925.cnf
Batch Identification: 240515PUX
Sample Identification: 718826
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA 011
Chamber Serial Number: 13000554A
Detector Serial Number: 20314
Env. Background: System Bkgd 247621
Reagent Blank: <not performed>

Sample Size: 1.000 +/- 0.0000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:45 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

Tracer Certificate: Pu242 124RadSol4
Tracer Quantity: 0.100 mL
Effective Efficiency: 0.1783 +/- 0.0066
Counting Efficiency: 0.2142 +/- 0.0026 on 8/28/2023 10:44:33 AM
Chem. Recovery Factor: 0.8321 +/- 0.0322

Peak Match Tolerance: 0.200 MeV

----- PEAK Location REPORT -----

| Nuclide | Left Channel | Channel Width | Right Channel | Left Energy Marker | Right Energy Marker |
|----------|--------------|---------------|---------------|--------------------|---------------------|
| PU-238 | 544 | 67 | 610 | 5307.7 | 5514.4 |
| PU-239 | 447 | 62 | 508 | 5004.0 | 5195.0 |
| PU-242 T | 331 | 92 | 422 | 4640.8 | 4925.7 |
| PU-244 | 287 | 33 | 319 | 4503.0 | 4603.2 |

----- PEAK AREA REPORT -----

| Nuclide | Energy (MeV) | Net Pk Area | Pk Area Error % | Ambient Backgnd | Reagent Backgnd | FWHM (keV) |
|----------|--------------|-------------|-----------------|-----------------|-----------------|------------|
| PU-238 | 5.450 | 25.00 | 20.59 | 1.00 | 0.00E+000 | 3.9 |
| PU-239 | 5.130 | 108.50 | 9.63 | 0.50 | 0.00E+000 | 15.7 |
| PU-242 T | 4.865 | 767.00 | 3.62 | 2.00 | 0.00E+000 | 36.0 |
| PU-244 | 4.553 | 0.00 | 1000.0 | 0.00 | 0.00E+000 | 0.0 |

Alpha Analysis Report
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Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272925.cnf
Batch Identification: 240515PUX
Sample Identification: 718826
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA_011
Chamber Serial Number: 13000554A
Detector Serial Number: 20314

Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:45 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ACTIVITY REPORT

| Nuclide | Energy (MeV) | Activity (pCi/unit) | Activity Error % | MDA (pCi/unit) | MDA Error % |
|---------|-----------------|-------------------------|---------------------|--------------------|----------------|
| PU-238 | | 1.2645E-001 | 21.69 | 4.3981E-002 | 6.82 |
| | 5.487 | 1.2645E-001 | 21.69 | | |
| PU-239 | | 5.4887E-001 | 11.80 | 3.5548E-002 | 6.82 |
| | 5.148 | 5.4887E-001 | 11.80 | | |
| PU-242 | | 3.8762E+000 | 6.82 | 5.5864E-002 | 6.82 |
| | 4.891 | 3.8762E+000 | 6.82 | | |
| PU-244 | | 0.0000E+000 | 0.00 | 3.8661E-002 | 6.82 |
| | 4.581 | 0.0000E+000 | 0.00 | | |

Errors quoted at 1.000 sigma

Alpha NID Report
Page 4 of 4

5/16/2024 1:37:56 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272925.cnf
Batch Identification: 240515PUX
Sample Identification: 718826
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA_011
Chamber Serial Number: 13000554A
Detector Serial Number: 20314

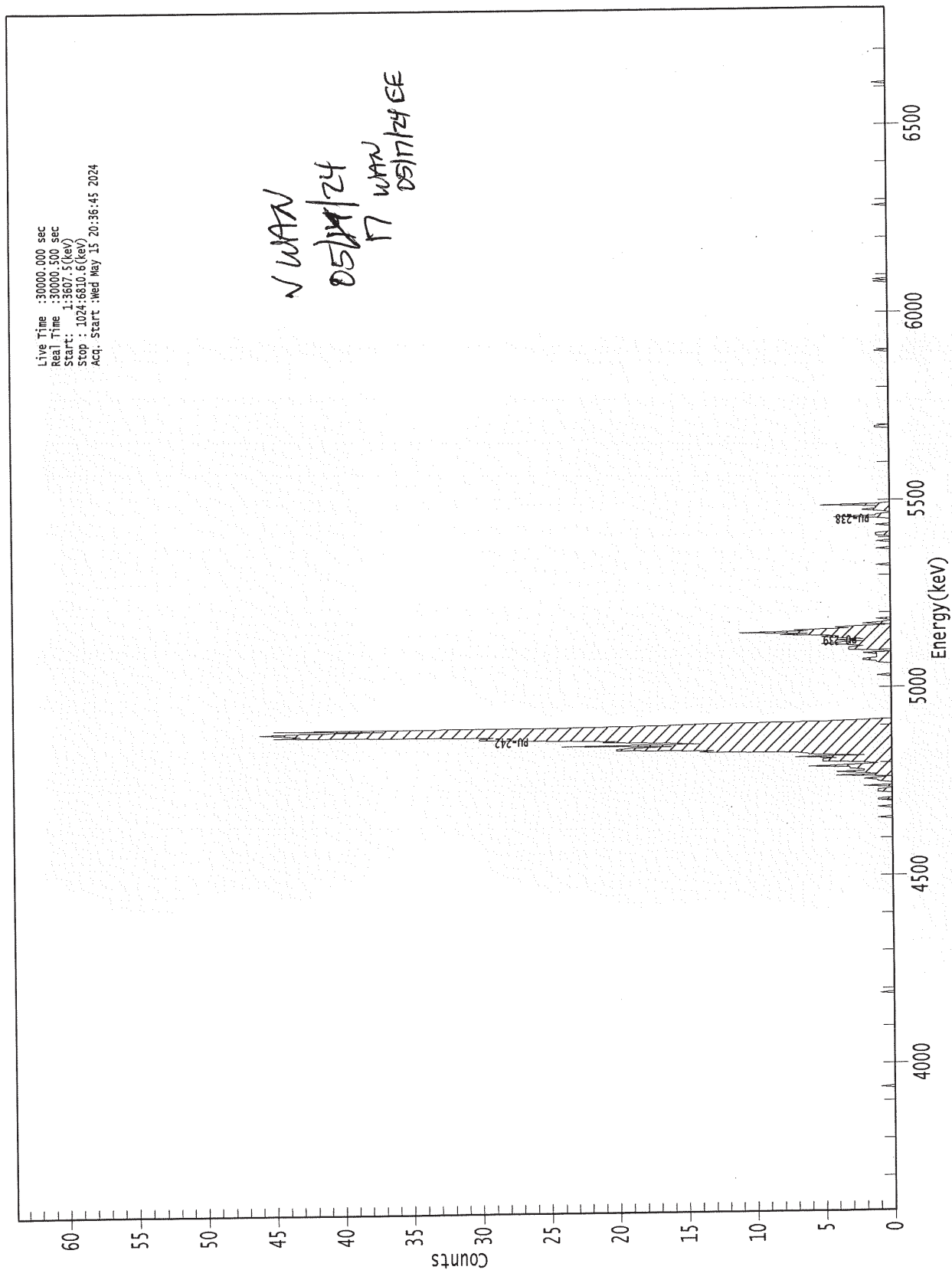
Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:45 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ANALYSIS RESULTS

| Nuclide Name | Id Conf. | Energy (keV) | Activity (pCi/unit) | MDA (pCi/unit) |
|--------------|----------|--------------|---------------------------|---------------------------|
| PU-238 | 0.995 | 5487.10* | 1.265E-001 +/- 2.743E-002 | 4.398E-002 +/- 2.999E-003 |
| PU-239 | 0.999 | 5147.70* | 5.489E-001 +/- 6.478E-002 | 3.555E-002 +/- 2.424E-003 |
| PU-242 | 0.997 | 4890.70* | 3.876E+000 +/- 2.643E-001 | 5.586E-002 +/- 3.809E-003 |
| PU-244 | 0.997 | 4581.00* | 0.000E+000 +/- 7.153E-003 | 3.866E-002 +/- 2.636E-003 |

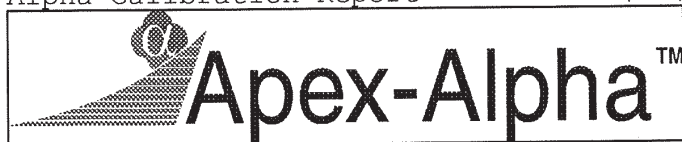
Activity reported as of : 5/15/24 8:36:45 PM

0000272925.CNF



Alpha Calibration Report

5/16/2024 1:39:06 PM



Sample Description:

Spectrum File: \\V79W-7\AlphaRoot\Data\0000272926.cnf
Detector Name: ALPHA_012
Chamber Serial Number: 13000554B
Detector Serial Number: 165851
Geometry Description: Shelf 2

Energy Calibration: 8/28/2023 10:44:42 AM by Administrator
Shape Calibration: 8/28/2023 10:44:42 AM by Administrator
Efficiency Calibration: 8/28/2023 10:44:43 AM by Administrator
Certificate Name: In7861 - primary

ENERGY / SHAPE CALIBRATION

Version: Alpha Encal v1.1
Energy = 3.620 MeV + 3.1261E-003*ch
FWHM = 2.6223E-002 MeV
Low Tail = 4.0003E-003 MeV

| Energy (MeV) | Centroid Channel | Centroid error | FWHM (ch) | FWHM error | TAIL (ch) | TAIL error |
|-----------------|---------------------|-------------------|--------------|---------------|--------------|---------------|
| 4.184 | 180.96 | 0.2226 | 8.22 | 0.5099 | 1.14 | 0.1625 |
| 4.761 | 366.37 | 0.2147 | 7.63 | 0.4823 | 0.97 | 0.1378 |
| 5.148 | 488.25 | 0.1122 | 8.08 | 0.2690 | 1.45 | 0.1164 |
| 5.479 | 595.69 | 0.2308 | 11.23 | 0.5900 | 2.87 | 0.4081 |

EFFICIENCY CALIBRATION

Version: Alpha Efcad v1.0
Avg Efficiency: 0.2095
Uncertainty: +/- 0.0026

| Energy (MeV) | Efficiency | Error |
|-----------------|-------------|-----------|
| 4.184 | 2.0365E-001 | 5.09E-003 |
| 4.761 | 2.0832E-001 | 5.09E-003 |
| 5.148 | 2.1752E-001 | 5.31E-003 |
| 5.479 | 2.0914E-001 | 5.18E-003 |

Alpha Analysis Report
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5/16/2024 1:39:06 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272926.cnf
Batch Identification: 240515PUX
Sample Identification: 718827
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA_012
Chamber Serial Number: 13000554B
Detector Serial Number: 165851
Env. Background: System Bkgd 247622
Reagent Blank: <not performed>

Sample Size: 1.000 +/- 0.0000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:47 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

Tracer Certificate: Pu242 124RadSol4
Tracer Quantity: 0.100 mL
Effective Efficiency: 0.1744 +/- 0.0065
Counting Efficiency: 0.2095 +/- 0.0026 on 8/28/2023 10:44:43 AM
Chem. Recovery Factor: 0.8326 +/- 0.0326

Peak Match Tolerance: 0.200 MeV

PEAK Location REPORT

| Nuclide | Left Channel | Channel Width | Right Channel | Left Energy Marker | Right Energy Marker |
|----------|--------------|---------------|---------------|--------------------|---------------------|
| PU-238 | 576 | 37 | 612 | 5420.4 | 5533.0 |
| PU-239 | 442 | 70 | 511 | 5001.5 | 5217.2 |
| PU-242 T | 327 | 92 | 418 | 4642.0 | 4926.5 |
| PU-244 | 283 | 33 | 315 | 4504.5 | 4604.5 |

PEAK AREA REPORT

| Nuclide | Energy (MeV) | Net Pk Area | Pk Area Error % | Ambient Backgnd | Reagent Backgnd | FWHM (keV) |
|----------|--------------|-------------|-----------------|-----------------|-----------------|------------|
| PU-238 | 5.488 | 26.00 | 20.17 | 1.00 | 0.00E+000 | 6.3 |
| PU-239 | 5.138 | 74.00 | 11.74 | 1.00 | 0.00E+000 | 4.6 |
| PU-242 T | 4.871 | 750.50 | 3.65 | 0.50 | 0.00E+000 | 35.6 |
| PU-244 | 4.551 | 1.00 | 141.42 | 0.00 | 0.00E+000 | 3.1 |

Alpha Analysis Report
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Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272926.cnf
Batch Identification: 240515PUX
Sample Identification: 718827
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA_012
Chamber Serial Number: 13000554B
Detector Serial Number: 165851

Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:47 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

----- NUCLIDE ACTIVITY REPORT -----

| Nuclide | Energy (MeV) | Activity (pCi/unit) | Activity Error % | MDA (pCi/unit) | MDA Error % |
|---------|-----------------|-------------------------|---------------------|--------------------|----------------|
| PU-238 | | 1.3440E-001 | 21.30 | 4.4948E-002 | 6.84 |
| | 5.487 | 1.3440E-001 | 21.30 | | |
| PU-239 | | 3.8258E-001 | 13.59 | 4.4953E-002 | 6.84 |
| | 5.148 | 3.8258E-001 | 13.59 | | |
| PU-242 | | 3.8762E+000 | 6.84 | 3.6293E-002 | 6.84 |
| | 4.891 | 3.8762E+000 | 6.84 | | |
| PU-244 | | 5.1648E-003 | 141.59 | 3.9511E-002 | 6.84 |
| | 4.581 | 5.1648E-003 | 141.59 | | |

Errors quoted at 1.000 sigma

Alpha NID Report
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5/16/2024 1:39:06 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272926.cnf
Batch Identification: 240515PUX
Sample Identification: 718827
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA_012
Chamber Serial Number: 13000554B
Detector Serial Number: 165851

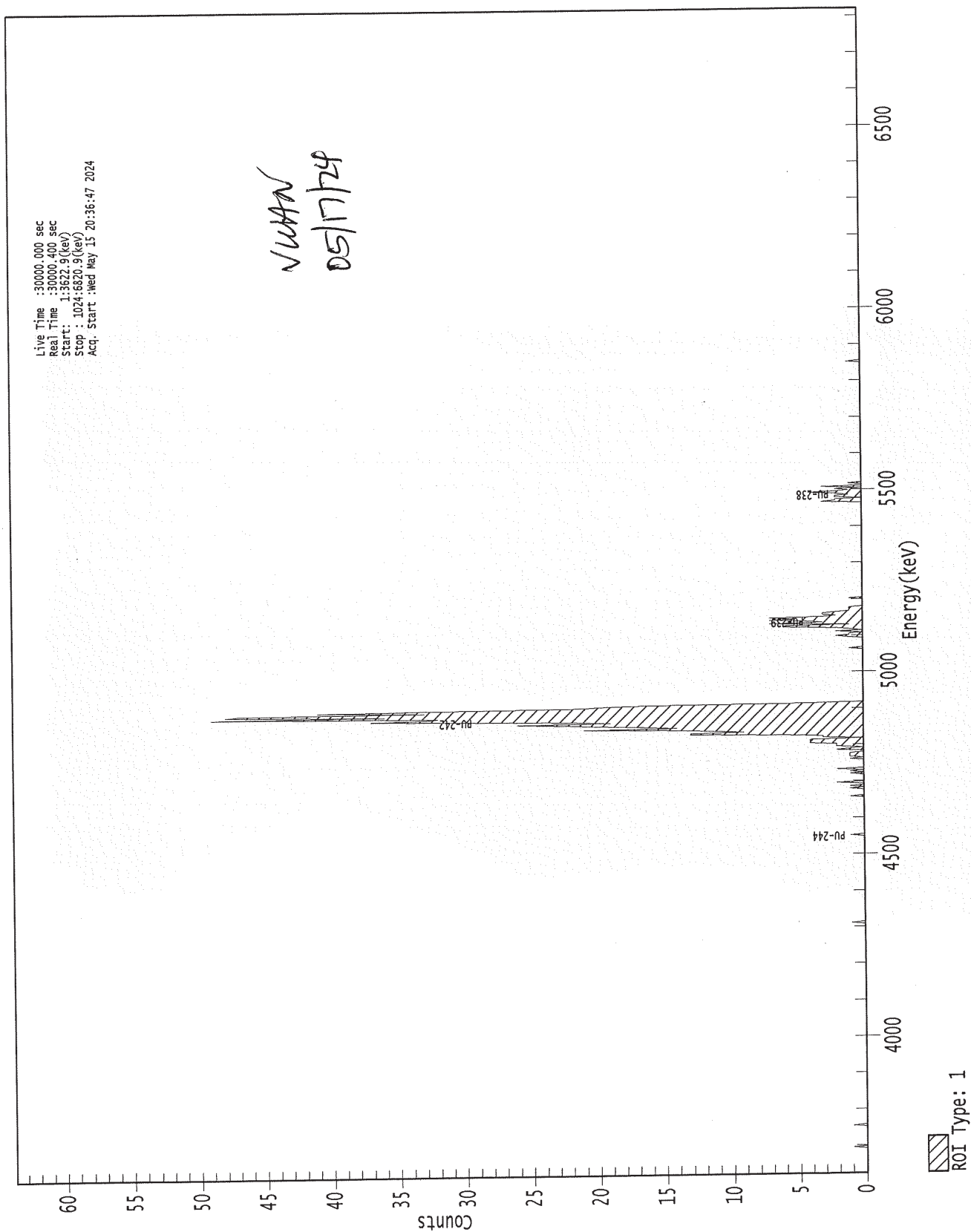
Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:47 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ANALYSIS RESULTS

| Nuclide Name | Id Conf. | Energy (keV) | Activity (pCi/unit) | MDA (pCi/unit) |
|-----------------|-------------|-----------------|---------------------------|---------------------------|
| PU-238 | 1.000 | 5487.10* | 1.344E-001 +/- 2.862E-002 | 4.495E-002 +/- 3.073E-003 |
| PU-239 | 1.000 | 5147.70* | 3.826E-001 +/- 5.198E-002 | 4.495E-002 +/- 3.074E-003 |
| PU-242 | 0.998 | 4890.70* | 3.876E+000 +/- 2.650E-001 | 3.629E-002 +/- 2.481E-003 |
| PU-244 | 0.996 | 4581.00* | 5.165E-003 +/- 7.313E-003 | 3.951E-002 +/- 2.701E-003 |

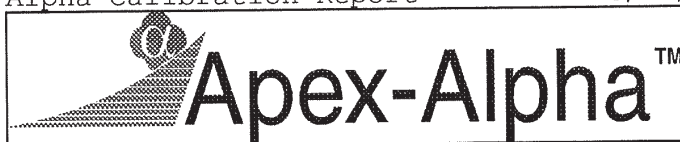
Activity reported as of : 5/15/24 8:36:47 PM

0000272926.CNF



Alpha Calibration Report

5/16/2024 1:40:07 PM



Sample Description:

Spectrum File: \\V79W-7\AlphaRoot\Data\0000272927.cnf
Detector Name: ALPHA_018
Chamber Serial Number: 03963051B
Detector Serial Number: 159388
Geometry Description: Shelf 2

Energy Calibration: 8/18/2022 12:08:57 AM by Administrator
Shape Calibration: 8/18/2022 12:08:57 AM by Administrator
Efficiency Calibration: 8/18/2022 12:08:59 AM by Administrator
Certificate Name: In7861 - primary

ENERGY / SHAPE CALIBRATION

Version: Alpha Encal v1.1
Energy = 3.445 MeV + 3.0032E-003*ch
FWHM = 2.4711E-002 MeV
Low Tail = 2.6560E-003 MeV

| Energy (MeV) | Centroid Channel | Centroid error | FWHM (ch) | FWHM error | TAIL (ch) | TAIL error |
|-----------------|---------------------|-------------------|--------------|---------------|--------------|---------------|
| 4.184 | 246.45 | 0.1923 | 7.11 | 0.4231 | 0.75 | 0.0995 |
| 4.761 | 439.75 | 0.2579 | 6.62 | 0.5550 | 0.57 | 0.1032 |
| 5.148 | 566.55 | 0.1306 | 8.02 | 0.3050 | 1.25 | 0.1119 |
| 5.479 | 678.08 | 0.2139 | 12.39 | 0.5527 | 3.41 | 0.4261 |

EFFICIENCY CALIBRATION

Version: Alpha Efcad v1.0
Avg Efficiency: 0.2202
Uncertainty: +/- 0.0027

| Energy (MeV) | Efficiency | Error |
|-----------------|-------------|-----------|
| 4.184 | 2.1053E-001 | 5.22E-003 |
| 4.761 | 2.2485E-001 | 5.38E-003 |
| 5.148 | 2.2538E-001 | 5.46E-003 |
| 5.479 | 2.2081E-001 | 5.40E-003 |

Alpha Analysis Report
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5/16/2024 1:40:07 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272927.cnf
Batch Identification: 240515PUX
Sample Identification: 718828
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA_018
Chamber Serial Number: 03963051B
Detector Serial Number: 159388
Env. Background: System Bkgd 247624
Reagent Blank: <not performed>

Sample Size: 1.000 +/- 0.0000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:49 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

Tracer Certificate: Pu242 124RadSol4
Tracer Quantity: 0.100 mL
Effective Efficiency: 0.1941 +/- 0.0068
Counting Efficiency: 0.2202 +/- 0.0027 on 8/18/2022 12:08:59 AM
Chem. Recovery Factor: 0.8813 +/- 0.0329

Peak Match Tolerance: 0.200 MeV

PEAK Location REPORT

| Nuclide | Left Channel | Channel Width | Right Channel | Left Energy Marker | Right Energy Marker |
|----------|--------------|---------------|---------------|--------------------|---------------------|
| PU-238 | 652 | 38 | 689 | 5402.7 | 5513.8 |
| PU-239 | 519 | 60 | 578 | 5003.3 | 5180.5 |
| PU-242 T | 402 | 98 | 499 | 4651.9 | 4943.2 |
| PU-244 | 353 | 34 | 386 | 4504.7 | 4603.8 |

PEAK AREA REPORT

| Nuclide | Energy (MeV) | Net Pk Area | Pk Area Error % | Ambient Backgnd | Reagent Backgnd | FWHM (keV) |
|----------|--------------|-------------|-----------------|-----------------|-----------------|------------|
| PU-238 | 5.472 | 15.00 | 26.67 | 0.00 | 0.00E+000 | 4.5 |
| PU-239 | 5.129 | 129.00 | 8.84 | 0.00 | 0.00E+000 | 8.0 |
| PU-242 T | 4.869 | 835.00 | 3.46 | 0.00 | 0.00E+000 | 22.8 |
| PU-244 | 4.592 | 1.00 | 141.42 | 0.00 | 0.00E+000 | 3.0 |

Alpha Analysis Report
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5/16/2024 1:40:07 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272927.cnf
Batch Identification: 240515PUX
Sample Identification: 718828
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA_018
Chamber Serial Number: 03963051B
Detector Serial Number: 159388

Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:49 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ACTIVITY REPORT

| Nuclide | Energy (MeV) | Activity (pCi/unit) | Activity Error % | MDA (pCi/unit) | MDA Error % |
|---------|-----------------|-------------------------|---------------------|--------------------|----------------|
| PU-238 | | 6.9694E-002 | 27.50 | 3.5544E-002 | 6.74 |
| | 5.487 | 6.9694E-002 | 27.50 | | |
| PU-239 | | 5.9943E-001 | 11.11 | 3.5548E-002 | 6.74 |
| | 5.148 | 5.9943E-001 | 11.11 | | |
| PU-242 | | 3.8762E+000 | 6.74 | 3.5512E-002 | 6.74 |
| | 4.891 | 3.8762E+000 | 6.74 | | |
| PU-244 | | 4.6421E-003 | 141.58 | 3.5512E-002 | 6.74 |
| | 4.581 | 4.6421E-003 | 141.58 | | |

Errors quoted at 1.000 sigma

Alpha NID Report
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5/16/2024 1:40:08 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272927.cnf
Batch Identification: 240515PUX
Sample Identification: 718828
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA_018
Chamber Serial Number: 03963051B
Detector Serial Number: 159388

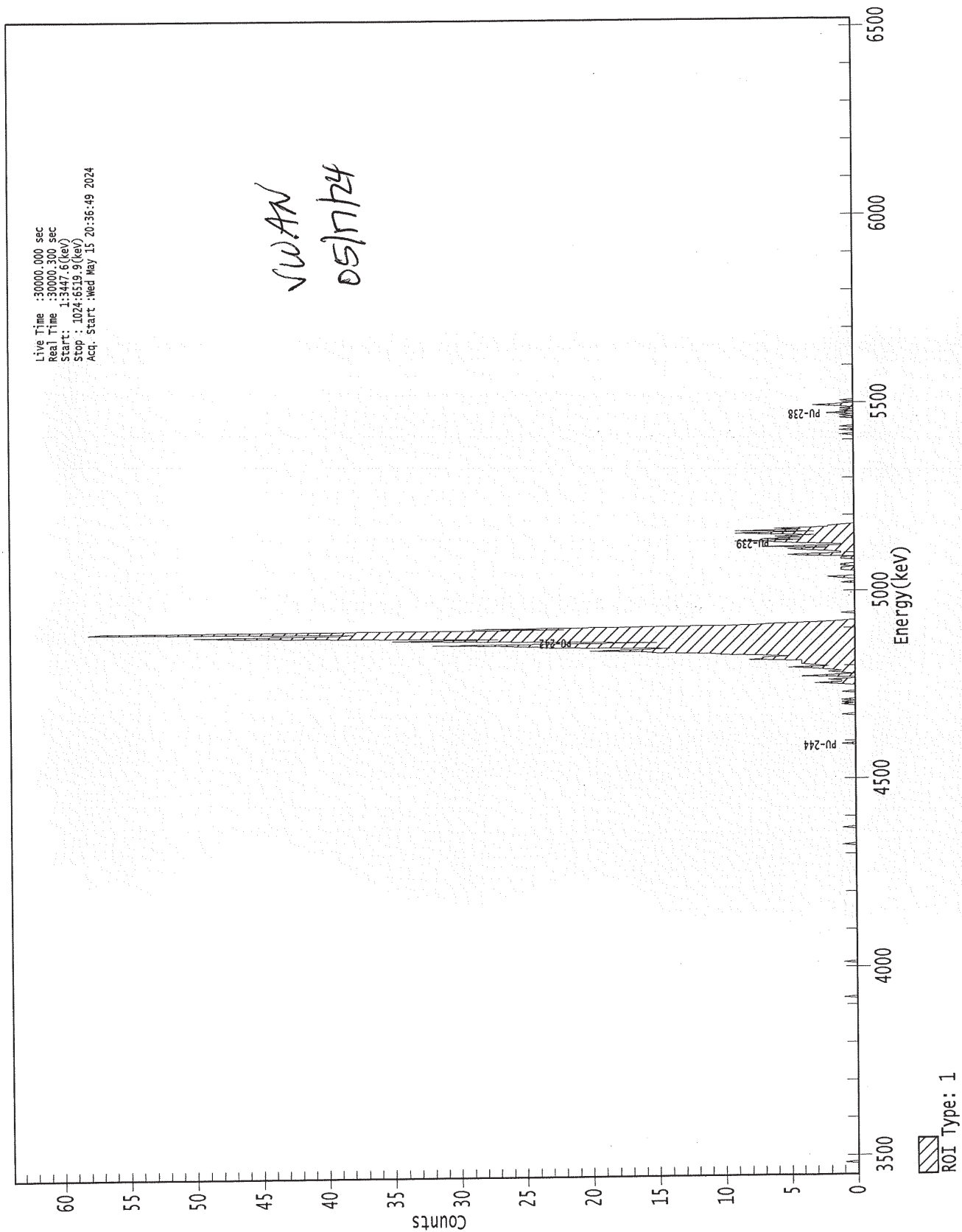
Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:49 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ANALYSIS RESULTS

| Nuclide Name | Id Conf. | Energy (keV) | Activity (pCi/unit) | MDA (pCi/unit) | |
|-----------------|-------------|-----------------|---------------------------|--------------------|----------------|
| PU-238 | 0.999 | 5487.10* | 6.969E-002 +/- 1.917E-002 | 3.554E-002 | +/- 2.395E-003 |
| PU-239 | 0.999 | 5147.70* | 5.994E-001 +/- 6.662E-002 | 3.555E-002 | +/- 2.395E-003 |
| PU-242 | 0.998 | 4890.70* | 3.876E+000 +/- 2.612E-001 | 3.551E-002 | +/- 2.393E-003 |
| PU-244 | 1.000 | 4581.00* | 4.642E-003 +/- 6.572E-003 | 3.551E-002 | +/- 2.393E-003 |

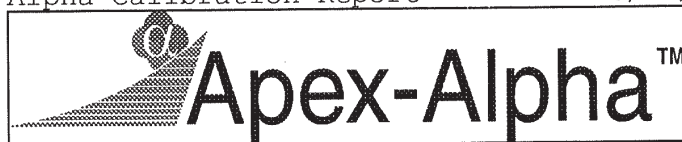
Activity reported as of : 5/15/24 8:36:49 PM

0000272927.CNF



Alpha Calibration Report

5/16/2024 1:42:35 PM



Sample Description:

Spectrum File: \\V79W-7\AlphaRoot\Data\0000272928.cnf
Detector Name: ALPHA_019
Chamber Serial Number: 02068348A
Detector Serial Number: 165864
Geometry Description: Shelf 2

Energy Calibration: 8/29/2023 1:25:32 PM by Administrator
Shape Calibration: 8/29/2023 1:25:32 PM by Administrator
Efficiency Calibration: 8/29/2023 1:25:33 PM by Administrator
Certificate Name: In7860 - primary

ENERGY / SHAPE CALIBRATION

Version: Alpha Encal v1.1
Energy = 3.432 MeV + 3.0042E-003*ch
FWHM = 2.7634E-002 MeV
Low Tail = 4.1993E-003 MeV

| Energy (MeV) | Centroid Channel | Centroid error | FWHM (ch) | FWHM error | TAIL (ch) | TAIL error |
|-----------------|---------------------|-------------------|--------------|---------------|--------------|---------------|
| 4.184 | 250.93 | 0.1846 | 8.27 | 0.4219 | 1.12 | 0.1308 |
| 4.761 | 443.26 | 0.2051 | 8.72 | 0.4757 | 1.24 | 0.1565 |
| 5.148 | 570.72 | 0.1308 | 8.68 | 0.3203 | 1.70 | 0.1539 |
| 5.479 | 682.21 | 0.2084 | 12.93 | 0.5483 | 4.00 | 0.5057 |

EFFICIENCY CALIBRATION

Version: Alpha Efcad v1.0
Avg Efficiency: 0.2140
Uncertainty: +/- 0.0022

| Energy (MeV) | Efficiency | Error |
|-----------------|-------------|-----------|
| 4.184 | 2.1021E-001 | 4.40E-003 |
| 4.761 | 2.1219E-001 | 4.45E-003 |
| 5.148 | 2.2044E-001 | 4.48E-003 |
| 5.479 | 2.1337E-001 | 4.45E-003 |

Alpha Analysis Report
Page 2 of 4

5/16/2024 1:42:35 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272928.cnf
Batch Identification: 240515PUX
Sample Identification: 718829
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA_019
Chamber Serial Number: 02068348A
Detector Serial Number: 165864
Env. Background: System Bkgd 247625
Reagent Blank: <not performed>

Sample Size: 1.000 +/- 0.0000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:51 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

Tracer Certificate: Pu242 124RadSol4
Tracer Quantity: 0.100 mL
Effective Efficiency: 0.1876 +/- 0.0067
Counting Efficiency: 0.2140 +/- 0.0022 on 8/29/2023 1:25:33 PM
Chem. Recovery Factor: 0.8764 +/- 0.0327

Peak Match Tolerance: 0.200 MeV

PEAK Location REPORT

| Nuclide | Left Channel | Channel Width | Right Channel | Left Energy Marker | Right Energy Marker |
|----------|--------------|---------------|---------------|--------------------|---------------------|
| PU-238 | 659 | 39 | 697 | 5411.3 | 5525.5 |
| PU-239 | 523 | 60 | 582 | 5002.7 | 5180.0 |
| PU-242 T | 425 | 77 | 501 | 4708.3 | 4936.6 |
| PU-244 | 357 | 34 | 390 | 4504.0 | 4603.2 |

PEAK AREA REPORT

| Nuclide | Energy (MeV) | Net Pk Area | Pk Area Error % | Ambient Backgnd | Reagent Backgnd | FWHM (keV) |
|----------|--------------|-------------|-----------------|-----------------|-----------------|------------|
| PU-238 | 5.471 | 22.00 | 21.80 | 0.00 | 0.00E+000 | 3.0 |
| PU-239 | 5.140 | 117.50 | 9.25 | 0.50 | 0.00E+000 | 28.5 |
| PU-242 T | 4.876 | 807.00 | 3.52 | 0.00 | 0.00E+000 | 22.2 |
| PU-244 | 4.552 | 0.00 | 1000.0 | 0.00 | 0.00E+000 | 0.0 |

Alpha Analysis Report
Page 3 of 4

5/16/2024 1:42:35 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272928.cnf
Batch Identification: 240515PUX
Sample Identification: 718829
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA_019
Chamber Serial Number: 02068348A
Detector Serial Number: 165864

Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:51 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ACTIVITY REPORT

| Nuclide | Energy (MeV) | Activity (pCi/unit) | Activity Error % | MDA (pCi/unit) | MDA Error % |
|---------|-----------------|-------------------------|---------------------|--------------------|----------------|
| PU-238 | | 1.0576E-001 | 22.83 | 3.6777E-002 | 6.77 |
| | 5.487 | 1.0576E-001 | 22.83 | | |
| PU-239 | | 5.6494E-001 | 11.47 | 3.3786E-002 | 6.77 |
| | 5.148 | 5.6494E-001 | 11.47 | | |
| PU-242 | | 3.8762E+000 | 6.77 | 3.6744E-002 | 6.77 |
| | 4.891 | 3.8762E+000 | 6.77 | | |
| PU-244 | | 0.0000E+000 | 0.00 | 3.6744E-002 | 6.77 |
| | 4.581 | 0.0000E+000 | 0.00 | | |

Errors quoted at 1.000 sigma

Alpha NID Report
Page 4 of 4

5/16/2024 1:42:36 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272928.cnf
Batch Identification: 240515PUX
Sample Identification: 718829
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA_019
Chamber Serial Number: 02068348A
Detector Serial Number: 165864

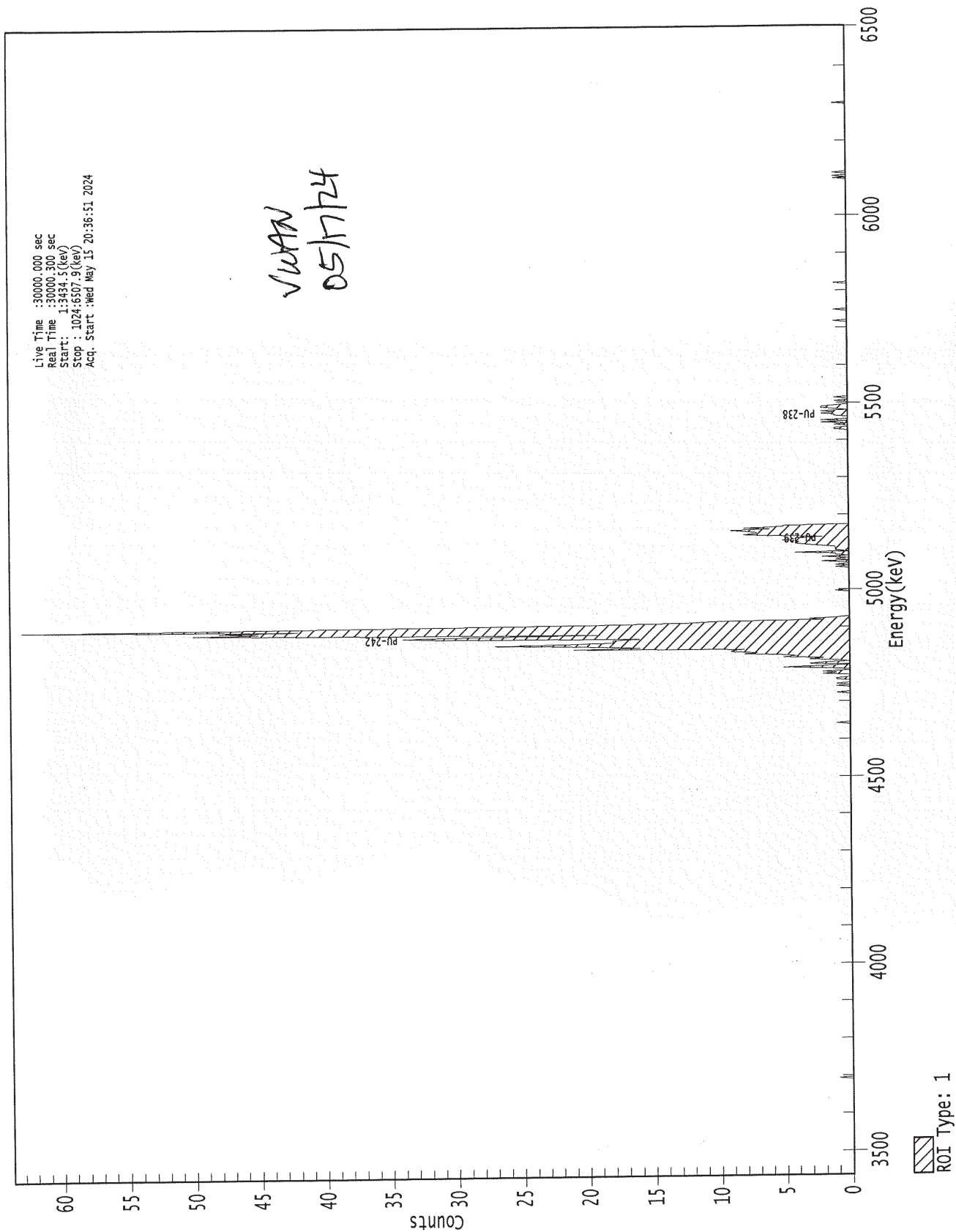
Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:51 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ANALYSIS RESULTS

| Nuclide Name | Id Conf. | Energy (keV) | Activity (pCi/unit) | MDA (pCi/unit) |
|-----------------|-------------|-----------------|---------------------------|---------------------------|
| PU-238 | 0.999 | 5487.10* | 1.058E-001 +/- 2.414E-002 | 3.678E-002 +/- 2.489E-003 |
| PU-239 | 1.000 | 5147.70* | 5.649E-001 +/- 6.478E-002 | 3.379E-002 +/- 2.287E-003 |
| PU-242 | 0.999 | 4890.70* | 3.876E+000 +/- 2.624E-001 | 3.674E-002 +/- 2.487E-003 |
| PU-244 | 0.997 | 4581.00* | 0.000E+000 +/- 6.798E-003 | 3.674E-002 +/- 2.487E-003 |

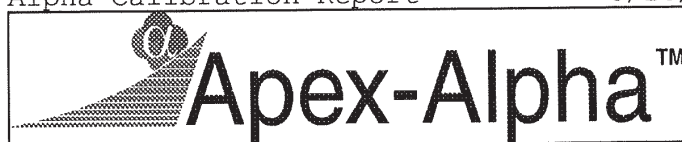
Activity reported as of : 5/15/24 8:36:51 PM

0000272928.CNF



Alpha Calibration Report

5/16/2024 1:43:56 PM



Sample Description:

Spectrum File: \\V79W-7\AlphaRoot\Data\0000272929.cnf
Detector Name: ALPHA_020
Chamber Serial Number: 02068348B
Detector Serial Number: 165865
Geometry Description: Shelf 2

Energy Calibration: 8/29/2023 1:25:24 PM by Administrator
Shape Calibration: 8/29/2023 1:25:24 PM by Administrator
Efficiency Calibration: 8/29/2023 1:25:24 PM by Administrator
Certificate Name: In7859 - primary

ENERGY / SHAPE CALIBRATION

Version: Alpha Encal v1.1
Energy = 3.436 MeV + 2.9965E-003*ch
FWHM = 2.8680E-002 MeV
Low Tail = 4.3948E-003 MeV

| Energy (MeV) | Centroid Channel | Centroid error | FWHM (ch) | FWHM error | TAIL (ch) | TAIL error |
|-----------------|---------------------|-------------------|--------------|---------------|--------------|---------------|
| 4.184 | 250.05 | 0.1671 | 8.82 | 0.3897 | 1.37 | 0.1421 |
| 4.761 | 443.10 | 0.1962 | 8.29 | 0.4458 | 1.05 | 0.1278 |
| 5.148 | 570.87 | 0.1236 | 9.33 | 0.3047 | 1.90 | 0.1548 |
| 5.479 | 682.43 | 0.1813 | 12.76 | 0.4777 | 4.03 | 0.4543 |

EFFICIENCY CALIBRATION

Version: Alpha Efcad v1.0
Avg Efficiency: 0.2122
Uncertainty: +/- 0.0025

| Energy (MeV) | Efficiency | Error |
|-----------------|-------------|-----------|
| 4.184 | 2.1099E-001 | 4.96E-003 |
| 4.761 | 2.2024E-001 | 5.15E-003 |
| 5.148 | 2.1418E-001 | 5.11E-003 |
| 5.479 | 2.0440E-001 | 4.89E-003 |

Alpha Analysis Report
Page 2 of 4

5/16/2024 1:43:57 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272929.cnf
Batch Identification: 240515PUX
Sample Identification: 718830
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA_020
Chamber Serial Number: 02068348B
Detector Serial Number: 165865
Env. Background: System Bkgd 247626
Reagent Blank: <not performed>

Sample Size: 1.000 +/- 0.0000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:53 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

Tracer Certificate: Pu242 124RadSol4
Tracer Quantity: 0.100 mL
Effective Efficiency: 0.1800 +/- 0.0066
Counting Efficiency: 0.2122 +/- 0.0025 on 8/29/2023 1:25:24 PM
Chem. Recovery Factor: 0.8482 +/- 0.0326

Peak Match Tolerance: 0.200 MeV

PEAK Location REPORT

| Nuclide | Left Channel | Channel Width | Right Channel | Left Energy Marker | Right Energy Marker |
|----------|--------------|---------------|---------------|--------------------|---------------------|
| PU-238 | 654 | 43 | 696 | 5395.4 | 5521.2 |
| PU-239 | 523 | 60 | 582 | 5002.8 | 5179.6 |
| PU-242 T | 407 | 96 | 502 | 4655.2 | 4939.9 |
| PU-244 | 357 | 34 | 390 | 4505.4 | 4604.3 |

PEAK AREA REPORT

| Nuclide | Energy (MeV) | Net Pk Area | Pk Area Error % | Ambient Backgnd | Reagent Backgnd | FWHM (keV) |
|----------|--------------|-------------|-----------------|-----------------|-----------------|------------|
| PU-238 | 5.472 | 23.50 | 20.96 | 0.50 | 0.00E+000 | 4.5 |
| PU-239 | 5.138 | 105.00 | 9.81 | 0.00 | 0.00E+000 | 5.2 |
| PU-242 T | 4.875 | 774.50 | 3.60 | 0.50 | 0.00E+000 | 19.7 |
| PU-244 | 4.553 | 0.00 | 1000.0 | 0.00 | 0.00E+000 | 0.0 |

Alpha Analysis Report
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5/16/2024 1:43:57 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272929.cnf
Batch Identification: 240515PUX
Sample Identification: 718830
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA_020
Chamber Serial Number: 02068348B
Detector Serial Number: 165865

Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:53 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ACTIVITY REPORT

| Nuclide | Energy (MeV) | Activity (pCi/unit) | Activity Error % | MDA (pCi/unit) | MDA Error % |
|---------|-----------------|-------------------------|---------------------|--------------------|----------------|
| PU-238 | | 1.1772E-001 | 22.03 | 3.5200E-002 | 6.81 |
| | 5.487 | 1.1772E-001 | 22.03 | | |
| PU-239 | | 5.2602E-001 | 11.94 | 3.8325E-002 | 6.81 |
| | 5.148 | 5.2602E-001 | 11.94 | | |
| PU-242 | | 3.8762E+000 | 6.81 | 3.5168E-002 | 6.81 |
| | 4.891 | 3.8762E+000 | 6.81 | | |
| PU-244 | | 0.0000E+000 | 0.00 | 3.8286E-002 | 6.81 |
| | 4.581 | 0.0000E+000 | 0.00 | | |

Errors quoted at 1.000 sigma

Alpha NID Report
Page 4 of 4

5/16/2024 1:43:57 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272929.cnf
Batch Identification: 240515PUX
Sample Identification: 718830
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA_020
Chamber Serial Number: 02068348B
Detector Serial Number: 165865

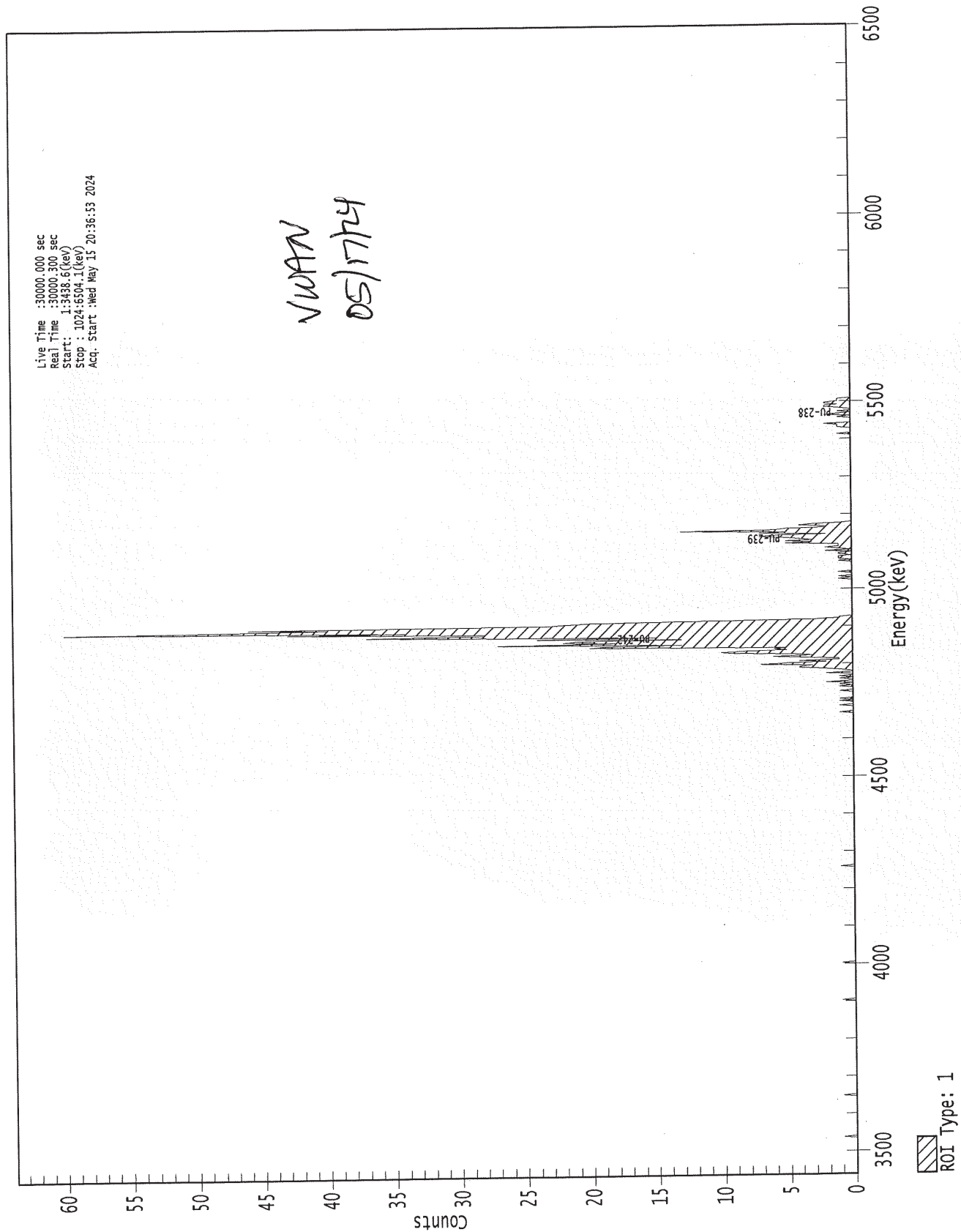
Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:53 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ANALYSIS RESULTS

| Nuclide Name | Id Conf. | Energy (keV) | Activity (pCi/unit) | MDA (pCi/unit) |
|--------------|----------|--------------|---------------------------|---------------------------|
| PU-238 | 0.999 | 5487.10* | 1.177E-001 +/- 2.594E-002 | 3.520E-002 +/- 2.396E-003 |
| PU-239 | 1.000 | 5147.70* | 5.260E-001 +/- 6.279E-002 | 3.832E-002 +/- 2.609E-003 |
| PU-242 | 0.999 | 4890.70* | 3.876E+000 +/- 2.638E-001 | 3.517E-002 +/- 2.394E-003 |
| PU-244 | 0.997 | 4581.00* | 0.000E+000 +/- 7.084E-003 | 3.829E-002 +/- 2.606E-003 |

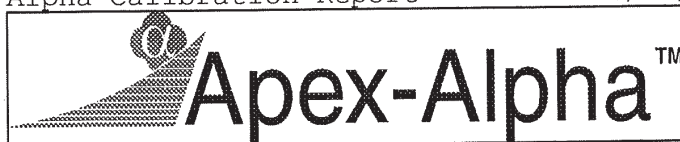
Activity reported as of : 5/15/24 8:36:53 PM

0000272929.CNF



Alpha Calibration Report

5/16/2024 1:45:14 PM



Sample Description:

Spectrum File: \\V79W-7\AlphaRoot\Data\0000272930.cnf
Detector Name: ALPHA_023
Chamber Serial Number: 02962245A
Detector Serial Number: 165866
Geometry Description: Shelf 2

Energy Calibration: 8/29/2023 6:28:52 PM by Administrator
Shape Calibration: 8/29/2023 6:28:52 PM by Administrator
Efficiency Calibration: 8/29/2023 6:28:53 PM by Administrator
Certificate Name: In7860 - primary

ENERGY / SHAPE CALIBRATION

Version: Alpha Encal v1.1
Energy = 3.263 MeV + 2.9176E-003*ch
FWHM = 2.7469E-002 MeV
Low Tail = 3.8001E-003 MeV

| Energy (MeV) | Centroid Channel | Centroid error | FWHM (ch) | FWHM error | TAIL (ch) | TAIL error |
|-----------------|---------------------|-------------------|--------------|---------------|--------------|---------------|
| 4.184 | 316.08 | 0.2051 | 8.38 | 0.4713 | 1.14 | 0.1472 |
| 4.761 | 515.50 | 0.2670 | 7.01 | 0.5907 | 0.76 | 0.1433 |
| 5.148 | 645.41 | 0.1295 | 9.35 | 0.3155 | 1.92 | 0.1575 |
| 5.479 | 760.71 | 0.2267 | 13.84 | 0.6009 | 4.53 | 0.6093 |

EFFICIENCY CALIBRATION

Version: Alpha Efcals v1.0
Avg Efficiency: 0.2240
Uncertainty: +/- 0.0023

| Energy (MeV) | Efficiency | Error |
|-----------------|-------------|-----------|
| 4.184 | 2.2277E-001 | 4.57E-003 |
| 4.761 | 2.1877E-001 | 4.54E-003 |
| 5.148 | 2.2938E-001 | 4.59E-003 |
| 5.479 | 2.2527E-001 | 4.60E-003 |

Alpha Analysis Report
Page 2 of 4

5/16/2024 1:45:15 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272930.cnf
Batch Identification: 240515PUX
Sample Identification: 718852
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA_023
Chamber Serial Number: 02962245A
Detector Serial Number: 165866
Env. Background: System Bkgd 247627
Reagent Blank: <not performed>

Sample Size: 1.000 +/- 0.0000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:55 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

Tracer Certificate: Pu242 124RadSol4
Tracer Quantity: 0.100 mL
Effective Efficiency: 0.1894 +/- 0.0068
Counting Efficiency: 0.2240 +/- 0.0023 on 8/29/2023 6:28:53 PM
Chem. Recovery Factor: 0.8456 +/- 0.0314

Peak Match Tolerance: 0.200 MeV

PEAK Location REPORT

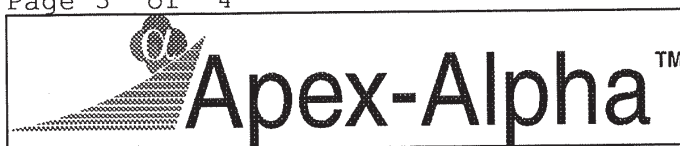
| Nuclide | Left Channel | Channel Width | Right Channel | Left Energy Marker | Right Energy Marker |
|----------|--------------|---------------|---------------|--------------------|---------------------|
| PU-238 | 740 | 38 | 777 | 5421.6 | 5529.5 |
| PU-239 | 596 | 66 | 661 | 5001.4 | 5191.1 |
| PU-242 T | 475 | 98 | 572 | 4648.4 | 4931.4 |
| PU-244 | 426 | 35 | 460 | 4505.5 | 4604.7 |

PEAK AREA REPORT

| Nuclide | Energy (MeV) | Net Pk Area | Pk Area Error % | Ambient Backgnd | Reagent Backgnd | FWHM (keV) |
|----------|--------------|-------------|-----------------|-----------------|-----------------|------------|
| PU-238 | 5.481 | 29.00 | 19.04 | 1.00 | 0.00E+000 | 4.4 |
| PU-239 | 5.136 | 121.00 | 9.15 | 1.00 | 0.00E+000 | 19.2 |
| PU-242 T | 4.874 | 815.00 | 3.50 | 0.00 | 0.00E+000 | 24.0 |
| PU-244 | 4.546 | 0.50 | 223.61 | 0.50 | 0.00E+000 | 2.9 |

Alpha Analysis Report
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5/16/2024 1:45:15 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272930.cnf
Batch Identification: 240515PUX
Sample Identification: 718852
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA_023
Chamber Serial Number: 02962245A
Detector Serial Number: 165866

Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:55 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ACTIVITY REPORT

| Nuclide | Energy (MeV) | Activity (pCi/unit) | Activity Error % | MDA (pCi/unit) | MDA Error % |
|---------|-----------------|-------------------------|---------------------|--------------------|----------------|
| PU-238 | | 1.3805E-001 | 20.21 | 4.1391E-002 | 6.76 |
| | 5.487 | 1.3805E-001 | 20.21 | | |
| PU-239 | | 5.7606E-001 | 11.37 | 4.1396E-002 | 6.76 |
| | 5.148 | 5.7606E-001 | 11.37 | | |
| PU-242 | | 3.8762E+000 | 6.76 | 3.6384E-002 | 6.76 |
| | 4.891 | 3.8762E+000 | 6.76 | | |
| PU-244 | | 2.3780E-003 | 223.71 | 3.3421E-002 | 6.76 |
| | 4.581 | 2.3780E-003 | 223.71 | | |

Errors quoted at 1.000 sigma

Alpha NID Report
Page 4 of 4

5/16/2024 1:45:15 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272930.cnf
Batch Identification: 240515PUX
Sample Identification: 718852
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA 023
Chamber Serial Number: 02962245A
Detector Serial Number: 165866

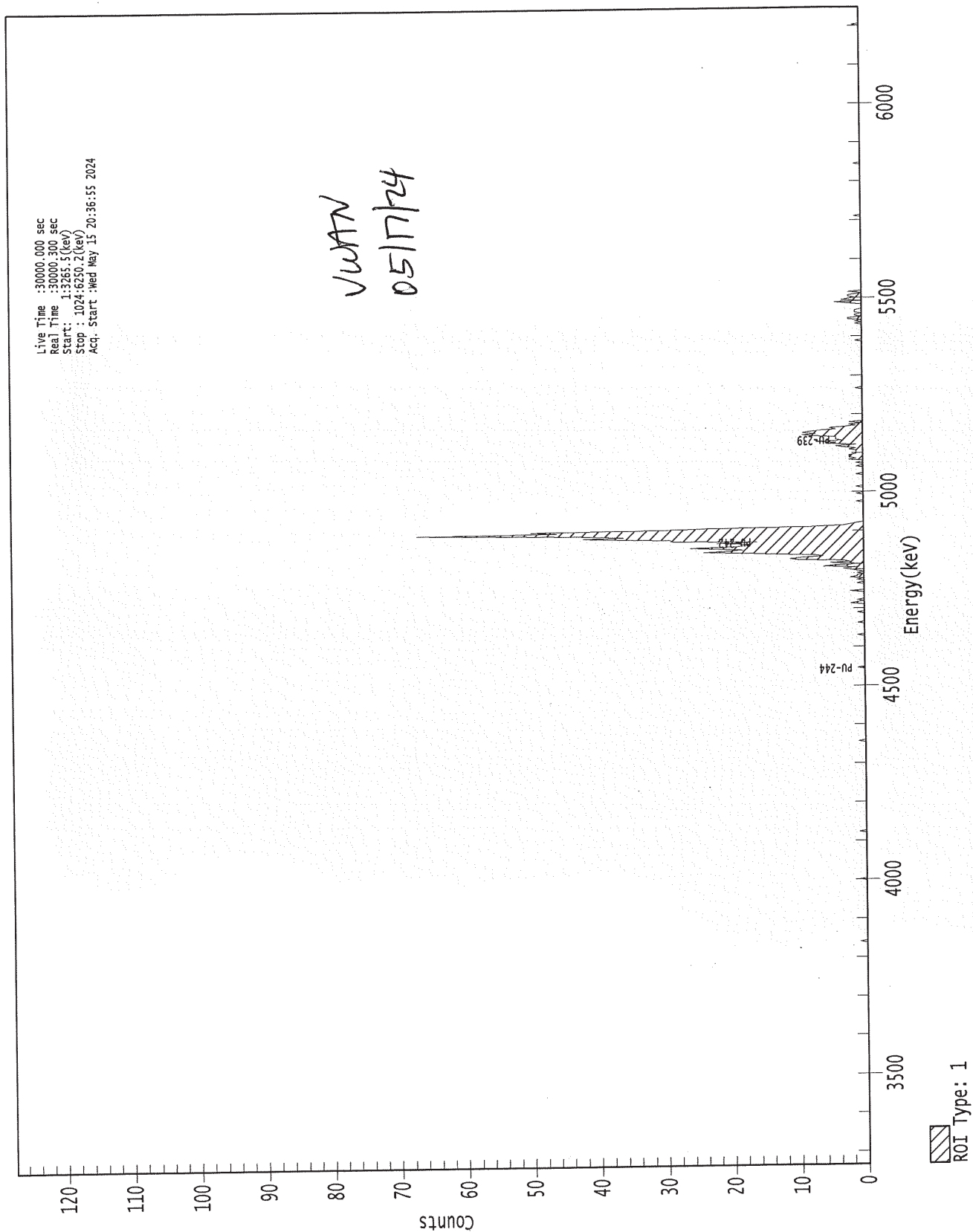
Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:55 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ANALYSIS RESULTS

| Nuclide Name | Id Conf. | Energy (keV) | Activity (pCi/unit) | MDA (pCi/unit) |
|-----------------|-------------|-----------------|---------------------------|---------------------------|
| PU-238 | 1.000 | 5487.10* | 1.380E-001 +/- 2.790E-002 | 4.139E-002 +/- 2.798E-003 |
| PU-239 | 0.999 | 5147.70* | 5.761E-001 +/- 6.552E-002 | 4.140E-002 +/- 2.798E-003 |
| PU-242 | 0.999 | 4890.70* | 3.876E+000 +/- 2.620E-001 | 3.638E-002 +/- 2.459E-003 |
| PU-244 | 0.995 | 4581.00* | 2.378E-003 +/- 5.320E-003 | 3.342E-002 +/- 2.259E-003 |

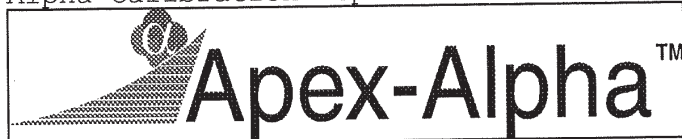
Activity reported as of : 5/15/24 8:36:55 PM

0000272930.CNF



Alpha Calibration Report

5/16/2024 1:46:21 PM



Sample Description:

Spectrum File: \\V79W-7\AlphaRoot\Data\0000272931.cnf
Detector Name: ALPHA 024
Chamber Serial Number: 02962245B
Detector Serial Number: 165867
Geometry Description: Shelf 2

Energy Calibration: 8/29/2023 6:29:01 PM by Administrator
Shape Calibration: 8/29/2023 6:29:01 PM by Administrator
Efficiency Calibration: 8/29/2023 6:29:02 PM by Administrator
Certificate Name: In7859 - primary

ENERGY / SHAPE CALIBRATION

Version: Alpha Encal v1.1
Energy = 3.301 MeV + 2.9381E-003*ch
FWHM = 2.5388E-002 MeV
Low Tail = 3.2395E-003 MeV

| Energy (MeV) | Centroid Channel | Centroid error | FWHM (ch) | FWHM error | TAIL (ch) | TAIL error |
|-----------------|---------------------|-------------------|--------------|---------------|--------------|---------------|
| 4.184 | 300.44 | 0.1991 | 8.57 | 0.4514 | 1.13 | 0.1354 |
| 4.761 | 497.80 | 0.2106 | 7.59 | 0.4684 | 0.81 | 0.1110 |
| 5.148 | 628.08 | 0.1432 | 8.06 | 0.3370 | 1.30 | 0.1285 |
| 5.479 | 741.74 | 0.2438 | 12.68 | 0.6267 | 3.40 | 0.4694 |

EFFICIENCY CALIBRATION

Version: Alpha Efcals v1.0
Avg Efficiency: 0.2203
Uncertainty: +/- 0.0026

| Energy (MeV) | Efficiency | Error |
|-----------------|-------------|-----------|
| 4.184 | 2.2291E-001 | 5.16E-003 |
| 4.761 | 2.2234E-001 | 5.19E-003 |
| 5.148 | 2.2882E-001 | 5.36E-003 |
| 5.479 | 2.0883E-001 | 4.97E-003 |

Alpha Analysis Report
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5/16/2024 1:46:21 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272931.cnf
Batch Identification: 240515PUX
Sample Identification: 718853
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA 024
Chamber Serial Number: 02962245B
Detector Serial Number: 165867
Env. Background: System Bkgd 247628
Reagent Blank: <not performed>

Sample Size: 1.000 +/- 0.0000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:57 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

Tracer Certificate: Pu242 124RadSol4
Tracer Quantity: 0.100 mL
Effective Efficiency: 0.1794 +/- 0.0066
Counting Efficiency: 0.2203 +/- 0.0026 on 8/29/2023 6:29:02 PM
Chem. Recovery Factor: 0.8143 +/- 0.0313

Peak Match Tolerance: 0.200 MeV

PEAK Location REPORT

| Nuclide | Left Channel | Channel Width | Right Channel | Left Energy Marker | Right Energy Marker |
|----------|--------------|---------------|---------------|--------------------|---------------------|
| PU-238 | 701 | 55 | 755 | 5360.7 | 5519.4 |
| PU-239 | 579 | 62 | 640 | 5002.3 | 5181.5 |
| PU-242 T | 468 | 86 | 553 | 4676.2 | 4925.9 |
| PU-244 | 410 | 35 | 444 | 4505.7 | 4605.6 |

PEAK AREA REPORT

| Nuclide | Energy (MeV) | Net Pk Area | Pk Area Error % | Ambient Backgnd | Reagent Backgnd | FWHM (keV) |
|----------|--------------|-------------|-----------------|-----------------|-----------------|------------|
| PU-238 | 5.474 | 30.00 | 19.15 | 2.00 | 0.00E+000 | 4.9 |
| PU-239 | 5.134 | 108.00 | 9.67 | 0.00 | 0.00E+000 | 14.7 |
| PU-242 T | 4.874 | 772.00 | 3.60 | 0.00 | 0.00E+000 | 13.6 |
| PU-244 | 4.556 | 0.00 | 1000.0 | 0.00 | 0.00E+000 | 0.0 |

Alpha Analysis Report
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5/16/2024 1:46:21 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272931.cnf
Batch Identification: 240515PUX
Sample Identification: 718853
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA 024
Chamber Serial Number: 02962245B
Detector Serial Number: 165867

Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:57 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ACTIVITY REPORT

| Nuclide | Energy (MeV) | Activity (pCi/unit) | Activity Error % | MDA (pCi/unit) | MDA Error % |
|---------|-----------------|-------------------------|---------------------|--------------------|----------------|
| PU-238 | | 1.5076E-001 | 20.32 | 5.5551E-002 | 6.81 |
| | 5.487 | 1.5076E-001 | 20.32 | | |
| PU-239 | | 5.4281E-001 | 11.82 | 3.8449E-002 | 6.81 |
| | 5.148 | 5.4281E-001 | 11.82 | | |
| PU-242 | | 3.8762E+000 | 6.81 | 3.8410E-002 | 6.81 |
| | 4.891 | 3.8762E+000 | 6.81 | | |
| PU-244 | | 0.0000E+000 | 0.00 | 3.8410E-002 | 6.81 |
| | 4.581 | 0.0000E+000 | 0.00 | | |

Errors quoted at 1.000 sigma

Alpha NID Report
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5/16/2024 1:46:21 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272931.cnf
Batch Identification: 240515PUX
Sample Identification: 718853
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA_024
Chamber Serial Number: 02962245B
Detector Serial Number: 165867

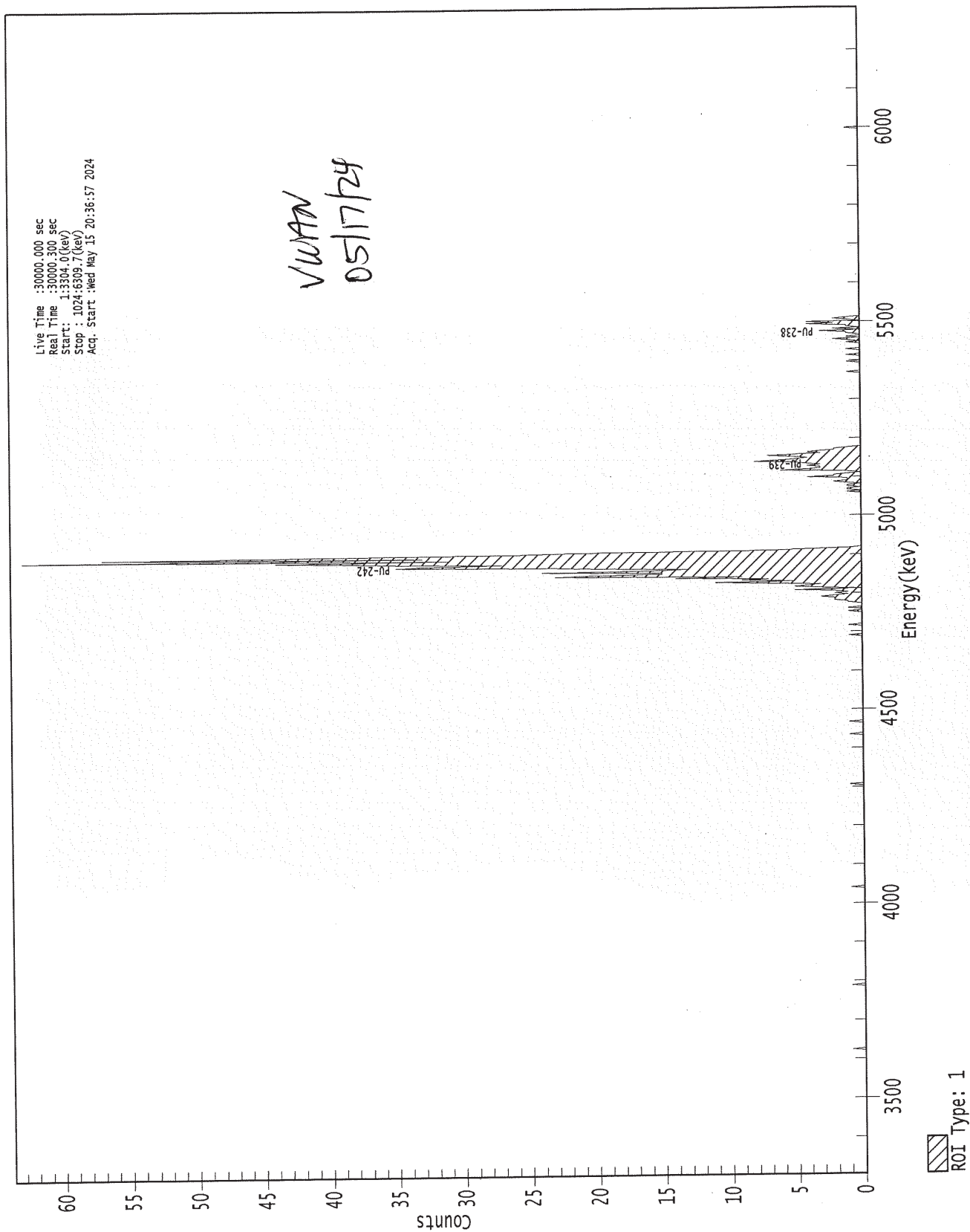
Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:57 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ANALYSIS RESULTS

| Nuclide Name | Id Conf. | Energy (keV) | Activity (pCi/unit) | MDA (pCi/unit) | |
|-----------------|-------------|-----------------|---------------------------|--------------------|----------------|
| PU-238 | 0.999 | 5487.10* | 1.508E-001 +/- 3.064E-002 | 5.555E-002 | +/- 3.783E-003 |
| PU-239 | 0.999 | 5147.70* | 5.428E-001 +/- 6.419E-002 | 3.845E-002 | +/- 2.618E-003 |
| PU-242 | 0.999 | 4890.70* | 3.876E+000 +/- 2.640E-001 | 3.841E-002 | +/- 2.616E-003 |
| PU-244 | 0.997 | 4581.00* | 0.000E+000 +/- 7.107E-003 | 3.841E-002 | +/- 2.616E-003 |

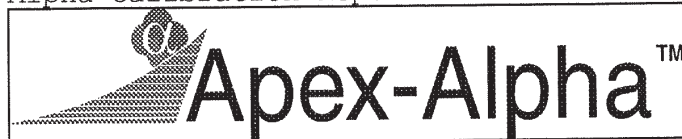
Activity reported as of : 5/15/24 8:36:57 PM

0000272931.CNF



Alpha Calibration Report

5/16/2024 1:47:25 PM



Sample Description:

Spectrum File: \\V79W-7\AlphaRoot\Data\0000272932.cnf
Detector Name: ALPHA 035
Chamber Serial Number: 13000560A
Detector Serial Number: 84475
Geometry Description: Shelf 2

Energy Calibration: 8/2/2023 9:26:08 PM by Administrator
Shape Calibration: 8/2/2023 9:26:08 PM by Administrator
Efficiency Calibration: 8/2/2023 9:26:10 PM by Administrator
Certificate Name: In7860 - primary

ENERGY / SHAPE CALIBRATION

Version: Alpha Encal v1.1
Energy = 3.428 MeV + 3.0216E-003*ch
FWHM = 2.9479E-002 MeV
Low Tail = 4.8822E-003 MeV

| Energy (MeV) | Centroid Channel | Centroid error | FWHM (ch) | FWHM error | TAIL (ch) | TAIL error |
|-----------------|---------------------|-------------------|--------------|---------------|--------------|---------------|
| 4.184 | 250.92 | 0.2007 | 9.34 | 0.4664 | 1.43 | 0.1680 |
| 4.761 | 442.46 | 0.2325 | 8.18 | 0.5270 | 1.07 | 0.1575 |
| 5.148 | 568.31 | 0.1212 | 9.54 | 0.3014 | 2.10 | 0.1698 |
| 5.479 | 679.68 | 0.1936 | 12.24 | 0.4991 | 3.34 | 0.3810 |

EFFICIENCY CALIBRATION

Version: Alpha Efcad v1.0
Avg Efficiency: 0.2150
Uncertainty: +/- 0.0022

| Energy (MeV) | Efficiency | Error |
|-----------------|-------------|-----------|
| 4.184 | 2.2250E-001 | 4.56E-003 |
| 4.761 | 2.1178E-001 | 4.45E-003 |
| 5.148 | 2.1458E-001 | 4.40E-003 |
| 5.479 | 2.1168E-001 | 4.43E-003 |

Alpha Analysis Report
Page 2 of 4

5/16/2024 1:47:25 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272932.cnf
Batch Identification: 240515PUX
Sample Identification: 718854
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA 035
Chamber Serial Number: 13000560A
Detector Serial Number: 84475
Env. Background: System Bkgd 247629
Reagent Blank: <not performed>

Sample Size: 1.000 +/- 0.0000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:59 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

Tracer Certificate: Pu242 124RadSol4
Tracer Quantity: 0.100 mL
Effective Efficiency: 0.1572 +/- 0.0061
Counting Efficiency: 0.2150 +/- 0.0022 on 8/2/2023 9:26:10 PM
Chem. Recovery Factor: 0.7312 +/- 0.0296

Peak Match Tolerance: 0.200 MeV

----- PEAK Location REPORT -----

| Nuclide | Left Channel | Channel Width | Right Channel | Left Energy Marker | Right Energy Marker |
|----------|--------------|---------------|---------------|--------------------|---------------------|
| PU-238 | 626 | 70 | 695 | 5319.7 | 5528.2 |
| PU-239 | 521 | 60 | 580 | 5002.4 | 5180.7 |
| PU-242 T | 394 | 106 | 499 | 4618.7 | 4936.0 |
| PU-244 | 356 | 34 | 389 | 4503.9 | 4603.6 |

----- PEAK AREA REPORT -----

| Nuclide | Energy (MeV) | Net Pk Area | Pk Area Error % | Ambient Backgnd | Reagent Backgnd | FWHM (keV) |
|----------|--------------|-------------|-----------------|-----------------|-----------------|------------|
| PU-238 | 5.469 | 27.00 | 20.79 | 3.00 | 0.00E+000 | 10.6 |
| PU-239 | 5.137 | 76.00 | 11.55 | 0.00 | 0.00E+000 | 4.8 |
| PU-242 T | 4.873 | 676.50 | 3.85 | 0.50 | 0.00E+000 | 29.3 |
| PU-244 | 4.552 | 0.00 | 1000.0 | 0.00 | 0.00E+000 | 0.0 |

Alpha Analysis Report
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5/16/2024 1:47:25 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272932.cnf
Batch Identification: 240515PUX
Sample Identification: 718854
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA 035
Chamber Serial Number: 13000560A
Detector Serial Number: 84475

Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:59 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

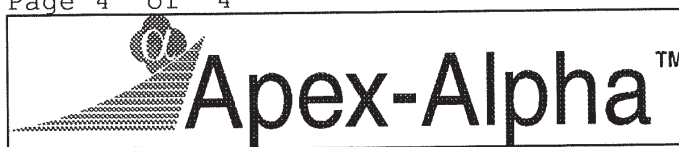
NUCLIDE ACTIVITY REPORT

| Nuclide | Energy (MeV) | Activity (pCi/unit) | Activity Error % | MDA (pCi/unit) | MDA Error % |
|---------|-----------------|-------------------------|---------------------|--------------------|----------------|
| PU-238 | | 1.5484E-001 | 21.92 | 7.3774E-002 | 6.94 |
| | 5.487 | 1.5484E-001 | 21.92 | | |
| PU-239 | | 4.3590E-001 | 13.47 | 4.3877E-002 | 6.94 |
| | 5.148 | 4.3590E-001 | 13.47 | | |
| PU-242 | | 3.8762E+000 | 6.94 | 4.0263E-002 | 6.94 |
| | 4.891 | 3.8762E+000 | 6.94 | | |
| PU-244 | | 0.0000E+000 | 0.00 | 4.3832E-002 | 6.94 |
| | 4.581 | 0.0000E+000 | 0.00 | | |

Errors quoted at 1.000 sigma

Alpha NID Report
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5/16/2024 1:47:25 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272932.cnf
Batch Identification: 240515PUX
Sample Identification: 718854
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA 035
Chamber Serial Number: 13000560A
Detector Serial Number: 84475

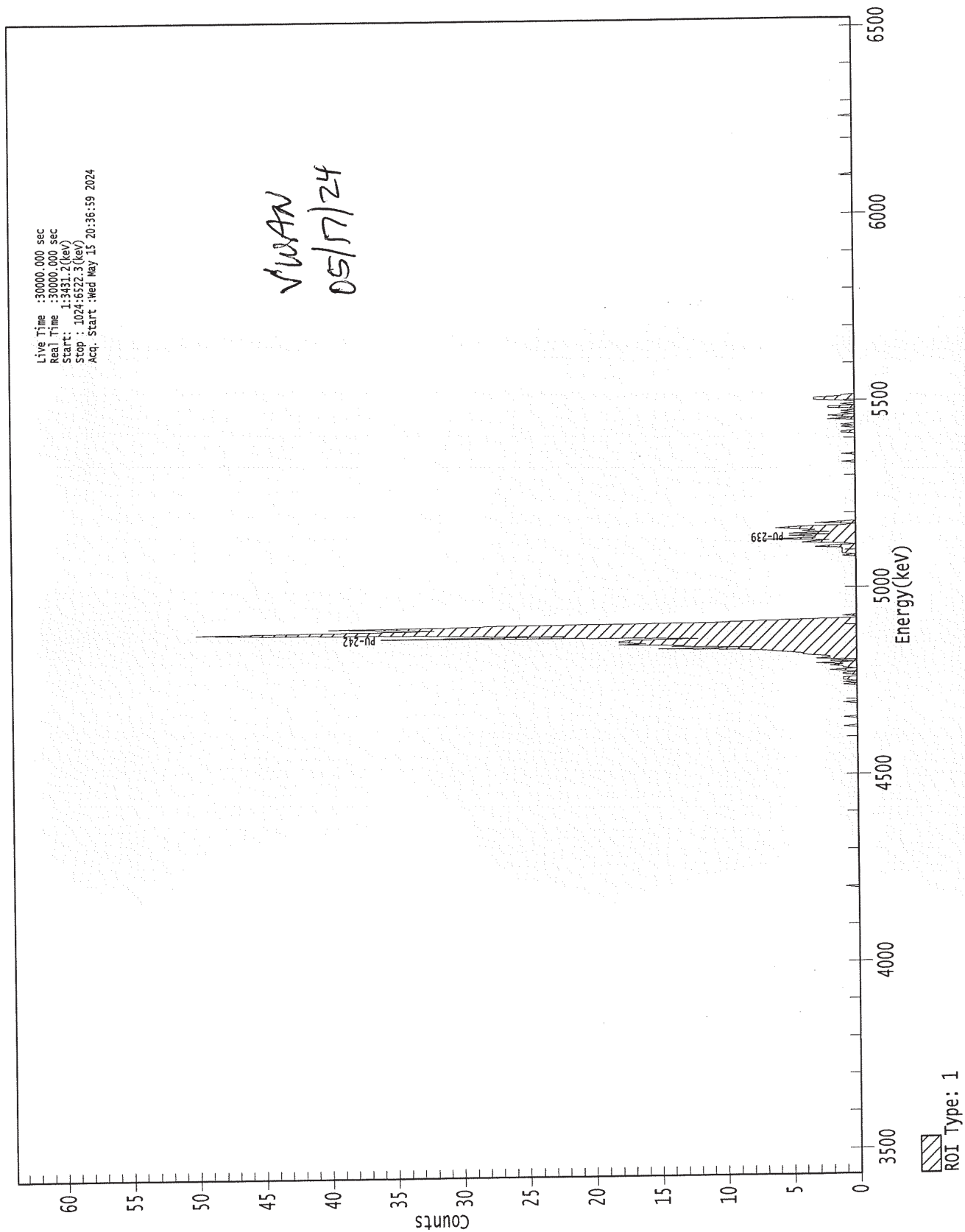
Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:36:59 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ANALYSIS RESULTS

| Nuclide Name | Id Conf. | Energy (keV) | Activity (pCi/unit) | MDA (pCi/unit) |
|-----------------|-------------|-----------------|---------------------------|---------------------------|
| PU-238 | 0.999 | 5487.10* | 1.548E-001 +/- 3.393E-002 | 7.377E-002 +/- 5.122E-003 |
| PU-239 | 1.000 | 5147.70* | 4.359E-001 +/- 5.873E-002 | 4.388E-002 +/- 3.046E-003 |
| PU-242 | 0.999 | 4890.70* | 3.876E+000 +/- 2.691E-001 | 4.026E-002 +/- 2.796E-003 |
| PU-244 | 0.997 | 4581.00* | 0.000E+000 +/- 8.110E-003 | 4.383E-002 +/- 3.043E-003 |

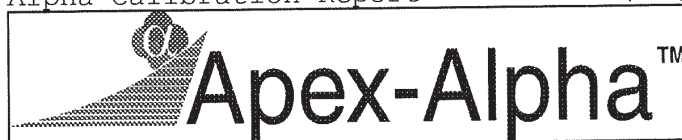
Activity reported as of : 5/15/24 8:36:59 PM

0000272932.CNF



Alpha Calibration Report

5/16/2024 1:48:19 PM



Sample Description:

Spectrum File: \\V79W-7\AlphaRoot\Data\0000272933.cnf
Detector Name: ALPHA 036
Chamber Serial Number: 13000560B
Detector Serial Number: 84476
Geometry Description: Shelf 2

Energy Calibration: 2/4/2023 2:13:38 AM by Administrator
Shape Calibration: 2/4/2023 2:13:38 AM by Administrator
Efficiency Calibration: 2/4/2023 2:13:39 AM by Administrator
Certificate Name: In7859 - primary

----- ENERGY / SHAPE CALIBRATION -----

Version: Alpha Encal v1.1
Energy = 3.429 MeV + 3.0125E-003*ch
FWHM = 2.9214E-002 MeV
Low Tail = 4.5041E-003 MeV

| Energy (MeV) | Centroid Channel | Centroid error | FWHM (ch) | FWHM error | TAIL (ch) | TAIL error |
|-----------------|---------------------|-------------------|--------------|---------------|--------------|---------------|
| 4.184 | 250.88 | 0.1841 | 9.31 | 0.4304 | 1.47 | 0.1606 |
| 4.761 | 442.90 | 0.2645 | 8.88 | 0.6034 | 1.21 | 0.1893 |
| 5.148 | 570.33 | 0.1384 | 8.58 | 0.3296 | 1.47 | 0.1344 |
| 5.479 | 680.85 | 0.2078 | 14.10 | 0.5485 | 4.52 | 0.5392 |

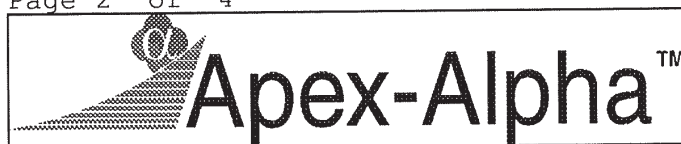
----- EFFICIENCY CALIBRATION -----

Version: Alpha Efcad v1.0
Avg Efficiency: 0.2138
Uncertainty: +/- 0.0025

| Energy (MeV) | Efficiency | Error |
|-----------------|-------------|-----------|
| 4.184 | 2.1659E-001 | 5.05E-003 |
| 4.761 | 2.1057E-001 | 4.99E-003 |
| 5.148 | 2.2537E-001 | 5.30E-003 |
| 5.479 | 2.0429E-001 | 4.89E-003 |

Alpha Analysis Report
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Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272933.cnf
Batch Identification: 240515PUX
Sample Identification: 718855
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA_036
Chamber Serial Number: 13000560B
Detector Serial Number: 84476
Env. Background: System Bkgd 247630
Reagent Blank: <not performed>

Sample Size: 1.000 +/- 0.0000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:37:01 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

Tracer Certificate: Pu242 124RadSol4
Tracer Quantity: 0.100 mL
Effective Efficiency: 0.1955 +/- 0.0069
Counting Efficiency: 0.2138 +/- 0.0025 on 2/4/2023 2:13:39 AM
Chem. Recovery Factor: 0.9144 +/- 0.0339

Peak Match Tolerance: 0.200 MeV

PEAK Location REPORT

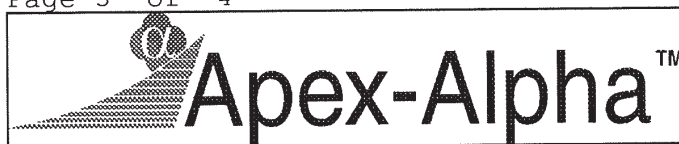
| Nuclide | | Left Channel | Channel Width | Right Channel | Left Energy Marker | Right Energy Marker |
|---------|---|-----------------|------------------|------------------|-----------------------|------------------------|
| PU-238 | | 652 | 44 | 695 | 5393.0 | 5522.5 |
| PU-239 | | 522 | 60 | 581 | 5001.3 | 5179.1 |
| PU-242 | T | 419 | 80 | 498 | 4691.0 | 4929.0 |
| PU-244 | | 357 | 34 | 390 | 4504.3 | 4603.7 |

PEAK AREA REPORT

| Nuclide | | Energy (MeV) | Net Pk Area | Pk Area Error % | Ambient Backgnd | Reagent Backgnd | FWHM (keV) |
|---------|---|-----------------|----------------|--------------------|--------------------|--------------------|---------------|
| PU-238 | | 5.474 | 29.00 | 19.04 | 1.00 | 0.00E+000 | 3.5 |
| PU-239 | | 5.136 | 97.00 | 10.23 | 1.00 | 0.00E+000 | 9.5 |
| PU-242 | T | 4.869 | 841.00 | 3.45 | 0.00 | 0.00E+000 | 30.3 |
| PU-244 | | 4.595 | 0.50 | 223.61 | 0.50 | 0.00E+000 | 3.0 |

Alpha Analysis Report
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Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272933.cnf
Batch Identification: 240515PUX
Sample Identification: 718855
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA_036
Chamber Serial Number: 13000560B
Detector Serial Number: 84476

Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:37:01 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

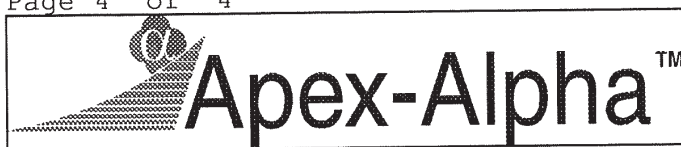
NUCLIDE ACTIVITY REPORT

| Nuclide | Energy (MeV) | Activity (pCi/unit) | Activity Error % | MDA (pCi/unit) | MDA Error % |
|---------|-----------------|-------------------------|---------------------|--------------------|----------------|
| PU-238 | | 1.3378E-001 | 20.20 | 4.0111E-002 | 6.73 |
| | 5.487 | 1.3378E-001 | 20.20 | | |
| PU-239 | | 4.4752E-001 | 12.25 | 4.0116E-002 | 6.73 |
| | 5.148 | 4.4752E-001 | 12.25 | | |
| PU-242 | | 3.8762E+000 | 6.73 | 3.5259E-002 | 6.73 |
| | 4.891 | 3.8762E+000 | 6.73 | | |
| PU-244 | | 2.3045E-003 | 223.71 | 3.2388E-002 | 6.73 |
| | 4.581 | 2.3045E-003 | 223.71 | | |

Errors quoted at 1.000 sigma

Alpha NID Report
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Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272933.cnf
Batch Identification: 240515PUX
Sample Identification: 718855
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA 036
Chamber Serial Number: 13000560B
Detector Serial Number: 84476

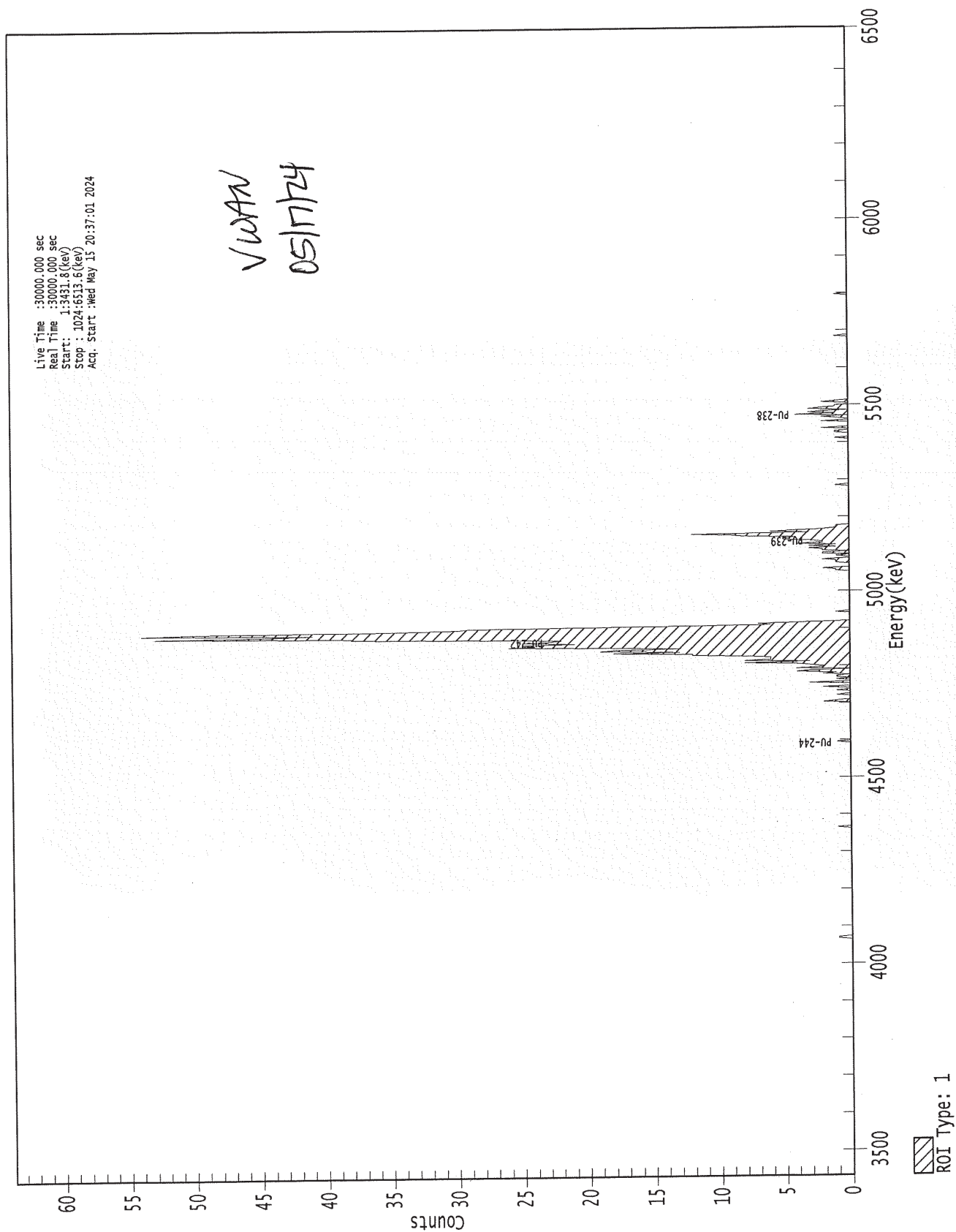
Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:37:01 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ANALYSIS RESULTS

| Nuclide Name | Id Conf. | Energy (keV) | Activity (pCi/unit) | MDA (pCi/unit) |
|-----------------|-------------|-----------------|---------------------------|---------------------------|
| PU-238 | 0.999 | 5487.10* | 1.338E-001 +/- 2.702E-002 | 4.011E-002 +/- 2.700E-003 |
| PU-239 | 0.999 | 5147.70* | 4.475E-001 +/- 5.481E-002 | 4.012E-002 +/- 2.700E-003 |
| PU-242 | 0.998 | 4890.70* | 3.876E+000 +/- 2.609E-001 | 3.526E-002 +/- 2.373E-003 |
| PU-244 | 0.999 | 4581.00* | 2.304E-003 +/- 5.155E-003 | 3.239E-002 +/- 2.180E-003 |

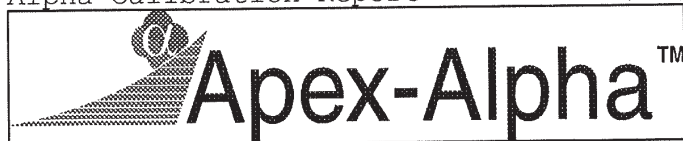
Activity reported as of : 5/15/24 8:37:01 PM

0000272933.CNF



Alpha Calibration Report

5/16/2024 1:49:01 PM



Sample Description:

Spectrum File: \\V79W-7\AlphaRoot\Data\0000272934.cnf
Detector Name: ALPHA 039
Chamber Serial Number: 13000762A
Detector Serial Number: 94691
Geometry Description: Shelf 2

Energy Calibration: 8/8/2023 6:01:00 PM by Administrator
Shape Calibration: 8/8/2023 6:01:00 PM by Administrator
Efficiency Calibration: 8/8/2023 6:01:01 PM by Administrator
Certificate Name: In8615 - primary

ENERGY / SHAPE CALIBRATION

Version: Alpha Encal v1.1
Energy = 3.413 MeV + 3.0312E-003*ch
FWHM = 2.4564E-002 MeV
Low Tail = 3.2004E-003 MeV

| Energy (MeV) | Centroid Channel | Centroid error | FWHM (ch) | FWHM error | TAIL (ch) | TAIL error |
|-----------------|---------------------|-------------------|--------------|---------------|--------------|---------------|
| 4.184 | 254.58 | 0.1430 | 7.23 | 0.3228 | 0.92 | 0.0929 |
| 4.761 | 445.79 | 0.2050 | 7.43 | 0.4585 | 0.82 | 0.1129 |
| 5.148 | 572.00 | 0.1172 | 7.85 | 0.2783 | 1.37 | 0.1165 |
| 5.479 | 682.16 | 0.1931 | 11.97 | 0.5094 | 3.81 | 0.4925 |

EFFICIENCY CALIBRATION

Version: Alpha Efcals v1.0
Avg Efficiency: 0.2148
Uncertainty: +/- 0.0026

| Energy (MeV) | Efficiency | Error |
|-----------------|-------------|-----------|
| 4.184 | 2.2009E-001 | 5.13E-003 |
| 4.761 | 2.1266E-001 | 4.97E-003 |
| 5.148 | 2.0504E-001 | 5.25E-003 |
| 5.479 | 2.2128E-001 | 5.19E-003 |

Alpha Analysis Report
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Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272934.cnf
Batch Identification: 240515PUX
Sample Identification: 718856
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA 039
Chamber Serial Number: 13000762A
Detector Serial Number: 94691
Env. Background: System Bkgd 247631
Reagent Blank: <not performed>

Sample Size: 1.000 +/- 0.0000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:37:02 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

Tracer Certificate: Pu242 124RadSol4
Tracer Quantity: 0.100 mL
Effective Efficiency: 0.1519 +/- 0.0060
Counting Efficiency: 0.2148 +/- 0.0026 on 8/8/2023 6:01:01 PM
Chem. Recovery Factor: 0.7071 +/- 0.0293

Peak Match Tolerance: 0.200 MeV

----- PEAK Location REPORT -----

| Nuclide | Left Channel | Channel Width | Right Channel | Left Energy Marker | Right Energy Marker |
|----------|--------------|---------------|---------------|--------------------|---------------------|
| PU-238 | 662 | 32 | 693 | 5419.3 | 5513.3 |
| PU-239 | 524 | 60 | 583 | 5001.0 | 5179.9 |
| PU-242 T | 422 | 78 | 499 | 4691.8 | 4925.2 |
| PU-244 | 360 | 34 | 393 | 4503.9 | 4603.9 |

----- PEAK AREA REPORT -----

| Nuclide | Energy (MeV) | Net Pk Area | Pk Area Error % | Ambient Backgnd | Reagent Backgnd | FWHM (keV) |
|----------|--------------|-------------|-----------------|-----------------|-----------------|------------|
| PU-238 | 5.474 | 29.50 | 18.64 | 0.50 | 0.00E+000 | 3.8 |
| PU-239 | 5.129 | 93.00 | 10.43 | 0.00 | 0.00E+000 | 6.3 |
| PU-242 T | 4.865 | 653.50 | 3.91 | 0.50 | 0.00E+000 | 13.9 |
| PU-244 | 4.552 | -0.50 | 223.61 | 0.50 | 0.00E+000 | 0.0 |

Alpha Analysis Report
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5/16/2024 1:49:01 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272934.cnf
Batch Identification: 240515PUX
Sample Identification: 718856
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA 039
Chamber Serial Number: 13000762A
Detector Serial Number: 94691

Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:37:02 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ACTIVITY REPORT

| Nuclide | Energy (MeV) | Activity (pCi/unit) | Activity Error % | MDA (pCi/unit) | MDA Error % |
|---------|-----------------|-------------------------|---------------------|--------------------|----------------|
| PU-238 | | 1.7513E-001 | 19.91 | 4.1717E-002 | 6.98 |
| | 5.487 | 1.7513E-001 | 19.91 | | |
| PU-239 | | 5.5217E-001 | 12.55 | 4.5421E-002 | 6.98 |
| | 5.148 | 5.5217E-001 | 12.55 | | |
| PU-242 | | 3.8762E+000 | 6.98 | 4.1680E-002 | 6.98 |
| | 4.891 | 3.8762E+000 | 6.98 | | |
| PU-244 | | -2.9657E-003 | -223.7 | 4.1680E-002 | 6.98 |
| | 4.581 | -2.9657E-003 | -223.7 | | |

Errors quoted at 1.000 sigma

Alpha NID Report 5/16/2024 1:49:01 PM
Page 4 of 4



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272934.cnf
Batch Identification: 240515PUX
Sample Identification: 718856
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA 039
Chamber Serial Number: 13000762A
Detector Serial Number: 94691

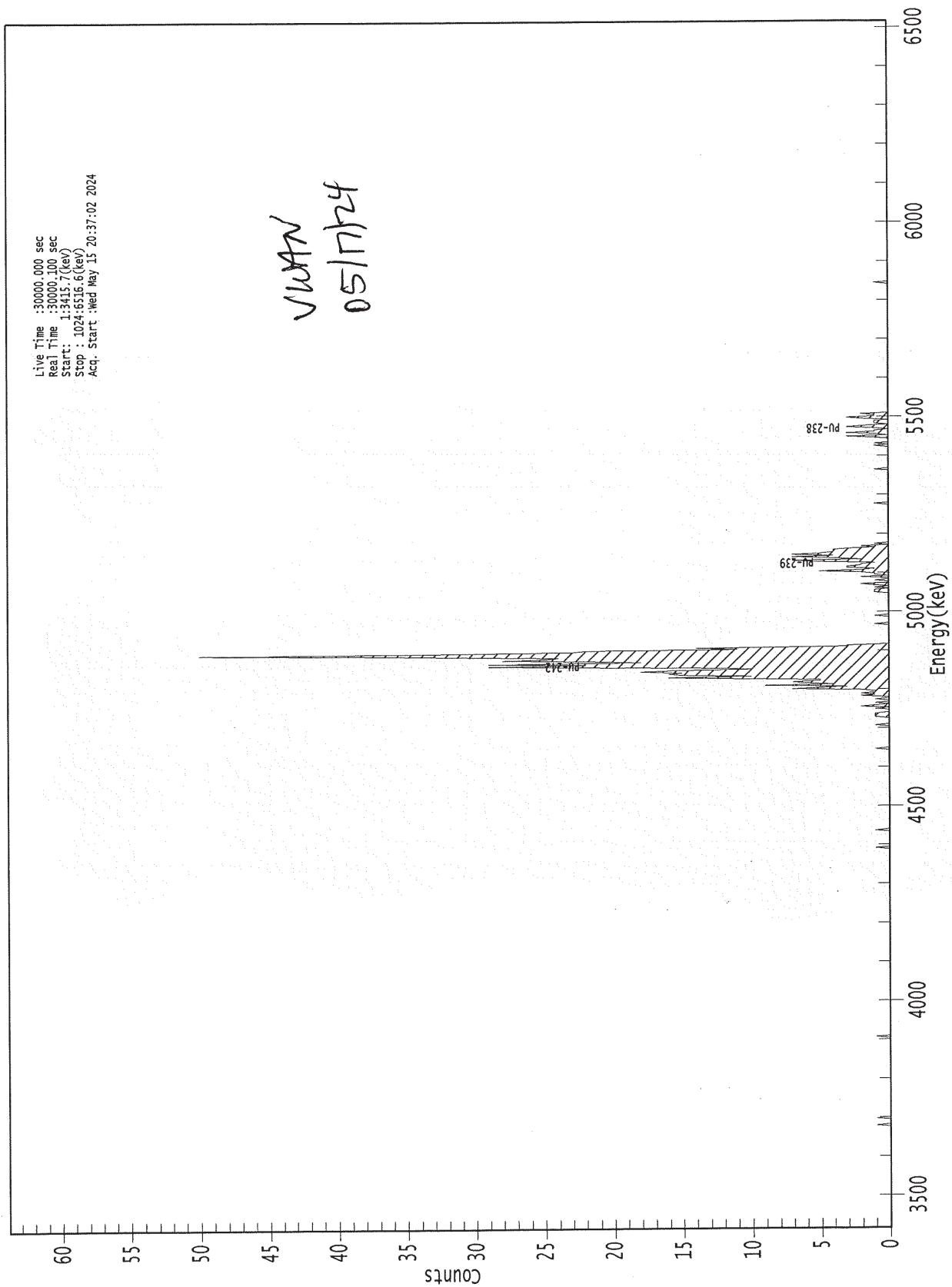
Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:37:02 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ANALYSIS RESULTS

| Nuclide Name | Id Conf. | Energy (keV) | Activity (pCi/unit) | MDA (pCi/unit) |
|--------------|----------|--------------|----------------------------|---------------------------|
| PU-238 | 0.999 | 5487.10* | 1.751E-001 +/- 3.487E-002 | 4.172E-002 +/- 2.912E-003 |
| PU-239 | 0.999 | 5147.70* | 5.522E-001 +/- 6.928E-002 | 4.542E-002 +/- 3.171E-003 |
| PU-242 | 0.997 | 4890.70* | 3.876E+000 +/- 2.706E-001 | 4.168E-002 +/- 2.910E-003 |
| PU-244 | 0.997 | 4581.00* | -2.966E-003 +/- 6.635E-003 | 4.168E-002 +/- 2.910E-003 |

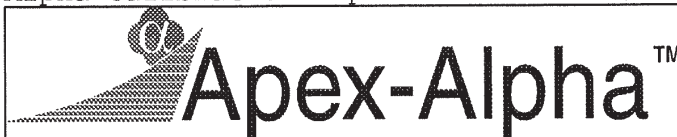
Activity reported as of : 5/15/24 8:37:02 PM

0000272934.CNF



Alpha Calibration Report

5/16/2024 1:50:49 PM



Sample Description:

Spectrum File: \\V79W-7\AlphaRoot\Data\0000272935.cnf
Detector Name: ALPHA 045
Chamber Serial Number: 13000766A
Detector Serial Number: 159389
Geometry Description: Shelf 2

Energy Calibration: 8/11/2022 6:02:28 PM by Administrator
Shape Calibration: 8/11/2022 6:02:28 PM by Administrator
Efficiency Calibration: 8/11/2022 6:02:29 PM by Administrator
Certificate Name: In7860 - primary

ENERGY / SHAPE CALIBRATION

Version: Alpha Encal v1.1
Energy = 3.415 MeV + 3.0304E-003*ch
FWHM = 2.5469E-002 MeV
Low Tail = 3.1508E-003 MeV

| Energy (MeV) | Centroid Channel | Centroid error | FWHM (ch) | FWHM error | TAIL (ch) | TAIL error |
|-----------------|---------------------|-------------------|--------------|---------------|--------------|---------------|
| 4.184 | 254.13 | 0.1689 | 6.98 | 0.3752 | 0.80 | 0.0958 |
| 4.761 | 445.37 | 0.2403 | 7.87 | 0.5360 | 0.93 | 0.1434 |
| 5.148 | 571.24 | 0.1516 | 8.66 | 0.3635 | 1.58 | 0.1607 |
| 5.479 | 681.96 | 0.2344 | 12.06 | 0.6029 | 3.23 | 0.4482 |

EFFICIENCY CALIBRATION

Version: Alpha Efcad v1.0
Avg Efficiency: 0.2138
Uncertainty: +/- 0.0022

| Energy (MeV) | Efficiency | Error |
|-----------------|-------------|-----------|
| 4.184 | 2.1256E-001 | 4.43E-003 |
| 4.761 | 2.0996E-001 | 4.42E-003 |
| 5.148 | 2.1717E-001 | 4.44E-003 |
| 5.479 | 2.1557E-001 | 4.47E-003 |

Alpha Analysis Report
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5/16/2024 1:50:49 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272935.cnf
Batch Identification: 240515PUX
Sample Identification: 718857
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA 045
Chamber Serial Number: 13000766A
Detector Serial Number: 159389
Env. Background: System Bkgd 247632
Reagent Blank: <not performed>

Sample Size: 1.000 +/- 0.0000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:37:04 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

Tracer Certificate: Pu242 124RadSol4
Tracer Quantity: 0.100 mL
Effective Efficiency: 0.1714 +/- 0.0064
Counting Efficiency: 0.2138 +/- 0.0022 on 8/11/2022 6:02:29 PM
Chem. Recovery Factor: 0.8017 +/- 0.0312

Peak Match Tolerance: 0.200 MeV

----- PEAK Location REPORT -----

| Nuclide | Left Channel | Channel Width | Right Channel | Left Energy Marker | Right Energy Marker |
|----------|--------------|---------------|---------------|--------------------|---------------------|
| PU-238 | 656 | 42 | 697 | 5402.6 | 5526.8 |
| PU-239 | 524 | 60 | 583 | 5002.6 | 5181.4 |
| PU-242 T | 416 | 86 | 501 | 4675.3 | 4932.9 |
| PU-244 | 360 | 34 | 393 | 4505.6 | 4605.6 |

----- PEAK AREA REPORT -----

| Nuclide | Energy (MeV) | Net Pk Area | Pk Area Error % | Ambient Backgnd | Reagent Backgnd | FWHM (keV) |
|----------|--------------|-------------|-----------------|-----------------|-----------------|------------|
| PU-238 | 5.482 | 26.00 | 19.99 | 0.00 | 0.00E+000 | 4.5 |
| PU-239 | 5.136 | 95.00 | 10.31 | 0.00 | 0.00E+000 | 4.1 |
| PU-242 T | 4.872 | 737.50 | 3.68 | 0.50 | 0.00E+000 | 23.5 |
| PU-244 | 4.548 | 2.00 | 86.60 | 0.00 | 0.00E+000 | 3.0 |

Alpha Analysis Report
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Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272935.cnf
Batch Identification: 240515PUX
Sample Identification: 718857
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA 045
Chamber Serial Number: 13000766A
Detector Serial Number: 159389

Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:37:04 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

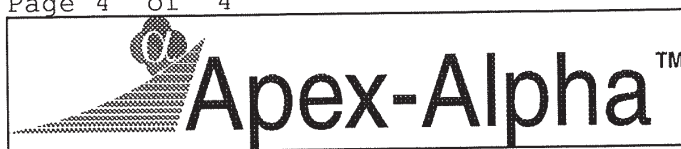
NUCLIDE ACTIVITY REPORT

| Nuclide | Energy (MeV) | Activity (pCi/unit) | Activity Error % | MDA (pCi/unit) | MDA Error % |
|---------|-----------------|-------------------------|---------------------|--------------------|----------------|
| PU-238 | | 1.3677E-001 | 21.13 | 4.0243E-002 | 6.85 |
| | 5.487 | 1.3677E-001 | 21.13 | | |
| PU-239 | | 4.9980E-001 | 12.38 | 4.0247E-002 | 6.85 |
| | 5.148 | 4.9980E-001 | 12.38 | | |
| PU-242 | | 3.8762E+000 | 6.85 | 3.6933E-002 | 6.85 |
| | 4.891 | 3.8762E+000 | 6.85 | | |
| PU-244 | | 1.0512E-002 | 86.87 | 4.0207E-002 | 6.85 |
| | 4.581 | 1.0512E-002 | 86.87 | | |

Errors quoted at 1.000 sigma

Alpha NID Report
Page 4 of 4

5/16/2024 1:50:49 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272935.cnf
Batch Identification: 240515PUX
Sample Identification: 718857
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA 045
Chamber Serial Number: 13000766A
Detector Serial Number: 159389

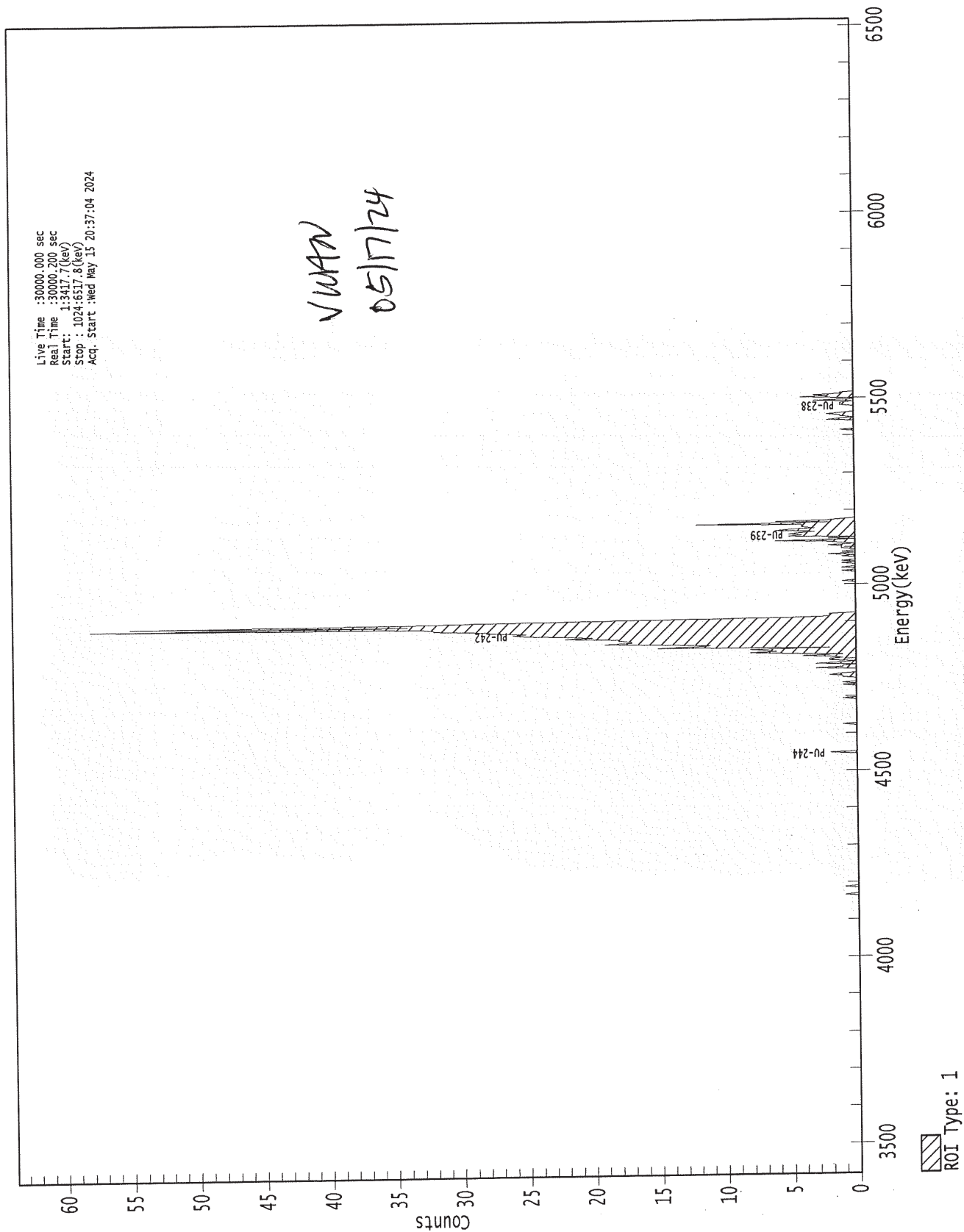
Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:37:04 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ANALYSIS RESULTS

| Nuclide Name | Id Conf. | Energy (keV) | Activity (pCi/unit) | MDA (pCi/unit) |
|--------------|----------|--------------|---------------------------|---------------------------|
| PU-238 | 1.000 | 5487.10* | 1.368E-001 +/- 2.890E-002 | 4.024E-002 +/- 2.758E-003 |
| PU-239 | 0.999 | 5147.70* | 4.998E-001 +/- 6.189E-002 | 4.025E-002 +/- 2.759E-003 |
| PU-242 | 0.999 | 4890.70* | 3.876E+000 +/- 2.657E-001 | 3.693E-002 +/- 2.532E-003 |
| PU-244 | 0.996 | 4581.00* | 1.051E-002 +/- 9.132E-003 | 4.021E-002 +/- 2.756E-003 |

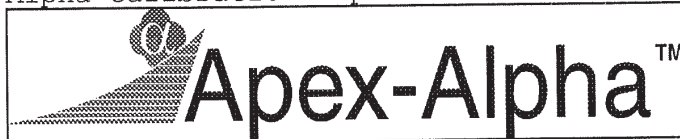
Activity reported as of : 5/15/24 8:37:04 PM

0000272935.CNF



Alpha Calibration Report

5/16/2024 1:53:39 PM



Sample Description:

Spectrum File: \\V79W-7\AlphaRoot\Data\0000272936.cnf
Detector Name: ALPHA 047
Chamber Serial Number: 13000767A
Detector Serial Number: 94697
Geometry Description: Shelf 2

Energy Calibration: 8/30/2023 1:19:16 PM by Administrator
Shape Calibration: 8/30/2023 1:19:16 PM by Administrator
Efficiency Calibration: 8/30/2023 1:19:17 PM by Administrator
Certificate Name: In7860 - primary

----- ENERGY / SHAPE CALIBRATION -----

Version: Alpha Encal v1.1
Energy = 3.421 MeV + 3.0295E-003*ch
FWHM = 2.8747E-002 MeV
Low Tail = 4.3610E-003 MeV

| Energy (MeV) | Centroid Channel | Centroid error | FWHM (ch) | FWHM error | TAIL (ch) | TAIL error |
|-----------------|---------------------|-------------------|--------------|---------------|--------------|---------------|
| 4.184 | 252.19 | 0.1737 | 8.71 | 0.4051 | 1.32 | 0.1429 |
| 4.761 | 443.44 | 0.2279 | 8.06 | 0.5169 | 1.06 | 0.1548 |
| 5.148 | 569.12 | 0.1580 | 9.13 | 0.3846 | 1.81 | 0.1896 |
| 5.479 | 679.94 | 0.1900 | 12.63 | 0.5011 | 3.92 | 0.4635 |

----- EFFICIENCY CALIBRATION -----

Version: Alpha Efcals v1.0
Avg Efficiency: 0.2256
Uncertainty: +/- 0.0023

| Energy (MeV) | Efficiency | Error |
|-----------------|-------------|-----------|
| 4.184 | 2.2836E-001 | 4.64E-003 |
| 4.761 | 2.2920E-001 | 4.67E-003 |
| 5.148 | 2.2618E-001 | 4.55E-003 |
| 5.479 | 2.1904E-001 | 4.52E-003 |

Alpha Analysis Report
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5/16/2024 1:53:39 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272936.cnf
Batch Identification: 240515PUX
Sample Identification: 718858
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA 047
Chamber Serial Number: 13000767A
Detector Serial Number: 94697
Env. Background: System Bkgd 247633
Reagent Blank: <not performed>

Sample Size: 1.000 +/- 0.0000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:37:06 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

Tracer Certificate: Pu242 124RadSol4
Tracer Quantity: 0.100 mL
Effective Efficiency: 0.2003 +/- 0.0070
Counting Efficiency: 0.2256 +/- 0.0023 on 8/30/2023 1:19:17 PM
Chem. Recovery Factor: 0.8881 +/- 0.0322

Peak Match Tolerance: 0.200 MeV

PEAK Location REPORT

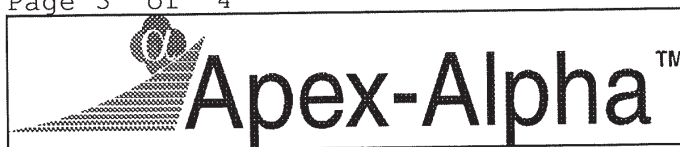
| Nuclide | Left Channel | Channel Width | Right Channel | Left Energy Marker | Right Energy Marker |
|----------|--------------|---------------|---------------|--------------------|---------------------|
| PU-238 | 648 | 46 | 693 | 5384.0 | 5520.4 |
| PU-239 | 522 | 60 | 581 | 5002.3 | 5181.1 |
| PU-242 T | 412 | 89 | 500 | 4669.1 | 4935.7 |
| PU-244 | 358 | 34 | 391 | 4505.5 | 4605.5 |

PEAK AREA REPORT

| Nuclide | Energy (MeV) | Net Pk Area | Pk Area Error % | Ambient Backgnd | Reagent Backgnd | FWHM (keV) |
|----------|--------------|-------------|-----------------|-----------------|-----------------|------------|
| PU-238 | 5.477 | 32.00 | 17.95 | 0.00 | 0.00E+000 | 4.5 |
| PU-239 | 5.132 | 126.00 | 8.94 | 0.00 | 0.00E+000 | 4.6 |
| PU-242 T | 4.871 | 862.00 | 3.41 | 0.00 | 0.00E+000 | 24.4 |
| PU-244 | 4.554 | 0.00 | 1000.0 | 0.00 | 0.00E+000 | 0.0 |

Alpha Analysis Report
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Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272936.cnf
Batch Identification: 240515PUX
Sample Identification: 718858
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA 047
Chamber Serial Number: 13000767A
Detector Serial Number: 94697

Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:37:06 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ACTIVITY REPORT

| Nuclide | Energy (MeV) | Activity (pCi/unit) | Activity Error % | MDA (pCi/unit) | MDA Error % |
|---------|-----------------|-------------------------|---------------------|--------------------|----------------|
| PU-238 | | 1.4402E-001 | 19.16 | 3.4430E-002 | 6.71 |
| | 5.487 | 1.4402E-001 | 19.16 | | |
| PU-239 | | 5.6715E-001 | 11.18 | 3.4434E-002 | 6.71 |
| | 5.148 | 5.6715E-001 | 11.18 | | |
| PU-242 | | 3.8762E+000 | 6.71 | 3.4400E-002 | 6.71 |
| | 4.891 | 3.8762E+000 | 6.71 | | |
| PU-244 | | 0.0000E+000 | 0.00 | 3.4400E-002 | 6.71 |
| | 4.581 | 0.0000E+000 | 0.00 | | |

Errors quoted at 1.000 sigma

Alpha NID Report
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5/16/2024 1:53:40 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272936.cnf
Batch Identification: 240515PUX
Sample Identification: 718858
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA 047
Chamber Serial Number: 13000767A
Detector Serial Number: 94697

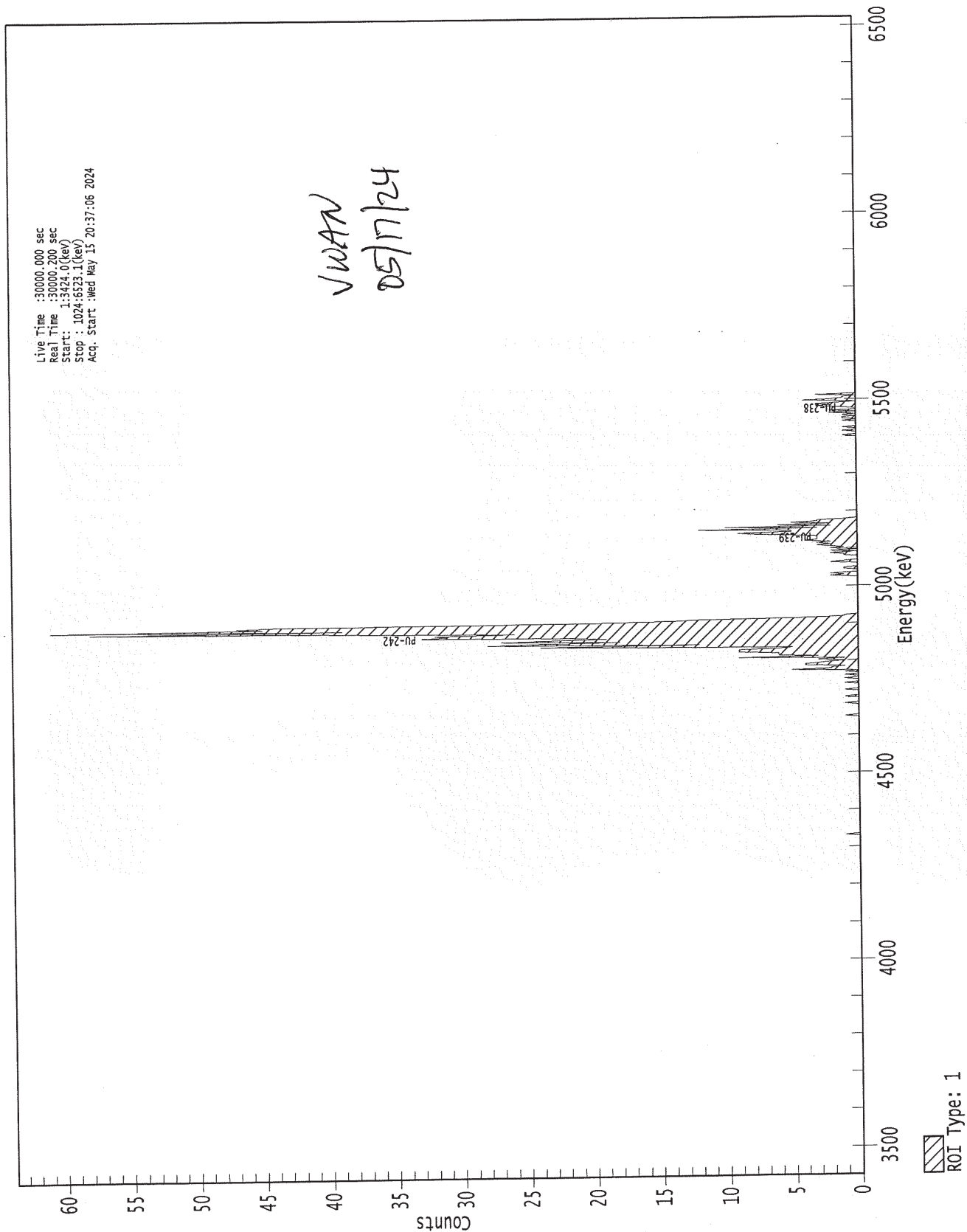
Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:37:06 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ANALYSIS RESULTS

| Nuclide Name | Id Conf. | Energy (keV) | Activity (pCi/unit) | MDA (pCi/unit) | |
|-----------------|-------------|-----------------|---------------------------|--------------------|----------------|
| PU-238 | 1.000 | 5487.10* | 1.440E-001 +/- 2.760E-002 | 3.443E-002 | +/- 2.310E-003 |
| PU-239 | 0.999 | 5147.70* | 5.672E-001 +/- 6.341E-002 | 3.443E-002 | +/- 2.311E-003 |
| PU-242 | 0.998 | 4890.70* | 3.876E+000 +/- 2.601E-001 | 3.440E-002 | +/- 2.308E-003 |
| PU-244 | 0.997 | 4581.00* | 0.000E+000 +/- 6.365E-003 | 3.440E-002 | +/- 2.308E-003 |

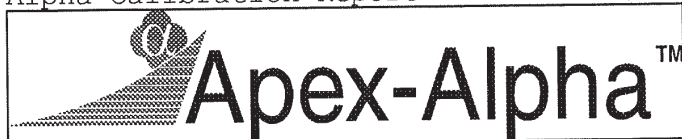
Activity reported as of : 5/15/24 8:37:06 PM

0000272936.CNF



Alpha Calibration Report

5/16/2024 1:54:17 PM



Sample Description:

Spectrum File: \\V79W-7\AlphaRoot\Data\0000272937.cnf
Detector Name: ALPHA 048
Chamber Serial Number: 13000767B
Detector Serial Number: 94698
Geometry Description: Shelf 2

Energy Calibration: 8/11/2022 6:02:15 PM by Administrator
Shape Calibration: 8/11/2022 6:02:15 PM by Administrator
Efficiency Calibration: 8/11/2022 6:02:16 PM by Administrator
Certificate Name: In7859 - primary

ENERGY / SHAPE CALIBRATION

Version: Alpha Encal v1.1
Energy = 3.423 MeV + 3.0310E-003*ch
FWHM = 2.8419E-002 MeV
Low Tail = 3.9832E-003 MeV

| Energy (MeV) | Centroid Channel | Centroid error | FWHM (ch) | FWHM error | TAIL (ch) | TAIL error |
|--------------|------------------|----------------|-----------|------------|-----------|------------|
| 4.184 | 251.03 | 0.2092 | 8.97 | 0.4798 | 1.26 | 0.1554 |
| 4.761 | 442.74 | 0.2372 | 7.36 | 0.5285 | 0.81 | 0.1283 |
| 5.148 | 568.72 | 0.1244 | 9.25 | 0.3033 | 1.78 | 0.1427 |
| 5.479 | 678.81 | 0.2119 | 12.54 | 0.5542 | 3.70 | 0.4743 |

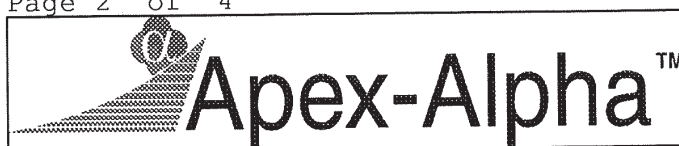
EFFICIENCY CALIBRATION

Version: Alpha Efcacal v1.0
Avg Efficiency: 0.2131
Uncertainty: +/- 0.0025

| Energy (MeV) | Efficiency | Error |
|--------------|-------------|-----------|
| 4.184 | 2.0955E-001 | 4.93E-003 |
| 4.761 | 2.1767E-001 | 5.11E-003 |
| 5.148 | 2.1411E-001 | 5.11E-003 |
| 5.479 | 2.1140E-001 | 5.01E-003 |

Alpha Analysis Report
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5/16/2024 1:54:17 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272937.cnf
Batch Identification: 240515PUX
Sample Identification: 718859
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA 048
Chamber Serial Number: 13000767B
Detector Serial Number: 94698
Env. Background: System Bkgd 247634
Reagent Blank: <not performed>

Sample Size: 1.000 +/- 0.0000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:37:07 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

Tracer Certificate: Pu242 124RadSol4
Tracer Quantity: 0.100 mL
Effective Efficiency: 0.1676 +/- 0.0063
Counting Efficiency: 0.2131 +/- 0.0025 on 8/11/2022 6:02:16 PM
Chem. Recovery Factor: 0.7864 +/- 0.0312

Peak Match Tolerance: 0.200 MeV

----- PEAK Location REPORT -----

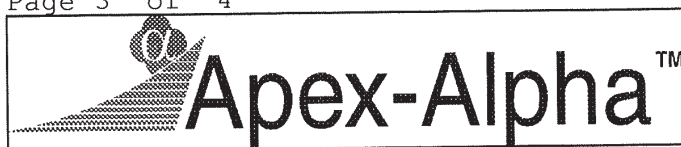
| Nuclide | Left Channel | Channel Width | Right Channel | Left Energy Marker | Right Energy Marker |
|----------|--------------|---------------|---------------|--------------------|---------------------|
| PU-238 | 659 | 32 | 690 | 5420.2 | 5514.2 |
| PU-239 | 521 | 60 | 580 | 5002.0 | 5180.8 |
| PU-242 T | 399 | 97 | 495 | 4632.2 | 4923.2 |
| PU-244 | 357 | 34 | 390 | 4504.9 | 4604.9 |

----- PEAK AREA REPORT -----

| Nuclide | Energy (MeV) | Net Pk Area | Pk Area Error % | Ambient Backgnd | Reagent Backgnd | FWHM (keV) |
|----------|--------------|-------------|-----------------|-----------------|-----------------|------------|
| PU-238 | 5.481 | 20.00 | 22.91 | 0.00 | 0.00E+000 | 4.5 |
| PU-239 | 5.132 | 109.00 | 9.62 | 0.00 | 0.00E+000 | 4.3 |
| PU-242 T | 4.866 | 721.00 | 3.73 | 0.00 | 0.00E+000 | 29.2 |
| PU-244 | 4.572 | 0.50 | 223.61 | 0.50 | 0.00E+000 | 3.0 |

Alpha Analysis Report
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5/16/2024 1:54:17 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272937.cnf
Batch Identification: 240515PUX
Sample Identification: 718859
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA 048
Chamber Serial Number: 13000767B
Detector Serial Number: 94698

Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:37:07 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ACTIVITY REPORT

| Nuclide | Energy (MeV) | Activity (pCi/unit) | Activity Error % | MDA (pCi/unit) | MDA Error % |
|---------|-----------------|-------------------------|---------------------|--------------------|----------------|
| PU-238 | | 1.0762E-001 | 23.92 | 4.1164E-002 | 6.88 |
| | 5.487 | 1.0762E-001 | 23.92 | | |
| PU-239 | | 5.8658E-001 | 11.83 | 4.1168E-002 | 6.88 |
| | 5.148 | 5.8658E-001 | 11.83 | | |
| PU-242 | | 3.8762E+000 | 6.88 | 4.1127E-002 | 6.88 |
| | 4.891 | 3.8762E+000 | 6.88 | | |
| PU-244 | | 2.6880E-003 | 223.71 | 3.7778E-002 | 6.88 |
| | 4.581 | 2.6880E-003 | 223.71 | | |

Errors quoted at 1.000 sigma

Alpha NID Report
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5/16/2024 1:54:18 PM



Sample Description:
Spectrum File: \\V79W-7\AlphaRoot\Data\0000272937.cnf
Batch Identification: 240515PUX
Sample Identification: 718859
Sample Geometry: Shelf 2
Procedure Description: Pu with 242 - 500min

Detector Name: ALPHA 048
Chamber Serial Number: 13000767B
Detector Serial Number: 94698

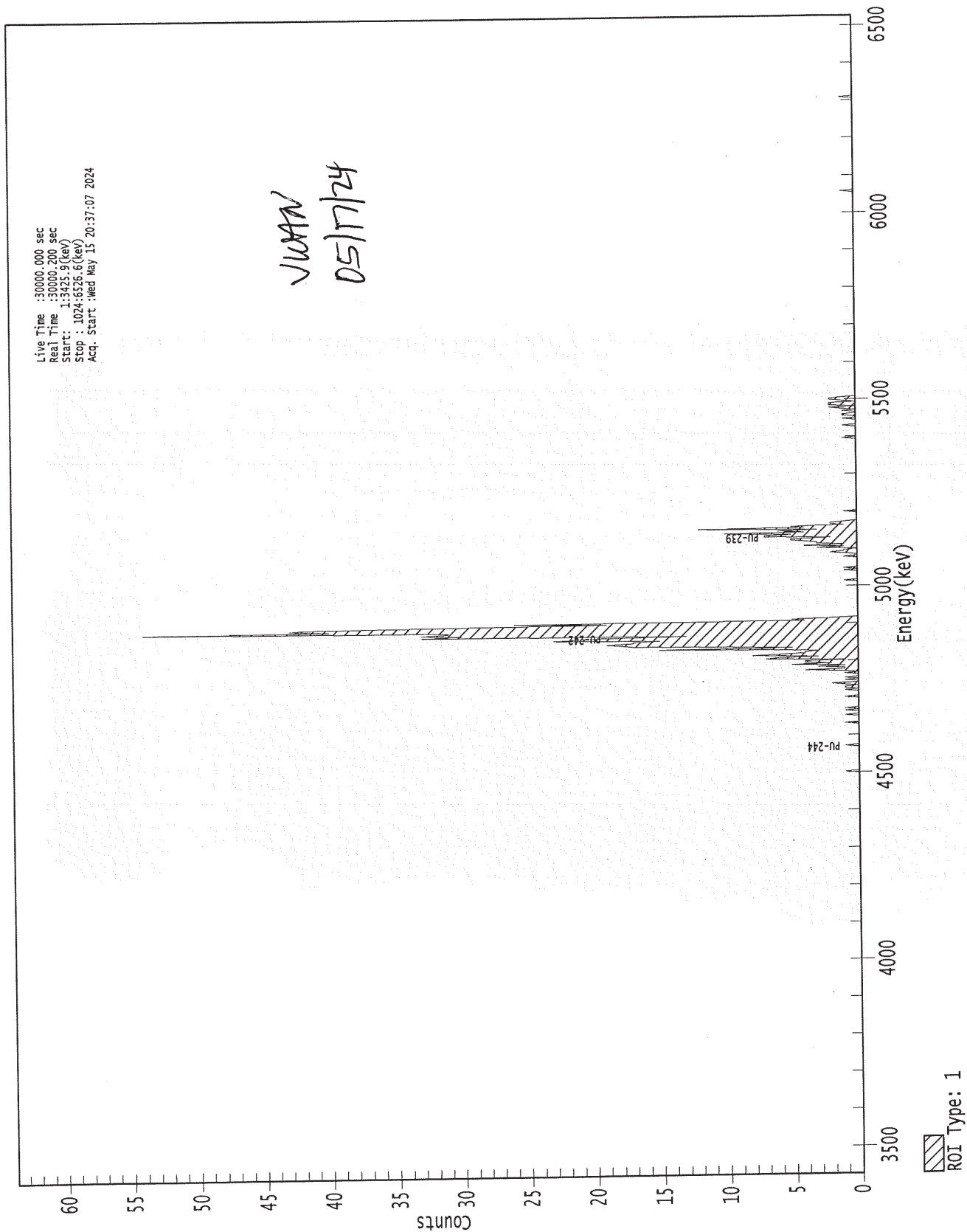
Sample Size: 1.000 unit
Sample Date/Time: 4/4/2024 8:06:50 PM
Acquisition Date/Time: 5/15/2024 8:37:07 PM
Acquisition Live Time: 500.0 minutes
Acquisition Real Time: 500.0 minutes

NUCLIDE ANALYSIS RESULTS

| Nuclide Name | Id Conf. | Energy (keV) | Activity (pCi/unit) | MDA (pCi/unit) | |
|-----------------|-------------|-----------------|---------------------------|--------------------|----------------|
| PU-238 | 1.000 | 5487.10* | 1.076E-001 +/- 2.575E-002 | 4.116E-002 | +/- 2.831E-003 |
| PU-239 | 0.999 | 5147.70* | 5.866E-001 +/- 6.938E-002 | 4.117E-002 | +/- 2.831E-003 |
| PU-242 | 0.998 | 4890.70* | 3.876E+000 +/- 2.666E-001 | 4.113E-002 | +/- 2.828E-003 |
| PU-244 | 1.000 | 4581.00* | 2.688E-003 +/- 6.014E-003 | 3.778E-002 | +/- 2.598E-003 |

Activity reported as of : 5/15/24 8:37:07 PM

0000272937.CNF



SOUTHWEST RESEARCH INSTITUTE

CLIENT: Battelle Memorial Institute PNNL

SwRI Project #: 27927.13.001

SwRI Task Order #: 240405-6

SDG #: 718819

TON #: 733437

Digestion Logs

Preparation Log

Metals



A37574

Southwest Research Institute
San Antonio, Texas 78238

Batch: 20240408-P006 (Ver. 1)

Status: CONSUMED

Client(s): Battelle Memorial Institute PNNL

Task Order(s): 240405-6

SDG(s): 718819

Case(s): 733437

Project(s): 27927.13.001

Method(s): Dose Rate on Contact (TAP: NA)

Matrix(s): Liquid

Equipment: Meter # 009597

Notes: Dose Rate of Sample on Contact or as close as reasonably possible

| <u>Sample Identification</u> | <u>Client Identification</u> | <u>Dose Rate (mR/hr)</u> |
|------------------------------|------------------------------|------------------------------|
| 718819 | TI155-A-2-A | 80 |
| 718820 | TI155-B-10-A | 140 |
| 718821 | TI155-EFF-Comp | 220 |
| 718822 | TI155-Feed-Comp | 200 |
| 718825 | TI155-A-11-A | 180 |
| 718826 | TI155-A-17-A | 160 |
| 718827 | TI155-A-21-A | 180 |
| 718828 | TI155-B-22-A | 200 |
| 718829 | TI155-B-24-A | 230 |
| 718830 | TI155-A-9-A | 200 |
| 718852 | TI155-A-13-A | 210 |
| 718853 | TI155-A-15-A | 160 |
| 718854 | TI155-A-19-A | 180 |
| 718855 | TI155-A-5-A | 140 |
| 718856 | TI155-A-7-A | 160 |
| 718857 | TI155-B-18-A | 160 |
| 718858 | TI155-B-2-A | 90 |
| 718859 | TI155-B-5-A | 130 |

Comments: NA

CGL - 05/22/2024

Prepared by: EDRISI, KHALED

Date: 04/08/2024

Reviewed by: MOKEN, JAMES

Date: 04/09/2024

Disposal Int/Date/Loc: JM / 04/09/2024 / NA - Consumed

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Program version(8/11/2011)

Preparation Log

RadChem



A38030

Southwest Research Institute
San Antonio, Texas 78238

Batch: 20240514-P003 (Ver. 1)

Status: APPROVED

Client(s): Battelle Memorial Institute PNNL
Task Order(s): 240405-6
SDG(s): 718819
Case(s): 733437
Project(s): 27927.13.001
Method(s): Acid Dissolution (TAP: 01-0406-037)
Matrix(s): Liquid
Instrument(s): RadChem
Reagent(s): 1:1 HNO3 260971
Pipette(s): 1000-J
Equipment: CT 20240510-Q003
Heating Device: ModBlock#1
Temperature (C): 80
Time In: 05/14/2024 10:30:25
Location: S13-B7

| <u>Sample Identification</u> | <u>Client Identification</u> | <u>Initial Volume (mL)</u> | <u>Final Volume (mL)</u> |
|------------------------------|------------------------------|------------------------------------|----------------------------------|
| PB24E14KE2 | NA | 0.5 | 50 |
| 718819 | TI155-A-2-A | 0.5 | 50 |
| 718820 | TI155-B-10-A | 0.5 | 50 |
| 718821 | TI155-EFF-Comp | 0.5 | 50 |
| 718821D | TI155-EFF-Comp | 0.5 | 50 |
| 718822 | TI155-Feed-Comp | 0.5 | 50 |
| 718825 | TI155-A-11-A | 0.5 | 50 |
| 718826 | TI155-A-17-A | 0.5 | 50 |
| 718827 | TI155-A-21-A | 0.5 | 50 |
| 718828 | TI155-B-22-A | 0.5 | 50 |
| 718829 | TI155-B-24-A | 0.5 | 50 |
| 718830 | TI155-A-9-A | 0.5 | 50 |
| 718852 | TI155-A-13-A | 0.5 | 50 |
| 718853 | TI155-A-15-A | 0.5 | 50 |
| 718854 | TI155-A-19-A | 0.5 | 50 |
| 718855 | TI155-A-5-A | 0.5 | 50 |
| 718856 | TI155-A-7-A | 0.5 | 50 |
| 718857 | TI155-B-18-A | 0.5 | 50 |
| 718858 | TI155-B-2-A | 0.5 | 50 |
| 718859 | TI155-B-5-A | 0.5 | 50 |

Comments:
aliquot 0.5mL into ct add 5mL 1M hno3 haet at 80°C for 2hrs, fv to 50mL with di nwater.

Procedure:
See TAP 01-0406-037 for details.

CGL - 05/22/2024

Prepared by: EDRISI, KHALED

Date: 05/14/2024

Reviewed by: TUTOR, JAMES

Date: 05/15/2024

Disposal Int/Date/Loc: _____

Page 1 of 1

Program version(8/11/2011)

Preparation Log



A38037

Southwest Research Institute
San Antonio, Texas 78238

Metals, RadChem

Batch: 20240514-P005 (Ver. 1)

Status: CONSUMED

Client(s): Battelle Memorial Institute PNNL
Task Order(s): 240405-6
SDG(s): 718819
Case(s): 733437
Project(s): 27927.13.001
Method(s): APU Water (TAP: 01-0411-062)
Matrix(s): Liquid
Reagent(s): HNO3 255646, 3M HNO3/1M AlN3O9 260960
Balance(s): Bal #88 (AN:014981)
Pipette(s): 200-4, 1000-4, 5000-16
Equipment: CT 20240510-Q003
Heating Device: HotPlate#7
Temperature (C): 120
Time In: 05/14/2024 15:12:00

| Sample Identification | Client Identification | PH | Dig Initial Vol (mL) | Dig Final Vol (mL) |
|-----------------------|-----------------------|----|----------------------|--------------------|
| PB24E14KE2 ①④ | NA | NA | 0.010 | 10 |
| LCS24E14JT1 ② | NA | NA | 0.010 | 10 |
| 718819 ③④ | TI155-A-2-A | NA | 0.00250 | 10 |
| 718820 ③④ | TI155-B-10-A | NA | 0.00250 | 10 |
| 718821 ①④ | TI155-EFF-Comp | NA | 0.010 | 10 |
| 718821D ①④ | TI155-EFF-Comp | NA | 0.010 | 10 |
| 718822 ①④ | TI155-Feed-Comp | NA | 0.0020 | 10 |
| 718825 ③④ | TI155-A-11-A | NA | 0.00250 | 10 |
| 718826 ③④ | TI155-A-17-A | NA | 0.00250 | 10 |
| 718827 ③④ | TI155-A-21-A | NA | 0.0020 | 10 |
| 718828 ③④ | TI155-B-22-A | NA | 0.00250 | 10 |
| 718829 ③④ | TI155-B-24-A | NA | 0.00250 | 10 |
| 718830 ③④ | TI155-A-9-A | NA | 0.00250 | 10 |
| 718852 ③④ | TI155-A-13-A | NA | 0.00250 | 10 |
| 718853 ③④ | TI155-A-15-A | NA | 0.00250 | 10 |
| 718854 ③④ | TI155-A-19-A | NA | 0.0020 | 10 |
| 718855 ③④ | TI155-A-5-A | NA | 0.00250 | 10 |
| 718856 ③④ | TI155-A-7-A | NA | 0.00250 | 10 |
| 718857 ③④ | TI155-B-18-A | NA | 0.00250 | 10 |
| 718858 ③④ | TI155-B-2-A | NA | 0.00250 | 10 |
| 718859 ③④ | TI155-B-5-A | NA | 0.00250 | 10 |

CGL - 05/22/2024

Prepared by: TUTOR, JAMES

Date: 05/14/2024

Reviewed by: NAEGELI, WARREN

Date: 05/17/2024

Disposal Int/Date/Loc: WN / 05/17/2024 / NA - Consumed

Page 1 of 2

Program version(8/11/2011)

Preparation Log



A38037

Southwest Research Institute
San Antonio, Texas 78238

Metals, RadChem

Batch: 20240514-P005 (Ver. 1)

Status: CONSUMED

Client(s): Battelle Memorial Institute PNNL
Task Order(s): 240405-6
SDG(s): 718819
Case(s): 733437
Project(s): 27927.13.001
Method(s): APU Water (TAP: 01-0411-062)
Matrix(s): Liquid
Reagent(s): HNO3 255646, 3M HNO3/1M AlN3O9 260960
Balance(s): Bal #88 (AN:014981)
Pipette(s): 200-4, 1000-4, 5000-16
Equipment: CT 20240510-Q003
Heating Device: HotPlate#7
Temperature (C): 120
Time In: 05/14/2024 15:12:00

| <u>Sample Identification</u> | <u>Client Identification</u> | <u>PH</u> | <u>Dig Initial Vol (mL)</u> | <u>Dig Final Vol (mL)</u> |
|--|------------------------------|-----------|---------------------------------|-------------------------------|
| ① spiked 0.100 mL of CI# 236972 Americium-243 106RadSol4 (Lot# 1121020, 2199-65, 23040044, Source: Fisher Scientific, Eckert & Ziegler Isotope Product, Exp: 06/09/2024) and 0.100 mL of CI# 245585 Plutonium-242 124RadSol4 (Lot# 22470021, 4334j, Source: Fisher Scientific, NIST, Exp: 10/16/2024) | | | | |
| Tracer Witness: PEREZ, BENITO | | | | |
| ② spiked 0.050 mL of CI# 176328 Americium-241 058RadSol4 (Lot# 75783-327, Source: Eckert & Ziegler Isotope Product, Exp: 10/25/2024) and 0.100 mL of CI# 236972 Americium-243 106RadSol4 (Lot# 1121020, 2199-65, 23040044, Source: Fisher Scientific, Eckert & Ziegler Isotope Product, Exp: 06/09/2024) and 0.050 mL of CI# 187516 Plutonium-239 074RadSol4 v2 (Lot# 7879909-327, 205499, Source: Fisher Scientific, Analytics, Eckert & Ziegler, Exp: 04/13/2025) and 0.100 mL of CI# 245585 Plutonium-242 124RadSol4 (Lot# 22470021, 4334j, Source: Fisher Scientific, NIST, Exp: 10/16/2024) | | | | |
| Spike Witness: PEREZ, BENITO | | | | |
| Tracer Witness: PEREZ, BENITO | | | | |
| ③ spiked 0.100 mL of CI# 245585 Plutonium-242 124RadSol4 (Lot# 22470021, 4334j, Source: Fisher Scientific, NIST, Exp: 10/16/2024) | | | | |
| Tracer Witness: PEREZ, BENITO | | | | |
| ④ prepared in batch 20240514-P003 | | | | |

Comments: NA

CGL - 05/22/2024

Prepared by: TUTOR, JAMES

Date: 05/14/2024

Reviewed by: NAEGELI, WARREN

Date: 05/17/2024

Disposal Int/Date/Loc: WN / 05/17/2024 / NA - Consumed

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Program version(8/11/2011)

Preparation Log

Metals, RadChem

Southwest Research Institute
San Antonio, Texas 78238



A38048
Batch: 20240515-P002 (Ver. 1)
Status: CONSUMED

Client(s): Battelle Memorial Institute PNNL

Task Order(s): 240405-6

SDG(s): 718819

Case(s): 733437

Project(s): 27927.13.001

Method(s): APU water separation (TAP: 01-0411-070)

Matrix(s): Liquid

Reagent(s): UTEVA 260677, TRU 258393, 3M HNO3 260724, 261299, 2M HNO3 260725, 227934, 0.5M HNO3 260327, 9M HCl 261050, 4M HCl 261052, 4M HCl/0.1M HF 261326, 0.1M NH4HCO3 261056, HNO3 255646, HCl 254458, 1M HCl 261298, Nd Std 244274, HF 254634, Ethyl Alcohol 246213

Pipette(s): 200-4, 1000-4, 5000-16

Equipment: Syringes 258546, Tips 199864, Tubes 197195, CT 20240510-Q003, Resolve Filters 258396, Planchets 243362

Heating Device: HotPlate#7

Temperature (C): 95-160

Time In: 05/15/2024 11:53:00

| Sample Identification | Client Identification | Sep Initial Vol (mL) | U Sep FV (mL) | U Precip IV (mL) | Am Sep FV (mL) | Am Precip IV (mL) | Pu Sep FV (mL) | Pu Precip IV (mL) |
|-----------------------|-----------------------|----------------------|---------------|------------------|----------------|-------------------|----------------|-------------------|
|-----------------------|-----------------------|----------------------|---------------|------------------|----------------|-------------------|----------------|-------------------|

① prepared in batch 20240514-P005

Comments: NA

CGL - 05/22/2024

Prepared by: TUTOR, JAMES
Reviewed by: NAEGELI, WARREN
Disposal Int/Date/Loc: WN / 05/17/2024 / NA - Consumed

Date: 05/15/2024
Date: 05/17/2024

Preparation Log



A38038

Southwest Research Institute
San Antonio, Texas 78238

Metals, RadChem

Batch: 20240514-P006 (Ver. 1)

Status: CONSUMED

Client(s): Battelle Memorial Institute PNNL
Task Order(s): 240405-6
SDG(s): 718819
Case(s): 733437
Project(s): 27927.13.001
Method(s): Np/Th Water (TAP: 01-0411-062)
Matrix(s): Liquid
Reagent(s): HNO3 255646, 3M HNO3/1M AlN3O9 260960
Balance(s): Bal #88 (AN:014981)
Pipette(s): 200-4, 1000-4, 5000-16
Equipment: CT 20240510-Q003
Heating Device: HotPlate#7
Temperature (C): 95-160
Time In: 05/14/2024 15:12:00

| Sample Identification | Client Identification | PH | Dig Initial Vol (mL) | Dig Final Vol (mL) |
|-----------------------|-----------------------|----|----------------------|--------------------|
| PB24E14KE2 ①③ | NA | NA | 0.10 | 10 |
| LCS24E14JT2 ② | NA | NA | 0.10 | 10 |
| 718821 ①③ | TI155-EFF-Comp | NA | 0.10 | 10 |
| 718821D ①③ | TI155-EFF-Comp | NA | 0.10 | 10 |
| 718822 ①③ | TI155-Feed-Comp | NA | 0.10 | 10 |

① spiked 0.800 mL of CI# 236972 Americium-243 106RadSol4 (Lot# 1121020, 2199-65, 23040044, Source: Fisher Scientific, Eckert & Ziegler Isotope Product, Exp: 06/09/2024)

Tracer Witness: PEREZ, BENITO

② spiked 0.800 mL of CI# 236972 Americium-243 106RadSol4 (Lot# 1121020, 2199-65, 23040044, Source: Fisher Scientific, Eckert & Ziegler Isotope Product, Exp: 06/09/2024) and 0.125 mL of CI# 218204 Neptunium-237 090RadSol4 (Lot# 4341A, Source: NIST, Exp: 08/02/2024)

Spike Witness: PEREZ, BENITO

Tracer Witness: PEREZ, BENITO

③ prepared in batch 20240514-P003

Comments: NA

CGL - 05/22/2024

Prepared by: TUTOR, JAMES

Date: 05/14/2024

Reviewed by: NAEGELI, WARREN

Date: 05/17/2024

Disposal Int/Date/Loc: WN / 05/17/2024 / NA - Consumed

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Program version(8/11/2011)

Preparation Log



A38064

Southwest Research Institute
San Antonio, Texas 78238

Metals, RadChem

Batch: 20240516-P004 (Ver. 1)

Status: CONSUMED

| | |
|---------------------|---|
| Client(s): | Battelle Memorial Institute PNNL |
| Task Order(s): | 240405-6 |
| SDG(s): | 718819 |
| Case(s): | 733437 |
| Project(s): | 27927.13.001 |
| Method(s): | Np/Th water sep (TAP: 01-0411-070) |
| Matrix(s): | Liquid |
| Reagent(s): | TEVA 256168, HNO3 255646, 3M HNO3 261299, 2.5M HNO3 245042, HCl 254458, 9M HCl 261050, 6M HCl 249434, 1M HCl 261298, 0.6M Fe Sulfamate 261688, 1M NH4SCN 253853, 1M Ascorbic Acid 261289, Nd Std 244274, HF 254634, Ethyl Alcohol 246013, 2.5MHNO3/ 0.1M Fe(NH2SO3)2 261489, 0.02M HNO3/0.02M HF 261057 |
| Balance(s): | Bal #88 (AN:014981) |
| Pipette(s): | 200-4, 1000-4, 5000-16 |
| Equipment: | CT 20240510-Q003, Tubes 197195, Tips 199864, Planchets 243363, Syringe 258546, Syringe Filter 250846, Resolve Filters 258396 |
| Heating Device: | HotPlate#7 |
| Temperature (C): | 95-160 |
| Time In: | 05/16/2024 12:30:00 |
| Elution Start Time: | 05/16/2024 14:12:00 |

| Sample Identification | Client Identification | Sep Initial Vol (mL) | Np Sep FV (mL) | Np Precip IV (mL) | Th Sep FV (mL) | Th Precip IV (mL) |
|-----------------------|-----------------------|----------------------|----------------|-------------------|----------------|-------------------|
| PB24E14KE2 ① | NA | 10 | 10 | 10 | NA | NA |
| LCS24E14JT2 ① | NA | 10 | 10 | 10 | NA | NA |
| 718821 ① | TI155-EFF-Comp | 10 | 10 | 10 | NA | NA |
| 718821D ① | TI155-EFF-Comp | 10 | 10 | 10 | NA | NA |
| 718822 ① | TI155-Feed-Comp | 10 | 10 | 10 | NA | NA |

① prepared in batch 20240514-P006

Comments: NA

CGL - 05/22/2024

Prepared by: TUTOR, JAMES

Date: 05/16/2024

Reviewed by: NAEGELI, WARREN

Date: 05/17/2024

Disposal Int/Date/Loc: WN / 05/17/2024 / NA - Consumed

Page 1 of 1

Program version(8/11/2011)

SOUTHWEST RESEARCH INSTITUTE

CLIENT: Battelle Memorial Institute PNNL

SwRI Project #: 27927.13.001

SwRI Task Order #: 240405-6

SDG #: 718819

TON #: 733437

Standard Logs & Certs

Chemical Information Sheet

Americium-243 106RadSol4

#236972



| | |
|----------------------|----------------------------|
| Grade: | Analytical |
| Type: | Working Level Solution |
| CAS: | - No Data - |
| Lot: | - No Data - |
| Received: | 06/09/2023 |
| Expiration: | 06/09/2024 |
| Location: | Bldg 70 Lab 55 Std counter |
| Current Lab: | Lab 46 Stds Bldg 70 |
| Original Amount: | 200 mL |
| Amount Remaining: | 200 |
| Supplier: | - No Data - |
| Concentration: | 10298 pCi |
| Project: | - No Data - |
| PO Number: | - No Data - |
| Internal Lab ID: | - No Data - |
| Density: | 1 |
| Storage Requirement: | Ambient |
| Measuring Device ID: | - No Data - |
| Date Disposed: | - No Data - |
| Notes: | |

Sources Table

| ID | Source | Manufacturer | Lot | Amount |
|--------|--------------------------|-------------------|----------|--------|
| 189515 | Americium-243 078RadSol4 | | | 10 mL |
| 234681 | Nitric Acid Trace Metals | Fisher Scientific | 23040044 | 10 mL |

Solvent Table

| ID | Solvent | Manufacturer | Lot | Amount |
|----|----------|--------------|-----|--------|
| | DI Water | | | |

Component Table

[illegible]

*CGI = Computer Generated Line out

Created by jtutor on 6/9/2023 3:25:33 PM.

--- No Secondary Review ---

Chemical Information Sheet

Americium-243 078RadSol4

#189515



| | |
|----------------------|------------------------|
| Grade: | Analytical |
| Type: | Working Level Solution |
| CAS: | - No Data - |
| Lot: | - No Data - |
| Received: | 07/21/2021 |
| Expiration: | 06/09/2024 |
| Location: | - No Data - |
| Current Lab: | Lab 46 Stds Bldg 70 |
| Original Amount: | 100 mL |
| Amount Remaining: | 30 |
| Supplier: | - No Data - |
| Concentration: | 102989.1 pCi |
| Project: | - No Data - |
| PO Number: | - No Data - |
| Internal Lab ID: | - No Data - |
| Density: | 1 |
| Storage Requirement: | Ambient |
| Measuring Device ID: | - No Data - |
| Date Disposed: | - No Data - |
| Notes: | |

Sources Table

| ID | Source | Manufacturer | Lot | Amount |
|--------|--------------------------|----------------------------------|---------|-----------|
| 185482 | Nitric Acid Trace Metals | Fisher Scientific | 1121020 | 5 ml |
| 189512 | Americium-243 | Eckert & Ziegler Isotope Product | 2199-65 | 5.06587 g |

Component Table

[illegible]

*CGL = Computer Generated Line out

Created by wnaegeli on 7/21/2021 4:48:16 PM.

--- No Secondary Review ---

Chemical Information Sheet

Americium-243

#189512



| | |
|----------------------|---|
| Grade: | Analytical |
| Type: | Commercial Stock |
| CAS: | 14993-75-0 |
| Lot: | 2199-65 |
| Received: | 02/22/2021 |
| Expiration: | 02/26/2026 |
| Location: | - No Data - |
| Current Lab: | Lab 46 Stds Bldg 70 |
| Original Amount: | 5.06587 g |
| Amount Remaining: | 0 |
| Supplier: | Eckert & Ziegler Isotope Product |
| Concentration: | 103000 pCi |
| Project: | - No Data - |
| PO Number: | P36850MM |
| Internal Lab ID: | - No Data - |
| Density: | 1.0171 |
| Storage Requirement: | Ambient |
| Measuring Device ID: | - No Data - |
| Date Disposed: | 07/29/2021 |
| Notes: | Americium-243 in 1M HCl, 5 ml flame sealed ampoule, 10 ug/ml Eu carrier |

Component Table

[illegible]

*CGL = Computer Generated Line out

Created by wnaegeli on 7/21/2021 3:52:02 PM.

--- No Secondary Review ---



Eckert & Ziegler
Isotope Products

24937 Avenue Tibbitts
Valencia, California 91355

Tel 661•309•1010
Fax 661•257•8303

CERTIFICATE OF CALIBRATION ALPHA STANDARD SOLUTION

Radionuclide: Am-243
Half-life: $(2.690 \pm 0.008)E+06$ days
Catalog No.: 7243
Source No.: 2199-65

Customer: SOUTHWEST RESEARCH INSTITUTE
P.O. No.: P36850MM
Reference Date: 1-Mar-21 12:00 PST
Contained Radioactivity: 103.0 nCi 3.811 kBq
(Am-243 only)

Physical Description:

A. Mass of solution: 5.06587 g in 5 mL flame-sealed ampoule
B. Chemical form: AmCl_3 in 1M HCl
C. Carrier content: 10 μg Eu/mL of solution
D. Density: 1.0171 g/mL @ 20°C

Radioimpurities:

None detected (Np-239 daughter in equilibrium)

Radionuclide Concentration: 20.33 nCi/g, 0.7522 kBq/g

Method of Calibration:

This source was prepared from a weighed aliquot of solution whose activity in $\mu\text{Ci/g}$ was determined using gamma ray spectrometry.

Peak energy used for integration: 74.7 keV
Branching ratio used: 0.674 gammas per decay

Uncertainty of Measurement:

A. Type A (random) uncertainty: $\pm 0.2 \%$
B. Type B (systematic) uncertainty: $\pm 3.0 \%$
C. Uncertainty in aliquot weighing: $\pm 0.2 \%$
D. Total uncertainty at the 99% confidence level: $\pm 3.0 \%$

Notes:

- See reverse side for leak test(s) performed on this source.
- EZIP participates in a NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials (as in NRC Regulatory Guide 4.15).
- Nuclear data was taken from IAEA-TECDOC-619, 1991.
- This solution has a recommended working life of 5 years.

David James Van Dalsem
Quality Control

15-Feb-21
Date

EZIP Ref. No.: 2199-65

ISO 9001 CERTIFIED

Medical Imaging Laboratory
24937 Avenue Tibbitts Valencia, California 91355



Industrial Gauging Laboratory
1800 North Keystone Street Burbank, California 91504
Page 200 of 241

Chemical Information Sheet

Plutonium-242 124RadSol4

#245585



| | | | |
|----------------------|----------------------------|---|---|
| Grade: | Analytical |  |  |
| Type: | Working Level Solution | | |
| CAS: | - No Data - | | |
| Lot: | - No Data - | | |
| Received: | 10/16/2023 | | |
| Expiration: | 10/16/2024 | Rad License: | |
| Location: | Bldg 70 Lab 55 Std counter | Rad License Line: | |
| Current Lab: | Lab 46 Stds Bldg 70 | | |
| Original Amount: | 100 mL | | |
| Amount Remaining: | 100 | | |
| Supplier: | - No Data - | | |
| Concentration: | | | |
| Project: | - No Data - | | |
| PO Number: | - No Data - | | |
| Internal Lab ID: | - No Data - | | |
| Density: | 1 | | |
| Storage Requirement: | Ambient | | |
| Measuring Device ID: | - No Data - | | |
| Date Disposed: | - No Data - | | |
| Notes: | | | |

Sources Table

| ID | Source | Manufacturer | Lot | Amount |
|--------|--------------------------|-------------------|----------|---------|
| 243294 | Nitric Acid Trace Metals | Fisher Scientific | 22470021 | 10 ml |
| 243590 | Plutonium-242 | NIST | 4334j | 5.499 g |

Solvent Table

| ID | Solvent | Manufacturer | Lot | Amount |
|----|----------|--------------|-----|--------|
| | DI Water | | | |

Component Table

[illegible]

*CGL = Computer Generated Line out

Created by wnaegeli on 10/16/2023 7:32:42 PM.

--- No Secondary Review ---



| Standards Verification Form | | | | Date Analyzed: 10/17/2023 | | | | CRITERIA |
|---------------------------------|--------|-------|-----------------------------|-------------------------------------|-----------|-----------------------------|--------|----------------------------|
| | | | | Count Time (minutes): 1000 | | Instrument ID: Alpha | | |
| Tracer | | | | Prep Batch: N/A | | Analytical Batch: 231017PUX | | |
| Pu239 | | | | Pu242 | | | | |
| Logbook ID: 074RadSol4 | | | | Logbook ID: 124RadSol4 | | | | |
| CIMS# 187516 | | | | CIMS# 245585 | | | | |
| | Read | TV | Tracer Corrected Efficiency | Read | Corrected | TV | | |
| ID | Counts | pCi | | Counts | pCi | pCi | %R | |
| 1 | 3734 | 9.994 | | 3113 | 8.332 | 7.75 | 107.5% | |
| 2 | 3605 | 9.994 | 16.2% | 2853 | 7.909 | 7.75 | 102.0% | |
| 3 | 2766 | 9.994 | 12.5% | 2244 | 8.108 | 7.75 | 104.6% | |
| 4 | 4595 | 9.994 | 20.7% | 3469 | 7.545 | 7.75 | 97.3% | |
| Reference Date: 6/8/2009 | | | | Reference Date | 8/9/2017 | Average | 102.9% | 95%-105% < 10% < 10% |
| Reference Activity (pCi) 49.992 | | | | Reference Activity (pCi) | 38.761 | Std Deviation | 4.31% | |
| Tracer Volume (ml) 0.20 | | | | Standard Volume (ml) | 0.20 | Conf Interval | 4.22% | |
| Decay Corrected Value: 49.971 | | | | Pu242 Decay Corrected Value: 38.761 | | | | |

Chemical Information Sheet

Plutonium-242

#243590



| | | | |
|----------------------|--|---|---|
| Grade: | Analytical |  |  |
| Type: | Commercial Stock | | |
| CAS: | 13982-10-0 | | |
| Lot: | 4334j | | |
| Received: | 09/20/2023 | | |
| Expiration: | 09/20/2033 | Rad License: | |
| Location: | - No Data - | Rad License Line: | |
| Current Lab: | Lab 46 Stds Bldg 70 | | |
| Original Amount: | 5.499 g | | |
| Amount Remaining: | 0 | | |
| Supplier: | NIST | | |
| Concentration: | 26.08 Bq | | |
| Project: | - No Data - | | |
| PO Number: | R46547SS | | |
| Internal Lab ID: | - No Data - | | |
| Density: | - No Data - | | |
| Storage Requirement: | Ambient | | |
| Measuring Device ID: | - No Data - | | |
| Date Disposed: | 10/16/2023 | | |
| Notes: | Massic activity: 26.08 Bq/g. Solution mass: 5.499g. Reference Time of 1200 EST, 9 August 2017. | | |

Component Table

[illegible]

*CGL = Computer Generated Line out

Created by dramirez on 9/20/2023 2:13:30 PM.

--- No Secondary Review ---



National Institute of Standards & Technology

Certificate

Standard Reference Material® 4334j

Plutonium-242 Radioactivity Standard

This Standard Reference Material (SRM) consists of a solution of a standardized and certified quantity of radioactive plutonium-242 in a suitably stable and homogeneous matrix. It is intended primarily for the calibration of instruments that are used to measure radioactivity and for the monitoring of radiochemical procedures. A unit of SRM 4334j consists of approximately 5 mL of a solution, whose composition is specified in Tables 1 and 2, contained in a flame-sealed borosilicate-glass ampoule [1].

The certified **Plutonium-242** massic activity, at a **Reference Time of 1200 EST, 9 August 2017**, is:

$$(26.08 \pm 0.13) \text{ Bq}\cdot\text{g}^{-1}.$$

A NIST certified value, as used within the context of this certificate, is a value for which NIST has the highest confidence in its uncertainty assessment. It is a “measurement result” [2] obtained directly or indirectly from a “primary reference measurement procedure” [3]. The certified value is traceable to the derived SI unit, becquerel (Bq).

Additional physical, chemical, and radiological properties for this SRM, as well as details on the standardization method, are given in Tables 1 and 2. Uncertainties for the certified quantities are expanded ($k = 2$). The uncertainties are calculated according to the ISO/JCGM and NIST Guides [4,5]. Table 3 contains a specification of the components that comprise the uncertainty analysis.

Expiration of Certification: The certification of **SRM 4334j** is valid indefinitely, within the measurement uncertainty specified, provided that the SRM is handled and stored properly and that no evaporation or change in composition has occurred. The solution matrix, in an unopened ampoule, is homogeneous and stable within its half-life-dependent useful lifetime provided the SRM is handled in accordance with instructions given in this certificate (see “Instructions for Handling and Storage”). Periodic recertification of this SRM is not required. The certification is nullified if the SRM is damaged, contaminated, or otherwise modified.

Maintenance of Certification: NIST will monitor this SRM over the period of its certification. If substantive technical changes occur that affect the certification before the expiration of this certificate, NIST will notify the purchaser. Registration (see attached sheet or register online) will facilitate notification.

Radiological and chemical hazard: Consult the Safety Data Sheet (SDS), enclosed with the SRM shipment, for radiological and chemical hazard information.

This SRM was prepared in the NIST Physical Measurement Laboratory, Radiation Physics Division, under the direction of M.P. Unterwiesing, Group Leader of the Radioactivity Group. Overall technical direction and physical measurement leading to certification were provided by R. Collé and L. Laureano-Perez of the NIST Radiation Physics Division, Radioactivity Group. Photon-emitting-impurity analyses were provided by L. Pibida.

Support aspects involved in the issuance of this SRM were coordinated through the NIST Office of Reference Materials.

Michael G. Mitch, Acting Chief
Radiation Physics Division

Gaithersburg, Maryland 20899
Certificate Issue Date: 30 May 2018

Steven J. Choquette, Director
Office of Reference Materials

Table 1. Certified Massic Activity of SRM 4334j

| | |
|---|-----------------------------------|
| Radionuclide | Plutonium-242 |
| Reference time | 1200 EST, 09 August 2017 |
| Massic activity of the solution | 26.08 Bq•g^{-1(a)} |
| Relative expanded uncertainty ($k = 2$) | 0.51 % ^(b) |

^(a) Both SRM 4334j and SRM 4334i (a previous issue of ²⁴²Pu) were derived from two independent gravimetric dilutions of the identical standard master solution. The massic activity of SRM 4334j is in agreement with the decay corrected massic activity of SRM 4334i to ± 0.12 %.

^(b) The uncertainties on certified values are expanded uncertainties, $U = k u_c$. The quantity u_c is the combined standard uncertainty calculated according to the ISO/JCGM and NIST Guides [4-5]. The combined standard uncertainty is multiplied by a coverage factor of $k = 2$ and was chosen to obtain an approximate 95 % level of confidence.

Table 2. Uncertified Information of SRM 4334j

| | |
|---------------------------------------|--|
| Source description | Liquid in a flame-sealed 5 mL borosilicate-glass ampoule [1] |
| Solution composition | 3.1 mol•L ⁻¹ HNO ₃ |
| Solution density | (1.099 ± 0.002) g•mL ⁻¹ at 24.4 °C ^(a) |
| Solution mass | (5.499 ± 0.003) g ^(a) |
| Alpha-particle- emitting impurities | ²⁴¹ Am: (0.0021 ± 0.0003) Bq•g ^{-1(a,b,c,d)} |
| Beta-particle- emitting impurities | ²⁴¹ Pu: (0.039 ± 0.009) Bq•g ^{-1(a,d)} |
| Photon-emitting impurities | None detected ^(e) , excepting ²⁴¹ Am |
| Half-lives used [6] | ²⁴² Pu: (3.73 ± 0.03) × 10 ⁵ a ^(f) ²⁴¹ Pu: (14.33 ± 0.04) a ²⁴⁰ Pu: (6 561 ± 7) a ²³⁹ Pu: (24 100 ± 11) a ²³⁸ Pu: (87.74 ± 0.03) a ²⁴¹ Am: (432.6 ± 0.6) a |
| Calibration methods (and instruments) | The certified massic activity for ²⁴² Pu was obtained by 4π α liquid scintillation (LS) spectrometry with two commercial LS counters. Four separate measurement trials using nine LS cocktails prepared directly from the SRM solution and six cocktails prepared from a master stock solution with known gravimetric dilution factor. |

- (a) The stated uncertainty is two times the standard uncertainty [5].
- (b) The ²⁴²Pu was chemically purified 07 June 1994 at the Lawrence Livermore National Laboratory (LLNL). Americium-241, the daughter of ²⁴¹Pu, was removed but has been growing in since that time. Photonic emission measurements of the ²⁴¹Am ingrowth were made at NIST in 1998-1999 and 2017.
- (c) The estimated limits of detection for alpha-particle-emitting impurities, expressed as massic alpha-particle emission rates (number of alpha-particles emission rates per second per gram), are:
0.003 s⁻¹•g⁻¹ for energies less than 3.1 MeV,
0.03 s⁻¹•g⁻¹ for energies between 3.1 MeV and 4.4 MeV, and
0.003 s⁻¹•g⁻¹ for energies greater than 5.0 MeV
- (d) The ²⁴²Pu was chemically purified 07 June 1994. The relative massic activities of radionuclidic impurities follow:

| Radionuclide | Relative Activity at Purification Time (07 June 1994) As Measured By | | |
|---------------------------------------|--|-------------------------------------|-------------------------------------|
| | LLNL in 1994 | NIST in 1998-1999 | NIST in 2017 |
| ²⁴² Pu | 1 | 1 | 1 |
| ²⁴¹ Pu | -- | (3.5 ± 0.4) × 10 ^{-3(1,2)} | (3.6 ± 1.1) × 10 ^{-3(1,5)} |
| ²⁴⁰ Pu + ²³⁹ Pu | < 10 ⁻⁶ (3) | (2.0 ± 2.1) × 10 ^{-5(1,4)} | -- |
| ²³⁸ Pu + ²⁴¹ Am | < 1.6 × 10 ⁻⁵ (3) | (9 ± 16) × 10 ^{-6(1,4)} | -- |
| ²⁴¹ Am | -- | assumed 0 ⁽²⁾ | assumed 0 ⁽⁵⁾ |

- 1) The stated uncertainty is the standard uncertainty.
- 2) The ²⁴¹Pu activity was calculated from a gamma-ray measurement of the ²⁴¹Am ingrowth as of 25 November 1998, assuming that ²⁴¹Am was completely removed at the time of chemical purification.
- 3) Using alpha-particle spectrometry. The value shown is an estimated upper limit based upon background and counting statistics. Measurements were made at LLNL in July of 1994.
- 4) Alpha-particle spectrometry measurements were made at the National Institute of Standards and Technology (NIST) in June and July 1999.
- 5) The ²⁴¹Pu activity was calculated from a gamma-ray measurement of the ²⁴¹Am ingrowth as of 01 September 2017, assuming that ²⁴¹Am was completely removed at the time of chemical purification.
- (e) The estimated limits of detection for photon-emitting impurities, expressed as massic photon emission rates (numbers of photons per second per gram), are:
1 × 10⁻³ s⁻¹•g⁻¹ for energies between 20 keV and 35 keV,
6 × 10⁻⁴ s⁻¹•g⁻¹ for energies between 40 keV and 50 keV,
5 × 10⁻⁴ s⁻¹•g⁻¹ for energies between 55 keV and 95 keV,
4 × 10⁻⁴ s⁻¹•g⁻¹ for energies between 100 keV and 600 keV
4 × 10⁻⁴ s⁻¹•g⁻¹ for energies between 610 keV and 1440 keV
6 × 10⁻⁴ s⁻¹•g⁻¹ for energies between 1450 keV and 1480 keV, and
3 × 10⁻⁴ s⁻¹•g⁻¹ for energies between 1490 keV and 2000 keV,
provided that the photons are separated in energy by 4 keV or more from photons emitted in the decay of ²⁴²Pu, ²⁴¹Pu, or ²⁴¹Am.
- (f) The stated uncertainty is the standard uncertainty. See reference 6.

Table 2. Uncertainty evaluation for the massic activity of SRM 4334j

| Uncertainty component | | Assessment Type ^(a) | Relative standard uncertainty contribution on massic activity of ²⁴² Pu (%) |
|---|---|--------------------------------|--|
| 1 | LS measurement precision: Relative standard deviation of the mean on the great-grand mean for 4 LS measurement trials, considering all of the within-trial and between-trial components of variance. Each of the 4 grand mean values was based on 5 replicate measurements on each of either 6 or 9 LS counting sources. The typical within-trial relative standard deviation of the mean (considering the variations for the between 5 measurements and the between 6 to 9 sources) for each trial was 0.08 %. The between-trial relative standard deviation across the 4 trials was 0.18 %. | A | 0.22 |
| 2 | Background; LS measurement variability and cocktail composition stability effects; wholly embodied in component 1. | A | -- |
| 3 | LS counters dependencies; wholly embodied in components 1 & 2 | A | -- |
| 4 | Live time determinations for LS counting time intervals, includes uncorrected dead time effects | B | 0.07 |
| 5 | Aliquant mass determinations by gravimetric measurements for preparation of counting sources; includes mass measurement precision partially embodied in component 1. | B | 0.05 |
| 6 | LS detection inefficiency, includes wall effect; partially embodied in component 1. | B | 0.01 |
| 7 | ²⁴² Pu decay corrections for half-life uncertainty of 0.22 %. | B | < 10 ⁻¹⁰ |
| 8 | Potential alpha- and photon-emitting impurities | B | 0.1 |
| Relative combined standard uncertainty | | | 0.26 |
| Relative expanded uncertainty (<i>k</i> = 2) | | | 0.51 |

^(a) Letter A denotes evaluation by statistical methods; B denotes evaluation by other methods.

INSTRUCTIONS FOR USE AND HANDLING

Storage: SRM 4334j should be stored and used at a temperature between 5 °C and 65 °C. The ampoule (or any subsequent container) should always be clearly marked as containing radioactive material.

Handling: If the ampoule is transported, it should be packed, marked, labeled, and shipped in accordance with the applicable national, international, and carrier regulations. The solution in the ampoule is a dangerous good (hazardous material) because of both the radioactivity and the strong acid. The ampoule should be opened only by persons qualified to handle both radioactive material and alkaline and/or acidic solutions. Appropriate shielding and/or distance should be used to minimize personnel exposure. Refer to SDS for further information.

REFERENCES

- [1] NIST Physical Measurement Laboratory; *Storage and Handling of Radioactive Standard Reference Materials, Ampoule Specifications and Opening Procedure*; available at <https://www.nist.gov/pml/radiation-physics/ampoule-specifications-and-opening-procedure> (accessed May 2018). Note: This SRM is contained in a generic borosilicate-glass ampoule and not in the standard NIST ampoule.
- [2] JCGM 200:2012; *International Vocabulary of Metrology - Basic and General Concepts and Associated Terms (VIM)*; (2008 version with Minor Corrections), 3rd edition; Joint Committee for Guides in Metrology (JCGM): BIPM, Sevres Cedex, France; p. 19 (2012); available at https://www.bipm.org/utis/common/documents/jcgm/JCGM_200_2012.pdf (accessed May 2018).
- [3] JCGM 200:2012; *International Vocabulary of Metrology - Basic and General Concepts and Associated Terms (VIM)*; (2008 version with Minor Corrections), 3rd edition; JCGM: BIPM, Sevres Cedex, France; p. 18 (2012); available at https://www.bipm.org/utis/common/documents/jcgm/JCGM_200_2012.pdf (accessed May 2018).
- [4] JCGM 100:2008; *Guide to the Expression of Uncertainty in Measurement*; (GUM 1995 with Minor Corrections), JCGM: BIPM, Sevres Cedex, France (2008); available at https://www.bipm.org/utis/common/documents/jcgm/JCGM_100_2008_E.pdf (accessed May 2018).
- [5] Taylor, B.N.; Kuyatt, C.E.; *Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results*; NIST Technical Note 1297, U.S. Government Printing Office: Washington, DC (1994); available at <https://www.nist.gov/pml/nist-technical-note-1297> (accessed Apr 2018).
- [6] Chechev, V.P.; *LNE-LNHB/CEA Table of Radionuclides, ²⁴²Pu*; (June 2009); available at http://www.nucleide.org/DDEP_WG/Nuclides/Pu-242_tables.pdf (accessed May 2018).



Users of this SRM should ensure that the Certificate in their possession is current. This can be accomplished by contacting the SRM Program: telephone (301) 975-2200; fax (301) 948-3730; e-mail srmstds@nist.gov; or via the Internet at <https://www.nist.gov/srm>.

Chemical Information Sheet

Americium-241 058RadSol4

#176328



| | | | |
|----------------------|----------------------------------|---|---|
| Grade: | Analytical |  |  |
| Type: | Working Level Solution | | |
| CAS: | - No Data - | | |
| Lot: | - No Data - | | |
| Received: | 01/04/2021 | | |
| Expiration: | 10/25/2024 | Rad License: | |
| Location: | Bldg 70 Lab 46 Std counter | Rad License Line: | |
| Current Lab: | Lab 46 Stds Bldg 70 | | |
| Original Amount: | 100 mL | | |
| Amount Remaining: | 100 | | |
| Supplier: | Eckert & Ziegler Isotope Product | | |
| Concentration: | 50.1006 pCi/mL | | |
| Project: | - No Data - | | |
| PO Number: | - No Data - | | |
| Internal Lab ID: | - No Data - | | |
| Density: | 1 | | |
| Storage Requirement: | Ambient | | |
| Measuring Device ID: | - No Data - | | |
| Date Disposed: | - No Data - | | |
| Notes: | Added 1mL of nitric acid #175305 | | |

Sources Table

| ID | Source | Manufacturer | Lot | Amount |
|-------|--------------------------|--------------|-----|--------|
| 37531 | Americium-241 085RadSol2 | | | 2.2 ml |

Component Table

[illegible]

*CGL = Computer Generated Line out

Created by wnaegeli on 1/8/2021 12:11:05 AM.

--- No Secondary Review ---



| Standards Verification Form | | | | Date Analyzed: | | 10/25/2023 | | CRITERIA |
|-----------------------------|--------|-------|-----------------------------|------------------------------|-----------|----------------------------|---------|----------------------------|
| | | | | Count Time (minutes): 1000 | | Instrument ID: Alpha | | |
| Tracer | | | | Prep Batch: N/A | | Analytical Batch: 231025AM | | |
| Am243 | | | | Am241 | | | | |
| Logbook ID: 106RadSol4 | | | | Logbook ID: 058RadSol4 | | | | |
| CIMS# 236972 | | | | CIMS# 176328 | | | | |
| | Read | TV | Tracer Corrected Efficiency | Read | TV | | | |
| Replicate | Counts | pCi | | Counts | pCi | pCi | %R | |
| 1 | 1902 | 5.148 | 16.6% | 886 | 2.398 | 2.44 | 98.2% | |
| 2 | 2203 | 5.148 | 19.3% | 1045 | 2.442 | 2.44 | 100.0% | |
| 3 | 2227 | 5.148 | 19.5% | 988 | 2.284 | 2.44 | 93.6% | |
| 4 | N/A | 5.148 | #VALUE! | N/A | #VALUE! | 2.44 | #VALUE! | |
| Reference Date: | | | 3/1/2021 | Reference Date | 8/17/2007 | Average | 97.3% | |
| Reference Activity (pCi) | | | 51.49 | Reference Activity (pCi) | 50.1006 | Std Deviation | 3.34% | |
| Tracer Volume (ml) | | | 0.10 | Standardr Volume (ml) | 0.050 | Conf Interval | 3.28% | |
| Decay Corrected Value: | | | 51.4772 | Am241 Decay Corrected Value: | 48.817 | | | |
| | | | | | | | | 95%-105% < 10% < 10% |

Chemical Information Sheet

Americium-241 085RadSol2

#37531



| | | | |
|----------------------|---|---|---|
| Grade: | Analytical |  |  |
| Type: | Working Level Solution | | |
| CAS: | - No Data - | | |
| Lot: | - No Data - | | |
| Received: | 12/28/2007 | | |
| Expiration: | 03/02/2024 | Rad License: | L00775 |
| Location: | Lab 46 island | Rad License Line: | |
| Current Lab: | Lab 46 Stds Bldg 70 | | |
| Original Amount: | 100 mL | | |
| Amount Remaining: | 95.6 | | |
| Supplier: | - No Data - | | |
| Concentration: | 100 % | | |
| Project: | - No Data - | | |
| PO Number: | - No Data - | | |
| Internal Lab ID: | - No Data - | | |
| Density: | 1 | | |
| Storage Requirement: | Ambient | | |
| Measuring Device ID: | - No Data - | | |
| Date Disposed: | - No Data - | | |
| Notes: | Secondary recertification 116RadSol3 on 04.11.2014. | | |

Sources Table

| ID | Source | Manufacturer | Lot | Amount | |
|-------|---------------|----------------------------------|-----------|--------|--|
| 32811 | Americium-241 | Eckert & Ziegler Isotope Product | 75783-327 | 1 mL | |

Component Table

[illegible]

Created by wnaegeli on 1/22/2013 11:20:46 AM.



--- No Secondary Review ---

Chemical Information Sheet

Americium-241

#32811



| | | | |
|----------------------|----------------------------------|---|---|
| Grade: | Research/Pending Re-evaluation |  |  |
| Type: | Neat | | |
| CAS: | 14596-10-2 | | |
| Lot: | 75783-327 | | |
| Received: | 09/27/2007 | | |
| Expiration: | 09/30/2008 | Rad License: | L00775 |
| Location: | Lab 43 Bin A-2, Shelf-3 | Rad License Line: | |
| Current Lab: | Lab 46 Bldg 70 | | |
| Original Amount: | 5 ml | | |
| Amount Remaining: | 1.8 | | |
| Supplier: | Eckert & Ziegler Isotope Product | | |
| Concentration: | 100 % | | |
| Project: | - No Data - | | |
| PO Number: | - No Data - | | |
| Internal Lab ID: | 6674 | | |
| Density: | - No Data - | | |
| Storage Requirement: | Ambient | | |
| Measuring Device ID: | - No Data - | | |
| Date Disposed: | 01/22/2013 | | |
| Notes: | EXPIRED | | |

Component Table

[illegible]

*CGL = Computer Generated Line out

Created by WNaegeli on 11/9/2012 10:20:02 AM.

--- No Secondary Review ---



1380 Seaboard Industrial Blvd.
Atlanta, Georgia 30318
Tel 404.352.8677
Fax 404.352.2837
www.analyticsinc.com

CERTIFICATE OF CALIBRATION

Standard Radionuclide Source

75783-327

Am-241 5 mL Liquid in Flame Sealed Vial

This standard radionuclide source was prepared gravimetrically from a calibrated master liquid radionuclide solution source. The master source was calibrated by liquid scintillation counting.

Radionuclide purity and calibration were checked with germanium gamma-ray spectrometry and liquid scintillation counting. The nuclear decay rate and assay date for this source are given below.

ANALYTICS maintains traceability to the National Institute of Standards and Technology through Measurements Assurance Programs as described in USNRC Reg. Guide 4.15, Revision 1.

ISOTOPE: Am-241
ACTIVITY (Bq): 4.213 E4
HALF-LIFE: 4.322 E2 years
CALIBRATION DATE: August 17, 2007 12:00 EST
RELATIVE EXPANDED
UNCERTAINTY (k=2): 2.0%

Impurities: γ -impurities <0.1%
 α -impurities <0.04%

5.14212 grams 1M HCl solution.

P O NUMBER 798703MM, Item 1

SOURCE PREPARED BY: N. E. Kiesman
N. E. Kiesman, Radiochemist

Q A APPROVED: JM. May 8-20-07

INORGANIC LABS/RADCHEM LABS
DATE RECEIVED: 8/22/07
DATE EXPIRED: 8/22/2008
DATE OPENED: 10/1/07
INORG: 6674 PO: 798703MM



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Chemical Information Sheet

Plutonium-239 074RadSol4

#187516



| | | | |
|----------------------|----------------------------|---|---|
| Grade: | Analytical |  |  |
| Type: | Working Level Solution | | |
| CAS: | - No Data - | | |
| Lot: | - No Data - | | |
| Received: | 06/18/2021 | | |
| Expiration: | 04/13/2025 | Rad License: | |
| Location: | Bldg 70 Lab 55 Std counter | Rad License Line: | |
| Current Lab: | Lab 46 Stds Bldg 70 | | |
| Original Amount: | 100 mL | | |
| Amount Remaining: | 100 | | |
| Supplier: | - No Data - | | |
| Concentration: | | | |
| Project: | - No Data - | | |
| PO Number: | - No Data - | | |
| Internal Lab ID: | - No Data - | | |
| Density: | 1 | | |
| Storage Requirement: | Ambient | | |
| Measuring Device ID: | - No Data - | | |
| Date Disposed: | - No Data - | | |
| Notes: | | | |

Sources Table

| ID | Source | Manufacturer | Lot | Amount |
|--------|--------------------------|-------------------|--------|----------|
| 37610 | Plutonium-239 163RadSol2 | | | 2.575 ml |
| 184321 | Nitric Acid ACS | Fisher Scientific | 205499 | 2 ml |

Component Table

[illegible]

*CGL = Computer Generated Line out

Created by wnaegeli on 6/18/2021 5:36:37 PM.

--- No Secondary Review ---



| Standards Verification Form | | | | Date Analyzed: | | 4/11/2024 | | CRITERIA |
|-----------------------------|--------|-----------|-----------------------------|------------------------------|--------|-----------------------------|--------|----------------------------|
| | | | | Count Time (minutes): 1000 | | Instrument ID: Alpha | | |
| Tracer | | | | Prep Batch: N/A | | Analytical Batch: 240411PUX | | |
| Am241 | | | | Pu239 | | | | |
| Logbook ID: 058RadSol4 | | | | Logbook ID: 074RadSol4 | | | | |
| CIMS# 176328 | | | | CIMS# 187516 | | | | |
| Read | | TV | | Read | | TV | | |
| ID | Counts | pCi | Tracer Corrected Efficiency | Counts | pCi | pCi | %R | |
| 1 | 4485 | 9.756 | 20.7% | 4706 | 10.237 | 9.99 | 102.4% | |
| 2 | 4473 | 9.756 | 20.7% | 4645 | 10.131 | 9.99 | 101.4% | |
| 3 | 4572 | 9.756 | 21.1% | 4926 | 10.511 | 9.99 | 105.2% | |
| 4 | 4521 | 9.756 | 20.9% | 4711 | 10.166 | 9.99 | 101.7% | |
| Reference Date: | | 8/17/2007 | | Reference Date | | 6/8/2009 | | 95%-105% < 10% < 10% |
| Reference Activity (pCi) | | 50.1006 | | Reference Activity (pCi) | | 49.992 | | |
| Tracer Volume (ml) | | 0.20 | | Standardr Volume (ml) | | 0.20 | | |
| Decay Corrected Value: | | 48.780 | | Pu239 Decay Corrected Value: | | 49.971 | | |

Chemical Information Sheet

Plutonium-239 163RadSol2

#37610



| | | | |
|----------------------|--|---|---|
| Grade: | Research/Pending Re-evaluation |  |  |
| Type: | Working Level Solution | | |
| CAS: | - No Data - | | |
| Lot: | - No Data - | | |
| Received: | 08/06/2009 | | |
| Expiration: | 04/13/2024 | Rad License: | L00775 |
| Location: | Lab 43 Bin A-2, Shelf-3 | Rad License Line: | |
| Current Lab: | Lab 46 Bldg 70 | | |
| Original Amount: | 100 mL | | |
| Amount Remaining: | 92.275 | | |
| Supplier: | - No Data - | | |
| Concentration: | 100 % | | |
| Project: | - No Data - | | |
| PO Number: | - No Data - | | |
| Internal Lab ID: | - No Data - | | |
| Density: | 19.816 g·cm ⁻³ | | |
| Storage Requirement: | Ambient | | |
| Measuring Device ID: | - No Data - | | |
| Date Disposed: | - No Data - | | |
| Notes: | Secondary recert 110RadSol3 10.22.2013 | | |

Sources Table

| ID | Source | Manufacturer | Lot | Amount |
|-------|---------------|----------------------------|-------------|----------|
| 33721 | Plutonium-239 | Analytics,Eckert & Ziegler | 7879909-327 | 5.5409 g |

Component Table



[illegible]

Created by WNaegeli on 2/5/2013 8:22:46 PM.

--- No Secondary Review ---

Plutonium-239



| | | | |
|----------------------|----------------------------|---|---|
| Grade: | Analytical |  |  |
| Type: | Neat | | |
| CAS: | 15117-48-3 | | |
| Lot: | 7879909-327 | | |
| Received: | 06/11/2009 | | |
| Expiration: | 06/11/2019 | Rad License: | L00775 |
| Location: | Bldg 70 Lab 46 | Rad License Line: | |
| Current Lab: | Lab 46 Bldg 70 | | |
| Original Amount: | 5.55882 g | | |
| Amount Remaining: | 0.01792000000000002 | | |
| Supplier: | Analytics,Eckert & Ziegler | | |
| Concentration: | 36240 Bq | | |
| Project: | - No Data - | | |
| PO Number: | - No Data - | | |
| Internal Lab ID: | 7584 | | |
| Density: | 19.816 g·cm-3 | | |
| Storage Requirement: | Ambient | | |
| Measuring Device ID: | - No Data - | | |
| Date Disposed: | 06/03/2014 | | |
| Notes: | | | |

[illegible]

*CGL = Computer Generated Line out

--- No Secondary Review ---



INORGANIC LABS/RADCHEM LABS
DATE RECEIVED: 6/11/09
DATE EXPIRED: 6/11/2019
DATE OPENED: 6/12/09
INORG: 7584 PO: A45476A

rd Industrial Blvd.
rgia 30318
•8677
•2837
icsinc.com

CERTIFICATE OF CALIBRATION

Standard Radionuclide Source

79909-327

Pu-239 5 mL Liquid in Flame Sealed Vial

Customer: Southwest Research Institute/San Antonio, TX
P.O. No.: A45478A, Item 1

This standard radionuclide source was prepared gravimetrically from a calibrated master solution. The master solution was calibrated by liquid scintillation counting. The calibration was checked by liquid scintillation counting after source preparation.

ANALYTICS maintains traceability to the National Institute of Standards and Technology through Measurements Assurance Programs as described in USNRC Reg. Guide 4.15, Revision 1.

Calibration Date: June 8, 2009 12:00 EST

| Isotope | Activity (Bq) | Half-Life | Uncertainty Type (%) | | |
|---------|---------------|---------------|----------------------|-------|-----|
| | | | u_A | u_B | U |
| Pu-239 | 3.624 E4 | 2.41 E4 years | 0.1 | 0.9 | 1.9 |

Uncertainty: U – Relative expanded uncertainty, $k=2$. See NIST Technical Note 1297, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results."

Comments:

Impurities: Am-241 2.783 E2 Bq, Pu-240 1.189 E3 Bq, Pu-241 1.283 E3 Bq, Pu-242 1.800 E-1 Bq
5.55882 grams 3M HNO₃ solution, carrier free.
Master Solution ID#: P290V140

Please note that this Pu-239 standard solution includes Pu-240 which cannot be resolved from Pu-239 by conventional alpha spectroscopy. The Pu-240 activity is provided above.

Source Prepared By: W. Mao
W. Mao, Radiochemist

QA Approved: D. M. Montgomery
D. M. Montgomery, QA Manager

Date: 6-10-09



End of Certificate

Chemical Information Sheet

Neptunium-237 090RadSol4

#218204



| | | | |
|----------------------|----------------------------|---|---|
| Grade: | Analytical |  |  |
| Type: | Working Level Solution | | |
| CAS: | - No Data - | | |
| Lot: | - No Data - | | |
| Received: | 07/11/2022 | | |
| Expiration: | 08/02/2024 | Rad License: | |
| Location: | Bldg 70 Lab 55 Std counter | Rad License Line: | |
| Current Lab: | Lab 46 Stds Bldg 70 | | |
| Original Amount: | 100 mL | | |
| Amount Remaining: | 100 | | |
| Supplier: | - No Data - | | |
| Concentration: | 2189.83 pCi | | |
| Project: | - No Data - | | |
| PO Number: | - No Data - | | |
| Internal Lab ID: | - No Data - | | |
| Density: | 1 | | |
| Storage Requirement: | Ambient | | |
| Measuring Device ID: | - No Data - | | |
| Date Disposed: | - No Data - | | |
| Notes: | | | |

Sources Table

| ID | Source | Manufacturer | Lot | Amount |
|-------|--------------------------|--------------|-----|--------|
| 67095 | Neptunium-237 144RadSol3 | | | 10 ml |

Component Table

[illegible]

*CGL = Computer Generated Line out

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--- No Secondary Review ---



| Standards Verification Form | | | | Date Analyzed: 8/2/2023 | | CRITERIA | | | |
|--------------------------------|--------|--------|-----------------------------|-------------------------------------|--------|---------------------|-------|----------------------------|--------|
| Tracer | | | | Count Time (minutes): 1000 | | | | Instrument ID: Alpha | |
| Am243 | | | | Prep Batch: N/A | | | | Analytical Batch: 230802NP | |
| Logbook ID: 106RadSol4 | | | | Logbook ID: 090RadSol4 | | | | | |
| CIMS# 236972 | | | | CIMS# 218204 | | | | | |
| Read | | TV | | Read | | | | TV | |
| Replicate | Counts | pCi | Tracer Corrected Efficiency | Counts | pCi | | | pCi | %R |
| 1 | 4385 | 10.298 | 19.2% | 4874 | 11.443 | | | 10.95 | 104.5% |
| 2 | 4346 | 10.298 | 19.0% | 4642 | 10.999 | | | 10.95 | 100.5% |
| 3 | 4599 | 10.298 | 20.1% | 4812 | 10.775 | | | 10.95 | 98.4% |
| 4 | 4531 | 10.298 | 19.8% | 4804 | 10.918 | 10.95 | 99.7% | | |
| Reference Date: 3/1/2023 | | | | Reference Date 9/1/2012 | | Average 100.8% | | 95%-105% | |
| Reference Activity (pCi) 51.49 | | | | Reference Activity (pCi) 21.8983 | | Std Deviation 2.64% | | | < 10% |
| Tracer Volume (ml) 0.20 | | | | Standardr Volume (ml) 0.50 | | Conf Interval 2.58% | | | < 10% |
| Decay Corrected Value: 51.488 | | | | Np237 Decay Corrected Value: 21.891 | | | | | |

Chemical Information Sheet

Neptunium-237 144RadSol3

#67095



| | | | |
|----------------------|--------------------------------|---|---|
| Grade: | Research/Pending Re-evaluation |  |  |
| Type: | Working Level Solution | | |
| CAS: | - No Data - | | |
| Lot: | - No Data - | | |
| Received: | 08/12/2015 | | |
| Expiration: | 08/19/2016 | Rad License: | L00775 |
| Location: | Lab 43 Bin A-1, Shelf-3 | Rad License Line: | |
| Current Lab: | Lab 46 Bldg 70 | | |
| Original Amount: | 100 mL | | |
| Amount Remaining: | 80 | | |
| Supplier: | - No Data - | | |
| Concentration: | 810.236 Bq | | |
| Project: | - No Data - | | |
| PO Number: | - No Data - | | |
| Internal Lab ID: | - No Data - | | |
| Density: | 1 | | |
| Storage Requirement: | Ambient | | |
| Measuring Device ID: | - No Data - | | |
| Date Disposed: | - No Data - | | |
| Notes: | | | |

Sources Table

| ID | Source | Manufacturer | Lot | Amount |
|-------|---------------|--------------|-------|---------|
| 52517 | Neptunium-237 | NIST | 4341A | 5.320 g |

Component Table

[illegible]

Created by wnaegeli on 2/12/2016 3:30:10 PM.



--- No Secondary Review ---

Chemical Information Sheet

Neptunium-237

#52517



| | | | |
|----------------------|------------------|---|---|
| Grade: | Analytical |  |  |
| Type: | Commercial Stock | | |
| CAS: | 13994-20-2 | | |
| Lot: | 4341A | | |
| Received: | 08/15/2014 | | |
| Expiration: | 08/15/2024 | Rad License: | |
| Location: | - No Data - | Rad License Line: | |
| Current Lab: | Lab 46 Bldg 70 | | |
| Original Amount: | 5.320 g | | |
| Amount Remaining: | 0 | | |
| Supplier: | NIST | | |
| Concentration: | 152.3 Bq | | |
| Project: | - No Data - | | |
| PO Number: | G39178E | | |
| Internal Lab ID: | - No Data - | | |
| Density: | 1.067 g/mL | | |
| Storage Requirement: | Ambient | | |
| Measuring Device ID: | - No Data - | | |
| Date Disposed: | 02/12/2016 | | |
| Notes: | | | |

Component Table

[illegible]

*CGL = Computer Generated Line out

Created by DRamirez on 8/15/2014 2:23:24 PM.

--- No Secondary Review ---



National Institute of Standards & Technology

Certificate

Standard Reference Material[®] 4341a

Neptunium-237 Radioactivity Standard

This Standard Reference Material (SRM) consists of a solution of a standardized and certified quantity of radioactive neptunium-237 in a suitably stable and homogeneous matrix. It is intended primarily for the calibration of instruments that are used to measure radioactivity and for the monitoring of radiochemical procedures. A unit of SRM 4341a consists of approximately 5 mL of a nitric acid solution, whose composition is specified in Table 1 and 2, contained in a flame-sealed borosilicate-glass ampoule [1].

The certified **neptunium-237** massic activity value, at a **Reference Time of 1200 EST, 01 September 2012**, is:

$$(152.3 \pm 1.4) \text{ Bq}\cdot\text{g}^{-1}$$

A NIST certified value, as used within the context of this certificate, is a value for which NIST has the highest confidence in its uncertainty assessment. It is a “measurement result” [2] obtained directly or indirectly from a “primary reference measurement procedure” [3]. The certified value is traceable to the derived SI unit, becquerel (Bq).

Additional physical, chemical, and radiological properties for this SRM, as well as details on the standardization method, are given in Table 1 and 2. Uncertainties for the certified quantities are expanded ($k = 2$). The uncertainties are calculated according to the ISO and NIST Guides [4,5]. Table 3 contains a specification of the components that comprise the uncertainty analyses.

Expiration of Certification: The certification of **SRM 4341a** is valid indefinitely, within the measurement uncertainty specified, provided that the SRM is handled and stored properly and that no evaporation or change in composition has occurred. The solution matrix, in an unopened ampoule, is homogeneous and stable within its half-life-dependent useful lifetime provided the SRM is handled in accordance with instructions given in this certificate (see “Instructions for Handling and Storage”). Periodic recertification of this SRM is not required. The certification is nullified if the SRM is damaged, contaminated, or otherwise modified.

Maintenance of Certification: NIST will monitor this SRM over the period of its certification. If substantive technical changes occur that affect the certification, NIST will notify the purchaser. Registration (see attached sheet) will facilitate notification.

Radiological and chemical hazard: Consult the Safety Data Sheet (SDS), enclosed with the SRM shipment, for radiological and chemical hazard information.

This SRM was prepared in the NIST Physical Measurement Laboratory, Radiation and Biomolecular Physics Division, under the direction of M.P. Unterwieser, Group Leader of the Radioactivity Group. The overall production, technical direction, and physical measurement leading to certification were provided by R. Collé and L. Laureano-Pérez of the NIST Radiation and Biomolecular Physics Division, Radioactivity Group. Independent confirmatory measurements of the massic activity were performed by R. Fitzgerald and photon-emitting impurity analyses were provided by L. Pibida of the NIST Radiation and Biomolecular Physics Division, Radioactivity Group.

Support aspects involved in the issuance of this SRM were coordinated through the NIST Office of Reference Materials.

Lisa R. Karam, Chief
Radiation and Biomolecular Physics Division

Gaithersburg, Maryland 20899
Certificate Issue Date: 26 March 2013
SRM 4341a

Robert L. Watters, Jr., Director
Office of Reference Materials
Page 1 of 5

Table 1. Certified Massic Activity of SRM 4341a

| | |
|---|------------------------------------|
| Radionuclide | Neptunium-237^(a) |
| Reference time | 1200 EST, 01 September 2012 |
| Massic activity of the solution | 152.3 Bq•g^{-1(b)} |
| Relative expanded uncertainty ($k = 2$) | 0.94 %^(c) |

^(a) The ²³⁷Np stock solution used to prepare this SRM was obtained from the National Physical Laboratory (NPL; Middlesex, UK) as part of the EUROMET action 416 (²³⁷Np exercise) measurement comparison amongst national metrology institutes [6]. The stock solution was chemically purified on approximately 19-22 August 1997 by the Institute for Reference Materials and Measurements (IRMM; Geel, BE). Protactinium-233 is the daughter product that results from ²³⁷Np decay and has been growing in since that time. Users should not assume that the ²³³Pa daughter will remain in radioactive equilibrium with ²³⁷Np in the SRM solution when aliquots are removed from the ampoule.

^(b) The certified massic activity of SRM 4341a, as obtained from the 4 $\pi\alpha\beta$ liquid scintillation based standardization, could be directly compared to the results obtained from the unweighted mean of 9 primary standardizations by 5 laboratories and performed in 1998-99 as part of the EUROMET ²³⁷Np measurement comparison. NIST confirmatory standardizations of the ²³⁷Np massic activity for SRM 4341a were performed by live-timed anticoincidence (LTAC) 4 $\pi\alpha\beta$ (LS) - γ (NaI) measurements and by high-resolution HPGe gamma-ray spectrometry (γ -spec). A direct LS comparison of this SRMs standardization was also made with previous issue of ²³⁷Np (SRM 4341) that was first disseminated in 1993. The results of these comparisons follow:

| | Massic activity (Bq•g ⁻¹) | Relative Standard Uncertainty (%) | Difference (%) |
|----------------------|--|--------------------------------------|-------------------|
| SRM 4341a (LS) | 152.3 | 0.46 | --- |
| LTAC | 152.0 | 0.22 | -0.20 |
| γ -spec | 158.0 | 6.5 | +3.7 |
| Relative to SRM 4341 | 152.5 | 0.46 | +0.13 |
| Relative to EUROMET | 152.4 | 0.16 | +0.07 |

^(c) The uncertainties on certified values are expanded uncertainties, $U = ku_c$. The quantity u_c is the combined standard uncertainty calculated according to the ISO and NIST Guides [4,5]. The combined standard uncertainty is multiplied by a coverage factor of $k = 2$ and was chosen to obtain an approximate 95 % level of confidence.

SwRI Chem ID: 52517

SwRI Chem ID: 52517

SwRI Chem ID: 52517

Table 2. Uncertified Information of SRM 4341a

| | |
|---|---|
| Source description | Liquid in a flame-sealed 5 mL borosilicate-glass ampoule [1] |
| Solution composition | 2.0 mol•L ⁻¹ HNO ₃ |
| Solution density | (1.067 ± 0.002) g•mL ⁻¹ at 16.3 °C ^(a) |
| Solution mass | (5.320 ± 0.003) g ^(a) |
| Photon-Emitting Impurities | None detected ^(b) |
| Total alpha-emitting impurity activity ratio to ²³⁷ Np | 0.0015 ± 0.0005 [6] |
| Half-lives used | ²³⁷ Np: (2.144 ± 0.007) × 10 ⁶ a [7] ^(c) ²³³ Pa: 26.98 ± 0.02 d [8] ^(c) |
| Calibration methods (and instruments) | The certified massic activity for ²³⁷ Np was obtained by 4παβ liquid scintillation (LS) spectrometry with three commercial LS counters. The LS detection efficiency was calculated using the CN2003 code [9] for the CIEMAT/NIST method with composition matched LS cocktails of a ³ H standard as the efficiency detection monitor. Confirmatory measurements were also performed by high-resolution HPGe gamma-ray spectrometry, and by 4παβ(LS) - γ(NaI) anticoincidence counting. |

^(a) The stated uncertainty is two times the standard uncertainty. See reference 5.

^(b) The estimated lower limits of detection for photon-emitting impurities, expressed as massic photon emission rate, in October 2012 are:

- 200 s⁻¹•g⁻¹ for energies between 30 keV and 115 keV,
- 100 s⁻¹•g⁻¹ for energies between 120 keV and 290 keV,
- 250 s⁻¹•g⁻¹ for energies between 295 keV and 320 keV,
- 100 s⁻¹•g⁻¹ for energies between 330 keV and 360 keV,
- 100 s⁻¹•g⁻¹ for energies between 370 keV and 430 keV, and
- 20 s⁻¹•g⁻¹ for energies between 440 keV and 2000 keV.

provided that the photons are separated in energy by 4 keV or more from photons emitted in the decay of ²³⁷Np or progeny.

^(c) The stated uncertainty is the standard uncertainty. See reference 5.

SwRI Chem ID: 52517

SwRI Chem ID: 52517

SwRI Chem ID: 52517

Table 3. Uncertainty Evaluation for the Massic Activity of SRM 4341a

| Uncertainty component | | Assessment Type ^(a) | Relative standard uncertainty contribution on massic activity of ²³⁷ Np (%) |
|---|---|--------------------------------|--|
| 1 | LS measurement precision; standard deviation of the mean for 4 sets of measurements obtained with 3 different LS counters; each set of 6 LS sources was measured 3 to 5 times in each counter on 1 or 2 occasions. The typical internal relative standard deviation of the mean within a measurement data set was typically 0.03 % for $n = 18$ to $n = 30$ measurements with 6 LS sources. | A | 0.12 |
| 2 | Background LS measurement variability and cocktail stability; wholly embodied in component 1 | B | --- |
| 3 | Live time determinations for LS counting time intervals, includes uncorrected dead time effects; assumed from specified tolerance limits of counters' gated oscillators | B | 0.10 |
| 4 | LS α -detection inefficiency for ²³⁷ Np | B | <0.01 |
| 5 | Gravimetric (mass) determinations for LS sources, dilution factors and counting source preparations | B | 0.17 |
| 6 | Decay corrections for ²³⁷ Np and ²³³ Pa; half-life uncertainties of 0.07 % and 0.33 %, respectively [6] | B | 2×10^{-7} |
| 7 | Assumed radioactive equilibrium between ²³⁷ Np and ²³³ Pa in the LS sources after 33 days of decay; wholly embodied in component 1 | B | --- |
| 8 | Uncertainty in massic activity for the ³ H efficiency monitor; includes that for the ³ H standard of 0.36 % and decay corrections for ³ H half-life uncertainty of 0.16 % [6] | B | 0.06 |
| 9 | Calculated beta efficiency for ²³³ Pa, including uncertainties in decay scheme data | B | 0.4 |
| 10 | Impurities, report of alpha impurity activity ratio to ²³⁷ Np of 0.0015 (5) from the 1997 EUROMET measurement comparison [6] of the master solution. No photon-emitting impurities were found. No ²⁴¹ Am was found, indicating that beta-emitting ²⁴¹ Pu was not present. | B | 0.05 |
| Relative combined standard uncertainty | | | 0.47 |
| Relative expanded uncertainty ($k = 2$) | | | 0.94 |

^(a) Letter A, denotes evaluation by statistical methods; B denotes evaluation by other methods.

SwRI Chem ID: 52517

SwRI Chem ID: 52517

SwRI Chem ID: 52517

INSTRUCTIONS FOR HANDLING AND STORAGE

Handling: If the ampoule is transported, it should be packed, marked, labeled, and shipped in accordance with the applicable national, international, and carrier regulations. The solution in the ampoule is a dangerous good (hazardous material) because of both the radioactivity and the strong acid. Only persons qualified to handle both radioactive material and alkaline and/or acidic solutions, should open the ampoule. To minimize personnel exposure, appropriate shielding and/or distance should be used. Refer to the SDS for further information.

Storage: SRM 4341a should be stored and used at a temperature between 5 °C and 65 °C. The ampoule (or any subsequent container) should always be clearly marked as containing radioactive material.

REFERENCES

- [1] NIST Physical Measurement Laboratory; *Storage and Handling of Radioactive Standard Reference Materials, Ampoule Specifications and Opening Procedure*, available at <http://www.nist.gov/pml/div682/grp04/srm.cfm> (accessed Mar 2013). Note: This SRM is contained in a generic borosilicate-glass ampoule and not in the standard NIST ampoule.
- [2] JCGM 200:2012; *International Vocabulary of Metrology - Basic and General Concepts and Associated Terms (VIM)* (2008 version with Minor Corrections), 3rd edition; Joint Committee for Guides in Metrology: BIPM, Sevres Cedex, France; p. 19 (2012); available at http://www.bipm.org/utis/common/documents/jcgm/JCGM_200_2012.pdf (accessed Mar 2013).
- [3] JCGM 200:2012; *International Vocabulary of Metrology - Basic and General Concepts and Associated Terms (VIM)* (2008 version with Minor Corrections), 3rd edition; Joint Committee for Guides in Metrology: BIPM, Sevres Cedex, France; p. 18 (2012); available at http://www.bipm.org/utis/common/documents/jcgm/JCGM_200_2012.pdf (accessed Mar 2013).
- [4] JCGM 100:2008; *Guide to the Expression of Uncertainty in Measurement*; (GUM 1995 with Minor Corrections), Joint Committee for Guides in Metrology: BIPM, Sevres Cedex, France (2008); available at http://www.bipm.org/utis/common/documents/jcgm/JCGM_100_2008_E.pdf (accessed Mar 2013).
- [5] Taylor, B.N.; Kuyatt, C.E.; *Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results*; NIST Technical Note 1297, U.S. Government Printing Office: Washington, DC (1994); available at <http://www.nist.gov/pml/pubs/index.cfm> (accessed Mar 2013).
- [6] Smith D., Woods M.J., Woods D.H.; *Results from the ²³⁷Np Exercise EUROMET Action 416*, NPL Report CIRM 43, p 76 (2001); available at http://publications.npl.co.uk/npl_web/pdf/CIRM43.pdf (accessed Mar 2013)
- [7] Chechev, V.P.; Kuzmenko N.K.; *July 2010, ²³⁷Np*; LNE-LNHB/CEA Table of Radionuclides, available at http://www.nucleide.org/DDEP_WG/Nuclides/Np-237_tables.pdf (accessed Mar 2013).
- [8] Chechev, V.P.; Kuzmenko N.K.; *July 2010, ²³³Pa*; LNE-LNHB/CEA Table of Radionuclides, available at http://www.nucleide.org/DDEP_WG/Nuclides/Pa-233_tables.pdf (accessed Mar 2013).
- [9] Gunther, E.; Physikalisch-Technische Bundesanstalt (Braunschweig, Germany), personal communication (2003).

Users of this SRM should ensure that the Certificate in their possession is current. This can be accomplished by contacting the SRM Program: telephone (301) 975-2200; fax (301) 948-3730; e-mail srminfo@nist.gov; or via the Internet at <http://www.nist.gov/srm>.

SOUTHWEST RESEARCH INSTITUTE

CLIENT: Battelle Memorial Institute PNNL

SwRI Project #: 27927.13.001

SwRI Task Order #: 240405-6

SDG #: 718819

TON #: 733437

Sample Receipt Paperwork

Southwest Research Institute

Laboratory Task Order

TO #: 240405-6 Revision: 1

SDG: 718819
RECEIVED: 04/04/24
TON: 733437

SRR #s: 70993
Client(s): Battelle Memorial Institute PNNL

Project(s): 27927.13.001
Manager(s): Ranger, Jacqueline
To Client: 05/22/24

Instructions

Contract: 660825 Mod 1. PNNL Task Order: 733437
18 overall RAD LIQUID samples were received on 04/04/2024, which are ALL listed here.

SOLUTION VOLUME IS SHARED WITH ALL REQUIRED TESTS.
RAD ACTIVITY: At Sample Receipt LOGIN _ samples ranged from 50-160mR/hr.

SEE COC and SOW for methods requested for analysis:

ICP-MS Tc
Alpha Spec _ Np-237
Alpha Spec _ Am-241, Cm-242, Cm-244
Alpha Spec _ Pu-238, Pu-239/240, Pu-244

Services to be completed in compliance with DOEAP-AP and HASQARD compliant quality program.
QUALITY ASSURANCE Adherence to quality assurance (QA) protocols is extremely important to PNNL. SwRI shall follow documented QA program protocol and perform all work in accordance with the standard practices required by PNNL to support work being accomplished as an Evaluated Supplier. SwRI will perform matrix spike, and laboratory sample duplicate(s) or matrix spike duplicate on sample sets. All instrument calibrations, sample batch preparations, and analytical quality control samples will be performed and documented. If nonconformance conditions occur during performance of analysis of PNNL samples, SwRI will notify PNNL of the occurrence. The project will notify SwRI of the disposition of the nonconforming conditions.

LEVEL 4 DATA PACKAGE REQUIRED

The final report will reference the contract number. Final reports shall be submitted to PNNL as PDF ONLY.

Project Point of contact: Derek Dixon, derek.dixon@pnnl.gov. Cassie A. Martin, cassie.martin@pnnl.gov. Amy Westesen, amy.westesen@pnnl.gov

Final report: Derek Dixon
BATTELLE MEMORIAL INSTITUTE - PNNL
902 Battelle Blvd
Richland WA 99354

Rev 1 (JR, 4/15/24) - Test codes and instructions were updated based on client's (Amy Westesen) email dated 4/15/24. PNNL task order had incorrect dose rate and TRU information. Per Amy, expected dose rate 20-50 mR/hr and TRU 0.1-100 uCi/sample should have been on the task order. A modified PNNL TO will be provided when available.

Documents Related to this task order: 391794[Pic 1 SRR 70993], 391795[Pic 2 SRR 70993], 391796 [Pic 3 SRR 70993], 391797[Pic 4 SRR 70993], 391798[Pic 5 SRR 70993], 391799[Pic 6 SRR 70993], 391800[Pic 7 SRR 70993], 391801[Pic 8 SRR 70993], 391802[Pic 9 SRR 70993], 391803[Pic 10 SRR 70993], 391804[Pic 11 SRR 70993], 391805[Pic 12 SRR 70993], 391806[Pic 13 SRR 70993], 391807[Pic 14 SRR 70993], 391808[Pic 15 SRR 70993], 391809[Pic 16 SRR 70993], 391810[Pic 17 SRR 70993], 391811[Pic 18 SRR 70993], 391812[Pic 19 SRR 70993], 391813[Pic 20 SRR 70993], 391814[Pic 21 SRR 70993], 391815[Pic 22 SRR 70993], 391816[Pic 23 SRR 70993], 391959[RAD Form 315 for SRR 70993], 391991[COC for SRR 70993], 391992[Paperwork for SRR 70993], 395153[Project Email for SRR 70993]

Deliverables --> Hard Copy: no EDD: no PDF: -YES-

Test: ALPHA-AM_SWRI
Section: RADCHEM

Holding: 180 days from CED

Alpha Spec Analysis for isotopic Americium

Cnt: 2

| System ID | Type | Cont | Matrix | Customer ID | CED | Method Date |
|-----------|-------|------|--------|-----------------|---------|-------------|
| 718821 | HiRad | 1 | Liquid | TI155-EFF-Comp | NO DATA | NO DATA |
| 718822 | HiRad | 1 | Liquid | TI155-Feed-Comp | NO DATA | NO DATA |

Test: ALPHA-CM_SWRI
Section: RADCHEM

Holding: 180 days from CED

Alpha Spec Analysis for isotopic Curium

Cnt: 2

| System ID | Type | Cont | Matrix | Customer ID | CED | Method Date |
|-----------|-------|------|--------|----------------|---------|-------------|
| 718821 | HiRad | 1 | Liquid | TI155-EFF-Comp | NO DATA | NO DATA |



Southwest Research Institute

Laboratory Task Order

TO #: 240405-6 Revision: 1

SDG: 718819
RECEIVED: 04/04/24
TON: 733437

SRR #s: 70993
Client(s): Battelle Memorial Institute PNNL

Project(s): 27927.13.001
Manager(s): Ranger, Jacqueline
To Client: 05/22/24

| System ID | Type | Cont | Matrix | Customer ID | CED | Method Date |
|-----------|-------|------|--------|-----------------|---------|-------------|
| 718822 | HiRad | 1 | Liquid | TI155-Feed-Comp | NO DATA | NO DATA |

Test: ALPHA-NP_SWRI
Section: RADCHEM

Holding: 180 days from CED

Alpha Spec Analysis for Neptunium-237

Cnt: 2

| System ID | Type | Cont | Matrix | Customer ID | CED | Method Date |
|-----------|-------|------|--------|-----------------|---------|-------------|
| 718821 | HiRad | 1 | Liquid | TI155-EFF-Comp | NO DATA | NO DATA |
| 718822 | HiRad | 1 | Liquid | TI155-Feed-Comp | NO DATA | NO DATA |

Test: ALPHA-PU_SWRI
Section: RADCHEM

Holding: 180 days from CED

Alpha Spec Analysis for isotopic Plutonium

Cnt: 18

| System ID | Type | Cont | Matrix | Customer ID | CED | Method Date |
|-----------|-------|------|--------|-----------------|---------|-------------|
| 718819 | HiRad | 1 | Liquid | TI155-A-2-A | NO DATA | NO DATA |
| 718820 | HiRad | 1 | Liquid | TI155-B-10-A | NO DATA | NO DATA |
| 718821 | HiRad | 1 | Liquid | TI155-EFF-Comp | NO DATA | NO DATA |
| 718822 | HiRad | 1 | Liquid | TI155-Feed-Comp | NO DATA | NO DATA |
| 718825 | HiRad | 1 | Liquid | TI155-A-11-A | NO DATA | NO DATA |
| 718826 | HiRad | 1 | Liquid | TI155-A-17-A | NO DATA | NO DATA |
| 718827 | HiRad | 1 | Liquid | TI155-A-21-A | NO DATA | NO DATA |
| 718828 | HiRad | 1 | Liquid | TI155-B-22-A | NO DATA | NO DATA |
| 718829 | HiRad | 1 | Liquid | TI155-B-24-A | NO DATA | NO DATA |
| 718830 | HiRad | 1 | Liquid | TI155-A-9-A | NO DATA | NO DATA |
| 718852 | HiRad | 1 | Liquid | TI155-A-13-A | NO DATA | NO DATA |
| 718853 | HiRad | 1 | Liquid | TI155-A-15-A | NO DATA | NO DATA |
| 718854 | HiRad | 1 | Liquid | TI155-A-19-A | NO DATA | NO DATA |
| 718855 | HiRad | 1 | Liquid | TI155-A-5-A | NO DATA | NO DATA |
| 718856 | HiRad | 1 | Liquid | TI155-A-7-A | NO DATA | NO DATA |
| 718857 | HiRad | 1 | Liquid | TI155-B-18-A | NO DATA | NO DATA |
| 718858 | HiRad | 1 | Liquid | TI155-B-2-A | NO DATA | NO DATA |
| 718859 | HiRad | 1 | Liquid | TI155-B-5-A | NO DATA | NO DATA |

Test: DIG-PRECIP-APU
Section: RADPREP

Holding: 180 days from CED

Digestion for Am, Pu, and U with Precip

Cnt: 18

| System ID | Type | Cont | Matrix | Customer ID | CED | Method Date |
|-----------|-------|------|--------|-----------------|---------|-------------|
| 718819 | HiRad | 1 | Liquid | TI155-A-2-A | NO DATA | NO DATA |
| 718820 | HiRad | 1 | Liquid | TI155-B-10-A | NO DATA | NO DATA |
| 718821 | HiRad | 1 | Liquid | TI155-EFF-Comp | NO DATA | NO DATA |
| 718822 | HiRad | 1 | Liquid | TI155-Feed-Comp | NO DATA | NO DATA |
| 718825 | HiRad | 1 | Liquid | TI155-A-11-A | NO DATA | NO DATA |
| 718826 | HiRad | 1 | Liquid | TI155-A-17-A | NO DATA | NO DATA |
| 718827 | HiRad | 1 | Liquid | TI155-A-21-A | NO DATA | NO DATA |
| 718828 | HiRad | 1 | Liquid | TI155-B-22-A | NO DATA | NO DATA |
| 718829 | HiRad | 1 | Liquid | TI155-B-24-A | NO DATA | NO DATA |
| 718830 | HiRad | 1 | Liquid | TI155-A-9-A | NO DATA | NO DATA |
| 718852 | HiRad | 1 | Liquid | TI155-A-13-A | NO DATA | NO DATA |
| 718853 | HiRad | 1 | Liquid | TI155-A-15-A | NO DATA | NO DATA |
| 718854 | HiRad | 1 | Liquid | TI155-A-19-A | NO DATA | NO DATA |
| 718855 | HiRad | 1 | Liquid | TI155-A-5-A | NO DATA | NO DATA |
| 718856 | HiRad | 1 | Liquid | TI155-A-7-A | NO DATA | NO DATA |



Southwest Research Institute

Laboratory Task Order

TO #: 240405-6 Revision: 1

SDG: 718819
RECEIVED: 04/04/24
TON: 733437

SRR #s: 70993
Client(s): Battelle Memorial Institute PNNL

Project(s): 27927.13.001
Manager(s): Ranger, Jacqueline
To Client: 05/22/24

| System ID | Type | Cont | Matrix | Customer ID | CED | Method Date |
|-----------|-------|------|--------|--------------|---------|-------------|
| 718857 | HiRad | 1 | Liquid | TI155-B-18-A | NO DATA | NO DATA |
| 718858 | HiRad | 1 | Liquid | TI155-B-2-A | NO DATA | NO DATA |
| 718859 | HiRad | 1 | Liquid | TI155-B-5-A | NO DATA | NO DATA |

Test: DIG-PRECIP-Np
Section: RADPREP

Holding: 180 days from CED

Digestion for Np with Precip

Cnt: 2

| System ID | Type | Cont | Matrix | Customer ID | CED | Method Date |
|-----------|-------|------|--------|-----------------|---------|-------------|
| 718821 | HiRad | 1 | Liquid | TI155-EFF-Comp | NO DATA | NO DATA |
| 718822 | HiRad | 1 | Liquid | TI155-Feed-Comp | NO DATA | NO DATA |

Test: DIG-TOTALDISS_Tc99
Section: METALPREP

Holding: 180 days from CED

Digestion Method Total Dissolution for Technetium-99

Cnt: 2

| System ID | Type | Cont | Matrix | Customer ID | CED | Method Date |
|-----------|-------|------|--------|-----------------|---------|-------------|
| 718821 | HiRad | 1 | Liquid | TI155-EFF-Comp | NO DATA | NO DATA |
| 718822 | HiRad | 1 | Liquid | TI155-Feed-Comp | NO DATA | NO DATA |

Test: ICPMS-SWRI_Tc99
Section: METALS

Holding: 180 days from CED

ICPMS SwRI Method for Technetium-99

Cnt: 2

| System ID | Type | Cont | Matrix | Customer ID | CED | Method Date |
|-----------|-------|------|--------|-----------------|---------|-------------|
| 718821 | HiRad | 1 | Liquid | TI155-EFF-Comp | NO DATA | NO DATA |
| 718822 | HiRad | 1 | Liquid | TI155-Feed-Comp | NO DATA | NO DATA |

Test: RAD Narrative
Section: RADCHEM

Holding: 28 days from VTSR

Narrative

Cnt: 18

| System ID | Type | Cont | Matrix | Customer ID | VTSR | Method Date |
|-----------|-------|------|--------|-----------------|-----------|-------------|
| 718819 | HiRad | 1 | Liquid | TI155-A-2-A | 04 Apr 24 | 02 May 24 |
| 718820 | HiRad | 1 | Liquid | TI155-B-10-A | 04 Apr 24 | 02 May 24 |
| 718821 | HiRad | 1 | Liquid | TI155-EFF-Comp | 04 Apr 24 | 02 May 24 |
| 718822 | HiRad | 1 | Liquid | TI155-Feed-Comp | 04 Apr 24 | 02 May 24 |
| 718825 | HiRad | 1 | Liquid | TI155-A-11-A | 04 Apr 24 | 02 May 24 |
| 718826 | HiRad | 1 | Liquid | TI155-A-17-A | 04 Apr 24 | 02 May 24 |
| 718827 | HiRad | 1 | Liquid | TI155-A-21-A | 04 Apr 24 | 02 May 24 |
| 718828 | HiRad | 1 | Liquid | TI155-B-22-A | 04 Apr 24 | 02 May 24 |
| 718829 | HiRad | 1 | Liquid | TI155-B-24-A | 04 Apr 24 | 02 May 24 |
| 718830 | HiRad | 1 | Liquid | TI155-A-9-A | 04 Apr 24 | 02 May 24 |
| 718852 | HiRad | 1 | Liquid | TI155-A-13-A | 04 Apr 24 | 02 May 24 |
| 718853 | HiRad | 1 | Liquid | TI155-A-15-A | 04 Apr 24 | 02 May 24 |
| 718854 | HiRad | 1 | Liquid | TI155-A-19-A | 04 Apr 24 | 02 May 24 |
| 718855 | HiRad | 1 | Liquid | TI155-A-5-A | 04 Apr 24 | 02 May 24 |
| 718856 | HiRad | 1 | Liquid | TI155-A-7-A | 04 Apr 24 | 02 May 24 |
| 718857 | HiRad | 1 | Liquid | TI155-B-18-A | 04 Apr 24 | 02 May 24 |
| 718858 | HiRad | 1 | Liquid | TI155-B-2-A | 04 Apr 24 | 02 May 24 |
| 718859 | HiRad | 1 | Liquid | TI155-B-5-A | 04 Apr 24 | 02 May 24 |

Test: SEP-APU
Section: RADPREP

Holding: 180 days from CED

Separation for Am, Pu, and U

Cnt: 18

| System ID | Type | Cont | Matrix | Customer ID | CED | Method Date |
|-----------|-------|------|--------|-------------|---------|-------------|
| 718819 | HiRad | 1 | Liquid | TI155-A-2-A | NO DATA | NO DATA |



Southwest Research Institute

Laboratory Task Order

TO #: 240405-6 Revision: 1

SDG: 718819
RECEIVED: 04/04/24
TON: 733437

SRR #s: 70993

Client(s): Battelle Memorial Institute PNNL

Project(s): 27927.13.001
Manager(s): Ranger, Jacqueline
To Client: 05/22/24

| System ID | Type | Cont | Matrix | Customer ID | CED | Method Date |
|-----------|-------|------|--------|-----------------|---------|-------------|
| 718820 | HiRad | 1 | Liquid | TI155-B-10-A | NO DATA | NO DATA |
| 718821 | HiRad | 1 | Liquid | TI155-EFF-Comp | NO DATA | NO DATA |
| 718822 | HiRad | 1 | Liquid | TI155-Feed-Comp | NO DATA | NO DATA |
| 718825 | HiRad | 1 | Liquid | TI155-A-11-A | NO DATA | NO DATA |
| 718826 | HiRad | 1 | Liquid | TI155-A-17-A | NO DATA | NO DATA |
| 718827 | HiRad | 1 | Liquid | TI155-A-21-A | NO DATA | NO DATA |
| 718828 | HiRad | 1 | Liquid | TI155-B-22-A | NO DATA | NO DATA |
| 718829 | HiRad | 1 | Liquid | TI155-B-24-A | NO DATA | NO DATA |
| 718830 | HiRad | 1 | Liquid | TI155-A-9-A | NO DATA | NO DATA |
| 718852 | HiRad | 1 | Liquid | TI155-A-13-A | NO DATA | NO DATA |
| 718853 | HiRad | 1 | Liquid | TI155-A-15-A | NO DATA | NO DATA |
| 718854 | HiRad | 1 | Liquid | TI155-A-19-A | NO DATA | NO DATA |
| 718855 | HiRad | 1 | Liquid | TI155-A-5-A | NO DATA | NO DATA |
| 718856 | HiRad | 1 | Liquid | TI155-B-7-A | NO DATA | NO DATA |
| 718857 | HiRad | 1 | Liquid | TI155-B-18-A | NO DATA | NO DATA |
| 718858 | HiRad | 1 | Liquid | TI155-B-2-A | NO DATA | NO DATA |
| 718859 | HiRad | 1 | Liquid | TI155-B-5-A | NO DATA | NO DATA |

Test: SEP-Np
Section: RADPREP

Holding: 180 days from CED

Separation for Np

Cnt: 2

| System ID | Type | Cont | Matrix | Customer ID | CED | Method Date |
|-----------|-------|------|--------|-----------------|---------|-------------|
| 718821 | HiRad | 1 | Liquid | TI155-EFF-Comp | NO DATA | NO DATA |
| 718822 | HiRad | 1 | Liquid | TI155-Feed-Comp | NO DATA | NO DATA |



70993 Battelle Memorial Institute

Southwest Research Institute

Sample Receipt

Sample Receipt Number: 70993

VTSR: 04/04/24

Time: 10:00:00

Project: 27927.13.001
Case #: 733437
Client: Battelle Memorial Institute PNNL

Manager: Ranger, Jacqueline
Logged in by: DXGARCIA
Creation Date: 04/04/24

Notes

3 _ 16x16x16 _ boxes were delivered to SwRI's Shipping & Receiving Warehouse. Division 01 AEC LOGIN staff picked up the boxes from Receiving and took custody. Samples were received intact.

FED EX Tracking #:
7279 2104 0311 _ 21.9°C (Ambient, no ice).
7279 2104 0322 _ 21.9°C (Ambient, no ice).
7279 2104 0333 _ 21.9°C (Ambient, no ice).

Model 9 Ion Chamber, Ludlum SN 183532, AN 009597; Due: 09/22/2024
Background: Passed
2401-P, Survey Meter SN 183532, AN 007335; Due: 08/24/2024
Background: Passed

UN2910, Radioactive Material, Excepted Package.

RAD: See Radioactive Material Receiving Form for additional info.
Lab will take contact RAD readings on actual samples.
Additional LOGIN notes and radioactive readings are provided with the SRR paper work.

See chain-of-custody for more information.

Test requirements located on applicable Task Order.

HIGH RAD SAMPLES.

Background CPM: NOTE
Container Wipe CPM: NOTE
Total CPM: NOTE

| System ID | Customer ID | CED | Matrix | Containers | Special Reqs. |
|-----------|-----------------|-----|--------|------------|---------------|
| 718825 | TI155-A-11-A | | Liquid | 1 | Rad |
| 718852 | TI155-A-13-A | | Liquid | 1 | Rad |
| 718853 | TI155-A-15-A | | Liquid | 1 | Rad |
| 718826 | TI155-A-17-A | | Liquid | 1 | Rad |
| 718854 | TI155-A-19-A | | Liquid | 1 | Rad |
| 718819 | TI155-A-2-A | | Liquid | 1 | Rad |
| 718827 | TI155-A-21-A | | Liquid | 1 | Rad |
| 718855 | TI155-A-5-A | | Liquid | 1 | Rad |
| 718856 | TI155-A-7-A | | Liquid | 1 | Rad |
| 718830 | TI155-A-9-A | | Liquid | 1 | Rad |
| 718820 | TI155-B-10-A | | Liquid | 1 | Rad |
| 718857 | TI155-B-18-A | | Liquid | 1 | Rad |
| 718858 | TI155-B-2-A | | Liquid | 1 | Rad |
| 718828 | TI155-B-22-A | | Liquid | 1 | Rad |
| 718829 | TI155-B-24-A | | Liquid | 1 | Rad |
| 718859 | TI155-B-5-A | | Liquid | 1 | Rad |
| 718821 | TI155-EFF-Comp | | Liquid | 1 | Rad |
| 718822 | TI155-Feed-Comp | | Liquid | 1 | Rad |

Containers: 18

Samples: 18

Sample Receipt

Southwest Research Institute

Sample Receipt Number: 70993

VTSR: 04/04/24

Time: 10:00:00

Project: 27927.13.001
Case #: 733437
Client: Battelle Memorial Institute PNNL

Manager: Ranger, Jacqueline
Logged in by: DXGARCIA
Creation Date: 04/04/24

These documents are associated with this receipt: 391991[COC for SRR 70993], 391992[Paperwork for SRR 70993], 391959[RAD Form 315 for SRR 70993], 395153[Project Email for SRR 70993], 391794[Pic 1 SRR 70993], 391795[Pic 2 SRR 70993], 391796[Pic 3 SRR 70993], 391797[Pic 4 SRR 70993], 391798[Pic 5 SRR 70993], 391799[Pic 6 SRR 70993], 391800[Pic 7 SRR 70993], 391801[Pic 8 SRR 70993], 391802[Pic 9 SRR 70993], 391803[Pic 10 SRR 70993], 391804[Pic 11 SRR 70993], 391805[Pic 12 SRR 70993], 391806[Pic 13 SRR 70993], 391807[Pic 14 SRR 70993], 391808[Pic 15 SRR 70993], 391809[Pic 16 SRR 70993], 391810[Pic 17 SRR 70993], 391811[Pic 18 SRR 70993], 391812[Pic 19 SRR 70993], 391813[Pic 20 SRR 70993], 391814[Pic 21 SRR 70993], 391815[Pic 22 SRR 70993], 391816[Pic 23 SRR 70993]

Thermometer: 029926
Temperature: 21.9

70993 Battelle Memorial Institute

Supplement 1 of 3

| | | | |
|--|---|--|-----|
| Project Sample Transfer Form (PSTF) | | Page 2 of 2 | 031 |
| Final Sample Disposition: Dispose on-site | If samples are to be preserved, identify requirements here. | | |
| Project Approval | | | |
| Date | Approved by | Digitally signed by Reid A Peterson Date: 2024.03.18 11:23:08 -07'00' | |
| Reid A Peterson | | | |
| Receipt Acknowledgement | | | |
| Date | Received by | | |
| 04.04.24 | Daniel Horner / SWRI | | |

Client: Battelle Memorial Institute PNNL
SRR # 70993
Project # 27927.13.001
Case: 733437
VTSR: 04/04/24
Sample(s) Received: Intact
Temperature: 21.9°C SN # 029926

Project Sample Transfer Form (PSTF)

[illegible]

Project Sample Transfer Form (PSTF)

| | | | |
|--|-------------------|--|--|
| Final Sample Disposition: Dispose on-site | | If samples are to be preserved, identify requirements here. | |
| Project Approval | | | |
| Date | Approved by | Digitally signed by Reid A Peterson Date: 2024.03.18 11:23:08 -07'00' | |
| Receipt Acknowledgement | | | |
| Date | Received by | | |
| 04.04.24 | David Hauer / SWI | | |

Client: Battelle Memorial Institute PNNL
SRR # 70993
Project # 27927.13.001
Case: 733437
VTSR: 04/04/24
Sample(s) Received: Intact
Temperature: 21.9°C SN # 029926

Project Sample Transfer Form (PSTF)

[illegible]

Project Sample Transfer Form (PSTF) Page 2 of 2

| | | | |
|--|--------------------|--|--|
| Final Sample Disposition: Dispose on-site | | If samples are to be preserved, identify requirements here. | |
| Project Approval | | | |
| Date | Approved by | | |
| | Reid A Peterson | Digitally signed by Reid A Peterson Date: 2024.03.18 11:23:08 -07'00' | |
| Receipt Acknowledgement | | | |
| Date | Received by | | |
| 04-04-24 | David Martin / SWI | | |

Client: Battelle Memorial Institute PNNL
SRR # 70993
Project # 27927.13.001
Case: 733437
VTSR: 04/04/24
Sample(s) Received: Intact
Temperature: 21.9°C SN # 029926

Sample Custodian Signature:  Southwest Research Institute
Traffic Report



- 1. Custody Seal Present
- 2. Chain of Custody Present
- 3. Sample Tags Not Present *n/A*
Sample Tag Numbers Not on COC
- 4. SMO Forms Present

Client: Battelle Memorial Institute PNNL
Project: 27927.13.001
Case: 733437 / SDG: 719819
Sample Receipt: 70993
Airbill: 3 Air bills-See notes

Custody Seal #(s): Tape Only

| Date Received | Time Received | COC Record | SMO Sample # | Corresponding | | Traffic Rpt, Tags, COC Agree | Sample Condition |
|---------------|---------------|------------|-----------------|---------------|--------|------------------------------|------------------|
| | | | | Sample Tag # | SwRI # | | |
| 04/04/24 | 10:00:00 | 733437 | TI155-A-2-A | N/A | 718819 | YES | Intact |
| 04/04/24 | 10:00:00 | 733437 | TI155-B-10-A | N/A | 718820 | YES | Intact |
| 04/04/24 | 10:00:00 | 733437 | TI155-EFF-Comp | N/A | 718821 | YES | Intact |
| 04/04/24 | 10:00:00 | 733437 | TI155-Feed-Comp | N/A | 718822 | YES | Intact |
| 04/04/24 | 10:00:00 | 733437 | TI155-A-11-A | N/A | 718825 | YES | Intact |
| 04/04/24 | 10:00:00 | 733437 | TI155-A-17-A | N/A | 718826 | YES | Intact |
| 04/04/24 | 10:00:00 | 733437 | TI155-A-21-A | N/A | 718827 | YES | Intact |
| 04/04/24 | 10:00:00 | 733437 | TI155-B-22-A | N/A | 718828 | YES | Intact |
| 04/04/24 | 10:00:00 | 733437 | TI155-B-24-A | N/A | 718829 | YES | Intact |
| 04/04/24 | 10:00:00 | 733437 | TI155-A-9-A | N/A | 718830 | YES | Intact |
| 04/04/24 | 10:00:00 | 733437 | TI155-A-13-A | N/A | 718852 | YES | Intact |
| 04/04/24 | 10:00:00 | 733437 | TI155-A-15-A | N/A | 718853 | YES | Intact |
| 04/04/24 | 10:00:00 | 733437 | TI155-A-19-A | N/A | 718854 | YES | Intact |
| 04/04/24 | 10:00:00 | 733437 | TI155-A-5-A | N/A | 718855 | YES | Intact |
| 04/04/24 | 10:00:00 | 733437 | TI155-A-7-A | N/A | 718856 | YES | Intact |
| 04/04/24 | 10:00:00 | 733437 | TI155-B-18-A | N/A | 718857 | YES | Intact |
| 04/04/24 | 10:00:00 | 733437 | TI155-B-2-A | N/A | 718858 | YES | Intact |
| 04/04/24 | 10:00:00 | 733437 | TI155-B-5-A | N/A | 718859 | YES | Intact |



June 14th, 2024

Test Report

SwRI Project #: 27927.13.001
SwRI SDG: 718819
SwRI Task Order: 240405-6
SwRI Sample Receipt: 70993
Date Received: 04/04/2024

P.O.# 660825/TON 733437

Prepared by:
Southwest Research Institute®
Department of Analytical and Environmental Chemistry
6220 Culebra Road
San Antonio, Texas 78238

Prepared for:
Battelle Memorial Institute - PNNL
902 Battelle Boulevard
P.O. Box 999
Richland, WA 99354
Attn: Mr. Derek Dixon

Authorized for Release
06/14/2024 2:15PM
Jackie Ranger, Project Manager
[*jacqueline.ranger@swri.org*](mailto:jacqueline.ranger@swri.org)
210-522-3320

Mike Dammann
Laboratory Director



"I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed within this report. This report shall not be reproduced except in full without the written approval of SwRI."

SOUTHWEST RESEARCH INSTITUTE

CLIENT: Battelle Memorial Institute PNNL

SwRI Project #: 27927.13.001

SwRI Task Order #: 240405-6

SDG #: 718819

TON #: 733437

Case Narrative

CLIENT: Battelle Memorial Institute - PNNL
SwRI Project Number: 27927.13.001
SwRI Sample Receipt Number: 70993
PO 660825 R1, TO 733437
Page #: 1

Sample Index

1. Eighteen overall samples were received for various analyses. Only the samples below required Technetium-99 by ICP-MS and are reported here:

| SwRI ID | Sample Number | Analysis |
|----------------|----------------------|-----------------|
| 718821 | TI155-EFF-Comp | Tc-99 |
| 718822 | TI155-Feed-Comp | Tc-99 |

Client: Battelle Memorial Institute PNNL
SDG: 718819
SwRI Project Number: 27927.13.001
SwRI Task Order Number: 240405-6

TECHNETIUM-99 ANALYSES VIA ICP-MS

The samples were readied for analysis via an open vessel digestion using nitric acid. The resulting digestates were analyzed for Tc-99 by ICP-MS (TAP01-0413-006 Rev0).

All instrument QC criteria were evaluated. The percent recoveries were within 90-110% for the initial and continuing calibration verifications. Tc-99 was not detected above SwRI's reporting limit (RL) in the initial and continuing calibration blanks. The low level, check standard recovery was within 80-120%. The percent recovery for the ICSAB interference check sample was within 80-120%. The limit was met for the ICSA interference check sample. The ICSA limit is the ICSA true value ± 2 times the RL.

Description of "Qualifier": "U" indicates that an analyte was not detected above SwRI's RL. "D" indicates that the reported result was from a dilution of the prepared sample.

Tc-99 was not detected in the Prep Blank (ID: PB24E14KE1) above SwRI's RL. A laboratory control sample (ID: LCS24E14KE1) was prepared with the samples. The recovery was within 80-120%.

SwRI system id 718821 was QC'd.

- The matrix spike (MS) recovery was not within 75-125%. However, since the parent sample result was greater than 4 times the spike added amount, no limits were applied to the MS analysis and the Tc-99 results were not flagged. No MSD's were prepared due to limited sample masses.
- The duplicate RPDs were less than 20%.
- The QC criteria was met for the serial dilution analysis, for which no limits are applied unless the parent sample concentration is greater than 50 times the RL. The limit is then 10% difference.

Jacqueline Ranger Digitally signed by Jacqueline
Ranger
Date: 2024.06.13 13:28:31 -05'00'

Prepared By

SOUTHWEST RESEARCH INSTITUTE

CLIENT: Battelle Memorial Institute PNNL

SwRI Project #: 27927.13.001

SwRI Task Order #: 240405-6

SDG #: 718819

TON #: 733437

Technetium-99 Results

SOUTHWEST RESEARCH INSTITUTE
Metals Report
Cover Page

Client: Battelle Memorial Institute PNNL
Task Order: 240405-6

SDG: 718819
SRR: 70993

Case: 733437
Project: 27927.13.001

| Client Sample ID | Lab Sample ID |
|------------------|---------------|
| TI155-EFF-Comp | 718821 |
| TI155-EFF-CompD | 718821D |
| TI155-EFF-CompMS | 718821MS |
| TI155-Feed-Comp | 718822 |

Comments:

Cover Page

SOUTHWEST RESEARCH INSTITUTE
Metals Report - Form I
Certificate of Analysis

Client Sample ID
T1155-EFF-Comp
Type: Unknown

Client: Battelle Memorial Institute PNNL
Task Order: 240405-6
Lab ID: 718821
Result Units: mg/L

SDG: 718819
SRR: 70993
Matrix: Liquid
% Solids: NA

Case: 733437
Project: 27927.13.001
Receipt Date: 04/04/2024
Collection Date: NA

| CAS No. | Analyte | Result | Qual | M | RL | DF | Prep Batch | Analysis Date/Time |
|------------|---------------|--------|------|-----|--------|-----|--------------------------------|--------------------|
| 14133-76-7 | Technetium-99 | 0.564 | | MS2 | 0.0500 | 100 | 20240523-P005 20240514-P002 | 06/06/2024 11:12 |

| Data Reporting Qualifiers (Qual) | Columns | Instruments/Methods (M) |
|--|---|--|
| U - Result is less than the SwRI Reporting Limit (RL) N - Matrix spike and/or matrix spike duplicate criteria was not met X - Analytical spike criteria was not met E - Result is estimated due to interferences D - Result is reported from a dilution * - Duplicate criteria was not met & - See narrative | RL - SwRI Reporting Limit DF - Dilution Factor M - Instrument | MS2 - ICP-MS PE NexION/SW-846 Method 6020B NA - Not Applicable |

Form I-IN

SOUTHWEST RESEARCH INSTITUTE
Metals Report - Form I
Certificate of Analysis

Client Sample ID

TI155-Feed-Comp

Type: Unknown

Client: Battelle Memorial Institute PNNL
Task Order: 240405-6
Lab ID: 718822
Result Units: mg/L

SDG: 718819
SRR: 70993
Matrix: Liquid
% Solids: NA

Case: 733437
Project: 27927.13.001
Receipt Date: 04/04/2024
Collection Date: NA

| CAS No. | Analyte | Result | Qual | M | RL | DF | Prep Batch | Analysis Date/Time |
|------------|---------------|--------|------|-----|--------|-----|--------------------------------|--------------------|
| 14133-76-7 | Technetium-99 | 0.611 | | MS2 | 0.0500 | 100 | 20240523-P005 20240514-P002 | 06/06/2024 11:24 |

| Data Reporting Qualifiers (Qual) | Columns | Instruments/Methods (M) |
|--|---|--|
| U - Result is less than the SwRI Reporting Limit (RL) N - Matrix spike and/or matrix spike duplicate criteria was not met X - Analytical spike criteria was not met E - Result is estimated due to interferences D - Result is reported from a dilution * - Duplicate criteria was not met & - See narrative | RL - SwRI Reporting Limit DF - Dilution Factor M - Instrument | MS2 - ICP-MS PE NexION/SW-846 Method 6020B NA - Not Applicable |

Form I-IN

SOUTHWEST RESEARCH INSTITUTE
Metals Report - Form I
Certificate of Analysis

SwRI ID
PB24E14KE1
Type: Blank

Client: Battelle Memorial Institute PNNL
Task Order: 240405-6
Lab ID: PB24E14KE1
Result Units: mg/L

SDG: 718819
SRR: 70993
Matrix: Water
% Solids: NA

Case: 733437
Project: 27927.13.001
Receipt Date: NA
Collection Date: NA

| CAS No. | Analyte | Result | Qual | M | RL | DF | Prep Batch | Analysis Date/Time |
|------------|---------------|----------|------|-----|----------|----|--------------------------------|--------------------|
| 14133-76-7 | Technetium-99 | 0.000500 | U | MS2 | 0.000500 | 1 | 20240523-P005 20240514-P002 | 06/06/2024 11:26 |

| Data Reporting Qualifiers (Qual) | Columns | Instruments/Methods (M) |
|--|---|--|
| U - Result is less than the SwRI Reporting Limit (RL) N - Matrix spike and/or matrix spike duplicate criteria was not met X - Analytical spike criteria was not met E - Result is estimated due to interferences D - Result is reported from a dilution * - Duplicate criteria was not met & - See narrative | RL - SwRI Reporting Limit DF - Dilution Factor M - Instrument | MS2 - ICP-MS PE NexION/SW-846 Method 6020B NA - Not Applicable |

Form I-IN

SOUTHWEST RESEARCH INSTITUTE
Metals Report - Form IIA
Initial and Continuing Calibration Verification

Client: Battelle Memorial Institute PNNL
Task Order: 240405-6
Result Units: ug/L
Associated Analytical Batches: 20240606-A011

SDG: 718819
SRR: 70993
Initial Calibration Source: See Raw Data
Continuing Calibration Source: See Raw Data

Case: 733437
Project: 27927.13.001

| Analyte | Initial Calibration Verification | | | | Continuing Calibration Verification | | | | | | |
|---------------|----------------------------------|--------|-------|----------|-------------------------------------|--------|-------|--------|-------|----------|-----|
| | True | Found | %Rec | Limit | True | Found1 | %Rec | Found2 | %Rec | Limit | M |
| Technetium-99 | 0.1 | 0.0957 | 95.7% | 90%-110% | 0.1 | 0.0957 | 95.7% | 0.0967 | 96.7% | 90%-110% | MS2 |

| <i>Instruments/Methods (M)</i> |
|---|
| MS2 - ICP-MS PE NexION/SW-846 Method 6020B NA - Not Applicable |

Form IIA-IN

SOUTHWEST RESEARCH INSTITUTE
Metals Report - Form IIB
Low Level Check Standard

Client: Battelle Memorial Institute PNNL
Task Order: 240405-6
Result Units: ug/L
Associated Analytical Batch: 20240606-A011

SDG: 718819
SRR: 70993

Case: 733437
Project: 27927.13.001

| CRI/CRA Standards | | | | | |
|-------------------|-------|---------|-------|----------|-----|
| Analyte | True | Found1 | %Rec | Limit | M |
| Technetium-99 | 0.005 | 0.00464 | 92.7% | 80%-120% | MS2 |

| <i>Instruments/Methods (M)</i> |
|---|
| MS2 - ICP-MS PE NexION/SW-846 Method 6020B NA - Not Applicable |

Form IIB-IN

SOUTHWEST RESEARCH INSTITUTE

Metals Report - Form III

Blanks

Client: Battelle Memorial Institute PNNL
Task Order: 240405-6
Preparation Blank Result Units: mg/L
Initial/Continuing Blank Result Units: ug/L

SDG: 718819
SRR: 70993
Preparation Blank Matrix: Liquid
Associated Prep Batches: 20240523-P005
20240514-P002

Case: 733437
Project: 27927.13.001
Associated Analytical Batches: 20240606-A011

| Analyte | Preparation Blank | | Initial Calibration Blank | | Continuing Calibration Blank | | | | M |
|---------------|-------------------|------|---------------------------|------|------------------------------|------|---------|------|-----|
| | Result | Qual | Found | Qual | Found1 | Qual | Found2 | Qual | |
| Technetium-99 | 0.000500 | U | 0.00500 | U | 0.00500 | U | 0.00500 | U | MS2 |

| Data Reporting Qualifiers (Qual) | Instruments/Methods (M) |
|---|---|
| U - Result is less than the SwRI Reporting Limit (RL) N - Matrix spike and/or matrix spike duplicate criteria was not met X - Analytical spike criteria was not met E - Result is estimated due to interferences D - Result is reported from a dilution * - Duplicate criteria was not met | MS2 - ICP-MS PE NexION/SW-846 Method 6020B NA - Not Applicable |

Form III-IN

SOUTHWEST RESEARCH INSTITUTE
Metals Report - Form IVB
ICP-MS Interference Check Sample

Client: Battelle Memorial Institute PNNL
Task Order: 240405-6
Instrument: ICP-MS PE NexION
Result Units: ug/L

SDG: 718819
SRR: 70993
ICSA Source: See Raw Data
ICSB Source: See Raw Data

Case: 733437
Project: 27927.13.001
Analysis Date: 06/06/2024
Associated Analytical Batch: 20240606-A011

| Analyte | True | | Found | | | | Limit | |
|---------------|--------------|---------------|--------------|------|---------------|-------|--------------------|----------------|
| | Sol. ICSA | Sol. ICSAB | Sol. ICSA | %Rec | Sol. ICSAB | %Rec | Limit ICSA | Limit ICSAB |
| Technetium-99 | 0.0085 | 0.0285 | 0.00716 | - | 0.0284 | 99.5% | -0.00150 to 0.0185 | 80%-120% |

Form IVB-IN

SOUTHWEST RESEARCH INSTITUTE
Metals Report - Form VA
Matrix Spike/Matrix Spike Duplicate Sample Recovery

Client Sample ID
T1155-EFF-CompMS

Client: Battelle Memorial Institute PNNL
Task Order: 240405-6
Lab ID: 718821MS
Result Units: mg/L

SDG: 718819
SRR: 70993
Matrix: Liquid
% Solids: NA

Case: 733437
Project: 27927.13.001

| Analyte | Parent Sample Result | Qual | MS Result | MS Spike Added | MS %Rec | MSD Result | MSD Spike Added | MSD %Rec | %RPD | Control Limit %Rec | Control Limit %RPD | M | Note |
|---------------|----------------------|------|-----------|----------------|---------|------------|-----------------|----------|------|--------------------|--------------------|-----|------|
| Technetium-99 | 0.564 | | 0.600 | 0.0117 | 307.7% | - | - | - | - | 75%-125% | - | MS2 | # |

Parent value exceeded 4 times the spike added, therefore MS/MSD %Recovery and %RPD are not required for evaluation.

| Data Reporting Qualifiers (Qual) | Columns | Instruments/Methods (M) |
|---|---|--|
| U - Result is less than the SwRI Reporting Limit (RL) N - Matrix spike and/or matrix spike duplicate criteria was not met X - Analytical spike criteria was not met E - Result is estimated due to interferences D - Result is reported from a dilution * - Duplicate criteria was not met | M - Instrument MS - Matrix Spike MSD - Matrix Spike Duplicate Q - Qualifier RPD - Relative Percent Difference | MS2 - ICP-MS PE NexION/SW-846 Method 6020B NA - Not Applicable |

Form VA-IN

SOUTHWEST RESEARCH INSTITUTE
Metals Report - Form VI
Duplicates

Client Sample ID
T1155-EFF-CompD

Client: Battelle Memorial Institute PNNL
Task Order: 240405-6
Lab ID: 718821D
Result Units: mg/L

SDG: 718819
SRR: 70993
Matrix: Liquid
% Solids: NA

Case: 733437
Project: 27927.13.001

| Analyte | Parent Sample Result | Qual | Duplicate Result | Qual | RPD | RPD Limit | Control Limit | M | Note |
|---------------|----------------------|------|------------------|------|------|-----------|---------------|-----|------|
| Technetium-99 | 0.564 | | 0.539 | | 4.5% | 20% | - | MS2 | |

| <i>Data Reporting Qualifiers (Qual)</i> | <i>Columns</i> | <i>Instruments/Method (M)</i> |
|---|---|--|
| U - Result is less than the SwRI Reporting Limit (RL) N - Matrix spike and/or matrix spike duplicate criteria was not met X - Analytical spike criteria was not met E - Result is estimated due to interferences D - Result is reported from a dilution * - Duplicate criteria was not met | M - Instrument RPD - Relative Percent Difference | MS2 - ICP-MS PE NexION/SW-846 Method 6020B NA - Not Applicable |

Form VI-IN

SOUTHWEST RESEARCH INSTITUTE
Metals Report - Form VII
Laboratory Control Sample

SwRI ID

LCS24E14KE1

Client: Battelle Memorial Institute PNNL
Task Order: 240405-6
Lab ID: LCS24E14KE1
Result Units: mg/L

SDG:
SRR: 70993
Matrix: Water
Associated Prep Batches: 20240523-P005
20240514-P002

Case: 733437
Project: 27927.13.001
LCS Source:

| Analyte | True | Found | Qual | %Rec. | Limit | M | Analysis Date/Time |
|---------------|--------|--------|------|-------|----------|-----|--------------------|
| Technetium-99 | 0.0117 | 0.0108 | | 92.3% | 80%-120% | MS2 | 06/06/2024 11:29 |

Instruments/Methods (M)

MS2 - ICP-MS PE NexION/SW-846 Method 6020B
NA - Not Applicable

Form VII-IN

SOUTHWEST RESEARCH INSTITUTE
Metals Report - Form VIII
ICP-AES and ICP-MS Serial Dilutions

Client Sample ID
T1155-EFF-Compl

Client: Battelle Memorial Institute PNNL
Task Order: 240405-6
Lab ID: 718821L
Result Units: ug/L

SDG: 718819
SRR: 70993
Matrix: Liquid

Case: 733437
Project: 27927.13.001

| Analyte | Parent Sample Result | Qual | Serial Dilution Result | Qual | % Diff. | % Diff. Limit | M | Note | DF | Prep Batch | Analysis Date/Time |
|---------------|----------------------|------|------------------------|------|---------|---------------|-----|------|-----|---------------|--------------------|
| Technetium-99 | 0.0564 | D | 0.0532 | D | 5.72% | - | MS2 | # | 500 | 20240523-P005 | 06/06/2024 11:18 |

Indicates that the parent sample result is less than 50 times the RL, therefore no percent difference limit is applicable.

| Data Reporting Qualifiers (Qual) | Instruments/Methods (M) |
|--|--|
| J - Result is greater than or equal to the SwRI Reporting Limit (RL) and less than the SwRI Reporting Limit (RL) U - Result is less than the SwRI Reporting Limit (RL)) N - Matrix spike and/or matrix spike duplicate criteria was not met X - Analytical spike criteria was not met E - Result is estimated due to interferences D - Result is reported from a dilution * - Duplicate criteria was not met | MS2 - ICP-MS PE NexION/SW-846 Method 6020B NA - Not Applicable |

Form VIII-IN

SOUTHWEST RESEARCH INSTITUTE
Metals Report - Form IX
Detection Limits

Client: Battelle Memorial Institute PNNL
Task Order: 240405-6
Result Units: ug/L

SDG: 718819
SRR: 70993
Instrument: ICP-MS PE NexION

Case: 733437
Project: 27927.13.001

| Analyte | Mass | RL |
|---------------|------|---------|
| Technetium-99 | 99 | 0.00500 |

| <i>Columns</i> |
|---------------------------|
| RL - SwRI Reporting Limit |

Form IX-IN

SOUTHWEST RESEARCH INSTITUTE
Metals Report - Form XI
ICP-MS Internal Standard Association

Client: Battelle Memorial Institute PNNL
Task Order: 240405-6
Analytical Batch: 20240606-A011
Analysis Method: SW-846 Method 6020B

SDG: 718819
SRR: 70993
Instrument: ICP-MS PE NexION

Case: 733437
Project: 27927.13.001
Start Date/Time: 6/6/2024 10:33:34 AM
End Date/Time: 6/6/2024 11:35:22 AM

| Analyte | Assoc.Internal Standard |
|---------------|----------------------------|
| Technetium-99 | Rh103 |

SOUTHWEST RESEARCH INSTITUTE

Metals Report - Form XII

Analysis Run Log

Client: Battelle Memorial Institute PNNL
Task Order: 240405-6
Analytical Batch: 20240606-A011
Analysis Method: SW-846 Method 6020B

SDG: 718819
SRR: 70993
Instrument: ICP-MS PE NexION

Case: 733437
Project: 27927.13.001
Start Date: 06/06/2024
End Date: 06/06/2024

| Lab Sample ID | Client Sample ID | Time | DF | T c 9 9 |
|---------------|------------------|-------|-----|------------------|
| S-0 | S-0 | 10:33 | 1 | X |
| S-250 | S-250 | 10:36 | 1 | X |
| ICV | ICV | 10:39 | 1 | X |
| ICB | ICB | 10:42 | 1 | X |
| CRI 1.0 | CRI 1.0 | 10:44 | 1 | |
| CRI 5.0 | CRI 5.0 | 10:47 | 1 | X |
| ICSA | ICSA | 10:50 | 1 | X |
| ICSAB | ICSAB | 10:53 | 1 | X |
| ZZZZZ | ZZZZZ | 10:56 | 1 | |
| CCV | CCV | 10:59 | 1 | X |
| CCB | CCB | 11:01 | 1 | X |
| 718821 | TI155-EFF-Comp | 11:12 | 100 | X |
| 718821D | TI155-EFF-CompD | 11:15 | 100 | X |
| 718821L | TI155-EFF-CompL | 11:18 | 500 | X |
| 718821MS | TI155-EFF-CompMS | 11:21 | 100 | X |
| 718822 | TI155-Feed-Comp | 11:24 | 100 | X |
| PB24E14KE1 | NA | 11:26 | 1 | X |
| LCS24E14KE1 | NA | 11:29 | 1 | X |
| CCV | CCV | 11:32 | 1 | X |
| CCB | CCB | 11:35 | 1 | X |

SOUTHWEST RESEARCH INSTITUTE
Metals Report - Form XIV
Internal Standards Relative Intensity Summary

Client: Battelle Memorial Institute PNNL
Task Order: 240405-6
Analytical Batch: 20240606-A011
Analysis Method: SW-846 Method 6020B

SDG: 718819
SRR: 70993
Instrument: ICP-MS PE NexION

Case: 733437
Project: 27927.13.001
Start Date: 06/06/2024
End Date: 06/06/2024

| Lab Sample ID | Client Sample ID | Time | DF | Rh |
|---------------|------------------|-------|-----|------|
| S-0 | S-0 | 10:33 | 1 | - |
| S-250 | S-250 | 10:36 | 1 | - |
| ICV | ICV | 10:39 | 1 | 79.3 |
| ICB | ICB | 10:42 | 1 | 99.9 |
| CRI 1.0 | CRI 1.0 | 10:44 | 1 | 100 |
| CRI 5.0 | CRI 5.0 | 10:47 | 1 | 101 |
| ICSA | ICSA | 10:50 | 1 | 64.7 |
| ICSAB | ICSAB | 10:53 | 1 | 66.5 |
| ZZZZZ | ZZZZZ | 10:56 | 1 | 101 |
| CCV | CCV | 10:59 | 1 | 79.3 |
| CCB | CCB | 11:01 | 1 | 98.4 |
| 718821 | TI155-EFF-Comp | 11:12 | 100 | 101 |
| 718821D | TI155-EFF-CompD | 11:15 | 100 | 99.5 |
| 718821L | TI155-EFF-CompL | 11:18 | 500 | 101 |
| 718821MS | TI155-EFF-CompMS | 11:21 | 100 | 100 |
| 718822 | TI155-Feed-Comp | 11:24 | 100 | 100 |
| PB24E14KE1 | NA | 11:26 | 1 | 78.9 |
| LCS24E14KE1 | NA | 11:29 | 1 | 78.8 |
| CCV | CCV | 11:32 | 1 | 78.9 |
| CCB | CCB | 11:35 | 1 | 99.2 |

SOUTHWEST RESEARCH INSTITUTE
Metals Report - Form XVII
Linear Ranges

Client: Battelle Memorial Institute PNNL
Task Order: 240405-6
Result Units: ug/L

SDG: 718819
SRR: 70993
Instrument: ICP-MS PE NexION

Case: 733437
Project: 27927.13.001
Date: 06/06/2024

| Analyte | Upper Calibration Limit |
|---------------|-------------------------|
| Technetium-99 | 0.25 |

SOUTHWEST RESEARCH INSTITUTE
Metals Report - Form XVIII
Preparation/Digestion Summary

Client: Battelle Memorial Institute PNNL
Task Order: 240405-6

SDG: 718819
SRR: 70993

Case: 733437
Project: 27927.13.001

| Prep Batch | Method | Preparation Date |
|---------------|------------------|------------------|
| 20240514-P002 | Acid Dissolution | 05/14/2024 |
| 20240523-P005 | Tc99 | 05/23/2024 |

Preparation Log

Metals

A38029

A38029

Southwest Research Institute
San Antonio, Texas 78238

Batch: 20240514-P002 (Ver. 1)

Status: APPROVED

Client(s): Battelle Memorial Institute PNNL
Task Order(s): 240405-6
SDG(s): 718819
Case(s): 733437
Project(s): 27927.13.001
Method(s): Acid Dissolution (TAP: 01-0406-037)
Matrix(s): Liquid
Instrument(s): ICP-MS
Reagent(s): 1M HNO₃ 260971
Pipette(s): 1000-J, 200-1
Equipment: CT 20240510-Q003
Heating Device: ModBlock#1
Temperature (C): 80
Time In: 05/14/2024 10:40:08
Location: S12-B8

| Sample Identification | Client Identification | Initial Volume (mL) | Final Volume (mL) |
|-----------------------|-----------------------|---------------------|-------------------|
| PB24E14KE1 | NA | 0.5 | 25 |
| LCS24E14KE1 ① | NA | 0.5 | 25 |
| 718821 | TI155-EFF-Comp | 0.5 | 25 |
| 718821D | TI155-EFF-Comp | 0.5 | 25 |
| 718821MS ① | TI155-EFF-Comp | 0.5 | 25 |
| 718822 | TI155-Feed-Comp | 0.5 | 25 |

① spiked 0.2 mL of CI# 94145 Technetium-99 002RadSol4 (Lot# SRM4288A, Source: NIST, Exp: 03/14/2025)

Comments:

Aliquoted 0.5mL into CT and added 25mL 1M HNO₃.
Heated at 80°C for 3-4hrs.
FV to 25mL with DI water.

Procedure:

See TAP 01-0406-037 for details.

CGL - 06/13/2024

Prepared by: EDRISI, KHALED

Date: 05/14/2024

Reviewed by: SILVIN, KRISTA

Date: 05/20/2024

Disposal Int/Date/Loc: _____

Page 1 of 1

Program version(8/11/2011)

Preparation Log

Metals

A38154

A38154

Southwest Research Institute
San Antonio, Texas 78238

Batch: 20240523-P005 (Ver. 2)

Status: APPROVED

Client(s): Battelle Memorial Institute PNNL
Task Order(s): 240405-6
SDG(s): 718819
Case(s): 733437
Project(s): 27927.13.001
Method(s): Tc99 (TAP:)
Matrix(s): Liquid
Instrument(s): ICP-MS
Reagent(s): TEVA resin 229672, 0.1M HNO3 248619, 0.01M HNO3 236015, 0.5M HF/0.02M HNO3 247176, 1% Nitric Acid 262189
Balance(s): Bal #135 (AN:020014)
Pipette(s): 1000-4, 200-4, 5000-16
Equipment: Columns 229762, Column tips 199864, Connector tubes 197195, Centrifuge Tubes 20240510-Q003
Time In: 05/23/2024 10:05:00
Location: S14B6

| <u>Sample Identification</u> | <u>Client Identification</u> | <u>Initial Volume (mL)</u> | <u>Final Volume (mL)</u> |
|------------------------------|------------------------------|------------------------------------|----------------------------------|
| PB24E14KE1 | NA | 10 | 20 |
| LCS24E14KE1 | NA | 10 | 20 |
| 718821 | TI155-EFF-Comp | 10 | 20 |
| 718821D | TI155-EFF-Comp | 10 | 20 |
| 718821MS | TI155-EFF-Comp | 10 | 20 |
| 718822 | TI155-Feed-Comp | 10 | 20 |

+ all samples prepared in batch 20240514-P002

Comments:

Column Separation by James Tutor and Monica Settles
Initial Sep Volume = 10mL of digestate
Final Sep Volume = 25mL
Final Digestate Volume = 20mL (in 1% nitric acid)

CGL - 06/13/2024

Prepared by: SETTLES, MONICA

Date: 05/23/2024

Reviewed by: RANGER, JACQUELINE

Date: 05/31/2024

Disposal Int/Date/Loc: _____

Page 1 of 1

Program version(8/11/2011)

SOUTHWEST RESEARCH INSTITUTE

CLIENT: Battelle Memorial Institute PNNL

SwRI Project #: 27927.13.001

SwRI Task Order #: 240405-6

SDG #: 718819

TON #: 733437

Raw Data

SOUTHWEST RESEARCH INSTITUTE

CLIENT: Battelle Memorial Institute PNNL

SwRI Project #: 27927.13.001

SwRI Task Order #: 240405-6

SDG #: 718819

TON #: 733437

Sample Calculations

PNNL to#240405-6

| system id | instr | elem | I @instr (ng/L) | A @instr (ug/L) | B FV (L) | C IV (mL) | D DF | E result (mg/L) | reported mg/L |
|-----------|--------|---------------|--------------------|--------------------|-------------|--------------|---------|--------------------|------------------|
| 718821 | ICP-MS | technetium-99 | 56.437424 | 0.056437424 | 0.025 | 0.5 | 200 | 0.564 | 0.564 |

sample calculations:

$$A = I / 1000$$

10

20

DF includes DF100 at instrument and DF2 (10mL digestate to FV20mL) for column separation prep

$$E = (A * D * B) / C$$

[Handwritten Signature]
6/13/24

SOUTHWEST RESEARCH INSTITUTE

CLIENT: Battelle Memorial Institute PNNL

SwRI Project #: 27927.13.001

SwRI Task Order #: 240405-6

SDG #: 718819

TON #: 733437

ICP-MS
Tc-99 Raw Data

SOUTHWEST RESEARCH INSTITUTE

- ☒ 6020B TAP No. 01-0413-006
☐ TAP No. 01-0406-174
☐ TAP No. 01-0406-166: E Tc99, F Imp, C Iso U
☐ Other _____

ANALYSIS

Tc99

ICP-MS CALIB. STD. ID's

| | |
|--------|-------------------|
| S0 | <u>MS14-113-2</u> |
| STD. | <u>MS14-113-3</u> |
| I. STD | <u>256275</u> |
| I. STD | <u>—</u> |
| TUNE | <u>262389</u> |

QC STD. ID's

| | |
|---------|----------------------|
| ICV/CCV | <u>MS14-108-2</u> |
| UCL | <u>—</u> |
| CRI | <u>MS14-113-4/-5</u> |
| ICSA | <u>MS14-113-6</u> |
| ICSAB | <u>MS14-113-7</u> |

Pipettes

200- N
1000- M
5000- 161

| PROJECT# | CLIENT | TO# | DATE | PREP BATCH |
|---------------------|---------------------|-----------------|---------------|----------------------|
| <u>27927.13.001</u> | <u>BattellePNNL</u> | <u>240405-6</u> | <u>6/6/24</u> | <u>20240523-P005</u> |
| _____ | _____ | _____ | _____ | _____ |
| _____ | _____ | _____ | _____ | _____ |
| _____ | _____ | _____ | _____ | _____ |
| _____ | _____ | _____ | _____ | _____ |
| _____ | _____ | _____ | _____ | _____ |
| _____ | _____ | _____ | _____ | _____ |
| _____ | _____ | _____ | _____ | _____ |

INSTRUMENT: NexIon

FILENAME: N240606

Analyst: [Signature] Date: 6/6/24

Analytical Batch: 20240606-A011

SwRI - ICP-MS Dilution Sheet

Client(s): Battelle PNNL

Task Order(s): 240405-6

Prep Batch: 20240523-P005

Prepared By/Date: [Signature] 6/5/24

HNO₃: 256171 HCl: — Other: HF: 254634

Pipettes: 5000- 161 1000- M 200- N

5mL Final Volume

| | | | | | |
|--------------------------|--------|----------------|------------------|------------------------------|-----|
| <input type="checkbox"/> | DF2 | 2.5mL sample | + 2.5mL Matrix | ___%HNO ₃ ___%HCl | ___ |
| <input type="checkbox"/> | DF5 | 1.0mL sample | + 4.0mL Matrix | ___%HNO ₃ ___%HCl | ___ |
| <input type="checkbox"/> | DF10 | 0.5mL sample | + 4.5mL Matrix | ___%HNO ₃ ___%HCl | ___ |
| <input type="checkbox"/> | DF20 | 0.25mL sample | + 4.75mL Matrix | ___%HNO ₃ ___%HCl | ___ |
| <input type="checkbox"/> | DF25 | 0.2mL sample | + 4.8mL Matrix | ___%HNO ₃ ___%HCl | ___ |
| <input type="checkbox"/> | DF50 | 0.1mL sample | + 4.9mL Matrix | ___%HNO ₃ ___%HCl | ___ |
| <input type="checkbox"/> | DF100 | 0.05mL sample | + 4.95mL Matrix | ___%HNO ₃ ___%HCl | ___ |
| <input type="checkbox"/> | DF200 | 0.025mL sample | + 4.975mL Matrix | ___%HNO ₃ ___%HCl | ___ |
| <input type="checkbox"/> | DF250 | 0.02mL sample | + 4.98mL Matrix | ___%HNO ₃ ___%HCl | ___ |
| <input type="checkbox"/> | DF ___ | ___mL sample | + ___mL Matrix | ___%HNO ₃ ___%HCl | ___ |
| <input type="checkbox"/> | DF ___ | ___mL sample | + ___mL Matrix | ___%HNO ₃ ___%HCl | ___ |
| <input type="checkbox"/> | DF ___ | ___mL sample | + ___mL Matrix | ___%HNO ₃ ___%HCl | ___ |

10mL Final Volume

| | | | | | |
|-------------------------------------|--------|---------------|-----------------|-------------------------------------|------------------|
| <input type="checkbox"/> | DF2 | 5.0mL sample | + 5.0mL Matrix | ___%HNO ₃ ___%HCl | ___ |
| <input type="checkbox"/> | DF5 | 2.0mL sample | + 8.0mL Matrix | ___%HNO ₃ ___%HCl | ___ |
| <input type="checkbox"/> | DF10 | 1.0mL sample | + 9.0mL Matrix | ___%HNO ₃ ___%HCl | ___ |
| <input type="checkbox"/> | DF20 | 0.5mL sample | + 9.5mL Matrix | ___%HNO ₃ ___%HCl | ___ |
| <input type="checkbox"/> | DF25 | 0.4mL sample | + 9.6mL Matrix | ___%HNO ₃ ___%HCl | ___ |
| <input type="checkbox"/> | DF50 | 0.2mL sample | + 9.8mL Matrix | ___%HNO ₃ ___%HCl | ___ |
| <input checked="" type="checkbox"/> | DF100 | 0.1mL sample | + 9.9mL Matrix | <u>13</u> %HNO ₃ ___%HCl | <u>0.013%</u> HF |
| <input type="checkbox"/> | DF200 | 0.05mL sample | + 9.95mL Matrix | ___%HNO ₃ ___%HCl | ___ |
| <input type="checkbox"/> | DF250 | 0.04mL sample | + 9.96mL Matrix | ___%HNO ₃ ___%HCl | ___ |
| <input checked="" type="checkbox"/> | DF500 | 0.02mL sample | + 9.98mL Matrix | <u>13</u> %HNO ₃ ___%HCl | <u>0.013%</u> HF |
| <input type="checkbox"/> | DF ___ | ___mL sample | + ___mL Matrix | ___%HNO ₃ ___%HCl | ___ |
| <input type="checkbox"/> | DF ___ | ___mL sample | + ___mL Matrix | ___%HNO ₃ ___%HCl | ___ |
| <input type="checkbox"/> | DF ___ | ___mL sample | + ___mL Matrix | ___%HNO ₃ ___%HCl | ___ |

- | | |
|--|--|
| <input type="checkbox"/> ___ mL Final Volume Sample Spiked With (A) | <input type="checkbox"/> 0.020mL Multielement Solution 1 #253320 <input type="checkbox"/> 0.020mL Multielement Solution 2 #253323 <input type="checkbox"/> 0.020mL Multielement Solution 3 #253324 <input type="checkbox"/> 0.020mL Multielement Solution 4 #253325 <input type="checkbox"/> ___ mL ___ <input type="checkbox"/> ___ mL ___ |
|--|--|

| | |
|----------------|---|
| S-0 | 6/6/2024 10:33 C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Method\SwRI\Tc99-1.mth |
| S-250 | 6/6/2024 10:36 C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Method\SwRI\Tc99-1.mth |
| ICV | 6/6/2024 10:39 C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Method\SwRI\Tc99-1.mth |
| ICB | 6/6/2024 10:42 C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Method\SwRI\Tc99-1.mth |
| CRI 1.0 | 6/6/2024 10:44 C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Method\SwRI\Tc99-1.mth |
| CRI 5.0 | 6/6/2024 10:47 C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Method\SwRI\Tc99-1.mth |
| ICSA | 6/6/2024 10:50 C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Method\SwRI\Tc99-1.mth |
| ICSAB | 6/6/2024 10:53 C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Method\SwRI\Tc99-1.mth |
| ZZZZZ | 6/6/2024 10:56 C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Method\SwRI\Tc99-1.mth |
| CCV | 6/6/2024 10:59 C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Method\SwRI\Tc99-1.mth |
| CCB | 6/6/2024 11:01 C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Method\SwRI\Tc99-1.mth |
| 718821 DF100 | 6/6/2024 11:12 C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Method\SwRI\Tc99-1.mth |
| 718821D DF100 | 6/6/2024 11:15 C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Method\SwRI\Tc99-1.mth |
| 718821L DF500 | 6/6/2024 11:18 C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Method\SwRI\Tc99-1.mth |
| 718821MS DF100 | 6/6/2024 11:21 C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Method\SwRI\Tc99-1.mth |
| 718822 DF100 | 6/6/2024 11:24 C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Method\SwRI\Tc99-1.mth |
| PB24E14KE1 | 6/6/2024 11:26 C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Method\SwRI\Tc99-1.mth |
| LCS24E14KE1 | 6/6/2024 11:29 C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Method\SwRI\Tc99-1.mth |
| CCV | 6/6/2024 11:32 C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Method\SwRI\Tc99-1.mth |
| CCB | 6/6/2024 11:35 C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Method\SwRI\Tc99-1.mth |

| | |
|-------------|--------------------|
| Standard #1 | S-0.653 |
| Standard #2 | S-250.654 |
| Sample | ICV.655 |
| Sample | ICB.656 |
| Sample | CRI 1.0.657 |
| Sample | CRI 5.0.658 |
| Sample | ICSA.659 |
| Sample | ICSAB.660 |
| Sample | ZZZZZ.661 |
| Sample | CCV.662 |
| Sample | CCB.663 |
| Sample | 718821 DF100.664 |
| Sample | 718821D DF100.665 |
| Sample | 718821L DF500.666 |
| Sample | 718821MS DF100.667 |
| Sample | 718822 DF100.668 |
| Sample | PB24E14KE1.669 |
| Sample | LCS24E14KE1.670 |
| Sample | CCV.671 |
| Sample | CCB.672 |

SWRI

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6/6/24

Southwest Research Institute

Sample Date/Time: Thursday, June 06, 2024 08:38:59
Method File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Method\STD Performance Check SwRI.mth
Dataset File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\DataSet\Y24JUN\Lab Performance Check.627
MassCal File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\MassCal\Default.tun
Conditions File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Conditions\Default.dac
Dual Detector Mode: Pulse
Acq. Dead Time (ns): 35
Current Dead Time (ns): 35
Torch Position Vertical (Y) -0.93
Torch Position Horizontal (X) 0.49
Torch Z position (mm): 1.00

[Signature]
6/6/24

Summary

| Analyte | Mass | Meas. Intens. | Mean | Net Intens. | Mean | Net Intens. | SD | Net Intens. | RSD | Mode |
|---------|-------|---------------|----------|-------------|------------|-------------|---------|-------------|------|----------|
| Be | 9.0 | | 14574.2 | | 14574.164 | | 100.250 | | 0.7 | Standard |
| Mg | 24.0 | | 78501.2 | | 78501.175 | | 700.918 | | 0.9 | Standard |
| In | 114.9 | | 158785.4 | | 158785.377 | | 482.086 | | 0.3 | Standard |
| U | 238.1 | | 107776.4 | | 107776.360 | | 333.501 | | 0.3 | Standard |
| [CeO | 155.9 | | 3364.5 | | 0.023 | | 0.000 | | 1.2 | Standard |
| [> Ce | 139.9 | | 148960.4 | | 148960.407 | | 687.451 | | 0.5 | Standard |
| [Ce++ | 70.0 | | 2969.2 | | 0.020 | | 0.000 | | 1.5 | Standard |
| Bkgd | 220.0 | | 140.8 | | 140.767 | | 44.820 | | 31.8 | Standard |

Current Conditions File Data

| Current Value | Description |
|---------------|---|
| 1.04 | Standard - Nebulizer Gas Flow STD/KED [NEB] |
| 1.20 | Standard - Auxiliary Gas Flow |
| 18.00 | Standard - Plasma Gas Flow |
| -12.00 | Standard - Deflector Voltage |
| 1600.00 | Standard - ICP RF Power |
| -2962.00 | Standard - Analog Stage Voltage |
| 1950.00 | Standard - Pulse Stage Voltage |
| 0.00 | Standard - Quadrupole Rod Offset STD [QRO] |
| -4.00 | Standard - Cell Rod Offset STD [CRO] |
| 6.00 | Standard - Discriminator Threshold |
| -10.00 | Standard - Cell Entrance/Exit Voltage STD |
| 1.04 | Ammonia DRC - DRC Mode NEB |
| -9.00 | Ammonia DRC - DRC Mode QRO |
| -2.00 | Ammonia DRC - DRC Mode CRO |
| -7.00 | Ammonia DRC - DRC Mode Cell Entrance/Exit Voltage |
| 200.00 | Ammonia DRC - Axial Field Voltage |
| 0.00 | Ammonia DRC - RPa |
| 0.45 | Ammonia DRC - RPq |
| 0.60 | Ammonia DRC - Cell Gas A |
| -12.00 | Helium KED - KED Mode QRO |
| -15.00 | Helium KED - KED Mode CRO |
| -8.00 | Helium KED - KED Mode Cell Entrance Voltage |
| -25.00 | Helium KED - KED Mode Cell Exit Voltage |
| 475.00 | Helium KED - KED Mode Axial Field Voltage |
| 0.00 | Helium KED - KED RPa |
| 0.25 | Helium KED - KED RPq |
| 4.50 | Helium KED - Cell Gas B |

[Signature]
6/13/24

Instrument Mass Calibration Report

File Name: Default.tun
File Path: C:\Users\Public\Documents\PerkinElmer Syngistix\CPMS\MassCal\Default.tun
Acq. Date/Time: 08:38:59 Thu 06-Jun-24

| Analyte | Exact Mass | Meas. Mass | Mass DAC | Res. DAC | Meas. Peak Width | Custom Res. |
|---------|------------|------------|----------|----------|------------------|-------------|
| Li | 7.016 | 7.025 | 1315 | 2022 | 0.696 | |
| Mg | 23.985 | 23.975 | 4706 | 2019 | 0.711 | |
| In | 114.904 | 114.925 | 22873 | 2025 | 0.708 | |
| U | 238.050 | 238.075 | 47476 | 2042 | 0.678 | |

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Sample ID: S-0

Sample Date/Time: Thursday, June 06, 2024 10:33:34

Solution Type: Standard

Blank File:

Number of Replicates: 3

Peak Processing Mode: Average

Signal Profile Processing Mode: Average

Dual Detector Mode: Dual

Current Dead Time (ns): 35

Sample File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Sample\SwRI\Tc99-1.sam

Method File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Method\SwRI\Tc99-1.mth

Dataset File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\DataSet\Y24JUN\S-0.653

Tuning File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\MassCal\Default.tun

Optimization File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Conditions\Default.dac

Calibration File:

Calibration Type: External Calibration

Summary

Intensities

| | Analyte Mass | Meas. Intens. | Mean | Meas. Intens. | RSD | Blank Intensity | Blank Intens. | SD |
|----|--------------|---------------|--------------|---------------|--------|-----------------|---------------|-------|
| | Mo | 100 | 203.134 | | 13.846 | 0.000 | | 0.000 |
| | Ru | 101 | 798.689 | | 3.047 | 0.000 | | 0.000 |
| | Ru | 102 | -4633.353 | | 1.860 | 0.000 | | 0.000 |
| [| Tc | 99 | 623.347 | | 2.594 | 0.000 | | 0.000 |
| [> | Rh | 103 | 16817296.575 | | 0.754 | 0.000 | | 0.000 |
| | Rh-IS | 103 | 16817296.575 | | 0.754 | 0.000 | | 0.000 |

Concentration Results

| | Analyte Mass | Net Intens. | Mean | Conc. Mean | Conc. SD | Conc. RSD | Sample Unit |
|----|--------------|-------------|--------------|------------|----------|-----------|-------------|
| | Mo | 100 | 203.134 | | | | ng/L |
| | Ru | 101 | 798.689 | | | | ng/L |
| | Ru | 102 | -4633.353 | | | | ng/L |
| [| Tc | 99 | 0.000 | | | | ng/L |
| [> | Rh | 103 | 16817296.575 | | | | ng/L |
| | Rh-IS | 103 | 16817296.575 | 100.000000 | 0.754 | 0.754 | ng/L |

Southwest Research Institute

Sample ID: S-250

Sample Date/Time: Thursday, June 06, 2024 10:36:24

Solution Type: Standard

Blank File:

Number of Replicates: 3

Peak Processing Mode: Average

Signal Profile Processing Mode: Average

Dual Detector Mode: Dual

Current Dead Time (ns): 35

Sample File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Sample\SwRI\Tc99-1.sam

Method File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Method\SwRI\Tc99-1.mth

Dataset File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\DataSet\Y24JUN\S-250.654

Tuning File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\MassCal\Default.tun

Optimization File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Conditions\Default.dac

Calibration File:

Calibration Type: External Calibration

Summary

Intensities

| | Analyte Mass | Meas. Intens. | Mean | Meas. Intens. | RSD | Blank Intensity | Blank Intens. | SD |
|----|--------------|---------------|--------------|---------------|--------|-----------------|---------------|-------|
| | Mo | 100 | 239.351 | | 11.493 | 0.000 | | 0.000 |
| | Ru | 101 | 664.349 | | 7.323 | 0.000 | | 0.000 |
| | Ru | 102 | -4620.058 | | 2.103 | 0.000 | | 0.000 |
| [| Tc | 99 | 53949.355 | | 1.290 | 0.000 | | 0.000 |
| [> | Rh | 103 | 16636084.916 | | 0.688 | 0.000 | | 0.000 |
| | Rh-IS | 103 | 16636084.916 | | 0.688 | 0.000 | | 0.000 |

Concentration Results

| | Analyte Mass | Net Intens. | Mean | Conc. Mean | Conc. SD | Conc. RSD | Sample Unit |
|----|--------------|-------------|--------------|------------|----------|-----------|-------------|
| | Mo | 100 | 239.351 | | | | ng/L |
| | Ru | 101 | 664.349 | | | | ng/L |
| | Ru | 102 | -4620.058 | | | | ng/L |
| [| Tc | 99 | 0.003 | 250.000000 | 2.567 | 1.027 | ng/L |
| [> | Rh | 103 | 16636084.916 | | | | ng/L |
| | Rh-IS | 103 | 16636084.916 | 98.922469 | 0.681 | 0.688 | ng/L |

Southwest Research Institute

Sample ID: ICV

Sample Date/Time: Thursday, June 06, 2024 10:39:15

Solution Type: Sample

Blank File:

Number of Replicates: 3

Peak Processing Mode: Average

Signal Profile Processing Mode: Average

Dual Detector Mode: Dual

Current Dead Time (ns): 35

Sample File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Sample\SwRI\Tc99-1.sam

Method File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Method\SwRI\Tc99-1.mth

Dataset File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\DataSet\Y24JUN\ICV.655

Tuning File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\MassCal\Default.tun

Optimization File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Conditions\Default.dac

Calibration File:

Calibration Type: External Calibration

Summary

Intensities

| | Analyte Mass | Meas. Intens. | Mean | Meas. Intens. | RSD | Blank Intensity | Blank Intens. | SD |
|----|--------------|---------------|--------------|---------------|--------|-----------------|---------------|-------|
| | Mo | 100 | 103.138 | | 17.091 | 0.000 | | 0.000 |
| | Ru | 101 | 398.339 | | 3.276 | 0.000 | | 0.000 |
| | Ru | 102 | -2536.761 | | 2.461 | 0.000 | | 0.000 |
| [| Tc | 99 | 16874.628 | | 1.055 | 0.000 | | 0.000 |
| [> | Rh | 103 | 13342048.591 | | 0.351 | 0.000 | | 0.000 |
| | Rh-IS | 103 | 13342048.591 | | 0.351 | 0.000 | | 0.000 |

Concentration Results

| | Analyte Mass | Net Intens. | Mean | Conc. Mean | Conc. SD | Conc. RSD | Sample Unit |
|----|--------------|-------------|--------------|------------|----------|-----------|-------------|
| | Mo | 100 | 103.138 | | | | ng/L |
| | Ru | 101 | 398.339 | | | | ng/L |
| | Ru | 102 | -2536.761 | | | | ng/L |
| [| Tc | 99 | 0.001 | 95.738890 | 0.762 | 0.796 | ng/L |
| [> | Rh | 103 | 13342048.591 | | | | ng/L |
| | Rh-IS | 103 | 13342048.591 | 79.335276 | 0.279 | 0.351 | ng/L |

Southwest Research Institute

Sample ID: ICB

Sample Date/Time: Thursday, June 06, 2024 10:42:05

Solution Type: Sample

Blank File:

Number of Replicates: 3

Peak Processing Mode: Average

Signal Profile Processing Mode: Average

Dual Detector Mode: Dual

Current Dead Time (ns): 35

Sample File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Sample\SwRI\Tc99-1.sam

Method File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Method\SwRI\Tc99-1.mth

Dataset File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\DataSet\Y24JUN\ICB.656

Tuning File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\MassCal\Default.tun

Optimization File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Conditions\Default.dac

Calibration File:

Calibration Type: External Calibration

Summary

Intensities

| Analyte | Mass | Meas. Intens. | Mean | Meas. Intens. | RSD | Blank Intensity | Blank Intens. | SD |
|---------|------|---------------|--------------|---------------|--------|-----------------|---------------|-------|
| Mo | 100 | | 188.543 | | 45.312 | 0.000 | | 0.000 |
| Ru | 101 | | 805.356 | | 2.546 | 0.000 | | 0.000 |
| Ru | 102 | | -4561.621 | | 4.668 | 0.000 | | 0.000 |
| [Tc | 99 | | 606.013 | | 5.618 | 0.000 | | 0.000 |
| [> Rh | 103 | | 16800251.389 | | 1.254 | 0.000 | | 0.000 |
| Rh-IS | 103 | | 16800251.389 | | 1.254 | 0.000 | | 0.000 |

Concentration Results

| Analyte | Mass | Net Intens. | Mean | Conc. Mean | Conc. SD | Conc. RSD | Sample Unit |
|---------|------|-------------|--------------|------------|----------|-----------|-------------|
| Mo | 100 | | 188.543 | | | | ng/L |
| Ru | 101 | | 805.356 | | | | ng/L |
| Ru | 102 | | -4561.621 | | | | ng/L |
| [Tc | 99 | | 0.000 | -0.076407 | 0.179 | 234.523 | ng/L |
| [> Rh | 103 | | 16800251.389 | | | | ng/L |
| Rh-IS | 103 | | 16800251.389 | 99.898645 | 1.253 | 1.254 | ng/L |

Southwest Research Institute

Sample ID: CRI 1.0

Sample Date/Time: Thursday, June 06, 2024 10:44:55

Solution Type: Sample

Blank File:

Number of Replicates: 3

Peak Processing Mode: Average

Signal Profile Processing Mode: Average

Dual Detector Mode: Dual

Current Dead Time (ns): 35

Sample File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Sample\SwRI\Tc99-1.sam

Method File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Method\SwRI\Tc99-1.mth

Dataset File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\DataSet\Y24JUN\CRI 1.0.657

Tuning File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\MassCal\Default.tun

Optimization File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Conditions\Default.dac

Calibration File:

Calibration Type: External Calibration

Summary

Intensities

| | Analyte Mass | Meas. Intens. | Mean | Meas. Intens. | RSD | Blank Intensity | Blank Intens. | SD |
|----|--------------|---------------|--------------|---------------|--------|-----------------|---------------|-------|
| | Mo | 100 | 202.296 | | 15.563 | 0.000 | | 0.000 |
| | Ru | 101 | 776.354 | | 3.971 | 0.000 | | 0.000 |
| | Ru | 102 | -4577.592 | | 2.365 | 0.000 | | 0.000 |
| [| Tc | 99 | 758.353 | | 3.721 | 0.000 | | 0.000 |
| [> | Rh | 103 | 16871550.992 | | 0.257 | 0.000 | | 0.000 |
| | Rh-IS | 103 | 16871550.992 | | 0.257 | 0.000 | | 0.000 |

Concentration Results

| | Analyte Mass | Net Intens. | Mean | Conc. Mean | Conc. SD | Conc. RSD | Sample Unit |
|----|--------------|-------------|--------------|------------|----------|-----------|-------------|
| | Mo | 100 | 202.296 | | | | ng/L |
| | Ru | 101 | 776.354 | | | | ng/L |
| | Ru | 102 | -4577.592 | | | | ng/L |
| [| Tc | 99 | 0.000 | 0.614977 | 0.133 | 21.679 | ng/L |
| [> | Rh | 103 | 16871550.992 | | | | ng/L |
| | Rh-IS | 103 | 16871550.992 | 100.322611 | 0.258 | 0.257 | ng/L |

Southwest Research Institute

Sample ID: CRI 5.0

Sample Date/Time: Thursday, June 06, 2024 10:47:46

Solution Type: Sample

Blank File:

Number of Replicates: 3

Peak Processing Mode: Average

Signal Profile Processing Mode: Average

Dual Detector Mode: Dual

Current Dead Time (ns): 35

Sample File: C:\Users\Public\Documents\PerkinElmer Syngistix\CPMS\Sample\SwRI\Tc99-1.sam

Method File: C:\Users\Public\Documents\PerkinElmer Syngistix\CPMS\Method\SwRI\Tc99-1.mth

Dataset File: C:\Users\Public\Documents\PerkinElmer Syngistix\CPMS\DataSet\Y24JUN\CRI 5.0.658

Tuning File: C:\Users\Public\Documents\PerkinElmer Syngistix\CPMS\MassCal\Default.tun

Optimization File: C:\Users\Public\Documents\PerkinElmer Syngistix\CPMS\Conditions\Default.dac

Calibration File:

Calibration Type: External Calibration

Summary

Intensities

| Analyte | Mass | Meas. Intens. | Mean | Meas. Intens. | RSD | Blank Intensity | Blank Intens. | SD |
|---------|------|---------------|--------------|---------------|--------|-----------------|---------------|-------|
| Mo | 100 | | 120.435 | | 20.102 | 0.000 | | 0.000 |
| Ru | 101 | | 774.354 | | 2.807 | 0.000 | | 0.000 |
| Ru | 102 | | -4473.942 | | 2.689 | 0.000 | | 0.000 |
| [Tc | 99 | | 1645.095 | | 2.687 | 0.000 | | 0.000 |
| [> Rh | 103 | | 17044915.193 | | 0.863 | 0.000 | | 0.000 |
| Rh-IS | 103 | | 17044915.193 | | 0.863 | 0.000 | | 0.000 |

Concentration Results

| Analyte | Mass | Net Intens. | Mean | Conc. Mean | Conc. SD | Conc. RSD | Sample Unit |
|---------|------|-------------|--------------|-------------------|----------|-----------|-------------|
| Mo | 100 | | 120.435 | | | | ng/L |
| Ru | 101 | | 774.354 | | | | ng/L |
| Ru | 102 | | -4473.942 | | | | ng/L |
| [Tc | 99 | | 0.000 | 4.636828 | 0.224 | 4.828 | ng/L |
| [> Rh | 103 | | 17044915.193 | | | | ng/L |
| Rh-IS | 103 | | 17044915.193 | 101.353479 | 0.875 | 0.863 | ng/L |

Southwest Research Institute

Sample ID: ICSA

Sample Date/Time: Thursday, June 06, 2024 10:50:36

Solution Type: Sample

Blank File:

Number of Replicates: 3

Peak Processing Mode: Average

Signal Profile Processing Mode: Average

Dual Detector Mode: Dual

Current Dead Time (ns): 35

Sample File: C:\Users\Public\Documents\PerkinElmer Syngistix\CPMS\Sample\SwRI\Tc99-1.sam

Method File: C:\Users\Public\Documents\PerkinElmer Syngistix\CPMS\Method\SwRI\Tc99-1.mth

Dataset File: C:\Users\Public\Documents\PerkinElmer Syngistix\CPMS\DataSet\Y24JUN\ICSA.659

Tuning File: C:\Users\Public\Documents\PerkinElmer Syngistix\CPMS\MassCal\Default.tun

Optimization File: C:\Users\Public\Documents\PerkinElmer Syngistix\CPMS\Conditions\Default.dac

Calibration File:

Calibration Type: External Calibration

Summary

Intensities

| | Analyte Mass | Meas. Intens. Mean | Meas. Intens. RSD | Blank Intensity | Blank Intens. SD |
|----|--------------|--------------------|-------------------|-----------------|------------------|
| | Mo 100 | 27931671.745 | 0.401 | 0.000 | 0.000 |
| | Ru 101 | 295.336 | 6.292 | 0.000 | 0.000 |
| | Ru 102 | -4360.571 | 1.507 | 0.000 | 0.000 |
| [| Tc 99 | 1403.069 | 4.180 | 0.000 | 0.000 |
| [> | Rh 103 | 10880997.073 | 0.477 | 0.000 | 0.000 |
| | Rh-IS 103 | 10880997.073 | 0.477 | 0.000 | 0.000 |

Concentration Results

| | Analyte Mass | Net Intens. Mean | Conc. Mean | Conc. SD | Conc. RSD | Sample Unit |
|----|--------------|------------------|------------|----------|-----------|-------------|
| | Mo 100 | 27931671.745 | | | | ng/L |
| | Ru 101 | 295.336 | | | | ng/L |
| | Ru 102 | -4360.571 | | | | ng/L |
| [| Tc 99 | 0.000 | 7.164917 | 0.402 | 5.608 | ng/L |
| [> | Rh 103 | 10880997.073 | | | | ng/L |
| | Rh-IS 103 | 10880997.073 | 64.701226 | 0.308 | 0.477 | ng/L |

Southwest Research Institute

Sample ID: ICSAB

Sample Date/Time: Thursday, June 06, 2024 10:53:27

Solution Type: Sample

Blank File:

Number of Replicates: 3

Peak Processing Mode: Average

Signal Profile Processing Mode: Average

Dual Detector Mode: Dual

Current Dead Time (ns): 35

Sample File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Sample\SwRI\Tc99-1.sam

Method File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Method\SwRI\Tc99-1.mth

Dataset File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\DataSet\Y24JUN\ICSAB.660

Tuning File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\MassCal\Default.tun

Optimization File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Conditions\Default.dac

Calibration File:

Calibration Type: External Calibration

Summary

Intensities

| | Analyte Mass | Meas. Intens. | Mean | Meas. Intens. | RSD | Blank Intensity | Blank Intens. | SD |
|----|--------------|---------------|--------------|---------------|-------|-----------------|---------------|-------|
| | Mo | 100 | 29128368.014 | | 0.482 | 0.000 | | 0.000 |
| | Ru | 101 | 295.670 | | 5.499 | 0.000 | | 0.000 |
| | Ru | 102 | -4440.482 | | 1.000 | 0.000 | | 0.000 |
| [| Tc | 99 | 4481.036 | | 0.247 | 0.000 | | 0.000 |
| [> | Rh | 103 | 11183643.100 | | 0.355 | 0.000 | | 0.000 |
| | Rh-IS | 103 | 11183643.100 | | 0.355 | 0.000 | | 0.000 |

Concentration Results

| | Analyte Mass | Net Intens. | Mean | Conc. Mean | Conc. SD | Conc. RSD | Sample Unit |
|----|--------------|-------------|--------------|------------------|----------|-----------|-------------|
| | Mo | 100 | 29128368.014 | | | | ng/L |
| | Ru | 101 | 295.670 | | | | ng/L |
| | Ru | 102 | -4440.482 | | | | ng/L |
| [| Tc | 99 | 0.000 | 28.355826 | 0.080 | 0.283 | ng/L |
| [> | Rh | 103 | 11183643.100 | | | | ng/L |
| | Rh-IS | 103 | 11183643.100 | 66.500838 | 0.236 | 0.355 | ng/L |

Southwest Research Institute

Sample ID: ZZZZZ

Sample Date/Time: Thursday, June 06, 2024 10:56:16

Solution Type: Sample

Blank File:

Number of Replicates: 3

Peak Processing Mode: Average

Signal Profile Processing Mode: Average

Dual Detector Mode: Dual

Current Dead Time (ns): 35

Sample File: C:\Users\Public\Documents\PerkinElmer Syngistix\CPMS\Sample\SwRI\Tc99-1.sam

Method File: C:\Users\Public\Documents\PerkinElmer Syngistix\CPMS\Method\SwRI\Tc99-1.mth

Dataset File: C:\Users\Public\Documents\PerkinElmer Syngistix\CPMS\DataSet\Y24JUN\ZZZZ.661

Tuning File: C:\Users\Public\Documents\PerkinElmer Syngistix\CPMS\MassCal\Default.tun

Optimization File: C:\Users\Public\Documents\PerkinElmer Syngistix\CPMS\Conditions\Default.dac

Calibration File:

Calibration Type: External Calibration

Summary

Intensities

| | Analyte Mass | Meas. Intens. Mean | Meas. Intens. RSD | Blank Intensity | Blank Intens. SD |
|----|--------------|--------------------|-------------------|-----------------|------------------|
| | Mo 100 | 1101.868 | 2.999 | 0.000 | 0.000 |
| | Ru 101 | 638.014 | 5.423 | 0.000 | 0.000 |
| | Ru 102 | -5164.678 | 2.297 | 0.000 | 0.000 |
| [| Tc 99 | 483.342 | 0.861 | 0.000 | 0.000 |
| [> | Rh 103 | 16987663.704 | 0.469 | 0.000 | 0.000 |
| | Rh-IS 103 | 16987663.704 | 0.469 | 0.000 | 0.000 |

Concentration Results

| | Analyte Mass | Net Intens. Mean | Conc. Mean | Conc. SD | Conc. RSD | Sample Unit |
|----|--------------|------------------|------------|----------|-----------|-------------|
| | Mo 100 | 1101.868 | | | | ng/L |
| | Ru 101 | 638.014 | | | | ng/L |
| | Ru 102 | -5164.678 | | | | ng/L |
| [| Tc 99 | 0.000 | -0.671444 | 0.028 | 4.128 | ng/L |
| [> | Rh 103 | 16987663.704 | | | | ng/L |
| | Rh-IS 103 | 16987663.704 | 101.013047 | 0.474 | 0.469 | ng/L |

Southwest Research Institute

Sample ID: CCV

Sample Date/Time: Thursday, June 06, 2024 10:59:07

Solution Type: Sample

Blank File:

Number of Replicates: 3

Peak Processing Mode: Average

Signal Profile Processing Mode: Average

Dual Detector Mode: Dual

Current Dead Time (ns): 35

Sample File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Sample\SwRI\Tc99-1.sam

Method File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Method\SwRI\Tc99-1.mth

Dataset File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\DataSet\Y24JUN\CCV.662

Tuning File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\MassCal\Default.tun

Optimization File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Conditions\Default.dac

Calibration File:

Calibration Type: External Calibration

Summary

Intensities

| | Analyte Mass | Meas. Intens. | Mean | Meas. Intens. | RSD | Blank Intensity | Blank Intens. | SD |
|----|--------------|---------------|--------------|---------------|-------|-----------------|---------------|-------|
| | Mo | 100 | 256.262 | | 6.128 | 0.000 | | 0.000 |
| | Ru | 101 | 226.668 | | 8.915 | 0.000 | | 0.000 |
| | Ru | 102 | -3023.066 | | 1.347 | 0.000 | | 0.000 |
| [| Tc | 99 | 16862.281 | | 1.706 | 0.000 | | 0.000 |
| [> | Rh | 103 | 13333560.417 | | 0.717 | 0.000 | | 0.000 |
| | Rh-IS | 103 | 13333560.417 | | 0.717 | 0.000 | | 0.000 |

Concentration Results

| | Analyte Mass | Net Intens. | Mean | Conc. Mean | Conc. SD | Conc. RSD | Sample Unit |
|----|--------------|-------------|--------------|------------------|----------|-----------|-------------|
| | Mo | 100 | 256.262 | | | | ng/L |
| | Ru | 101 | 226.668 | | | | ng/L |
| | Ru | 102 | -3023.066 | | | | ng/L |
| [| Tc | 99 | 0.001 | 95.739891 | 2.249 | 2.349 | ng/L |
| [> | Rh | 103 | 13333560.417 | | | | ng/L |
| | Rh-IS | 103 | 13333560.417 | 79.284803 | 0.568 | 0.717 | ng/L |

Southwest Research Institute

Sample ID: CCB

Sample Date/Time: Thursday, June 06, 2024 11:01:58

Solution Type: Sample

Blank File:

Number of Replicates: 3

Peak Processing Mode: Average

Signal Profile Processing Mode: Average

Dual Detector Mode: Dual

Current Dead Time (ns): 35

Sample File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Sample\SwRI\Tc99-1.sam

Method File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Method\SwRI\Tc99-1.mth

Dataset File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\DataSet\Y24JUN\CCB.663

Tuning File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\MassCal\Default.tun

Optimization File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Conditions\Default.dac

Calibration File:

Calibration Type: External Calibration

Summary

Intensities

| | Analyte Mass | Meas. Intens. Mean | Meas. Intens. RSD | Blank Intensity | Blank Intens. SD |
|----|--------------|--------------------|-------------------|-----------------|------------------|
| | Mo 100 | 1292.790 | 4.301 | 0.000 | 0.000 |
| | Ru 101 | 498.675 | 0.989 | 0.000 | 0.000 |
| | Ru 102 | -5256.225 | 1.971 | 0.000 | 0.000 |
| [| Tc 99 | 394.005 | 3.119 | 0.000 | 0.000 |
| [> | Rh 103 | 16542688.527 | 0.667 | 0.000 | 0.000 |
| | Rh-IS 103 | 16542688.527 | 0.667 | 0.000 | 0.000 |

Concentration Results

| | Analyte Mass | Net Intens. Mean | Conc. Mean | Conc. SD | Conc. RSD | Sample Unit |
|----|--------------|------------------|------------|----------|-----------|-------------|
| | Mo 100 | 1292.790 | | | | ng/L |
| | Ru 101 | 498.675 | | | | ng/L |
| | Ru 102 | -5256.225 | | | | ng/L |
| [| Tc 99 | 0.000 | -1.033120 | 0.049 | 4.727 | ng/L |
| [> | Rh 103 | 16542688.527 | | | | ng/L |
| | Rh-IS 103 | 16542688.527 | 98.367109 | 0.656 | 0.667 | ng/L |

Southwest Research Institute

Sample ID: 718821 DF100

Sample Date/Time: Thursday, June 06, 2024 11:12:38

Solution Type: Sample

Blank File:

Number of Replicates: 3

Peak Processing Mode: Average

Signal Profile Processing Mode: Average

Dual Detector Mode: Dual

Current Dead Time (ns): 35

Sample File: C:\Users\Public\Documents\PerkinElmer Syngistix\CPMS\Sample\SwRI\Tc99-1.sam

Method File: C:\Users\Public\Documents\PerkinElmer Syngistix\CPMS\Method\SwRI\Tc99-1.mth

Dataset File: C:\Users\Public\Documents\PerkinElmer Syngistix\CPMS\DataSet\Y24JUN\718821 DF100.664

Tuning File: C:\Users\Public\Documents\PerkinElmer Syngistix\CPMS\MassCal\Default.tun

Optimization File: C:\Users\Public\Documents\PerkinElmer Syngistix\CPMS\Conditions\Default.dac

Calibration File:

Calibration Type: External Calibration

Summary

Intensities

| | Analyte Mass | Meas. Intens. Mean | Meas. Intens. RSD | Blank Intensity | Blank Intens. SD |
|----|--------------|--------------------|-------------------|-----------------|------------------|
| | Mo 100 | -6196.148 | 11.333 | 0.000 | 0.000 |
| | Ru 101 | 11526.331 | 7.343 | 0.000 | 0.000 |
| | Ru 102 | 4115.508 | 4.826 | 0.000 | 0.000 |
| [| Tc 99 | 12899.488 | 1.176 | 0.000 | 0.000 |
| [> | Rh 103 | 16956226.219 | 1.466 | 0.000 | 0.000 |
| | Rh-IS 103 | 16956226.219 | 1.466 | 0.000 | 0.000 |

Concentration Results

| | Analyte Mass | Net Intens. Mean | Conc. Mean | Conc. SD | Conc. RSD | Sample Unit |
|----|--------------|------------------|------------|----------|-----------|-------------|
| | Mo 100 | -6196.148 | | | | ng/L |
| | Ru 101 | 11526.331 | | | | ng/L |
| | Ru 102 | 4115.508 | | | | ng/L |
| [| Tc 99 | 0.001 | 56.437424 | 0.304 | 0.539 | ng/L |
| [> | Rh 103 | 16956226.219 | | | | ng/L |
| | Rh-IS 103 | 16956226.219 | 100.826112 | 1.478 | 1.466 | ng/L |

Southwest Research Institute

Sample ID: 718821D DF100

Sample Date/Time: Thursday, June 06, 2024 11:15:28

Solution Type: Sample

Blank File:

Number of Replicates: 3

Peak Processing Mode: Average

Signal Profile Processing Mode: Average

Dual Detector Mode: Dual

Current Dead Time (ns): 35

Sample File: C:\Users\Public\Documents\PerkinElmer Syngistix\CPMS\Sample\SwRI\Tc99-1.sam

Method File: C:\Users\Public\Documents\PerkinElmer Syngistix\CPMS\Method\SwRI\Tc99-1.mth

Dataset File: C:\Users\Public\Documents\PerkinElmer Syngistix\CPMS\DataSet\Y24JUN\718821D DF100.665

Tuning File: C:\Users\Public\Documents\PerkinElmer Syngistix\CPMS\MassCal\Default.tun

Optimization File: C:\Users\Public\Documents\PerkinElmer Syngistix\CPMS\Conditions\Default.dac

Calibration File:

Calibration Type: External Calibration

Summary

Intensities

| | Analyte Mass | Meas. Intens. Mean | Meas. Intens. RSD | Blank Intensity | Blank Intens. SD |
|----|--------------|--------------------|-------------------|-----------------|------------------|
| | Mo 100 | -4928.201 | 1.971 | 0.000 | 0.000 |
| | Ru 101 | 9689.952 | 1.096 | 0.000 | 0.000 |
| | Ru 102 | 3417.017 | 1.327 | 0.000 | 0.000 |
| [| Tc 99 | 12185.195 | 0.982 | 0.000 | 0.000 |
| [> | Rh 103 | 16733479.166 | 0.592 | 0.000 | 0.000 |
| | Rh-IS 103 | 16733479.166 | 0.592 | 0.000 | 0.000 |

Concentration Results

| | Analyte Mass | Net Intens. Mean | Conc. Mean | Conc. SD | Conc. RSD | Sample Unit |
|----|--------------|------------------|------------|----------|-----------|-------------|
| | Mo 100 | -4928.201 | | | | ng/L |
| | Ru 101 | 9689.952 | | | | ng/L |
| | Ru 102 | 3417.017 | | | | ng/L |
| [| Tc 99 | 0.001 | 53.898296 | 0.738 | 1.369 | ng/L |
| [> | Rh 103 | 16733479.166 | | | | ng/L |
| | Rh-IS 103 | 16733479.166 | 99.501600 | 0.589 | 0.592 | ng/L |

Southwest Research Institute

Sample ID: 718821L DF500

Sample Date/Time: Thursday, June 06, 2024 11:18:20

Solution Type: Sample

Blank File:

Number of Replicates: 3

Peak Processing Mode: Average

Signal Profile Processing Mode: Average

Dual Detector Mode: Dual

Current Dead Time (ns): 35

Sample File: C:\Users\Public\Documents\PerkinElmer Syngistix\CPMS\Sample\SwRI\Tc99-1.sam

Method File: C:\Users\Public\Documents\PerkinElmer Syngistix\CPMS\Method\SwRI\Tc99-1.mth

Dataset File: C:\Users\Public\Documents\PerkinElmer Syngistix\CPMS\DataSet\Y24JUN\718821L DF500.666

Tuning File: C:\Users\Public\Documents\PerkinElmer Syngistix\CPMS\MassCal\Default.tun

Optimization File: C:\Users\Public\Documents\PerkinElmer Syngistix\CPMS\Conditions\Default.dac

Calibration File:

Calibration Type: External Calibration

Summary

Intensities

| | Analyte Mass | Meas. Intens. | Mean | Meas. Intens. | RSD | Blank Intensity | Blank Intens. | SD |
|----|--------------|---------------|--------------|---------------|-------|-----------------|---------------|-------|
| | Mo | 100 | -870.772 | | 0.619 | 0.000 | | 0.000 |
| | Ru | 101 | 2708.590 | | 1.979 | 0.000 | | 0.000 |
| | Ru | 102 | -3098.838 | | 1.753 | 0.000 | | 0.000 |
| [| Tc | 99 | 2938.636 | | 2.974 | 0.000 | | 0.000 |
| [> | Rh | 103 | 16932900.950 | | 0.942 | 0.000 | | 0.000 |
| | Rh-IS | 103 | 16932900.950 | | 0.942 | 0.000 | | 0.000 |

Concentration Results

| | Analyte Mass | Net Intens. | Mean | Conc. Mean | Conc. SD | Conc. RSD | Sample Unit |
|----|--------------|-------------|--------------|-------------------|----------|-----------|-------------|
| | Mo | 100 | -870.772 | | | | ng/L |
| | Ru | 101 | 2708.590 | | | | ng/L |
| | Ru | 102 | -3098.838 | | | | ng/L |
| [| Tc | 99 | 0.000 | 10.641838 | 0.294 | 2.767 | ng/L |
| [> | Rh | 103 | 16932900.950 | | | | ng/L |
| | Rh-IS | 103 | 16932900.950 | 100.687414 | 0.949 | 0.942 | ng/L |

Southwest Research Institute

Sample ID: 718821MS DF100

Sample Date/Time: Thursday, June 06, 2024 11:21:12

Solution Type: Sample

Blank File:

Number of Replicates: 3

Peak Processing Mode: Average

Signal Profile Processing Mode: Average

Dual Detector Mode: Dual

Current Dead Time (ns): 35

Sample File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Sample\SwRI\Tc99-1.sam

Method File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Method\SwRI\Tc99-1.mth

Dataset File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\DataSet\Y24JUN\718821MS DF100.667

Tuning File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\MassCal\Default.tun

Optimization File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Conditions\Default.dac

Calibration File:

Calibration Type: External Calibration

Summary

Intensities

| | Analyte Mass | Meas. Intens. | Mean | Meas. Intens. | RSD | Blank Intensity | Blank Intens. SD |
|---|--------------|---------------|--------------|---------------|-------|-----------------|------------------|
| | Mo | 100 | -5219.106 | | 1.579 | 0.000 | 0.000 |
| | Ru | 101 | 10489.183 | | 0.935 | 0.000 | 0.000 |
| | Ru | 102 | 4188.864 | | 2.004 | 0.000 | 0.000 |
| [| Tc | 99 | 13560.767 | | 0.993 | 0.000 | 0.000 |
| > | Rh | 103 | 16815374.424 | | 0.520 | 0.000 | 0.000 |
| | Rh-IS | 103 | 16815374.424 | | 0.520 | 0.000 | 0.000 |

Concentration Results

| | Analyte | Mass | Net Intens. | Mean | Conc. Mean | Conc. SD | Conc. RSD | Sample Unit |
|----|---------|------|-------------|--------------|------------|----------|-----------|-------------|
| | Mo | 100 | | -5219.106 | | | | ng/L |
| | Ru | 101 | | 10489.183 | | | | ng/L |
| | Ru | 102 | | 4188.864 | | | | ng/L |
| [> | Tc | 99 | | 0.001 | 60.002128 | 0.931 | 1.551 | ng/L |
| | Rh | 103 | | 16815374.424 | | | | ng/L |
| | Rh-IS | 103 | | 16815374.424 | 99.988570 | 0.520 | 0.520 | ng/L |

Southwest Research Institute

Sample ID: 718822 DF100

Sample Date/Time: Thursday, June 06, 2024 11:24:02

Solution Type: Sample

Blank File:

Number of Replicates: 3

Peak Processing Mode: Average

Signal Profile Processing Mode: Average

Dual Detector Mode: Dual

Current Dead Time (ns): 35

Sample File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Sample\SwRI\Tc99-1.sam

Method File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Method\SwRI\Tc99-1.mth

Dataset File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\DataSet\Y24JUN\718822 DF100.668

Tuning File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\MassCal\Default.tun

Optimization File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Conditions\Default.dac

Calibration File:

Calibration Type: External Calibration

Summary

Intensities

| | Analyte Mass | Meas. Intens. | Mean | Meas. Intens. | RSD | Blank Intensity | Blank Intens. | SD |
|----|--------------|---------------|--------------|---------------|-------|-----------------|---------------|-------|
| | Mo | 100 | -8559.572 | | 1.093 | 0.000 | | 0.000 |
| | Ru | 101 | 14720.915 | | 1.223 | 0.000 | | 0.000 |
| | Ru | 102 | 7625.067 | | 1.284 | 0.000 | | 0.000 |
| [| Tc | 99 | 13813.009 | | 1.140 | 0.000 | | 0.000 |
| [> | Rh | 103 | 16845588.723 | | 0.595 | 0.000 | | 0.000 |
| | Rh-IS | 103 | 16845588.723 | | 0.595 | 0.000 | | 0.000 |

Concentration Results

| | Analyte Mass | Net Intens. | Mean | Conc. Mean | Conc. SD | Conc. RSD | Sample Unit |
|----|--------------|-------------|--------------|-------------------|----------|-----------|-------------|
| | Mo | 100 | -8559.572 | | | | ng/L |
| | Ru | 101 | 14720.915 | | | | ng/L |
| | Ru | 102 | 7625.067 | | | | ng/L |
| [| Tc | 99 | 0.001 | 61.058064 | 1.087 | 1.781 | ng/L |
| [> | Rh | 103 | 16845588.723 | | | | ng/L |
| | Rh-IS | 103 | 16845588.723 | 100.168232 | 0.596 | 0.595 | ng/L |

Southwest Research Institute

Sample ID: PB24E14KE1

Sample Date/Time: Thursday, June 06, 2024 11:26:52

Solution Type: Sample

Blank File:

Number of Replicates: 3

Peak Processing Mode: Average

Signal Profile Processing Mode: Average

Dual Detector Mode: Dual

Current Dead Time (ns): 35

Sample File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Sample\SwRI\Tc99-1.sam

Method File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Method\SwRI\Tc99-1.mth

Dataset File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\DataSet\Y24JUN\PB24E14KE1.669

Tuning File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\MassCal\Default.tun

Optimization File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Conditions\Default.dac

Calibration File:

Calibration Type: External Calibration

Summary

Intensities

| | Analyte Mass | Meas. Intens. | Mean | Meas. Intens. | RSD | Blank Intensity | Blank Intens. | SD |
|----|--------------|---------------|--------------|---------------|-------|-----------------|---------------|-------|
| | Mo | 100 | 2007.000 | | 2.133 | 0.000 | | 0.000 |
| | Ru | 101 | 313.003 | | 8.597 | 0.000 | | 0.000 |
| | Ru | 102 | -2774.691 | | 0.917 | 0.000 | | 0.000 |
| [| Tc | 99 | 225.002 | | 5.569 | 0.000 | | 0.000 |
| [> | Rh | 103 | 13272824.700 | | 0.842 | 0.000 | | 0.000 |
| | Rh-IS | 103 | 13272824.700 | | 0.842 | 0.000 | | 0.000 |

Concentration Results

| | Analyte Mass | Net Intens. | Mean | Conc. Mean | Conc. SD | Conc. RSD | Sample Unit |
|----|--------------|-------------|--------------|------------|----------|-----------|-------------|
| | Mo | 100 | 2007.000 | | | | ng/L |
| | Ru | 101 | 313.003 | | | | ng/L |
| | Ru | 102 | -2774.691 | | | | ng/L |
| [| Tc | 99 | 0.000 | -1.568185 | 0.078 | 4.956 | ng/L |
| [> | Rh | 103 | 13272824.700 | | | | ng/L |
| | Rh-IS | 103 | 13272824.700 | 78.923652 | 0.665 | 0.842 | ng/L |

Southwest Research Institute

Sample ID: LCS24E14KE1

Sample Date/Time: Thursday, June 06, 2024 11:29:42

Solution Type: Sample

Blank File:

Number of Replicates: 3

Peak Processing Mode: Average

Signal Profile Processing Mode: Average

Dual Detector Mode: Dual

Current Dead Time (ns): 35

Sample File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Sample\SwRI\Tc99-1.sam

Method File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Method\SwRI\Tc99-1.mth

Dataset File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\DataSet\Y24JUN\LCS24E14KE1.670

Tuning File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\MassCal\Default.tun

Optimization File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Conditions\Default.dac

Calibration File:

Calibration Type: External Calibration

Summary

Intensities

| | Analyte Mass | Meas. Intens. | Mean | Meas. Intens. | RSD | Blank Intensity | Blank Intens. | SD |
|----|--------------|---------------|--------------|---------------|-------|-----------------|---------------|-------|
| | Mo | 100 | 3063.025 | | 1.410 | 0.000 | | 0.000 |
| | Ru | 101 | 304.670 | | 2.633 | 0.000 | | 0.000 |
| | Ru | 102 | -2800.870 | | 0.983 | 0.000 | | 0.000 |
| [| Tc | 99 | 18904.502 | | 1.698 | 0.000 | | 0.000 |
| [> | Rh | 103 | 13244590.799 | | 0.981 | 0.000 | | 0.000 |
| | Rh-IS | 103 | 13244590.799 | | 0.981 | 0.000 | | 0.000 |

Concentration Results

| | Analyte Mass | Net Intens. | Mean | Conc. Mean | Conc. SD | Conc. RSD | Sample Unit |
|----|--------------|-------------|--------------|-------------------|----------|-----------|-------------|
| | Mo | 100 | 3063.025 | | | | ng/L |
| | Ru | 101 | 304.670 | | | | ng/L |
| | Ru | 102 | -2800.870 | | | | ng/L |
| [| Tc | 99 | 0.001 | 108.415189 | 1.257 | 1.160 | ng/L |
| [> | Rh | 103 | 13244590.799 | | | | ng/L |
| | Rh-IS | 103 | 13244590.799 | 78.755766 | 0.773 | 0.981 | ng/L |

Southwest Research Institute

Sample ID: CCV

Sample Date/Time: Thursday, June 06, 2024 11:32:32

Solution Type: Sample

Blank File:

Number of Replicates: 3

Peak Processing Mode: Average

Signal Profile Processing Mode: Average

Dual Detector Mode: Dual

Current Dead Time (ns): 35

Sample File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Sample\SwRI\Tc99-1.sam

Method File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Method\SwRI\Tc99-1.mth

Dataset File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\DataSet\Y24JUN\CCV.671

Tuning File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\MassCal\Default.tun

Optimization File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Conditions\Default.dac

Calibration File:

Calibration Type: External Calibration

Summary

Intensities

| | Analyte Mass | Meas. Intens. | Mean | Meas. Intens. | RSD | Blank Intensity | Blank Intens. | SD |
|----|--------------|---------------|--------------|---------------|--------|-----------------|---------------|-------|
| | Mo | 100 | 122.167 | | 28.881 | 0.000 | | 0.000 |
| | Ru | 101 | 320.670 | | 6.279 | 0.000 | | 0.000 |
| | Ru | 102 | -2699.349 | | 1.780 | 0.000 | | 0.000 |
| [| Tc | 99 | 16934.365 | | 0.346 | 0.000 | | 0.000 |
| [> | Rh | 103 | 13263934.092 | | 0.440 | 0.000 | | 0.000 |
| | Rh-IS | 103 | 13263934.092 | | 0.440 | 0.000 | | 0.000 |

Concentration Results

| | Analyte Mass | Net Intens. | Mean | Conc. Mean | Conc. SD | Conc. RSD | Sample Unit |
|----|--------------|-------------|--------------|------------------|----------|-----------|-------------|
| | Mo | 100 | 122.167 | | | | ng/L |
| | Ru | 101 | 320.670 | | | | ng/L |
| | Ru | 102 | -2699.349 | | | | ng/L |
| [| Tc | 99 | 0.001 | 96.672522 | 0.102 | 0.106 | ng/L |
| [> | Rh | 103 | 13263934.092 | | | | ng/L |
| | Rh-IS | 103 | 13263934.092 | 78.870787 | 0.347 | 0.440 | ng/L |

Southwest Research Institute

Sample ID: CCB

Sample Date/Time: Thursday, June 06, 2024 11:35:22

Solution Type: Sample

Blank File:

Number of Replicates: 3

Peak Processing Mode: Average

Signal Profile Processing Mode: Average

Dual Detector Mode: Dual

Current Dead Time (ns): 35

Sample File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Sample\SwRI\Tc99-1.sam

Method File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Method\SwRI\Tc99-1.mth

Dataset File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\DataSet\Y24JUN\CCB.672

Tuning File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\MassCal\Default.tun

Optimization File: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\Conditions\Default.dac

Calibration File:

Calibration Type: External Calibration

Summary

Intensities

| | Analyte Mass | Meas. Intens. | Mean | Meas. Intens. | RSD | Blank Intensity | Blank Intens. | SD |
|----|--------------|---------------|--------------|---------------|-------|-----------------|---------------|-------|
| | Mo | 100 | 1189.275 | | 4.528 | 0.000 | | 0.000 |
| | Ru | 101 | 505.676 | | 4.550 | 0.000 | | 0.000 |
| | Ru | 102 | -5313.225 | | 2.747 | 0.000 | | 0.000 |
| [| Tc | 99 | 372.005 | | 4.664 | 0.000 | | 0.000 |
| [> | Rh | 103 | 16683709.767 | | 0.557 | 0.000 | | 0.000 |
| | Rh-IS | 103 | 16683709.767 | | 0.557 | 0.000 | | 0.000 |

Concentration Results

| | Analyte Mass | Net Intens. | Mean | Conc. Mean | Conc. SD | Conc. RSD | Sample Unit |
|----|--------------|-------------|--------------|------------|----------|-----------|-------------|
| | Mo | 100 | 1189.275 | | | | ng/L |
| | Ru | 101 | 505.676 | | | | ng/L |
| | Ru | 102 | -5313.225 | | | | ng/L |
| [| Tc | 99 | 0.000 | -1.151170 | 0.091 | 7.872 | ng/L |
| [> | Rh | 103 | 16683709.767 | | | | ng/L |
| | Rh-IS | 103 | 16683709.767 | 99.205658 | 0.553 | 0.557 | ng/L |

SOUTHWEST RESEARCH INSTITUTE

CLIENT: Battelle Memorial Institute PNNL

SwRI Project #: 27927.13.001

SwRI Task Order #: 240405-6

SDG #: 718819

TON #: 733437



Standard Logs & Certs

Chemical Information Sheet

Technetium-99 002RadSol4

#94145



| | | | |
|----------------------|----------------------------|---|---|
| Grade: | Analytical |  |  |
| Type: | Working Level Solution | | |
| CAS: | - No Data - | | |
| Lot: | - No Data - | | |
| Received: | 01/22/2018 | | |
| Expiration: | 03/14/2025 | Rad License: | |
| Location: | Bldg 70 Lab 55 Std counter | Rad License Line: | |
| Current Lab: | Lab 46 Stds Bldg 70 | | |
| Original Amount: | 200 mL | | |
| Amount Remaining: | 192 | | |
| Supplier: | - No Data - | | |
| Concentration: | 499.66 pCi/mL | | |
| Project: | - No Data - | | |
| PO Number: | - No Data - | | |
| Internal Lab ID: | - No Data - | | |
| Density: | 1 | | |
| Storage Requirement: | Ambient | | |
| Measuring Device ID: | - No Data - | | |
| Date Disposed: | - No Data - | | |
| Notes: | Used Pipet 5000-L | | |

Sources Table

| | | | | | | |
|--|-------|--------------------------|--------------|-----|--------|--|
| | ID | Source | Manufacturer | Lot | Amount | |
| | 37619 | Technetium-99 034RadSol1 | | | 10 mL | |

Solvent Table

| | | | | | | |
|--|-------|---------------------------|-------------------|---------|--------|--|
| | ID | Solvent | Manufacturer | Lot | Amount | |
| | 91586 | Nitric Acid, Trace Metals | Fisher Scientific | 1117050 | 5 mL | |

Component Table

[illegible]

*CGL = Computer Generated Line out

Created by jtutor on 1/22/2018 5:28:34 PM.

--- No Secondary Review ---



| Standards Verification Form | | | | Date Analyzed: 3/14/2024 | | | |
|---|--------------------|------------------|-----------------------------|-----------------------------|---------------------------------|---------------|--------|
| Carrier | | | | Count Time (minutes): 30 | Instrument ID: Liquid Scint | | |
| N/A | | | | Prep Batch: N/A | Analytical Batch: 20240314_1504 | | |
| Logbook ID: N/A | | | | Tc99 | | | |
| CIMS# N/A | | | | Logbook ID: 002RadSol4 | | | |
| | | | | CIMS# 94145 | | | |
| | Read | Read | Tracer Corrected Efficiency | Read | Corrected | TV | |
| Replicate | Initial Weight (g) | Final Weight (g) | | Counts per minute | pCi | pCi | %R |
| 1 | 1.00000 | 2.00000 | 100.000% | 579.87 | 250.626 | 249.81 | 100.3% |
| 2 | 1.00000 | 2.00000 | 100.000% | 575.00 | 248.545 | 249.81 | 99.5% |
| 3 | 1.00000 | 2.00000 | 100.000% | 582.53 | 249.858 | 249.81 | 100.0% |
| 4 | 1.00000 | 2.00000 | 100.000% | 580.83 | 248.679 | 249.81 | 99.5% |
| Carrier Weight (g) | | | 1.000 | Reference Date | 9/1/1996 | Average | 99.8% |
| Reference Weight (mg) | | | 1000 | Reference Activity (pCi) | 499.66 | Std Deviation | 0.40% |
| Tracer Volume (ml) | | | 1.0 | Standard Volume (ml) | 0.50 | Conf Interval | 0.39% |
| | | | | Tc99 Decay Corrected Value: | 499.615 | | |
| <div>CRITERIA</div> <div>95%-105%</div> <div>< 10%</div> <div>< 10%</div> | | | | | | | |

Chemical Information Sheet

Technetium-99 034RadSol1

#37619



| | | | |
|----------------------|------------------------|---|---|
| Grade: | Analytical |  |  |
| Type: | Working Level Solution | | |
| CAS: | - No Data - | | |
| Lot: | - No Data - | | |
| Received: | 11/09/2004 | | |
| Expiration: | 05/22/2025 | Rad License: | L00775 |
| Location: | - No Data - | Rad License Line: | |
| Current Lab: | Lab 50 Bldg 70 | | |
| Original Amount: | 100 mL | | |
| Amount Remaining: | 59.5 | | |
| Supplier: | - No Data - | | |
| Concentration: | | | |
| Project: | - No Data - | | |
| PO Number: | - No Data - | | |
| Internal Lab ID: | - No Data - | | |
| Density: | 1 | | |
| Storage Requirement: | Ambient | | |
| Measuring Device ID: | - No Data - | | |
| Date Disposed: | - No Data - | | |
| Notes: | | | |

Sources Table

| ID | Source | Manufacturer | Lot | Amount |
|-------|---------------|--------------|----------|---------|
| 29222 | Technetium-99 | NIST | SRM4288A | 1.135 g |

Component Table

[illegible]



*CGL = Computer Generated Line out

Chemical Information Sheet

Technetium-99

#29222



| | | | |
|----------------------|--------------------------------|---|---|
| Grade: | Research/Pending Re-evaluation |  |  |
| Type: | Neat | | |
| CAS: | 14133-76-7 | | |
| Lot: | SRM4288A | | |
| Received: | 09/25/2001 | | |
| Expiration: | 09/25/2006 | Rad License: | L00775 |
| Location: | Bldg 70 Lab 46 | Rad License Line: | |
| Current Lab: | Lab 46 Bldg 70 | | |
| Original Amount: | 4.998 g | | |
| Amount Remaining: | 3.863 | | |
| Supplier: | NIST | | |
| Concentration: | 162984.78 Bq | | |
| Project: | - No Data - | | |
| PO Number: | - No Data - | | |
| Internal Lab ID: | 3082 | | |
| Density: | 1 | | |
| Storage Requirement: | - No Data - | | |
| Measuring Device ID: | - No Data - | | |
| Date Disposed: | 02/06/2013 | | |
| Notes: | EXPIRED | | |

Component Table

[illegible]

*CGL = Computer Generated Line out



National Institute of Standards & Technology Certificate

Standard Reference Material 4288A Technetium-99 Radioactivity Standard

This Standard Reference Material (SRM) consists of radioactive technetium-99, as potassium pertechnetate, and potassium hydroxide dissolved in 5 mL of distilled water. The solution is contained in a flame-sealed NIST borosilicate-glass ampoule. The SRM is intended for the calibration of beta-particle counting instruments and for the monitoring of radiochemical procedures.

Radiological Hazard

The SRM ampoule contains technetium-99 with a total activity of approximately 160 kBq. Technetium-99 decays by beta-particle emission. None of the beta particles escape from the SRM ampoule. During the decay process no photons are emitted. Approximate unshielded dose rates at several distances (as of the reference time) are given in note [a]*. There is no detectable external radiation. The SRM **should** be used only by persons qualified to handle radioactive material.

Chemical Hazard

The SRM ampoule contains potassium hydroxide (KOH) with a concentration of 0.001 moles per liter of water. The solution is mildly corrosive and could represent a health hazard if it comes in contact with eyes or skin. If the ampoule is to be opened to transfer the solution, the recommended procedure is given on page 2.

Storage and Handling

The SRM should be stored and used at a temperature between 5 and 65 °C. The solution in an unopened ampoule should remain stable and homogeneous until at least September 2006.

The ampoule (or any subsequent container) should always be clearly marked as containing radioactive material. If the ampoule is transported it should be packed, marked, labeled, and shipped in accordance with the applicable national, international, and carrier regulations. The solution in the ampoule is a dangerous good (hazardous material) because of the radioactivity.

Preparation

This Standard Reference Material was prepared in the Physics Laboratory, Ionizing Radiation Division, Radioactivity Group, J.M.R. Hutchinson, Group Leader. The overall technical direction and physical measurements leading to certification were provided by L.L. Lucas of the Radioactivity Group.

The support aspects involved in the preparation, certification, and issuance of this SRM were coordinated through the Standard Reference Materials Program by N.M. Trahey.

Gaithersburg, Maryland 20899
October 1996

Thomas E. Gills, Chief
Standard Reference Materials Program

Recommended Procedure for Opening the SRM Ampoule

- 1) If the SRM solution is to be diluted, it is recommended that the diluting solution have a composition comparable to that of the SRM solution.
- 2) Wear eye protection, gloves, and protective clothing and work over a tray with absorbent paper in it.
- 3) Shake the ampoule to wet **all of** the inside surface of the ampoule. Return **the** ampoule to the upright position.
- 4) Check that all of the liquid has drained out of the neck of the ampoule. If necessary, gently tap the neck to speed the process.
- 5) Holding the ampoule upright, score the narrowest part of the neck with a scribe or diamond pencil.
- 6) Lightly wet the scored line. This reduces the crack propagation velocity and makes for a cleaner break.
- 7) Hold the ampoule upright with a paper towel, a wiper, or a support jig. Position the scored line away from you. Using a paper towel or wiper to avoid contamination, snap off the top of the ampoule by pressing the narrowest part of the **neck** away from you while pulling the tip of the ampoule towards you.
- 8) Transfer the solution from the ampoule using a pycnometer or a pipet with dispenser handle. **NEVER PIPETTE BY MOUTH.**
- 9) Seal any unused SRM solution in a flame-sealed glass ampoule, if possible, to minimize the evaporation loss. See also reference [4]*.

PROPERTIES OF SRM 4288A
(Certified values are shown in bold type)

| | | | |
|--|--|--------------------------------------|------------------------------------|
| Source identification number | NIST SRM 4288A | | |
| Physical Properties: | | | |
| Source description | Liquid in flame-sealed NIST borosilicate-glass ampoule | | |
| Ampoule specifications | Body outside diameter | (16.5 ± 0.5) mm | |
| | Wall Thickness | (0.60 ± 0.04) mm | |
| | Barium content | Less than 2.5% | |
| | Lead-oxide content | Less than 0.02% | |
| | Other heavy elements | Trace quantities | |
| Solution density | (0.998 ± 0.002) g·mL ⁻¹ at 21 °C [b]* | | |
| Solution mass | (4.998 ± 0.002) g [b] | | |
| Chemical Properties: | | | |
| Solution composition | Chemical Formula | Concentration (mol·L ⁻¹) | Mass Fraction (g·g ⁻¹) |
| | H ₂ O | 55 | 1.00 |
| | KOH | 0.001 | 0.00006 |
| | K ⁹⁹ TcO ₄ | 0.0005 | 0.0001 |
| Radiological Properties: | | | |
| Radionuclide | Technetium-99 | | |
| Reference time | 1200 EST, 1 September 1996 | | |
| Massic activity of the solution [c] | 32.61 kBq·g ⁻¹ | | |
| Relative expanded uncertainty (k=2) | 1.14% [d] [e] | | |
| Photon-emitting impurities | None detected [f] | | |
| Half lives used in the decay corrections | Cobalt-60: (5.2714 ± 0.0005) a [g] Technetium-99: (2.111 ± 0.012) × 10 ⁵ a [g] | | |
| Measuring instrument | NIST 4πβ(LS)-γ-anticoincidence counting system using cobalt-60 as the efficiency-tracing radionuclide. The efficiency was varied electronically from 50 to 93 percent. | | |

EVALUATION OF THE UNCERTAINTY OF THE MASSIC ACTIVITY [d]*

| Input Quantity x_i , the source of uncertainty (and individual uncertainty components where appropriate) | Method Used To Evaluate $u(x_i)$, the standard uncertainty of x_i (A) denotes evaluation by statistical methods (B) denotes evaluation by other methods | Relative Uncertainty Of Input Quantity, $u(x_i)/x_i$, (%) [h] | Relative Sensitivity Factor, $ \partial y / \partial x_i \cdot$ (x/y) [i] | Relative Uncertainty Of Output Quantity, $u(y)/y$, (%) [j] |
|--|---|---|---|--|
| Extrapolated massic liquid-scintillation count rate of the Te-99 solution, corrected for background, cobalt-60 tracer count rate, and decay. | Standard deviation of the mean for 4 sets of repeated measurements on each of 3 samples (A) | 0.10 | 1.0 | 0.10 |
| Decay corrections for cobalt-60 for technetium-99 | Standard uncertainty of the half life (A) Standard uncertainty of the half life (A) | [k] 0.01 0.6 | [m] 0.01 0.000005 | 0.00001 0.000003 |
| Decay scheme data | Standard uncertainty of the probability of decay by beta-particle emission (A) | 0.01 | 1.0 | 0.01 |
| Extrapolation of the beta-particle-count-rate versus anticoincidence-gamma-ray-count-rate to zero anticoincidence-gamma-ray-count-rate | Estimated (B) | 0.40 | 1.0 | 0.40 |
| Calibration of the cobalt-60 tracer solution using the 4 $\pi\beta$ (LS)- γ -anticoincidence counting system | Standard uncertainty of the extrapolated massic count rate (B) | 0.25 | 1.0 | 0.25 |
| Gravimetric measurements | Estimated (B) | 0.20 | 1.0 | 0.20 |
| Live-time measurements [n] | Estimated (B) | 0.10 | 1.0 | 0.10 |
| Variability between ampoules | Estimated (B) | 0.20 | 1.0 | 0.20 |
| Photon-capturing impurities | Limit of detection (B) [p] | 100. | 0.00004 | 0.004 |
| Relative Combined Standard Uncertainty of the Output Quantity, $u_c(y)/y$, (%) | | | | 0.57 |
| Coverage Factor, k | | | | $\times 2$ |
| Relative Expanded Uncertainty of the Output Quantity, $U(y)$, (%) | | | | 1.14 |

SRM 4288A, page 4 of 6

*Notes and references are on pages 5 and 6.

NOTES

- [a] The Sievert is the SI unit for dose equivalent. See reference [1]. One μSv is equal to 0.1 mrem.
Distance from Ampoule (cm): 1 30 100
Approximate Dose Rate ($\mu\text{Sv/h}$): <0.1 (Not detectable)
- [b] The stated uncertainty is two times the standard uncertainty.
- [c] **Massic activity** is the preferred name for the quantity activity divided by the total mass of the sample. See reference [1].
- [d] **The** reported value, y , of massic activity (activity per unit mass) at the reference time was not measured directly but was derived from measurements and calculations of other quantities. This can be expressed as $y = f(x_1, x_2, x_3, \dots, x_n)$, where f is a mathematical function derived from the assumed model of the measurement process.
- The value, x_i , used for each input quantity i has a **standard uncertainty**, $u(x_i)$, that generates a corresponding uncertainty in y , $u_i(y) = |\partial y / \partial x_i| \cdot u(x_i)$, called a **component of combined standard uncertainty** of y .
- The **combined standard uncertainty** of y , $u_c(y)$, is the positive square root of the sum of the squares of the components of combined standard uncertainty.
- The combined standard uncertainty is multiplied by a **coverage factor** of $k = 2$ to obtain U , the **expanded uncertainty** of y .
- Since it can be assumed that the possible estimated values of the massic activity are approximately normally distributed with approximate standard deviation $u_c(y)$, the unknown value of the massic activity is believed to lie in the interval $y \pm U$ with a level of confidence of approximately 95 percent.
- For further information on the expression of uncertainties, see references [2] and [3].
- [e] The value of each standard uncertainty component, and hence the value of the expanded uncertainty itself, is a best estimate based upon all available information, but is only approximately known. That is to say, the "uncertainty of the uncertainty" is large and not well known. This is true for uncertainties evaluated by statistical methods (e.g., the relative standard deviation of the standard deviation of the mean for the liquid-scintillation counting is approximately 50%) and for uncertainties evaluated by other methods (which could easily be over estimated or under estimated by substantial amounts). The unknown value of the expanded uncertainty is believed to lie in the interval $U/2$ to $2U$ (i.e., within a factor of 2 of the estimated value).
- [f] Estimated limits of detection for photon-emitting impurities are:
 $2 \times 10^{-4} \text{ } \gamma \cdot \text{s}^{-1} \cdot \text{g}^{-1}$ for energies between 20 and 85 keV,
 $2 \times 10^{-5} \text{ } \gamma \cdot \text{s}^{-1} \cdot \text{g}^{-1}$ for energies between 93 and 503 keV,
 $1 \times 10^{-5} \text{ } \gamma \cdot \text{s}^{-1} \cdot \text{g}^{-1}$ for energies between 519 and 1457 keV, and
 $5 \times 10^{-6} \text{ } \gamma \cdot \text{s}^{-1} \cdot \text{g}^{-1}$ for energies between 1465 and 3250 keV.
- [g] The stated uncertainty is the standard uncertainty. See reference [5].

- [h] Relative standard uncertainty of the input quantity x_i .
- [i] The relative change in the output quantity y divided by the relative change in the input quantity x_i . If $|\partial y / \partial x_i| \cdot (x_i / y) = 1.0$, then a 1% change in x_i results in a 1% change in y . If $|\partial y / \partial x_i| \cdot (x_i / y) = 0.05$, then a 1% change in x_i results in a 0.05% change in y .
- [j] Relative component of combined standard uncertainty of output quantity y , rounded to two significant figures or less. The relative component of combined standard uncertainty of y is given by $u_i(y) / y \equiv |\partial y / \partial x_i| \cdot u(x_i) / y = |\partial y / \partial x_i| \cdot (x_i / y) \cdot u(x_i) / x_i$. The numerical values of $u(x_i) / x_i$, $|\partial y / \partial x_i| \cdot (x_i / y)$, and $u_i(y) / y$, all dimensionless quantities, are listed in columns 3, 4, and 5, respectively. Thus, the value in column 5 is equal to the value in column 4 multiplied by the value in column 3. The input quantities are independent, or very nearly so. Hence the covariances are zero or negligible.
- [k] The relative standard uncertainty of $\lambda \cdot t$ is determined by the relative standard uncertainty of λ (i.e., of the half life). The relative standard uncertainty of t is negligible.
- [m] $|\partial y / \partial x_i| \cdot (x_i / y) = |\lambda \cdot t|$, multiplied by other sensitivity factors where appropriate.
- [n] The live time is determined by counting the pulses from a gated crystal-controlled oscillator.
- [p] The standard uncertainty for each undetected impurity that might reasonably be expected to be present is estimated to be equal to the estimated limit of detection for that impurity, i.e. $u(x_i) / x_i = 100\%$. $|\partial y / \partial x_i| \cdot (x_i / y) = \{(\text{response per Bq of impurity}) / (\text{response per Bq of } ^{99}\text{Tc})\} \cdot \{(\text{Bq of impurity}) / (\text{Bq of } ^{99}\text{Tc})\}$. Thus $u_i(y) / y$ is the relative change in y if the impurity were present with a mass activity equal to the estimated limit of detection.

REFERENCES

- [1] International Organization for Standardization (ISO), *ISO Standards Handbook - Quantities and Units*, 1993. Available from the American National Standards Institute, 11 West 42nd Street, New York, NY 10036, U.S.A. 1-212-642-4900.
- [2] International Organization for Standardization (ISO), *Guide to the Expression of Uncertainty in Measurement*, 1993. Available from the American National Standards Institute, 11 West 42nd Street, New York, NY 10036, U.S.A. 1-212-642-4900. (Listed under ISO miscellaneous publications as "ISO Guide to the Expression 1993".)
- [3] B. N. Taylor and C. E. Kuyatt, *Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results*, NIST Technical Note 1297, 1994. Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20407, U.S.A.
- [4] National Council on Radiation Protection and Measurements Report No. 58, *A Handbook of Radioactivity Measurements Procedures*, Second Edition, 1985. Available from the National Council on Radiation Protection and Measurements, 7910 Woodmont Avenue, Bethesda, MD 20814 U.S.A.
- [5] Evaluated Nuclear Structure Data File (ENSDF), September 1996.

SOUTHWEST RESEARCH INSTITUTE

CLIENT: Battelle Memorial Institute PNNL

SwRI Project #: 27927.13.001

SwRI Task Order #: 240405-6

SDG #: 718819

TON #: 733437

Sample Receipt Paperwork

Southwest Research Institute

Laboratory Task Order

TO #: 240405-6 Revision: 1

SDG: 718819
RECEIVED: 04/04/24
TON: 733437

SRR #s: 70993
Client(s): Battelle Memorial Institute PNNL

Project(s): 27927.13.001
Manager(s): Ranger, Jacqueline
To Client: 05/22/24

Instructions

Contract: 660825 Mod 1. PNNL Task Order: 733437
18 overall RAD LIQUID samples were received on 04/04/2024, which are ALL listed here.

SOLUTION VOLUME IS SHARED WITH ALL REQUIRED TESTS.
RAD ACTIVITY: At Sample Receipt LOGIN _ samples ranged from 50-160mR/hr.

SEE COC and SOW for methods requested for analysis:

ICP-MS Tc
Alpha Spec _ Np-237
Alpha Spec _ Am-241, Cm-242, Cm-244
Alpha Spec _ Pu-238, Pu-239/240, Pu-244

Services to be completed in compliance with DOE CAP-AP and HASQARD compliant quality program.
QUALITY ASSURANCE _ Adherence to quality assurance (QA) protocols is extremely important to PNNL. SwRI shall follow documented QA program protocol and perform all work in accordance with the standard practices required by PNNL to support work being accomplished as an Evaluated Supplier. SwRI will perform matrix spike, and laboratory sample duplicate(s) or matrix spike duplicate on sample sets. All instrument calibrations, sample batch preparations, and analytical quality control samples will be performed and documented. If nonconformance conditions occur during performance of analysis of PNNL samples, SwRI will notify PNNL of the occurrence. The project will notify SwRI of the disposition of the nonconforming conditions.

LEVEL 4 DATA PACKAGE REQUIRED

The final report will reference the contract number. Final reports shall be submitted to PNNL as PDF ONLY.

Project Point of contact: Derek Dixon, derek.dixon@pnnl.gov. Cassie A. Martin, cassie.martin@pnnl.gov. Amy Westesen, amy.westesen@pnnl.gov

Final report: Derek Dixon

BATTELLE MEMORIAL INSTITUTE - PNNL
902 Battelle Blvd
Richland WA 99354

Rev 1 (JR, 4/15/24) - Test codes and instructions were updated based on client's (Amy Westesen) email dated 4/15/24. PNNL task order had incorrect dose rate and TRU information. Per Amy, expected dose rate 20-50 mR/hr and TRU 0.1-100 uCi/sample should have been on the task order. A modified PNNL TO will be provided when available.

Documents Related to this task order: 391794[Pic 1 SRR 70993], 391795[Pic 2 SRR 70993], 391796[Pic 3 SRR 70993], 391797[Pic 4 SRR 70993], 391798[Pic 5 SRR 70993], 391799[Pic 6 SRR 70993], 391800[Pic 7 SRR 70993], 391801[Pic 8 SRR 70993], 391802[Pic 9 SRR 70993], 391803[Pic 10 SRR 70993], 391804[Pic 11 SRR 70993], 391805[Pic 12 SRR 70993], 391806[Pic 13 SRR 70993], 391807[Pic 14 SRR 70993], 391808[Pic 15 SRR 70993], 391809[Pic 16 SRR 70993], 391810[Pic 17 SRR 70993], 391811[Pic 18 SRR 70993], 391812[Pic 19 SRR 70993], 391813[Pic 20 SRR 70993], 391814[Pic 21 SRR 70993], 391815[Pic 22 SRR 70993], 391816[Pic 23 SRR 70993], 391959[RAD Form 315 for SRR 70993], 391991[COC for SRR 70993], 391992[Paperwork for SRR 70993], 395153[Project Email for SRR 70993]

Deliverables --> Hard Copy: no EDD: no PDF: -YES-

Test: ALPHA-AM_SWRI
Section: RADCHEM

Holding: 180 days from CED

Alpha Spec Analysis for isotopic Americium

Cnt: 2

| System ID | Type | Cont | Matrix | Customer ID | CED | Method Date |
|-----------|-------|------|--------|-----------------|---------|-------------|
| 718821 | HiRad | 1 | Liquid | TI155-EFF-Comp | NO DATA | NO DATA |
| 718822 | HiRad | 1 | Liquid | TI155-Feed-Comp | NO DATA | NO DATA |

Test: ALPHA-CM_SWRI
Section: RADCHEM

Holding: 180 days from CED

Alpha Spec Analysis for isotopic Curium

Cnt: 2

| System ID | Type | Cont | Matrix | Customer ID | CED | Method Date |
|-----------|-------|------|--------|----------------|---------|-------------|
| 718821 | HiRad | 1 | Liquid | TI155-EFF-Comp | NO DATA | NO DATA |



Southwest Research Institute

Laboratory Task Order

TO #: 240405-6 Revision: 1

SDG: 718819
RECEIVED: 04/04/24
TON: 733437

SRR #s: 70993
Client(s): Battelle Memorial Institute PNNL

Project(s): 27927.13.001
Manager(s): Ranger, Jacqueline
To Client: 05/22/24

| System ID | Type | Cont | Matrix | Customer ID | CED | Method Date |
|-----------|-------|------|--------|-----------------|---------|-------------|
| 718822 | HiRad | 1 | Liquid | TI155-Feed-Comp | NO DATA | NO DATA |

Test: ALPHA-NP_SWRI
Section: RADCHEM

Holding: 180 days from CED

Alpha Spec Analysis for Neptunium-237

Cnt: 2

| System ID | Type | Cont | Matrix | Customer ID | CED | Method Date |
|-----------|-------|------|--------|-----------------|---------|-------------|
| 718821 | HiRad | 1 | Liquid | TI155-EFF-Comp | NO DATA | NO DATA |
| 718822 | HiRad | 1 | Liquid | TI155-Feed-Comp | NO DATA | NO DATA |

Test: ALPHA-PU_SWRI
Section: RADCHEM

Holding: 180 days from CED

Alpha Spec Analysis for Isotopic Plutonium

Cnt: 18

| System ID | Type | Cont | Matrix | Customer ID | CED | Method Date |
|-----------|-------|------|--------|-----------------|---------|-------------|
| 718819 | HiRad | 1 | Liquid | TI155-A-2-A | NO DATA | NO DATA |
| 718820 | HiRad | 1 | Liquid | TI155-B-10-A | NO DATA | NO DATA |
| 718821 | HiRad | 1 | Liquid | TI155-EFF-Comp | NO DATA | NO DATA |
| 718822 | HiRad | 1 | Liquid | TI155-Feed-Comp | NO DATA | NO DATA |
| 718825 | HiRad | 1 | Liquid | TI155-A-11-A | NO DATA | NO DATA |
| 718826 | HiRad | 1 | Liquid | TI155-A-17-A | NO DATA | NO DATA |
| 718827 | HiRad | 1 | Liquid | TI155-A-21-A | NO DATA | NO DATA |
| 718828 | HiRad | 1 | Liquid | TI155-B-22-A | NO DATA | NO DATA |
| 718829 | HiRad | 1 | Liquid | TI155-B-24-A | NO DATA | NO DATA |
| 718830 | HiRad | 1 | Liquid | TI155-A-9-A | NO DATA | NO DATA |
| 718852 | HiRad | 1 | Liquid | TI155-A-13-A | NO DATA | NO DATA |
| 718853 | HiRad | 1 | Liquid | TI155-A-15-A | NO DATA | NO DATA |
| 718854 | HiRad | 1 | Liquid | TI155-A-19-A | NO DATA | NO DATA |
| 718855 | HiRad | 1 | Liquid | TI155-A-5-A | NO DATA | NO DATA |
| 718856 | HiRad | 1 | Liquid | TI155-A-7-A | NO DATA | NO DATA |
| 718857 | HiRad | 1 | Liquid | TI155-B-18-A | NO DATA | NO DATA |
| 718858 | HiRad | 1 | Liquid | TI155-B-2-A | NO DATA | NO DATA |
| 718859 | HiRad | 1 | Liquid | TI155-B-5-A | NO DATA | NO DATA |

Test: DIG-PRECIP-APU
Section: RADPREP

Holding: 180 days from CED

Digestion for Am, Pu, and U with Precip

Cnt: 18

| System ID | Type | Cont | Matrix | Customer ID | CED | Method Date |
|-----------|-------|------|--------|-----------------|---------|-------------|
| 718819 | HiRad | 1 | Liquid | TI155-A-2-A | NO DATA | NO DATA |
| 718820 | HiRad | 1 | Liquid | TI155-B-10-A | NO DATA | NO DATA |
| 718821 | HiRad | 1 | Liquid | TI155-EFF-Comp | NO DATA | NO DATA |
| 718822 | HiRad | 1 | Liquid | TI155-Feed-Comp | NO DATA | NO DATA |
| 718825 | HiRad | 1 | Liquid | TI155-A-11-A | NO DATA | NO DATA |
| 718826 | HiRad | 1 | Liquid | TI155-A-17-A | NO DATA | NO DATA |
| 718827 | HiRad | 1 | Liquid | TI155-A-21-A | NO DATA | NO DATA |
| 718828 | HiRad | 1 | Liquid | TI155-B-22-A | NO DATA | NO DATA |
| 718829 | HiRad | 1 | Liquid | TI155-B-24-A | NO DATA | NO DATA |
| 718830 | HiRad | 1 | Liquid | TI155-A-9-A | NO DATA | NO DATA |
| 718852 | HiRad | 1 | Liquid | TI155-A-13-A | NO DATA | NO DATA |
| 718853 | HiRad | 1 | Liquid | TI155-A-15-A | NO DATA | NO DATA |
| 718854 | HiRad | 1 | Liquid | TI155-A-19-A | NO DATA | NO DATA |
| 718855 | HiRad | 1 | Liquid | TI155-A-5-A | NO DATA | NO DATA |
| 718856 | HiRad | 1 | Liquid | TI155-A-7-A | NO DATA | NO DATA |



Southwest Research Institute

Laboratory Task Order

TO #: 240405-6 Revision: 1

SDG: 718819
RECEIVED: 04/04/24
TON: 733437

SRR #s: 70993
Client(s): Battelle Memorial Institute PNNL

Project(s): 27927.13.001
Manager(s): Ranger, Jacqueline
To Client: 05/22/24

| System ID | Type | Cont | Matrix | Customer ID | CED | Method Date |
|-----------|-------|------|--------|--------------|---------|-------------|
| 718857 | HiRad | 1 | Liquid | TI155-B-18-A | NO DATA | NO DATA |
| 718858 | HiRad | 1 | Liquid | TI155-B-2-A | NO DATA | NO DATA |
| 718859 | HiRad | 1 | Liquid | TI155-B-5-A | NO DATA | NO DATA |

Test: DIG-PRECIP-Np
Section: RADPREP

Holding: 180 days from CED

Digestion for Np with Precip

Cnt: 2

| System ID | Type | Cont | Matrix | Customer ID | CED | Method Date |
|-----------|-------|------|--------|-----------------|---------|-------------|
| 718821 | HiRad | 1 | Liquid | TI155-EFF-Comp | NO DATA | NO DATA |
| 718822 | HiRad | 1 | Liquid | TI155-Feed-Comp | NO DATA | NO DATA |

Test: DIG-TOTALDISS_Tc99
Section: METALPREP

Holding: 180 days from CED

Digestion Method Total Dissolution for Technetium-99

Cnt: 2

| System ID | Type | Cont | Matrix | Customer ID | CED | Method Date |
|-----------|-------|------|--------|-----------------|---------|-------------|
| 718821 | HiRad | 1 | Liquid | TI155-EFF-Comp | NO DATA | NO DATA |
| 718822 | HiRad | 1 | Liquid | TI155-Feed-Comp | NO DATA | NO DATA |

Test: ICPMS-SWRI_Tc99
Section: METALS

Holding: 180 days from CED

ICPMS SwRI Method for Technetium-99

Cnt: 2

| System ID | Type | Cont | Matrix | Customer ID | CED | Method Date |
|-----------|-------|------|--------|-----------------|---------|-------------|
| 718821 | HiRad | 1 | Liquid | TI155-EFF-Comp | NO DATA | NO DATA |
| 718822 | HiRad | 1 | Liquid | TI155-Feed-Comp | NO DATA | NO DATA |

Test: RAD Narrative
Section: RADCHEM

Holding: 28 days from VTSR

Narrative

Cnt: 18

| System ID | Type | Cont | Matrix | Customer ID | VTSR | Method Date |
|-----------|-------|------|--------|-----------------|-----------|-------------|
| 718819 | HiRad | 1 | Liquid | TI155-A-2-A | 04 Apr 24 | 02 May 24 |
| 718820 | HiRad | 1 | Liquid | TI155-B-10-A | 04 Apr 24 | 02 May 24 |
| 718821 | HiRad | 1 | Liquid | TI155-EFF-Comp | 04 Apr 24 | 02 May 24 |
| 718822 | HiRad | 1 | Liquid | TI155-Feed-Comp | 04 Apr 24 | 02 May 24 |
| 718825 | HiRad | 1 | Liquid | TI155-A-11-A | 04 Apr 24 | 02 May 24 |
| 718826 | HiRad | 1 | Liquid | TI155-A-17-A | 04 Apr 24 | 02 May 24 |
| 718827 | HiRad | 1 | Liquid | TI155-A-21-A | 04 Apr 24 | 02 May 24 |
| 718828 | HiRad | 1 | Liquid | TI155-B-22-A | 04 Apr 24 | 02 May 24 |
| 718829 | HiRad | 1 | Liquid | TI155-B-24-A | 04 Apr 24 | 02 May 24 |
| 718830 | HiRad | 1 | Liquid | TI155-A-9-A | 04 Apr 24 | 02 May 24 |
| 718852 | HiRad | 1 | Liquid | TI155-A-13-A | 04 Apr 24 | 02 May 24 |
| 718853 | HiRad | 1 | Liquid | TI155-A-15-A | 04 Apr 24 | 02 May 24 |
| 718854 | HiRad | 1 | Liquid | TI155-A-19-A | 04 Apr 24 | 02 May 24 |
| 718855 | HiRad | 1 | Liquid | TI155-A-5-A | 04 Apr 24 | 02 May 24 |
| 718856 | HiRad | 1 | Liquid | TI155-A-7-A | 04 Apr 24 | 02 May 24 |
| 718857 | HiRad | 1 | Liquid | TI155-B-18-A | 04 Apr 24 | 02 May 24 |
| 718858 | HiRad | 1 | Liquid | TI155-B-2-A | 04 Apr 24 | 02 May 24 |
| 718859 | HiRad | 1 | Liquid | TI155-B-5-A | 04 Apr 24 | 02 May 24 |

Test: SEP-APU
Section: RADPREP

Holding: 180 days from CED

Separation for Am, Pu, and U

Cnt: 18

| System ID | Type | Cont | Matrix | Customer ID | CED | Method Date |
|-----------|-------|------|--------|-------------|---------|-------------|
| 718819 | HiRad | 1 | Liquid | TI155-A-2-A | NO DATA | NO DATA |



Southwest Research Institute

Laboratory Task Order

TO #: 240405-6 Revision: 1

SDG: 718819
RECEIVED: 04/04/24
TON: 733437

SRR #s: 70993
Client(s): Battelle Memorial Institute PNNL

Project(s): 27927.13.001
Manager(s): Ranger, Jacqueline
To Client: 05/22/24

| System ID | Type | Cont | Matrix | Customer ID | CED | Method Date |
|-----------|-------|------|--------|-----------------|---------|-------------|
| 718820 | HiRad | 1 | Liquid | TI155-B-10-A | NO DATA | NO DATA |
| 718821 | HiRad | 1 | Liquid | TI155-EFF-Comp | NO DATA | NO DATA |
| 718822 | HiRad | 1 | Liquid | TI155-Feed-Comp | NO DATA | NO DATA |
| 718825 | HiRad | 1 | Liquid | TI155-A-11-A | NO DATA | NO DATA |
| 718826 | HiRad | 1 | Liquid | TI155-A-17-A | NO DATA | NO DATA |
| 718827 | HiRad | 1 | Liquid | TI155-A-21-A | NO DATA | NO DATA |
| 718828 | HiRad | 1 | Liquid | TI155-B-22-A | NO DATA | NO DATA |
| 718829 | HiRad | 1 | Liquid | TI155-B-24-A | NO DATA | NO DATA |
| 718830 | HiRad | 1 | Liquid | TI155-A-9-A | NO DATA | NO DATA |
| 718852 | HiRad | 1 | Liquid | TI155-A-13-A | NO DATA | NO DATA |
| 718853 | HiRad | 1 | Liquid | TI155-A-15-A | NO DATA | NO DATA |
| 718854 | HiRad | 1 | Liquid | TI155-A-19-A | NO DATA | NO DATA |
| 718855 | HiRad | 1 | Liquid | TI155-A-5-A | NO DATA | NO DATA |
| 718856 | HiRad | 1 | Liquid | TI155-A-7-A | NO DATA | NO DATA |
| 718857 | HiRad | 1 | Liquid | TI155-B-18-A | NO DATA | NO DATA |
| 718858 | HiRad | 1 | Liquid | TI155-B-2-A | NO DATA | NO DATA |
| 718859 | HiRad | 1 | Liquid | TI155-B-5-A | NO DATA | NO DATA |

Test: SEP-Np
Section: RADPREP

Holding: 180 days from CED

Separation for Np

Cnt: 2

| System ID | Type | Cont | Matrix | Customer ID | CED | Method Date |
|-----------|-------|------|--------|-----------------|---------|-------------|
| 718821 | HiRad | 1 | Liquid | TI155-EFF-Comp | NO DATA | NO DATA |
| 718822 | HiRad | 1 | Liquid | TI155-Feed-Comp | NO DATA | NO DATA |



Sample Receipt

Southwest Research Institute

Sample Receipt Number: 70993

VTSR: 04/04/24

Time: 10:00:00

Project: 27927.13.001
Case #: 733437
Client: Battelle Memorial Institute PNNL

Manager: Ranger, Jacqueline
Logged in by: DXGARCIA
Creation Date: 04/04/24

Notes

3 _ 16x16x16 _ boxes were delivered to SwRI's Shipping & Receiving Warehouse. Division 01 AEC LOGIN staff picked up the boxes from Receiving and took custody. Samples were received intact.

FED EX Tracking #:

7279 2104 0311 _ 21.9°C (Ambient, no ice).

7279 2104 0322 _ 21.9°C (Ambient, no ice).

7279 2104 0333 _ 21.9°C (Ambient, no ice).

Model 9 Ion Chamber, Ludlum SN 183532, AN 009597; Due: 09/22/2024

Background: Passed

2401-P, Survey Meter SN 183532, AN 007335; Due: 08/24/2024

Background: Passed

UN2910, Radioactive Material, Excepted Package.

RAD: See Radioactive Material Receiving Form for additional info.

Lab will take contact RAD readings on actual samples.

Additional LOGIN notes and radioactive readings are provided with the SRR paper work.

See chain-of-custody for more information.

Test requirements located on applicable Task Order.

HIGH RAD SAMPLES.

Background CPM: NOTE
Container Wipe CPM: NOTE
Total CPM: NOTE

| System ID | Customer ID | CED | Matrix | Containers | Special Reqs. |
|-----------|-----------------|-----|--------|------------|---------------|
| 718825 | TI155-A-11-A | | Liquid | 1 | Rad |
| 718852 | TI155-A-13-A | | Liquid | 1 | Rad |
| 718853 | TI155-A-15-A | | Liquid | 1 | Rad |
| 718826 | TI155-A-17-A | | Liquid | 1 | Rad |
| 718854 | TI155-A-19-A | | Liquid | 1 | Rad |
| 718819 | TI155-A-2-A | | Liquid | 1 | Rad |
| 718827 | TI155-A-21-A | | Liquid | 1 | Rad |
| 718855 | TI155-A-5-A | | Liquid | 1 | Rad |
| 718856 | TI155-A-7-A | | Liquid | 1 | Rad |
| 718830 | TI155-A-9-A | | Liquid | 1 | Rad |
| 718820 | TI155-B-10-A | | Liquid | 1 | Rad |
| 718857 | TI155-B-18-A | | Liquid | 1 | Rad |
| 718858 | TI155-B-2-A | | Liquid | 1 | Rad |
| 718828 | TI155-B-22-A | | Liquid | 1 | Rad |
| 718829 | TI155-B-24-A | | Liquid | 1 | Rad |
| 718859 | TI155-B-5-A | | Liquid | 1 | Rad |
| 718821 | TI155-EFF-Comp | | Liquid | 1 | Rad |
| 718822 | TI155-Feed-Comp | | Liquid | 1 | Rad |

Containers: 18

Samples: 18

70993 Battelle Memorial Institute

Sample Receipt

Southwest Research Institute
Project: 27927.13.001
Case #: 733437
Client: Battelle Memorial Institute PNNL

Sample Receipt Number: 70993

VTSR: 04/04/24 Time: 10:00:00
Manager: Ranger, Jacqueline
Logged in by: DXGARCIA
Creation Date: 04/04/24

These documents are associated with this receipt: 391991[COC for SRR 70993], 391992[Paperwork for SRR 70993], 391959[RAD Form 315 for SRR 70993], 395153[Project Email for SRR 70993], 391794[Pic 1 SRR 70993], 391795[Pic 2 SRR 70993], 391796[Pic 3 SRR 70993], 391797[Pic 4 SRR 70993], 391798[Pic 5 SRR 70993], 391799[Pic 6 SRR 70993], 391800[Pic 7 SRR 70993], 391801[Pic 8 SRR 70993], 391802[Pic 9 SRR 70993], 391803[Pic 10 SRR 70993], 391804[Pic 11 SRR 70993], 391805[Pic 12 SRR 70993], 391806[Pic 13 SRR 70993], 391807[Pic 14 SRR 70993], 391808[Pic 15 SRR 70993], 391809[Pic 16 SRR 70993], 391810[Pic 17 SRR 70993], 391811[Pic 18 SRR 70993], 391812[Pic 19 SRR 70993], 391813[Pic 20 SRR 70993], 391814[Pic 21 SRR 70993], 391815[Pic 22 SRR 70993], 391816[Pic 23 SRR 70993]

Thermometer: 029926
Temperature: 21.9

70993 Battelle Memorial Institute

Project Sample Transfer Form (PSTF)

Page 1 of 2

0311

| | | | | | | | | | | | | |
|---|--|--|--|-----------------|-------------------------------|----------------------|-------------------|-----|--|-------------------------------|---|-----------------|
| Form # DFTP-PSTF-002 Rev. 0 | | Task Plan # DFTP-TP-154 Rev. 0 | | Analyses | | | | | Project Point of Contact/Phone # or email | | | |
| Scope of Work Document(s) PNNL REQ# 733437, Task Order 733437 SWRI Master Agreement 660825 | | | | ICP-AES | Alpha Spec (Am, Cm, Np, & Pu) | ICP-MS (Cs, I, & Tc) | IC (total fusion) | TOC | TIC | Alpha Spec (Am, Cm, Np, & Pu) | <u>Amy.Westesens@pnnl.gov</u> 509-371-7908 | |
| | | | | | | | | | | | | |
| Sample Identification | | # Cont. | | | | | | | | | Matrix | Comments |
| TI155-A-5-A | | 1 | | | X | X | | | | | Aqueous | pH = 14 |
| TI155-A-7-A | | 1 | | | X | X | | | | | Aqueous | pH = 14 |
| TI155-A-13-A | | 1 | | | X | X | | | | | Aqueous | pH = 14 |
| TI155-A-15-A | | 1 | | | X | X | | | | | Aqueous | pH = 14 |
| TI155-A-19-A | | 1 | | | X | X | | | | | Aqueous | pH = 14 |
| TI155-B-2-A | | 1 | | | X | X | | | | | Aqueous | pH = 14 |
| TI155-B-5-A | | 1 | | | X | X | | | | | Aqueous | pH = 14 |
| TI155-B-18-A | | 1 | | | X | X | | | | | Aqueous | pH = 14 |
| | | | | | | | | | | | | |
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shipment 1 of 3

Project Sample Transfer Form (PSTF)

Page 2 of 2

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| | | | |
|---|--|--|---|
| Final Sample Disposition: Dispose on-site | | If samples are to be preserved, identify requirements here. | |
| Project Approval | | | |
| <small>Date</small> Reid | | <small>Approved by</small> A Peterson | Digitally signed by Reid A Peterson Date: 2024.03.18 11:23:08 -07'00' |
| Receipt Acknowledgement | | | |
| <small>Date</small> 04.04.24 | | <small>Received by</small> Daniel Marner / SWRI | |

Client: Battelle Memorial Institute PNNL
SRR # 70993
Project # 27927.13.001
Case: 733437
VTSR: 04/04/24
Sample(s) Received: Intact
Temperature: 21.9°C SN # 029926

Project Sample Transfer Form (PSTF)

Page 1 of 2

0322

| | | | | | | | | | | | | |
|--|--|-----------------------------------|--|----------|-------------------------------|----------------------|-------------------|-----|---|-------------------------------|---------------------------------------|----------|
| Form # DFTP-PSTF-002 Rev. 0 | | Task Plan # DFTP-TP-154 Rev. 0 | | Analyses | | | | | Project Point of Contact/Phone # or email | | | |
| Scope of Work Document(s) PNNL REQ# 733437, Task Order 733437 SWRI Master Agreement 660825 | | | | ICP-AES | Alpha Spec (Am, Cm, Np, & Pu) | ICP-MS (Cs, I, & Tc) | IC (total fusion) | TOC | TIC | Alpha Spec (Am, Cm, Np, & Pu) | Amy.Westesen@pnnl.gov 509-371-7908 | |
| | | | | | | | | | | | | |
| Sample Identification | | # Cont. | | | | | | | | | Matrix | Comments |
| TI155-A-9-A | | 1 | | | X | X | | | | | Aqueous | pH = 14 |
| TI155-A-11-A | | 1 | | | X | X | | | | | Aqueous | pH = 14 |
| TI155-A-17-A | | 1 | | | X | X | | | | | Aqueous | pH = 14 |
| TI155-A-21-A | | 1 | | | X | X | | | | | Aqueous | pH = 14 |
| TI155-B-22-A | | 1 | | | X | X | | | | | Aqueous | pH = 14 |
| TI155-B-24-A | | 1 | | | X | X | | | | | Aqueous | pH = 14 |
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Shipment 2 of 3

Project Sample Transfer Form (PSTF)

Page 2 of 2 0322

| | | | |
|---|--|--|--|
| Final Sample Disposition: Dispose on-site | | If samples are to be preserved, identify requirements here. | |
| Project Approval | | | |
| <small>Date</small> Reid | | <small>Approved by</small> A Peterson | |
| | | Digitally signed by Reid A Peterson Date: 2024.03.18 11:23:08 -07'00' | |
| Receipt Acknowledgement | | | |
| <small>Date</small> 04.04.24 | | <small>Received by</small> Daniel Haines / SWHI | |

Client: Battelle Memorial Institute PNNL
SRR # 70993
Project # 27927.13.001
Case: 733437
VTSR: 04/04/24
Sample(s) Received: Intact
Temperature: 21.9°C SN # 029926

Project Sample Transfer Form (PSTF)

Page 2 of 2

| | | |
|---|--------------------|--|
| Final Sample Disposition: Dispose on-site | | If samples are to be preserved, identify requirements here. |
| Project Approval | | |
| Date | Approved by | |
| | Reid A Peterson | Digitally signed by Reid A Peterson Date: 2024.03.18 11:23:08 -07'00' |
| Receipt Acknowledgement | | |
| Date | Received by | |
| 04-04-24 | Doerflinger / SWRI | |

Client: Battelle Memorial Institute PNNL
SRR # 70993
Project # 27927.13.001
Case: 733437
VTSR: 04/04/24
Sample(s) Received: Intact
Temperature: 21.9°C SN # 029926

Sample Custodian Signature: *David Glau* Southwest Research Institute
Traffic Report



- 1. Custody Seal Present
- 2. Chain of Custody Present
- 3. Sample Tags Not Present
Sample Tag Numbers Not on COC *n/a*
- 4. SMO Forms Present

Client: Battelle Memorial Institute PNNL
Project: 27927.13.001
Case: 733437 / SDG: 718819
Sample Receipt: 70993
Airbill: 3 Air bills-See notes

Custody Seal #(s): Tape Only

| Date Received | Time Received | COC Record | SMO Sample # | Corresponding | | Traffic Rpt, Tags, COC Agree | Sample Condition |
|---------------|---------------|------------|-----------------|---------------|--------|------------------------------|------------------|
| | | | | Sample Tag # | SwRI # | | |
| 04/04/24 | 10:00:00 | 733437 | TI155-A-2-A | N/A | 718819 | YES | Intact |
| 04/04/24 | 10:00:00 | 733437 | TI155-B-10-A | N/A | 718820 | YES | Intact |
| 04/04/24 | 10:00:00 | 733437 | TI155-EFF-Comp | N/A | 718821 | YES | Intact |
| 04/04/24 | 10:00:00 | 733437 | TI155-Feed-Comp | N/A | 718822 | YES | Intact |
| 04/04/24 | 10:00:00 | 733437 | TI155-A-11-A | N/A | 718825 | YES | Intact |
| 04/04/24 | 10:00:00 | 733437 | TI155-A-17-A | N/A | 718826 | YES | Intact |
| 04/04/24 | 10:00:00 | 733437 | TI155-A-21-A | N/A | 718827 | YES | Intact |
| 04/04/24 | 10:00:00 | 733437 | TI155-B-22-A | N/A | 718828 | YES | Intact |
| 04/04/24 | 10:00:00 | 733437 | TI155-B-24-A | N/A | 718829 | YES | Intact |
| 04/04/24 | 10:00:00 | 733437 | TI155-A-9-A | N/A | 718830 | YES | Intact |
| 04/04/24 | 10:00:00 | 733437 | TI155-A-13-A | N/A | 718852 | YES | Intact |
| 04/04/24 | 10:00:00 | 733437 | TI155-A-15-A | N/A | 718853 | YES | Intact |
| 04/04/24 | 10:00:00 | 733437 | TI155-A-19-A | N/A | 718854 | YES | Intact |
| 04/04/24 | 10:00:00 | 733437 | TI155-A-5-A | N/A | 718855 | YES | Intact |
| 04/04/24 | 10:00:00 | 733437 | TI155-A-7-A | N/A | 718856 | YES | Intact |
| 04/04/24 | 10:00:00 | 733437 | TI155-B-18-A | N/A | 718857 | YES | Intact |
| 04/04/24 | 10:00:00 | 733437 | TI155-B-2-A | N/A | 718858 | YES | Intact |
| 04/04/24 | 10:00:00 | 733437 | TI155-B-5-A | N/A | 718859 | YES | Intact |

Appendix C – Batch Contact Results

Table C.1 provides the experimental results used to produce the AN-107 Cs distribution coefficient (K_d) curves and isotherms at four contact temperatures (Figure 4.5 and Figure 4.6 in the main body of this report). The dry crystalline silicotitanate (CST) masses were based on an F-factor of 0.9282 at the nominal 105 °C drying temperature.

Table C.1. AN-107 Tank Waste Isotherm Data

| Sample ID | Dry CST Mass (g) | AN-107 Vol. (mL) | Initial Cs Conc. (µg/mL) | Equil. Cs Conc. (M) | K_d (mL/g) | Q (mmoles Cs/g) |
|---------------|------------------|------------------|--------------------------|---------------------|--------------|-----------------|
| 16.1 °C | | | | | | |
| TI156-S1-16 | 0.0744 | 15.1271 | 19.8 | 1.35E-05 | 2032 | 2.76E-02 |
| TI156-S1-16-d | 0.0756 | 15.1480 | 19.8 | 1.36E-05 | 1980 | 2.72E-02 |
| TI156-S2-16 | 0.0754 | 15.0598 | 50.6 | 3.31E-05 | 2092 | 6.94E-02 |
| TI156-S2-16-d | 0.0750 | 15.0961 | 50.6 | 3.31E-05 | 2118 | 7.00E-02 |
| TI156-S3-16 | 0.0756 | 15.0902 | 101.5 | 6.61E-05 | 2105 | 1.39E-01 |
| TI156-S3-16-d | 0.0751 | 15.1119 | 101.5 | 6.71E-05 | 2071 | 1.40E-01 |
| TI156-S4-16 | 0.0744 | 15.0823 | 1941.6 | 1.09E-02 | 68 | 7.44E-01 |
| TI156-S4-16-d | 0.0756 | 15.0804 | 1941.6 | 1.09E-02 | 67 | 7.31E-01 |
| 20.0 °C | | | | | | |
| TI156-S1-21 | 0.0751 | 15.0614 | 19.8 | 1.63E-05 | 1630 | 2.67E-02 |
| TI156-S1-21-d | 0.0751 | 15.0928 | 19.8 | 1.63E-05 | 1630 | 2.67E-02 |
| TI156-S2-21 | 0.0749 | 14.9869 | 50.6 | 3.97E-05 | 1717 | 6.82E-02 |
| TI156-S2-21-d | 0.0742 | 15.0981 | 50.6 | 3.99E-05 | 1735 | 6.94E-02 |
| TI156-S3-21 | 0.0745 | 15.0947 | 101.5 | 8.00E-05 | 1725 | 1.38E-01 |
| TI156-S3-21-d | 0.0756 | 15.1270 | 101.5 | 8.09E-05 | 1691 | 1.37E-01 |
| TI156-S4-21 | 0.0744 | 15.0038 | 1941.6 | 1.10E-02 | 68 | 7.37E-01 |
| TI156-S4-21-d | 0.0746 | 14.9872 | 1941.6 | 1.10E-02 | 65 | 7.22E-01 |
| 25.5 °C | | | | | | |
| TI156-S1-25 | 0.0751 | 15.1159 | 19.8 | 1.94E-05 | 1354 | 2.61E-02 |
| TI156-S1-25-d | 0.0751 | 15.1127 | 19.8 | 1.97E-05 | 1330 | 2.61E-02 |
| TI156-S2-25 | 0.0756 | 15.1075 | 50.6 | 4.68E-05 | 1427 | 6.68E-02 |
| TI156-S2-25-d | 0.0743 | 15.0995 | 50.6 | 4.72E-05 | 1439 | 6.78E-02 |
| TI156-S3-25 | 0.0755 | 15.1438 | 101.5 | 9.37E-05 | 1431 | 1.34E-01 |
| TI156-S3-25-d | 0.0754 | 15.1056 | 101.5 | 1.01E-04 | 1310 | 1.33E-01 |
| TI156-S4-25 | 0.0757 | 15.0826 | 1941.6 | 1.06E-02 | 74 | 7.90E-01 |
| TI156-S4-25-d | 0.0742 | 15.1247 | 1941.6 | 1.09E-02 | 70 | 7.67E-01 |
| 34.9 °C | | | | | | |
| TI156-S1-35 | 0.0753 | 14.7198 | 19.8 | 2.81E-05 | 843 | 2.37E-02 |
| TI156-S1-35-d | 0.0751 | 15.1562 | 19.8 | 2.85E-05 | 852 | 2.44E-02 |
| TI156-S2-35 | 0.0758 | 15.0061 | 50.6 | 7.15E-05 | 853 | 6.12E-02 |
| TI156-S2-35-d | 0.0746 | 15.0476 | 50.6 | 7.01E-05 | 888 | 6.26E-02 |
| TI156-S3-35 | 0.0750 | 15.0992 | 101.5 | 1.34E-04 | 950 | 1.27E-01 |
| TI156-S3-35-d | 0.0750 | 15.0686 | 101.5 | 1.34E-04 | 948 | 1.27E-01 |
| TI156-S4-35 | 0.0742 | 15.0412 | 1941.6 | 1.08E-02 | 71 | 7.70E-01 |
| TI156-S4-35-d | 0.0759 | 15.0278 | 1941.6 | 1.08E-02 | 69 | 7.49E-01 |

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