

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

August 2024

AM Westesen  
AM Carney  
EL Campbell  
C Alvarez  
JE Turner  
TT Trang-Le  
RA Peterson

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the U.S. Department of Energy  
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Pacific Northwest National Laboratory  
Richland, Washington 99354

## 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  $3.18 \times 10^{-5}$  Ci  $^{137}\text{Cs}$  per mole of Na.<sup>1</sup> For the AN-107 tank waste to meet this criterion, only 0.147% of the influent  $^{137}\text{Cs}$  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  $3.06 \times 10^0$   $\mu\text{Ci/mL}$ , 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.

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<sup>1</sup> 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)	<sup>137</sup> Cs Loaded (μCi)	Cs Loaded (mmoles Cs/g CST)
Lead	277	1873 <sup>(a)</sup>	1.41E+06	0.0965
Lag	1097	3378 <sup>(a)</sup>	2.32E+05	0.0159
Polish	2031 <sup>(a)</sup>	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.

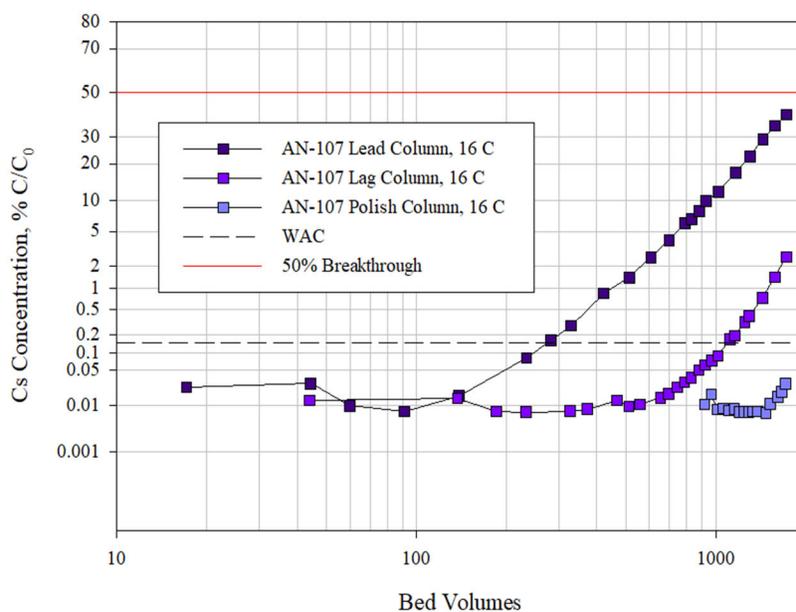


Figure S.1. Lead, Lag, and Polish Column Cs Load Profiles for AN-107 at 16 °C

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

	Analyte	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 <sup>(a)</sup>	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%
	<sup>241</sup> Am	1.34E-01	2.81E-01	--
	<sup>137</sup> 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 mmoles 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 mmoles Cs/ g CST — 100.9% of the maximum Cs loading at feed condition based on prediction from batch contact testing.

## Acknowledgements

The authors thank Shielded Facility Operations staff Victor Aguilar and Robert Cox for hot cell operations. We thank the Analytical Support Operations (ASO) staff Steven Baum, Leah Arrigo, Christian Perez, and Dave Blanchard for the sample analysis, data processing, and reporting. The authors thank Emily Campbell, Abigail Robb, and Renee Russell for conducting the technical reviews of the calculation files and this report. The authors also thank David MacPherson for the quality review of the calculation files and Aaron Sachs for the quality review of this report as well as Matt Wilburn for his technical editing contribution to this report.

## 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  $^{137}\text{Cs}$ , this requirement is  $<3.18\text{E-}5 \text{ Ci } ^{137}\text{Cs}/\text{mole of Na}$ .<sup>2</sup>

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  $^{90}\text{Sr}$  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.

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<sup>2</sup> 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.<sup>3</sup>

#### 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,<sup>4</sup> 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 persulfate
TOC	1.908	1.747	M	Hot persulfate
Cl <sup>-</sup>	0.032	0.030	M	IC
NO <sub>3</sub> <sup>-</sup>	1.887	1.790	M	IC
NO <sub>2</sub> <sup>-</sup>	0.976	0.933	M	IC
PO <sub>4</sub> <sup>3-</sup>	0.015	0.014	M	IC
SO <sub>4</sub> <sup>2-</sup>	0.060	0.056	M	IC
Total Cs	1.06E-04	1.11E-04	M	ICP-MS
<sup>137</sup> Cs	203.0 <sup>(a)</sup>	195.1 <sup>(a)</sup>	μCi/mL	GEA
Density	1.426 <sup>(b)</sup>	1.424 <sup>(b)</sup>	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

<sup>3</sup> 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.

<sup>4</sup> 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  $^{133}\text{Cs}$ , direct analysis of AN-107 for the  $^{135}\text{Cs}$  and  $^{137}\text{Cs}$  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  $\text{HNO}_3$ . 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  $^{137}\text{Cs}$  and the ICP-MS-measured isotopic composition. The calculated  $^{133}\text{Cs}$  concentration agreed within 4% of the ICP-MS-measured  $^{133}\text{Cs}$  concentration (shown in Table 3.2).

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

Analyte <sup>(a)</sup>	7AN-23-01 Results	7AN-23-36 Results	Units
Cs isotopic mass ratio <sup>(a,b,c)</sup>	66.7	68.2	wt% $^{133}\text{Cs}$
	17.2	16.5	wt% $^{135}\text{Cs}$
	16.1	15.4	wt% $^{137}\text{Cs}$
Total Cs	14.56		$\mu\text{g/mL Cs}$

(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)  $^{134}\text{Cs}$ , 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  $^{137}\text{Cs}$  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  $^{137}\text{Cs}$  average was 119.3  $\mu\text{Ci/mL}$  (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  $^{137}\text{Cs}$  concentration (in terms of  $\mu\text{g/mL}$  with unit conversion per the specific activity) and  $^{137}\text{Cs}$  mass fraction (average 15.7 wt%). The total Cs concentration in the AN-107 was 8.73  $\mu\text{g/mL}$  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.<sup>5</sup>

#### 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.

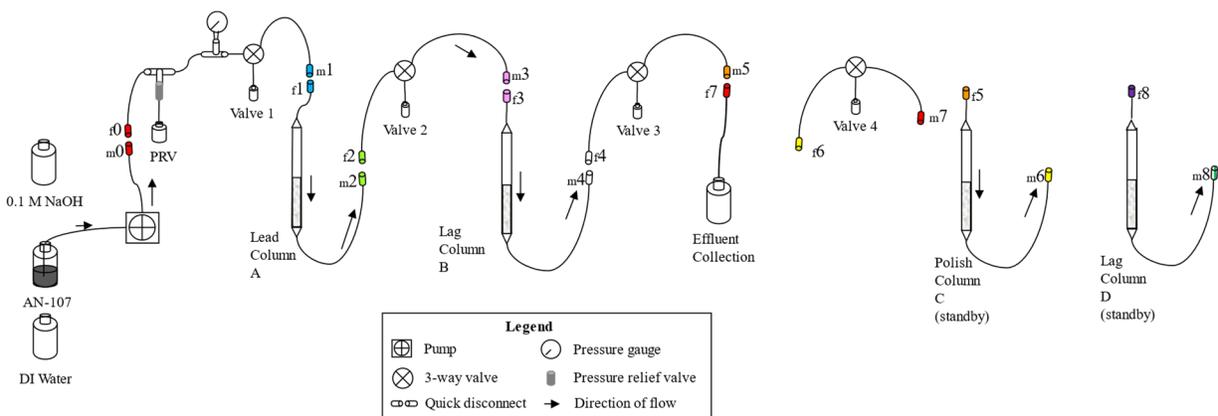


Figure 3.1. AN-107 Column System Schematic

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.

<sup>5</sup> 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.

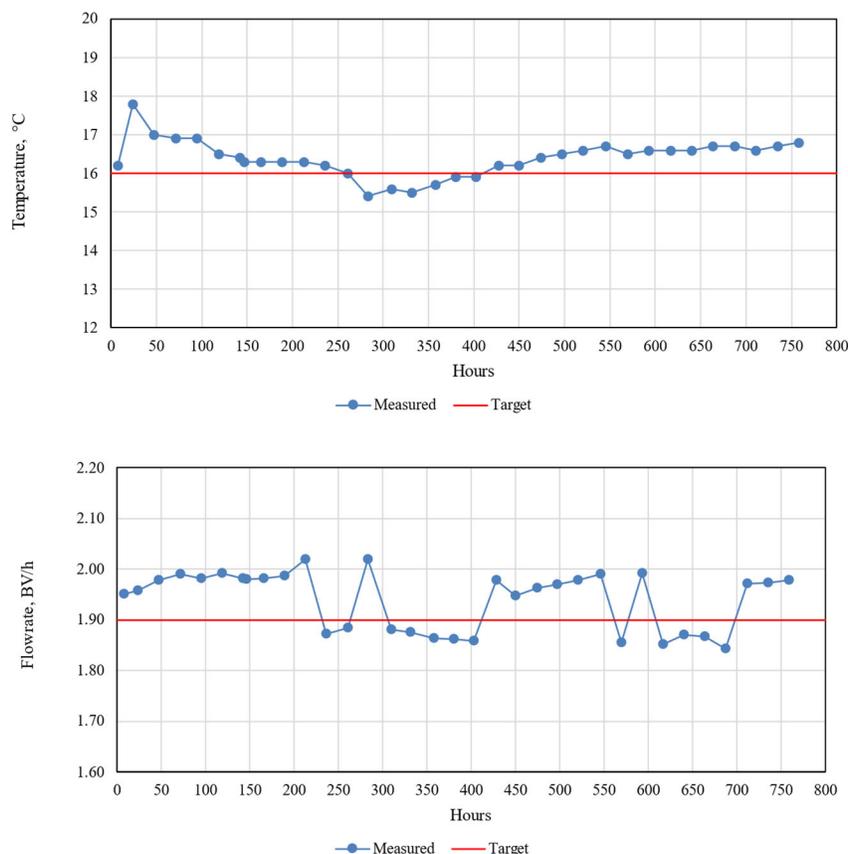


Figure 3.2. AN-107 Daily Column Temperature and Flowrate during Testing

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 <sup>(a)</sup>	AN-107	1717.6	13741	1.94	0.324	890:31
Loading polish column <sup>(b)</sup>	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 CsNO<sub>3</sub> 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 <sup>137</sup>Cs 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  $200 \pm 1.8$  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.

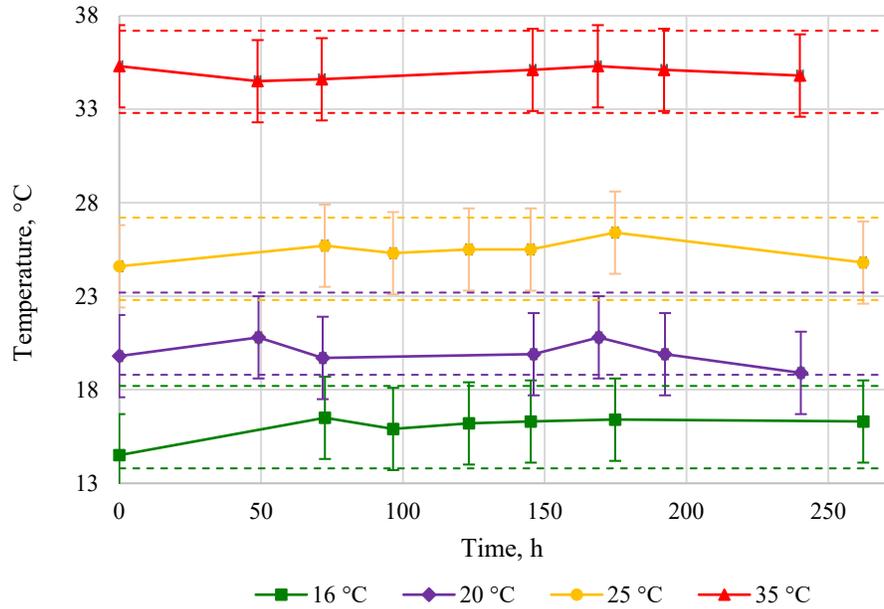


Figure 3.3. Temperature Profiles of Batch Contact Testing with AN-107 Tank Waste Supernate

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 <sup>137</sup>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 <sup>137</sup>Cs concentration (μCi/mL)
- $A_1$  = final (equilibrium) <sup>137</sup>Cs concentration (μCi/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)

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

where  $Q$  = equilibrium Cs concentration in the CST (mmole/g CST)  
 1000 = conversion factor to convert  $\mu\text{g}$  to mg  
 FW = Cs formula weight

### 3.5 Sample Analysis

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

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 ( <sup>241</sup> Am, <sup>137</sup> Cs, <sup>60</sup> Co) ICP-MS ( <sup>133</sup> Cs, <sup>135</sup> Cs, <sup>137</sup> Cs)
	331: 2310007-01 and -02	IC anions (F <sup>-</sup> , Cl <sup>-</sup> , NO <sub>2</sub> <sup>-</sup> , NO <sub>3</sub> <sup>-</sup> , PO <sub>4</sub> <sup>3-</sup> , C <sub>2</sub> O <sub>4</sub> <sup>2-</sup> , SO <sub>4</sub> <sup>2-</sup> )
AN-107 IX Feed		GEA ( <sup>241</sup> Am, <sup>137</sup> Cs, <sup>60</sup> Co, <sup>154</sup> Eu) OH <sup>-</sup>
	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 <sup>-</sup> , Cl <sup>-</sup> , NO <sub>2</sub> <sup>-</sup> , NO <sub>3</sub> <sup>-</sup> , PO <sub>4</sub> <sup>3-</sup> , C <sub>2</sub> O <sub>4</sub> <sup>2-</sup> , SO <sub>4</sub> <sup>2-</sup> ) TIC/TOC
	SwRI: 718822	Total Alpha and <sup>99</sup> Tc
AN-107 IX Effluent		GEA ( <sup>241</sup> Am, <sup>137</sup> Cs, <sup>60</sup> Co, <sup>154</sup> Eu) OH <sup>-</sup>
	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 <sup>-</sup> , Cl <sup>-</sup> , NO <sub>2</sub> <sup>-</sup> , NO <sub>3</sub> <sup>-</sup> , PO <sub>4</sub> <sup>3-</sup> , C <sub>2</sub> O <sub>4</sub> <sup>2-</sup> , SO <sub>4</sub> <sup>2-</sup> ) TIC/TOC
	SwRI: 718821	Total Alpha and <sup>99</sup> 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  $^{137}\text{Cs}$  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).<sup>6</sup>

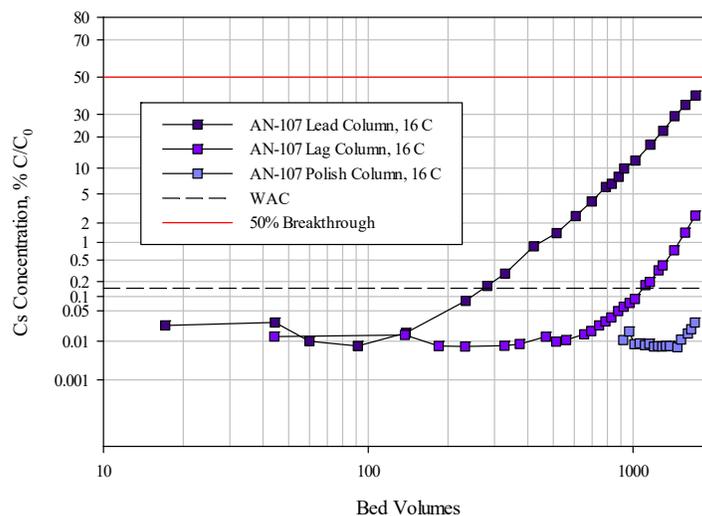


Figure 4.1. Lead, Lag, and Polish Column Cs Load Profiles of AN-107 at 1.9 BV/h

<sup>6</sup> The WAC limit was derived from the allowed curies of  $^{137}\text{Cs}$  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  $\mu\text{Ci } ^{137}\text{Cs}/\text{mL}$  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.

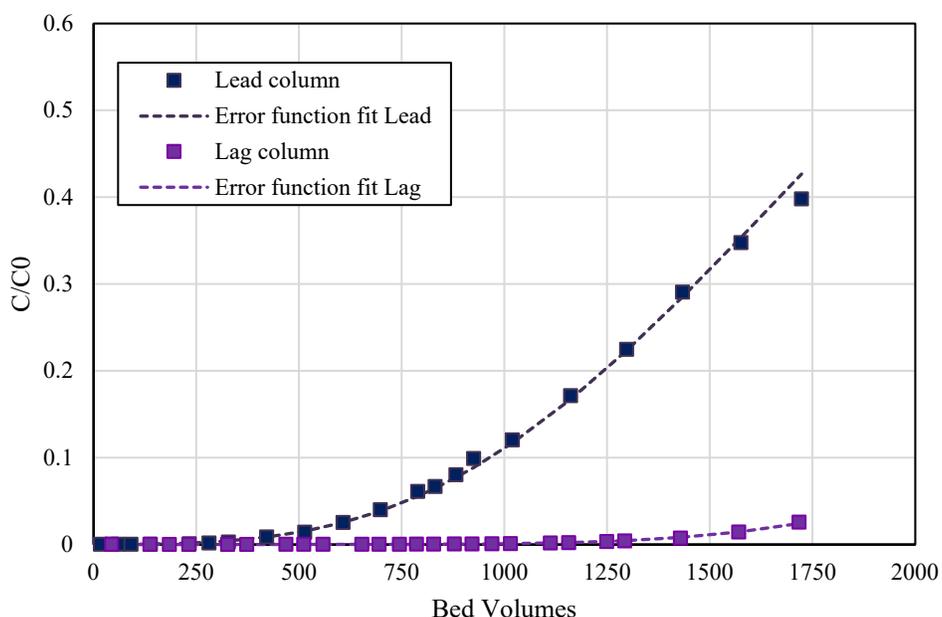


Figure 4.2. AN-107 Lead and Lag Column Cs Breakthrough with Error Function Fit

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 ( $\lambda$ ) can be predicted from the product of the  $K_d$  value and the ion exchanger bed density ( $\rho_b$ ) 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  $\lambda$  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/C<sub>0</sub> 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)

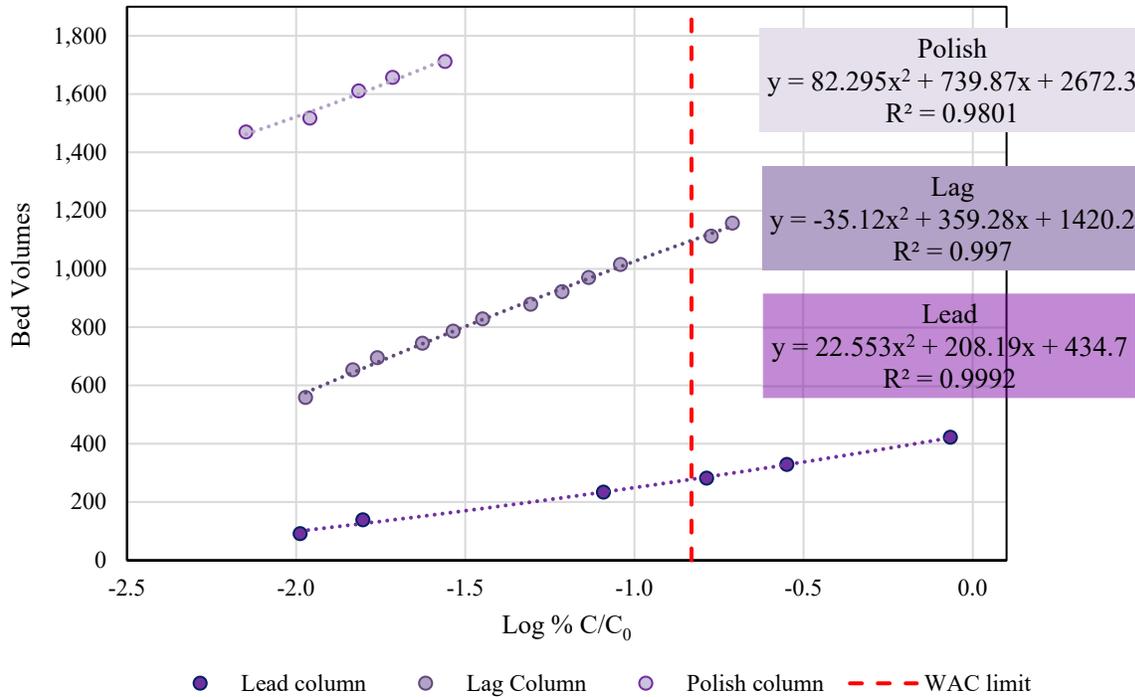


Figure 4.3. Curve Fits to Interpolate WAC Limit Breakthroughs from AN-107 Lead, Lag, and Polish Columns

#### 4.1.2 Cesium Activity Balance

The Cs fractionations to the effluents and the columns were determined based on the input <sup>137</sup>Cs and the measured <sup>137</sup>Cs 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 <sup>137</sup>Cs fractions found in the various effluents as well as the calculated <sup>137</sup>Cs 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. <sup>137</sup>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 <sup>137</sup> Cs recovered in effluents	735	4.45E-02
Total <sup>137</sup> 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):

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

where

- A<sub>Cs</sub> = activity of <sup>137</sup>Cs, μCi on the lead column
- CF = conversion factor, mg Cs/μCi <sup>137</sup>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  $\leq 16^\circ\text{C}$ , 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.

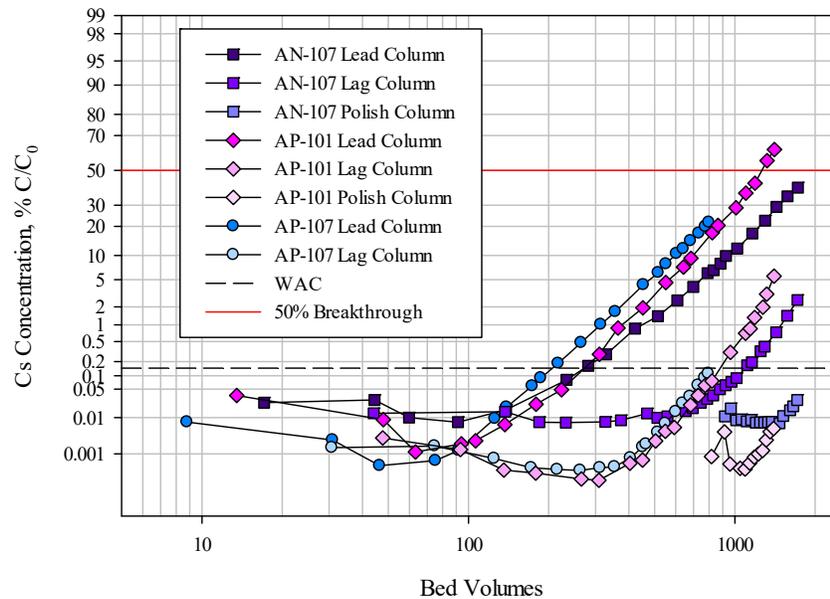


Figure 4.4. Comparative Cs Breakthrough Performance for AN-107, AP-101 and AP-107, Probability-Log Plot

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 <sub>0</sub>	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 <sup>137</sup>Cs, <sup>243+244</sup>Cm, and <sup>237</sup>Np 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<sub>Da</sub> = concentration of analyte *a* in the Cs-decontaminated effluent
- V<sub>D</sub> = volume of Cs-decontaminated effluent
- C<sub>Fa</sub> = concentration of analyte *a* in the AN-107 feed
- V<sub>F</sub> = volume of AN-107 feed
- F<sub>Da</sub> = 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) <sup>(a)</sup>	<sup>60</sup> Co	2.90E-03	3.19E-03	--
	<sup>137</sup> Cs	1.12E+02	1.42E-02	0.013%
	<sup>152</sup> Eu	8.60E-04	1.07E-03	--
	<sup>154</sup> Eu	2.33E-02	3.12E-02	--
	<sup>241</sup> Am	1.34E-01	2.81E-01	--
Separations/ Alpha energy analysis (AEA) <sup>(b)</sup>	<sup>241</sup> Am	2.11E-01	3.19E-01	--
	<sup>242</sup> Cm	3.54E-04	1.97E-03	--
	<sup>243+244</sup> Cm	5.34E-03	3.90E-03	73%
	<sup>237</sup> Np	1.14E-04	4.95E-05	44%
	<sup>238</sup> Pu	4.41E-03	6.80E-03	--
	<sup>239+240</sup> 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 <sup>-</sup>	6.84E-03	7.58E-03	111%
	Cl <sup>-</sup>	3.10E-02	3.10E-02	100%
	NO <sub>2</sub> <sup>-</sup>	9.65E-01	9.72E-01	101%
	NO <sub>3</sub> <sup>-</sup>	1.81E+00	1.81E+00	100%
	PO <sub>4</sub> <sup>3-</sup>	1.25E-02	1.17E-02	94%
	SO <sub>4</sub> <sup>2-</sup>	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 <sup>(a)</sup>	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  $C_s$  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  $C_s$  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  $C_s$  concentrations of  $<10^{-3}$  M  $C_s$ .

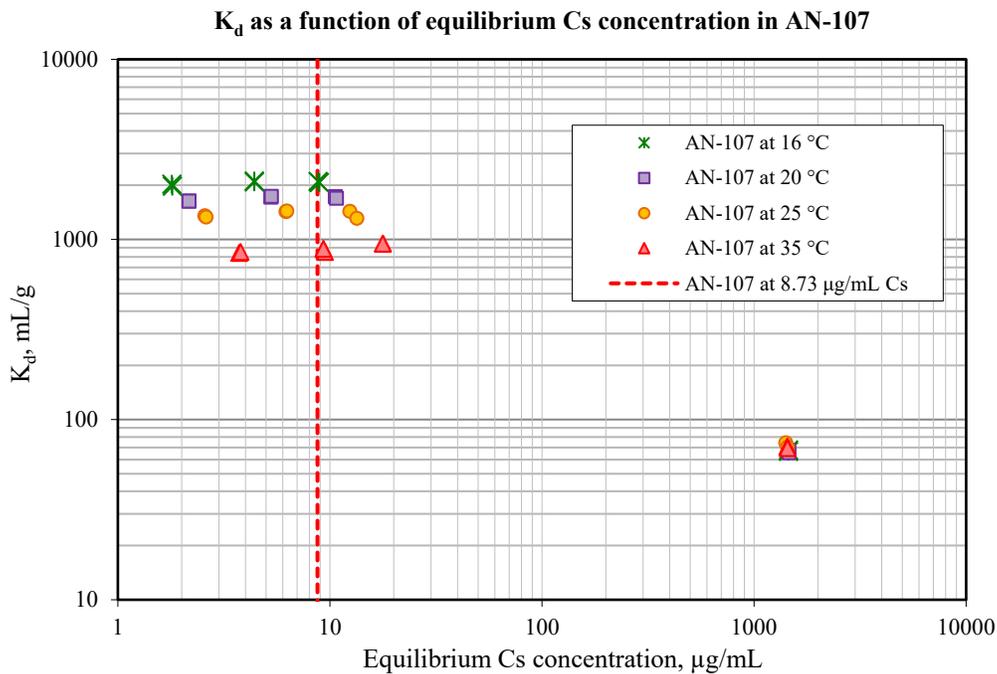


Figure 4.5.  $C_s$   $K_d$  vs.  $C_s$  Concentration, AN-107 Tank Waste, Four Temperatures

Figure 4.6 shows the corresponding isotherms and  $Q$  (mmoles  $C_s$ /g dry CST) values vs.  $C_s$  molarity at all four test temperatures with AN-107 tank waste. It is important to note that the  $\alpha_i$ , or total capacity in the matrix, was set to 0.68 mmoles  $C_s$ /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).

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

where

- [Cs] = equilibrium Cs concentration, mmoles/mL or M
- Q = equilibrium Cs loading on the CST, mmole Cs per g CST
- $\alpha_i$  = isotherm parameter constant (mmoles/g), equivalent to total capacity in the matrix
- $\beta$  = isotherm parameter constant (mmoles/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)

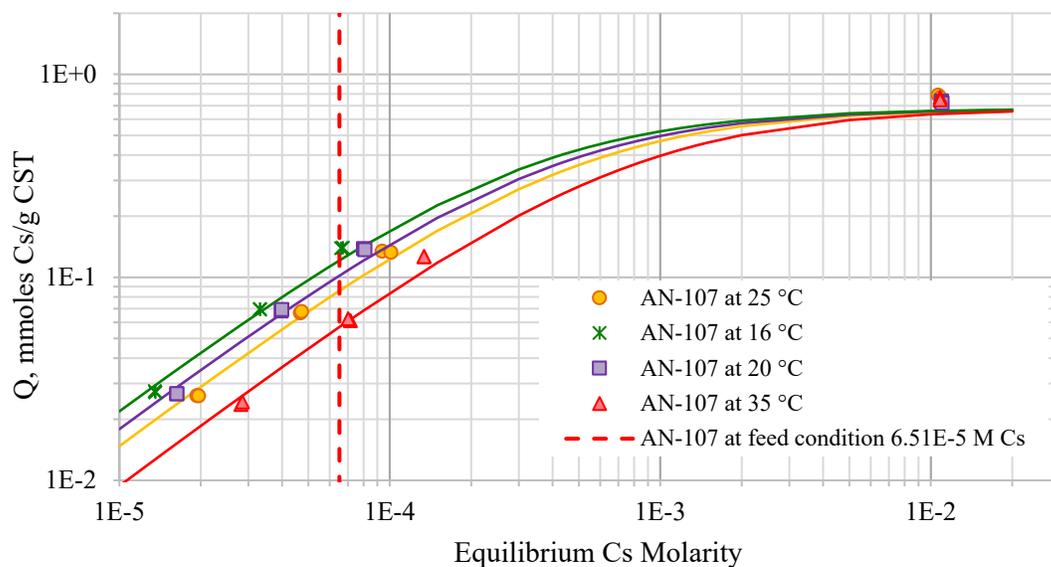


Figure 4.6. Q vs. Cs Equilibrium Concentration, AN-107 Tank Waste with Freundlich/Langmuir Hybrid Equilibrium Fits, Four Temperatures. The dashed red line represents the Cs concentration (6.51E-5 M) in AN-107 feed adjusted to 5.6 M Na.

A plot of Q (mmoles 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).

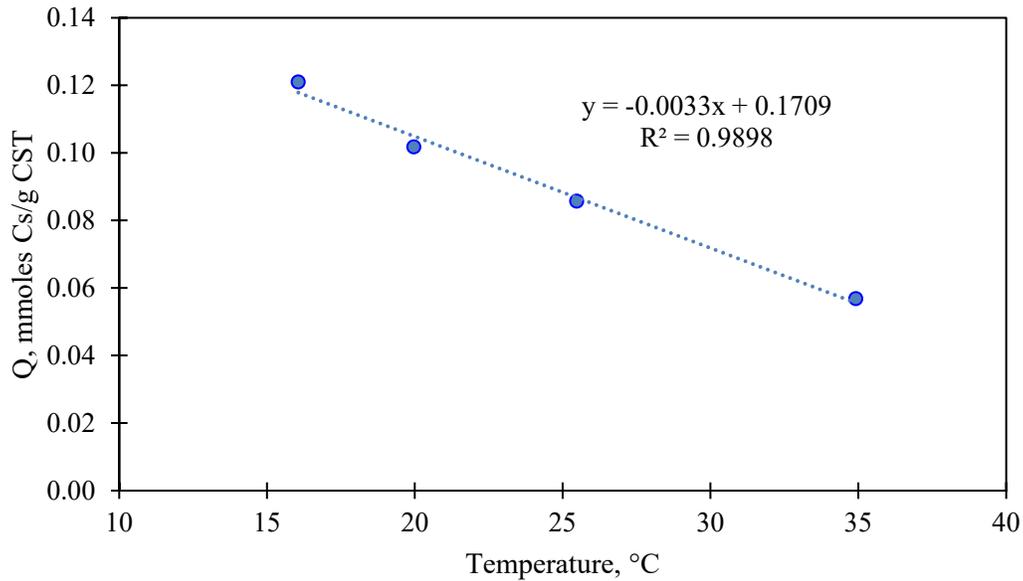


Figure 4.7. Q Dependence on Temperature for AN-107 Tank Waste

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.

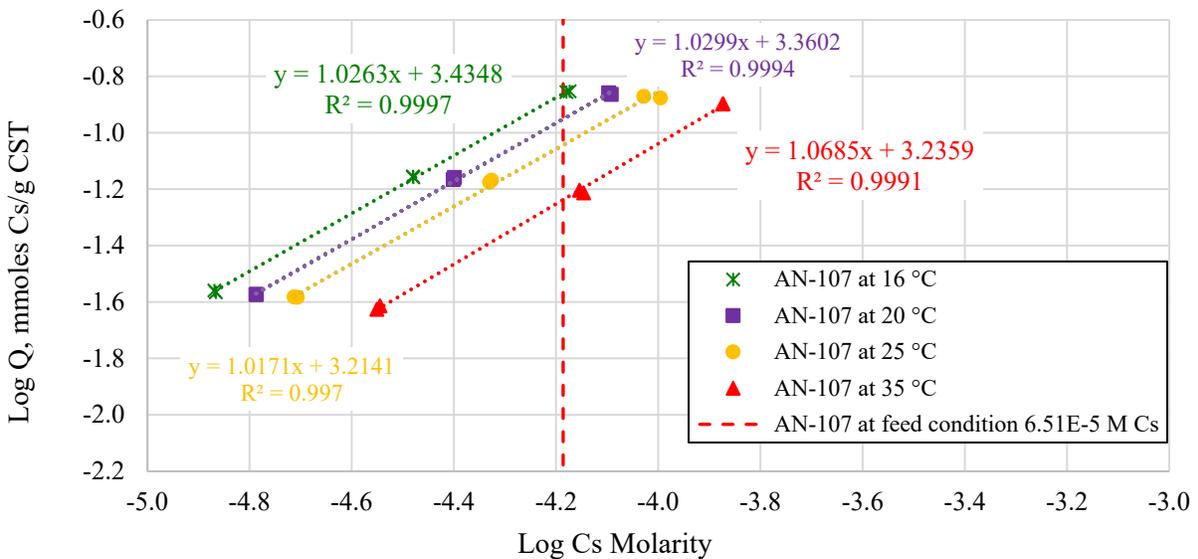


Figure 4.8. Linear Fits for Log Q vs. Log [Cs] for AN-107 at Four Test Temperatures

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,  $\alpha_i$  (maximum Cs loading) was set to 0.68 mmoles Cs/g CST and Excel Solver was used to calculate the  $\beta$  parameters using a generalized reduced gradient nonlinear method. The calculated  $\beta$  parameters for AP-107, AP-101, AP-105, and AN-107 are shown in Table 4.7 and graphed in Figure 4.9. The  $\beta$  values, or selectivity coefficient, can be used to compare Cs selectivity in the different tank waste matrices. The  $\beta$  values linearly increased with temperature, which is expected as increasing temperature inhibits Cs loading. The smaller the  $\beta$  value, the more favorable the exchange. The  $\beta$  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  $\beta$  Parameter Summary for AP-107, AP-105, AP-101, and AN-107 Tank Waste and Calculated Q and  $K_d$

Matrix	Process Temperature (°C)	$\beta$ , (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

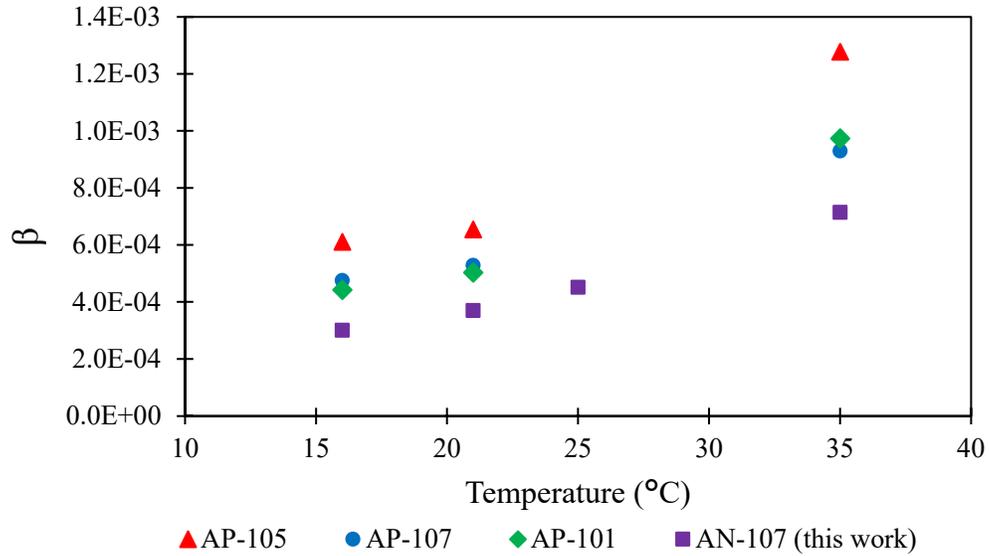


Figure 4.9.  $\beta$  values vs. Temperature for AP-107, AP-105, AP-101, and AN-107 Tank Waste

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.

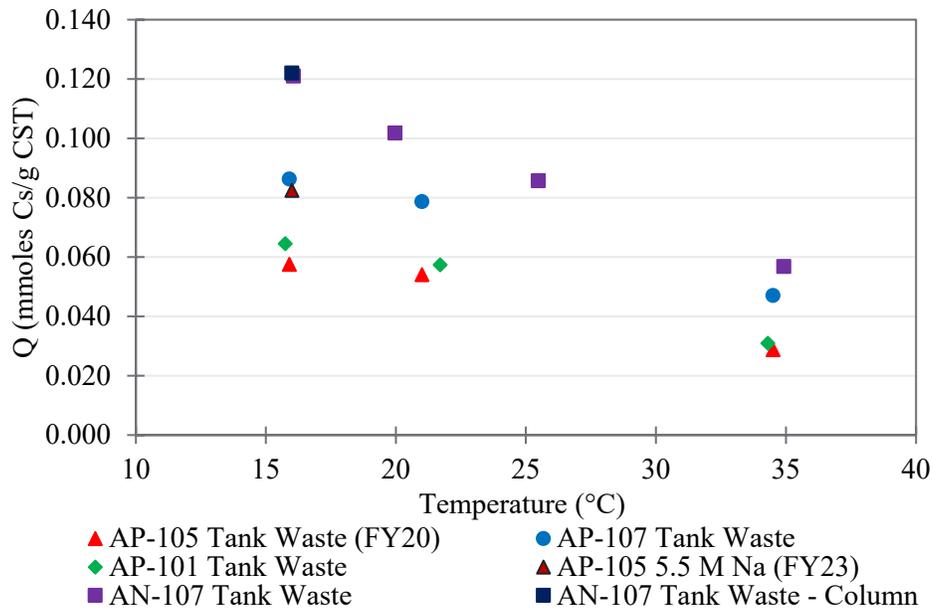


Figure 4.10. Q vs. Temperature for AP-107, AP-105, AP-101, and AP-106 Tank Waste at Corresponding Feed Conditions

### 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 mmoles 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.

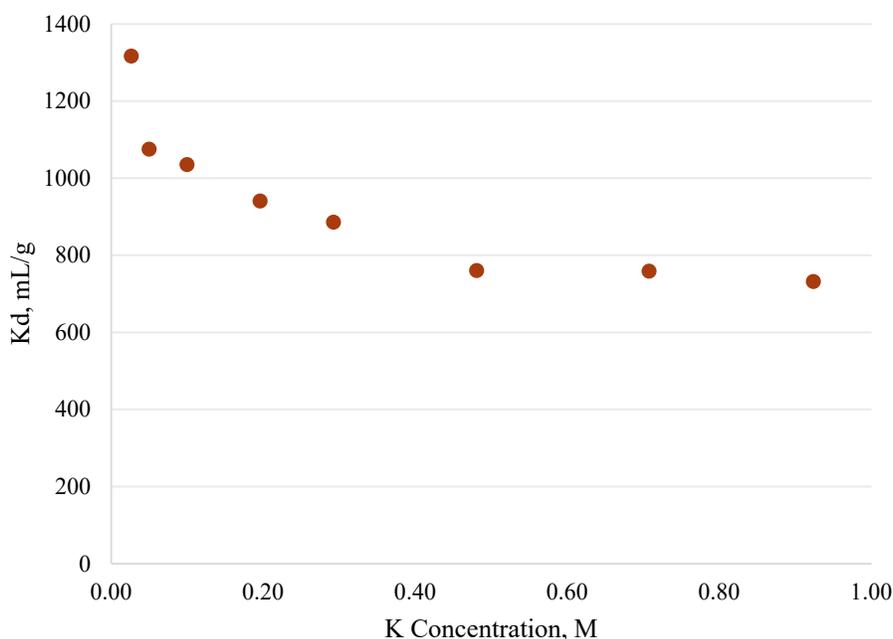


Figure 4.11.  $K_d$  values vs. K concentration for AN-107 Tank Waste

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

Sample ID <sup>(a)</sup>	Dry CST Mass, g <sup>(b)</sup>	AN-107 Vol. <sup>(c)</sup> , mL	Initial K Conc., M	Initial Cs Conc., M	Average K <sub>d</sub> , mL/g
CST-A-S1	0.0822	15.2521	0.05	1.32×10 <sup>-4</sup>	1030
CST-A-S1-d	0.0826	15.1825			
CST-A-S2	0.0767	15.2852		3.32×10 <sup>-4</sup>	1175
CST-A-S2-d	0.0794	15.2006			
CST-A-S3	0.0753	15.2867			
CST-A-S3-d	0.0799	15.1872			
CST-B-S1	0.0781	15.3673	0.11	1.33×10 <sup>-4</sup>	1020
CST-B-S1d	0.0760	15.2341			
CST-B-S2	0.0810	15.3859		3.27×10 <sup>-4</sup>	1088
CST-B-S2d	0.0802	15.0704			
CST-B-S3	0.0786	15.3325			
CST-B-S3d	0.0814	15.0053			
CST-C-S1	0.0782	15.3493	0.21	1.33×10 <sup>-4</sup>	928
CST-C-S1d	0.0813	14.9823			
CST-C-S2	0.0795	15.4297		3.23×10 <sup>-4</sup>	979
CST-C-S2d	0.0751	14.9956			
CST-C-S3	0.0759	15.4414			
CST-C-S3d	0.0803	15.0008			
CST-D-S1	0.0755	15.4838	0.32	1.33×10 <sup>-4</sup>	903
CST-D-S1d	0.0799	15.2745			
CST-D-S2	0.0793	15.5005		3.26×10 <sup>-4</sup>	901
CST-D-S2d	0.0743	15.3417			
CST-D-S3	0.0793	15.4660			
CST-D-S3d	0.0772	15.1885			
CST-E-S1	0.0770	15.4990	0.50	1.31×10 <sup>-4</sup>	716
CST-E-S1d	0.0790	14.9799			
CST-E-S2	0.0783	15.4960		3.24×10 <sup>-4</sup>	735
CST-E-S2d	0.0781	15.0955			
CST-E-S3	0.0752	15.5623			
CST-E-S3d	0.0759	15.4394			
CST-F-S1	0.0784	15.6775	0.78	1.32×10 <sup>-4</sup>	779
CST-F-S1d	0.0783	15.3528			
CST-F-S2	0.0791	15.7120		3.28×10 <sup>-4</sup>	794
CST-F-S2d	0.0788	15.2682			
CST-F-S3	0.0784	15.5924			
CST-F-S3d	0.0780	15.3863			
CST-G-S1	0.0772	15.6732	0.99	1.33×10 <sup>-4</sup>	774
CST-G-S1d	0.0751	15.5591			
CST-G-S2	0.0783	15.7851		3.24×10 <sup>-4</sup>	724
CST-G-S2d	0.0780	15.6907			
CST-G-S3	0.0759	15.7176			
CST-G-S3d	0.0768	15.4997			

(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  $\beta$  Parameter Summary for AN-107 Tank Waste with added K and Calculated Q and  $K_d$

Matrix	K Concentration, M	$\beta$ , (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  $\mu\text{Ci/mL}$   $^{137}\text{Cs}$ , 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  $^{137}\text{Cs}$  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  $Q = 0.10$  mmoles 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  $\beta$  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 <sup>137</sup>Cs concentration in the collected sample, % C/C<sub>0</sub>, 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	μCi <sup>137</sup> Cs/ mL	% C/C <sub>0</sub>	DF	BV	μCi <sup>137</sup> Cs/ mL	% C/C <sub>0</sub>	DF	BV	μCi <sup>137</sup> Cs/ mL	% C/C <sub>0</sub>	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

C<sub>0</sub> = 119.3 μCi <sup>137</sup>Cs/ 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



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

ASO Staff Use Only	<b>Provide Analytes of Interest and Required Detection limits - <input type="checkbox"/> Below <input type="checkbox"/> Attached</b>			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) 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			
24-0925	TI155-EFF-Comp					
24-0926	TI155-A-1-A	AN-107 Tank waste	1) Acid Digestion-128 Prep Lab 2) ICP/OES- Al, As, Ba, Ca, Cd, Cr, Fe, K, Na, Ni, P, Pb, S, Sr, Ti, U, Zn, Zr 3) ICP-MS – Ba, Nb, Pb, Sr, U-238			
24-0927	TI155-A-4-A					
24-0928	TI155-A-6-A					
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,  $\mu\text{Ci}/\text{sample} \pm 1\text{s}$**

RPL ID:	24-0924		24-0925	
	Tl155-Feed-Comp		Tl155-Eff-Comp	
Sample ID:				
Reference Date	2/16/2024		2/16/2024	
<b>Isotope</b>	$\mu\text{Ci}/\text{sample}$	+/-	$\mu\text{Ci}/\text{sample}$	+/-
<b>Co-60</b>	<b>5.80E-03</b>	<b>± 3.6%</b>	<b>6.38E-03</b>	<b>± 2.0%</b>
<b>Cs-137</b>	<b>2.24E+02</b>	<b>± 2.0%</b>	<b>2.84E-02</b>	<b>± 2.0%</b>
<b>Eu-152</b>	<b>1.72E-03</b>	<b>± 38.5%</b>	<b>2.13E-03</b>	<b>± 3.5%</b>
<b>Eu-154</b>	<b>4.65E-02</b>	<b>± 2.8%</b>	<b>6.23E-02</b>	<b>± 2.0%</b>
<b>Eu-155</b>	<b>&lt;4.34E-02</b>		<b>1.21E-02</b>	<b>± 6.5%</b>
<b>Am241</b>	<b>2.67E-01</b>	<b>± 16.3%</b>	<b>5.62E-01</b>	<b>± 2.0%</b>

*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	
<b>Sample Preparation:</b> Simple dilution of “as received” samples in 5% v/v HNO3 performed by C. Perez and J. Waller.		

<b>Procedure:</b> <u>RPG-CMC-211, Rev. 4</u> , “Determination of Elemental Composition by Inductively Coupled Argon Plasma Optical Emission Spectrometry (ICP-OES).”					
<b>Analyst:</b>	C. Perez	<b>Analysis Date:</b>	4/3/2024	<b>ICP File:</b>	C0931
<b>See Chemical Measurement Center 98620 file:</b> <u>ICP-325-405-3</u> (Calibration and Maintenance Records)					
<b>M&amp;TE:</b>	<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
<b>Steven Baum</b>	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<sub>3</sub> 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 HNO<sub>3</sub>) 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 HNO<sub>3</sub> 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

		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 Na<sub>2</sub>O<sub>2</sub> flux and Zr crucible for fusion preparations, or Si for HF assisted digests.

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

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
<b>Other Analytes</b>							
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 Na<sub>2</sub>O<sub>2</sub> 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 HNO<sub>3</sub> 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"

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

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

M&TE:		SN:	RPL
<input checked="" type="checkbox"/>	PerkinElmer NexION™ 350X ICP-MS	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 HNO<sub>3</sub>) 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 HNO<sub>3</sub> 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. 16<sup>th</sup> 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

Units: ng/g		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
		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%
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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
Instr. Def. Limit (IDL)	Est. Quant. Limit (EQL)	Process Factor	1.00	477	477	469
0.0017	0.0166	RPL/LAB >	Blank Avg.	24-0924 (30x)	24-0925 (30x)	24-0925 (30x) Dup
		Client ID >	2% HNO3 Lab Blank	Tl155-Feed-Comp	Tl155-EFF-Comp	
		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 ≥ 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%	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 measured 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  $0.0552 \pm 0.004$  M HCl prepared 4/2/2024 and the spike used for the blank and matrix spike samples was standardized  $0.04598 \pm 0.00007$  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 H<sub>2</sub>O 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 H<sub>2</sub>O

**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 ± 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 H<sub>2</sub>O). 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](mailto: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
<b>Analysis</b>						
ICP-MS RCRA <sup>3</sup>			\$98			
ICP-MS Tc/U/Th			\$98			
ICP-MS Lanthanides <sup>4</sup>			\$98			
ICP-MS Actinides <sup>5</sup>			\$98			
ICP-MS I-127 (total)			\$98			
ICP-MS I-129 (total)			\$98			
ICP-MS I-/IO3- 127 Speciation <sup>1</sup>			\$141			
ICP-MS I-/IO3- 129 Speciation <sup>1</sup>			\$141			
ICP-MS Cr(III/IV) Speciation <sup>1</sup>			\$141			
ICP-OES Standard List <sup>6</sup>			\$98			
ICP-OES/MS Other Analytes			\$98			
IC Standard Anions List <sup>7</sup>		2	\$98	\$88	\$284	\$389
Sample Prep <sup>2</sup>			\$343			
<sup>1</sup> Per QA plan, speciation analysis requires that a total analysis also be performed in order to validate speciation recovery.						
<sup>2</sup> Sample Prep may involve Acid Digestion or Flux Fusion techniques.						
<sup>†</sup> 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.				<b>GRAND TOTAL ESTIMATE:</b>	<b>\$389</b>	

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

<sup>3</sup>ICP-MS RCRA includes: Ag, As, Ba, Cd, Cr, Cs, Cu, Hg, Mo, Pb, Re, Ru, Sb, & Se  
<sup>4</sup>ICP-MS Lanthanides includes: Ce, Dy, Er, Eu, Gd, Ho, La, Lu, Nd, Pr, Sc, Sm, Tb, Tm, Y, & Yb  
<sup>5</sup>ICP-MS Actinides includes: Am, Np, Pu, Th, & U  
<sup>6</sup>ICP-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, & Zr  
<sup>7</sup>IC 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](mailto: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 :	<input type="checkbox"/> NONE <input type="checkbox"/> Refrigerate <input type="checkbox"/> Other (specify):		
Hazardous Waste Disposal Issues:	<input type="checkbox"/> NONE or Listed Waste Code (circle): <input checked="" type="radio"/> F <input type="checkbox"/> K <input type="checkbox"/> P <input type="checkbox"/> U    WA State Code? [TEXT HERE]		
Type of Liquid Sample: (chose one)	<input type="checkbox"/> ACIDIFIED <input type="checkbox"/> FUSION <input type="checkbox"/> WATER <input checked="" type="checkbox"/> WASTE <input type="checkbox"/> Other: [TEXT HERE]		
Analyze within hold times?	<input checked="" type="checkbox"/> NO <input type="checkbox"/> YES <b>NOTE: Advance notice is required for analytes with &lt;7 day hold times</b>		
Have the Samples been filtered?	<input checked="" type="checkbox"/> NO <input type="checkbox"/> 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)					
<b>GRAND TOTAL ESTIMATE:</b>					<b>\$1,800</b>

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)

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

<b>Battelle Memorial Institute, Pacific Northwest Division</b>	<b>Contractor shall sign and return a copy of this document</b>
Signature of person authorized to sign Heather N Mayfield Digitally signed by Heather N Mayfield Date: 2024.04.23 15:03:30 -07'00'	Signature of person authorized to sign
Name Heather N. Mayfield	Name
Title Contracts Specialist	Title
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
<b>Total</b>						<b>\$28,302.00</b>

**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 DOECAP-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.

**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)		ICP-AES	Alpha Spec (Am, Cm, Np, & Pu)	ICP-MS (Cs, I, & Tc)	IC (total fusion)	TOC	TIC	Alpha Spec (Am, Cm, Np, & Pu)	Matrix	Comments	
Sample Identification	# Cont.										
PNNL REQ# 733437, Task Order 733437 SWRI Master Agreement 660825									<a href="mailto:Amy.Westesen@pnnl.gov">Amy.Westesen@pnnl.gov</a> 509-371-7908		
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	

shipment 1 of 3

### Project Sample Transfer Form (PSTF)

Page 2 of 2

0311

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

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)		ICP-AES	Alpha Spec (Am, Cm, Np, & Pu)	ICP-MS (Cs, I, & Te)	IC (total fusion)	TOC	TIC	Alpha Spec (Am, Cm, Np, & Pu)	Matrix	Comments	
Sample Identification	# Cont.										
PNNL REQ# 733437, Task Order 733437 SWRI Master Agreement 660825								<a href="mailto:Amy.Westesen@pnnl.gov">Amy.Westesen@pnnl.gov</a> 509-371-7908			
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	

Shipment 2 of 3

### Project Sample Transfer Form (PSTF)

Page 2 of 2 0322

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

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



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'

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

*Authorized for Release  
05/22/2024 5:00PM  
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."

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:

<b>SwRI ID</b>	<b>Sample Number</b>	<b>Analysis</b>
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	<sup>239</sup> Neptunium Alpha/Beta analysis	Gas Proportional Counting
Liquid	<sup>241</sup> Americium	Alpha Spectroscopy
Liquid	<sup>242</sup> Curium, <sup>243/244</sup> Curium	Alpha Spectroscopy
Liquid	<sup>238</sup> Plutonium, <sup>239/240</sup> Pu, <sup>244</sup> Pu	Alpha Spectroscopy
Liquid	<sup>237</sup> 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.

*<sup>239</sup>Neptunium tracer*

The <sup>237</sup>Neptunium samples were counted in the GPC for 30 minutes each for Gross Alpha/Beta analysis prior to counting by alpha spectroscopy. <sup>239</sup>Neptunium is used as a tracer for <sup>237</sup>Neptunium analysis. <sup>243</sup>Americium is added to the samples and <sup>239</sup>Neptunium 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.

*<sup>241</sup>Americium*

<sup>243</sup>Americium 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.

*<sup>242</sup>Curium, <sup>243/244</sup>Curium*

<sup>242</sup>Curium and <sup>243/244</sup>Curium were separated, precipitated, and analyzed from the same aliquot as <sup>241</sup>Americium. <sup>241</sup>Americium was used as the spiking solution in the laboratory control samples and <sup>243</sup>Americium was used to determine tracer recovery. <sup>243</sup>Americium 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 <sup>242</sup>Curium and <sup>243/244</sup>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.

*<sup>238</sup>Plutonium, <sup>239/240</sup>Plutonium, <sup>244</sup>Plutonium*

<sup>242</sup>Plutonium 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 <sup>238</sup>Pu, <sup>239/240</sup>Pu, and <sup>244</sup>Pu 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 <sup>238</sup>Pu and <sup>244</sup>Pu were less than three. <sup>239/240</sup>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**

*<sup>237</sup>Neptunium*

<sup>239</sup>Neptunium was used as a tracer to follow chemical separation efficiency and losses. The <sup>239</sup>Np was spiked in using high activity <sup>243</sup>Am in secular equilibrium with its <sup>239</sup>Np daughter. The neptunium was separated and the decay of the <sup>239</sup>Np was calculated from the end of separation. The samples were then precipitated and the filters analyzed by beta GPC to determine the <sup>239</sup>Np 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<sup>®</sup>  
Date: 2024.05.21  
19:56:03 -05'00'

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

Q - Data Qualifier. MDA - Minimum Detectable Activity. TPU - Total Propagated Uncertainty. U - Less than MDA. MDAs are sample specific.

# ***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)	<sup>239</sup> Np Tracer Rec.	Date Analyzed
Prep Blank	pb24e14ke2	<sup>237</sup> Np	-2.69E+00	U	1.20E+01	3.78E+01	1.20E+01	81.6%	05/16/24
Lab Control	lcs24e14jt2	<sup>237</sup> Np	2.69E+03		3.87E+02	3.59E+01	2.25E+02	93.5%	05/16/24
True Value	-----	<sup>237</sup> Np	2.74E+03		-----	-----	-----	-----	-----
Recovery	-----	<sup>237</sup> Np	98.2%		-----	-----	-----	-----	-----
T1155-EFF-Comp	718821	<sup>237</sup> Np	5.79E+01		3.40E+01	3.41E+01	3.33E+01	97.8%	05/16/24
<i>Duplicate result</i>	718821D	<sup>237</sup> Np	2.09E+01	U	2.38E+01	4.62E+01	2.37E+01	105.2%	05/16/24
<i>Dup Evaluation</i>	-----	<sup>237</sup> Np	1.8		-----	-----	-----	-----	-----
T1155-Feed-Comp	718822	<sup>237</sup> 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)	<sup>242</sup> Pu Tracer Rec.	Date Analyzed
Prep Blank	pb24e14ke2	<sup>238</sup> Pu	-5.10E+01	U	1.25E+02	4.43E+02	1.25E+02	81.9%	05/15/24
	pb24e14ke2	<sup>239/240</sup> Pu	1.53E+02	U	2.05E+02	3.90E+02	2.04E+02	81.9%	05/15/24
	pb24e14ke2	<sup>244</sup> Pu	2.04E+02	U	2.30E+02	3.90E+02	2.28E+02	81.9%	05/15/24
Lab Control	lcs24e14jt1	<sup>238</sup> Pu	3.10E+01	U	1.39E+02	4.35E+02	1.38E+02	71.2%	05/15/24
	lcs24e14jt1	<sup>239/240</sup> Pu	2.94E+04		4.94E+03	4.74E+02	2.70E+03	71.2%	05/15/24
	lcs24e14jt1	<sup>244</sup> Pu	-3.10E+01	U	1.39E+02	4.35E+02	1.38E+02	71.2%	05/15/24
True Value	----	<sup>238</sup> Pu	----		----	----	----	----	----
	----	<sup>239/240</sup> Pu	2.50E+04		----	----	----	----	----
	----	<sup>244</sup> Pu	----		----	----	----	----	----
Recovery	----	<sup>238</sup> Pu	----		----	----	----	----	----
	----	<sup>239/240</sup> Pu	117.6%		----	----	----	----	----
	----	<sup>244</sup> Pu	----		----	----	----	----	----
TI155-A-2-A	718819	<sup>238</sup> Pu	5.45E+03		2.23E+03	1.39E+03	2.11E+03	84.9%	05/15/24
	718819	<sup>239/240</sup> Pu	1.89E+04		4.66E+03	1.39E+03	3.89E+03	84.9%	05/15/24
	718819	<sup>244</sup> Pu	1.98E+02	U	5.60E+02	1.51E+03	5.60E+02	84.9%	05/15/24
TI155-B-10-A	718820	<sup>238</sup> Pu	4.48E+03		2.16E+03	1.61E+03	2.07E+03	75.4%	05/15/24
	718820	<sup>239/240</sup> Pu	2.43E+04		5.83E+03	1.76E+03	4.75E+03	75.4%	05/15/24
	718820	<sup>244</sup> Pu	-1.15E+02	U	5.13E+02	1.61E+03	5.13E+02	75.4%	05/15/24
TI155-EFF-Comp	718821	<sup>238</sup> Pu	5.06E+03		1.23E+03	3.61E+02	1.02E+03	80.3%	05/15/24
	718821	<sup>239/240</sup> Pu	2.20E+04		3.68E+03	3.93E+02	2.13E+03	80.3%	05/15/24
	718821	<sup>244</sup> Pu	5.13E+01	U	1.45E+02	3.92E+02	1.45E+02	80.3%	05/15/24
Duplicate result	718821D	<sup>238</sup> Pu	5.76E+03		1.33E+03	3.53E+02	1.08E+03	83.5%	05/15/24
	718821D	<sup>239/240</sup> Pu	3.56E+04		5.54E+03	3.85E+02	2.68E+03	83.5%	05/15/24
	718821D	<sup>244</sup> Pu	1.00E+02	U	1.75E+02	3.84E+02	1.74E+02	83.5%	05/15/24
Dup Evaluation	----	<sup>238</sup> Pu	0.8		----	----	----	----	----
	----	<sup>239/240</sup> Pu	4.1		----	----	----	----	----
	----	<sup>244</sup> Pu	0.4		----	----	----	----	----
TI155-Feed-Comp	718822	<sup>238</sup> Pu	3.49E+03		2.09E+03	1.96E+03	2.03E+03	75.2%	05/15/24
	718822	<sup>239/240</sup> Pu	1.62E+04		4.84E+03	2.14E+03	4.29E+03	75.2%	05/15/24
	718822	<sup>244</sup> Pu	0.00E+00	U	7.89E+02	2.13E+03	7.89E+02	75.2%	05/15/24

Q - Data Qualifier. MDA - Minimum Detectable Activity. TPU - Total Propagated Uncertainty. U - Less than MDA. MDAs are sample specific.

# 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)	<sup>242</sup> Pu Tracer Rec.	Date Analyzed
TII55-A-11-A	718825	<sup>238</sup> Pu	6.12E+03		2.36E+03	1.36E+03	2.21E+03	85.8%	05/15/24
	718825	<sup>239/240</sup> Pu	2.25E+04		5.20E+03	1.49E+03	4.20E+03	85.8%	05/15/24
	718825	<sup>244</sup> Pu	1.94E+02	U	5.49E+02	1.48E+03	5.49E+02	85.8%	05/15/24
TII55-A-17-A	718826	<sup>238</sup> Pu	5.06E+03		2.19E+03	1.76E+03	2.08E+03	83.2%	05/15/24
	718826	<sup>239/240</sup> Pu	2.20E+04		5.18E+03	1.42E+03	4.23E+03	83.2%	05/15/24
	718826	<sup>244</sup> Pu	0.00E+00	U	5.72E+02	1.55E+03	5.72E+02	83.2%	05/15/24
TII55-A-21-A	718827	<sup>238</sup> Pu	6.72E+03		2.86E+03	2.25E+03	2.71E+03	83.3%	05/15/24
	718827	<sup>239/240</sup> Pu	1.91E+04		5.20E+03	2.25E+03	4.49E+03	83.3%	05/15/24
	718827	<sup>244</sup> Pu	2.58E+02	U	7.31E+02	1.98E+03	7.30E+02	83.3%	05/15/24
TII55-B-22-A	718828	<sup>238</sup> Pu	2.79E+03		1.53E+03	1.42E+03	1.49E+03	88.1%	05/15/24
	718828	<sup>239/240</sup> Pu	2.40E+04		5.33E+03	1.42E+03	4.24E+03	88.1%	05/15/24
	718828	<sup>244</sup> Pu	1.86E+02	U	5.26E+02	1.42E+03	5.25E+02	88.1%	05/15/24
TII55-B-24-A	718829	<sup>238</sup> Pu	4.23E+03		1.93E+03	1.47E+03	1.84E+03	87.6%	05/15/24
	718829	<sup>239/240</sup> Pu	2.26E+04		5.18E+03	1.35E+03	4.18E+03	87.6%	05/15/24
	718829	<sup>244</sup> Pu	0.00E+00	U	5.44E+02	1.47E+03	5.44E+02	87.6%	05/15/24
TII55-A-9-A	718830	<sup>238</sup> Pu	4.71E+03		2.07E+03	1.41E+03	1.97E+03	84.8%	05/15/24
	718830	<sup>239/240</sup> Pu	2.10E+04		5.02E+03	1.53E+03	4.13E+03	84.8%	05/15/24
	718830	<sup>244</sup> Pu	0.00E+00	U	5.67E+02	1.53E+03	5.67E+02	84.8%	05/15/24
TII55-A-13-A	718852	<sup>238</sup> Pu	5.52E+03		2.23E+03	1.66E+03	2.10E+03	84.6%	05/15/24
	718852	<sup>239/240</sup> Pu	2.30E+04		5.24E+03	1.66E+03	4.22E+03	84.6%	05/15/24
	718852	<sup>244</sup> Pu	9.51E+01	U	4.26E+02	1.34E+03	4.25E+02	84.6%	05/15/24
TII55-A-15-A	718853	<sup>238</sup> Pu	6.03E+03		2.45E+03	2.22E+03	2.31E+03	81.4%	05/15/24
	718853	<sup>239/240</sup> Pu	2.17E+04		5.13E+03	1.54E+03	4.20E+03	81.4%	05/15/24
	718853	<sup>244</sup> Pu	0.00E+00	U	5.69E+02	1.54E+03	5.69E+02	81.4%	05/15/24
TII55-A-19-A	718854	<sup>238</sup> Pu	7.74E+03		3.39E+03	3.69E+03	3.22E+03	73.1%	05/15/24
	718854	<sup>239/240</sup> Pu	2.18E+04		5.87E+03	2.19E+03	5.03E+03	73.1%	05/15/24
	718854	<sup>244</sup> Pu	0.00E+00	U	8.11E+02	2.19E+03	8.11E+02	73.1%	05/15/24
TII55-A-5-A	718855	<sup>238</sup> Pu	5.35E+03		2.16E+03	1.60E+03	2.04E+03	91.4%	05/15/24
	718855	<sup>239/240</sup> Pu	1.79E+04		4.38E+03	1.60E+03	3.66E+03	91.4%	05/15/24
	718855	<sup>244</sup> Pu	9.22E+01	U	4.12E+02	1.30E+03	4.12E+02	91.4%	05/15/24

Q - Data Qualifier. MDA - Minimum Detectable Activity. TPU - Total Propagated Uncertainty. U - Less than MDA. MDAs are sample specific.

Alpha Page 4 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

<b>PLUTONIUM-238, 239/240, 244</b>									
Sample ID	Lab System ID	Analyte	Results (pCi/g)	Q	TPU (2s) (pCi/g)	MDA (pCi/g)	Counting Error (2s)	<sup>242</sup> Pu Tracer Rec.	Date Analyzed
TII55-A-7-A	718856	<sup>238</sup> Pu	7.01E+03		2.79E+03	1.67E+03	2.61E+03	70.7%	05/15/24
	718856	<sup>239/240</sup> Pu	2.21E+04		5.54E+03	1.82E+03	4.61E+03	70.7%	05/15/24
	718856	<sup>244</sup> Pu	-1.19E+02	U	5.31E+02	1.67E+03	5.31E+02	70.7%	05/15/24
TII55-B-18-A	718857	<sup>238</sup> Pu	5.47E+03		2.31E+03	1.61E+03	2.19E+03	80.2%	05/15/24
	718857	<sup>239/240</sup> Pu	2.00E+04		4.95E+03	1.61E+03	4.12E+03	80.2%	05/15/24
	718857	<sup>244</sup> Pu	4.20E+02	U	7.31E+02	1.61E+03	7.28E+02	80.2%	05/15/24
TII55-B-2-A	718858	<sup>238</sup> Pu	5.76E+03		2.21E+03	1.38E+03	2.07E+03	88.8%	05/15/24
	718858	<sup>239/240</sup> Pu	2.27E+04		5.07E+03	1.38E+03	4.06E+03	88.8%	05/15/24
	718858	<sup>244</sup> Pu	0.00E+00	U	5.09E+02	1.38E+03	5.09E+02	88.8%	05/15/24
TII55-B-5-A	718859	<sup>238</sup> Pu	4.30E+03		2.06E+03	1.65E+03	1.97E+03	78.6%	05/15/24
	718859	<sup>239/240</sup> Pu	2.35E+04		5.55E+03	1.65E+03	4.52E+03	78.6%	05/15/24
	718859	<sup>244</sup> 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  
WAN 05/17/24

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 Rev: ew*  
*EW 5/17/24*

Notes:

Item	Lab Id	A	B	B1	C	D1	D2	D3	D	E	F
		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	LCS Duplicate Evaluation RPD	Dup Eval 1 sig
Standard ID: 058RadSol4	Am242 RL: 750	N/A	N/A
Activity (pCi/ml): 50.1006	Am244 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			

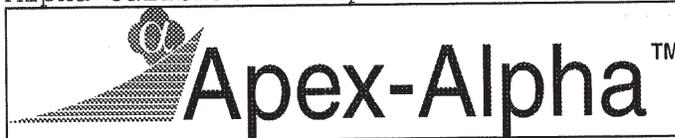
Item Lab Id	Date Analyzed	Nuclide	TRACER	Rec %	FWHM	Nuclide	Raw pCi/planchet		ERR	Corrected Activity	Report pCi/ml			TV	%r	Relative Bias
							Act	TPU			Act	TPU (2s)	MDC			
1 PB24E14KE2	5/16/24 22:39	Am243 106RadSol4		88.4	30.2	AM-241	4.79E-03	4.16E-02	7.57E-03	4.79E-03	4.79E+01	1.52E+02	4.16E+02	1.51E+02		PB < 3*TPU
						CM-242	0.00E+00	6.75E-03	6.75E-03	0.00E+00	0.00E+00	1.35E+02	3.65E+02	1.35E+02		PB < 3*TPU
						CM-244	0.00E+00	6.69E-03	6.69E-03	0.00E+00	0.00E+00	1.34E+02	3.62E+02	1.34E+02		PB < 3*TPU
2 LCS24E14JT1	5/16/24 22:39	Am243 106RadSol4		92.0	29.7	AM-241	2.55E+00	2.37E-01	1.11E-01	2.55E+00	2.55E+04	4.73E+03	4.84E+02	2.23E+03		2.44E+04 104.4% 0.044
						CM-242	0.00E+00	6.85E-03	6.85E-03	0.00E+00	0.00E+00	1.37E+02	3.70E+02	1.37E+02		
						CM-244	0.00E+00	6.78E-03	6.78E-03	0.00E+00	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	2.52E+01	2.52E+05	4.16E+04	3.89E+02	6.71E+03		
						CM-242	1.83E-01	3.48E-02	3.14E-02	1.83E-01	1.83E+03	6.95E+02	3.72E+02	6.28E+02		
						CM-244	2.82E-01	4.24E-02	3.56E-02	2.82E-01	2.82E+03	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	2.55E+01	2.55E+05	4.25E+04	3.48E+02	7.10E+03		Dup Eval (1 sig)
						CM-242	1.31E-01	3.02E-02	2.82E-02	1.31E-01	1.31E+03	6.04E+02	4.11E+02	5.64E+02		1.3
						CM-244	3.38E-01	4.97E-02	4.12E-02	3.38E-01	3.38E+03	9.94E+02	4.26E+02	8.24E+02		0.1
5 718822	5/16/24 22:39	Am243 106RadSol4		88.0	39.7	AM-241	3.33E+00	3.33E-02	1.26E-01	3.33E+00	1.67E+05	3.00E+04	1.67E+03	1.26E+04		1.1
						CM-242	5.60E-03	7.94E-03	7.92E-03	5.60E-03	2.80E+02	7.94E+02	2.14E+03	7.92E+02		1.1
						CM-244	8.46E-02	2.16E-02	2.06E-02	8.46E-02	4.23E+03	2.16E+03	1.80E+03	2.05E+03		0.9

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

Am241 G = Planchet Result - Tracer Correction  
K = G \* F  
M244 G = Planchet Result - Tracer Correction  
L = H \* F \* 0.5  
(Sample-Duplicate) / sqrt ((TPUsample\*2) + (TPUdup\*2)) ≤ 3  
M = I \* F  
N = J \* F \* 0.5

Alpha Calibration Report

5/17/2024 1:52:09 PM



Battelle Memorial Institute PNNL  
OHDO1.113  
TO# 2404056  
20240514-PO05  
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 Efcad 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



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

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



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

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	5.479	4.7855E-003	158.33	4.1610E-002	8.19
CM-242	6.091	0.0000E+000	0.00	3.6492E-002	8.19
AM-243	5.270	5.2171E+000	8.19	3.6683E-002	8.19
CM-244	5.795	0.0000E+000	0.00	3.6162E-002	8.19

Errors quoted at 1.000 sigma

Alpha NID Report  
 Page 4 of 4

5/17/2024 1:52:09 PM



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

Detector Name: ALPHA\_001  
 Chamber Serial Number: 05010114A  
 Detector Serial Number: 91232

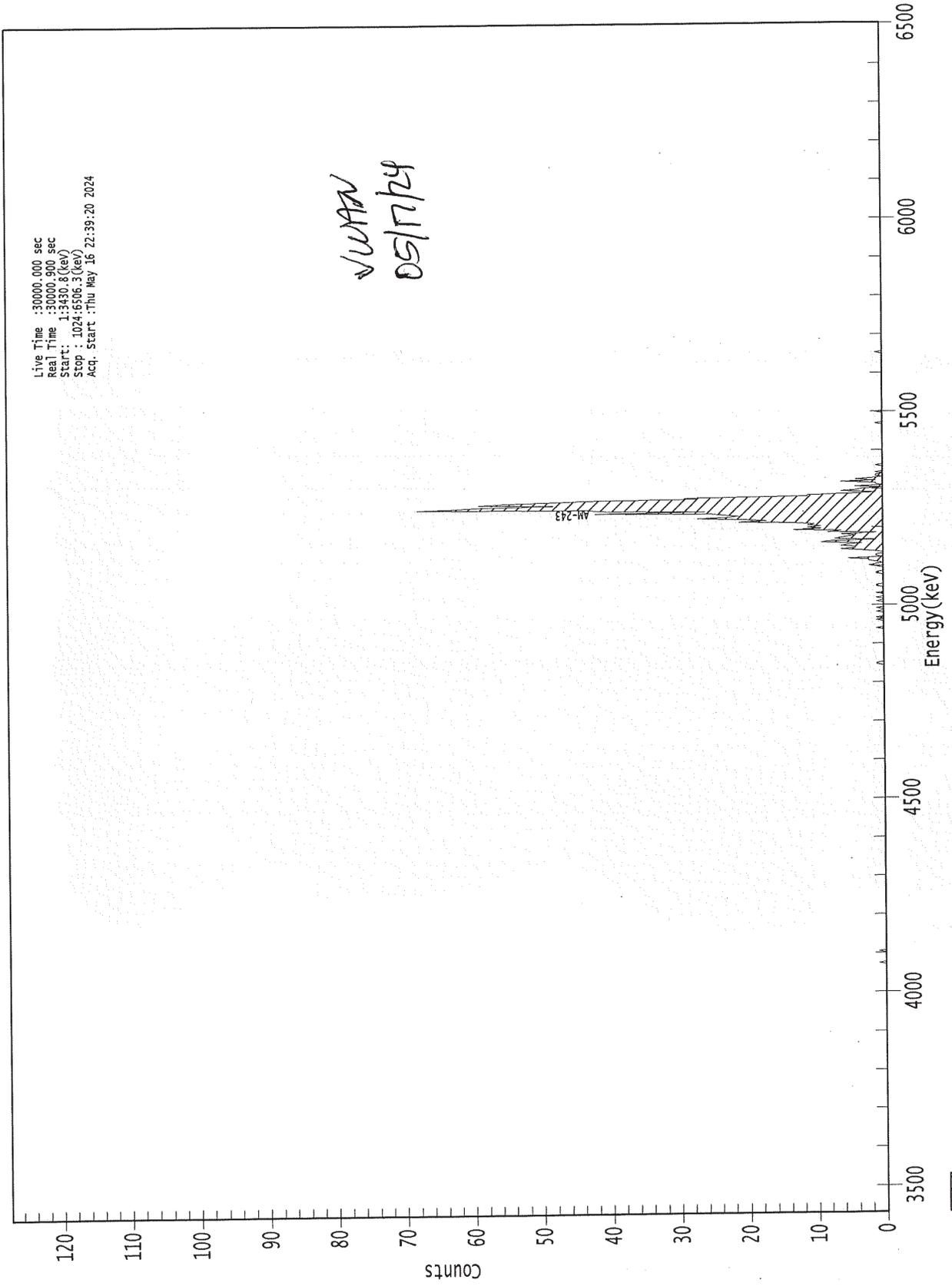
Sample Size: 1.000 unit  
 Sample Date/Time: 5/14/2024 10:30:13 PM  
 Acquisition Date/Time: 5/16/2024 10:39:20 PM  
 Acquisition Live Time: 500.0 minutes  
 Acquisition Real Time: 500.0 minutes

-----  
 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

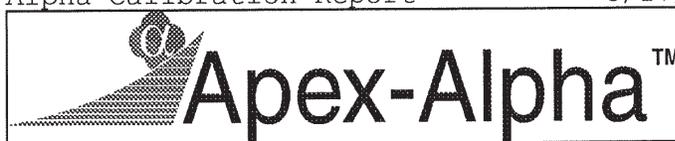
Activity reported as of : 5/16/24 10:39:20 PM

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 Efcals 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



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

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 -----  
-----

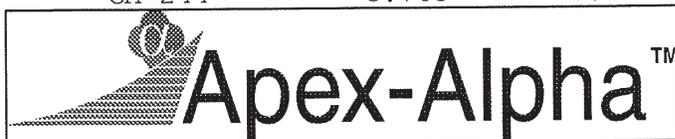
Nuclide	Energy (MeV)	Net Pk Area	Pk Area Error %	Ambient Backgnd	Reagent Backgnd	FWHM (keV)
AM-241	5.440	524.50	4.38	1.50	0.00E+000	17.5
CM-242	6.062	0.00	1000.0	0.00	0.00E+000	0.0
AM-243 T	5.229	1073.00	3.05	1.00	0.00E+000	29.7

Alpha Analysis Report

5/17/2024 1:53:07 PM

Page 3 of 4

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



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

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 5/17/2024 1:53:07 PM  
 Page 4 of 4



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

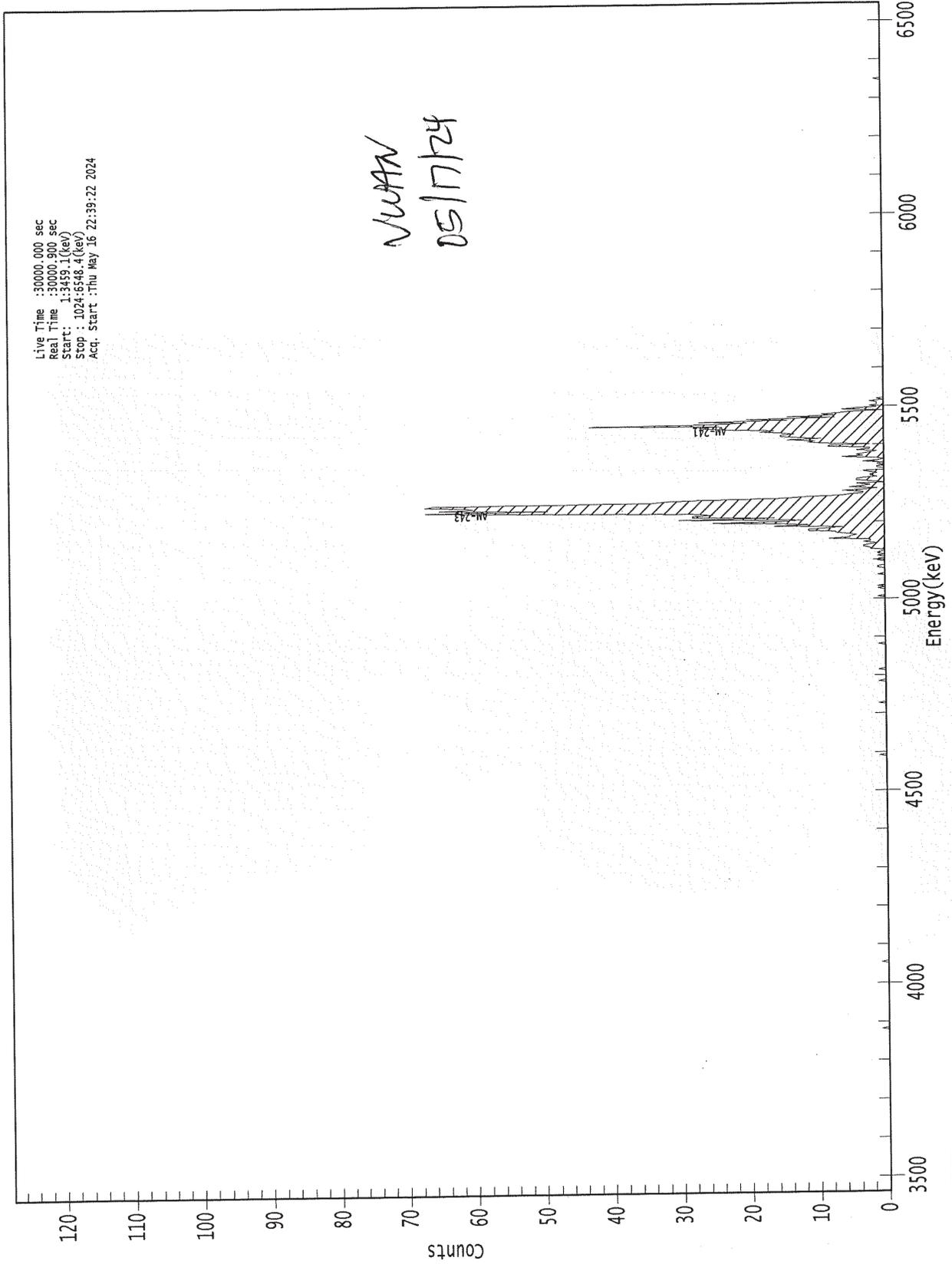
Sample Size: 1.000 unit  
 Sample Date/Time: 5/14/2024 10:30:13 PM  
 Acquisition Date/Time: 5/16/2024 10:39:22 PM  
 Acquisition Live Time: 500.0 minutes  
 Acquisition Real Time: 500.0 minutes

-----  
 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

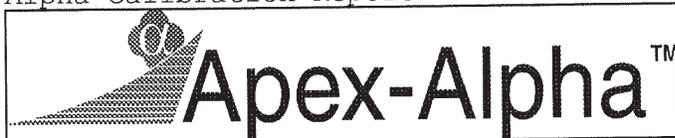
0000272954 . CNF



NUNAN  
05/17/24

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 Efcals 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



Sample Description: \\V79W-7\AlphaRoot\Data\0000272955.cnf  
Spectrum File:  
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



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

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

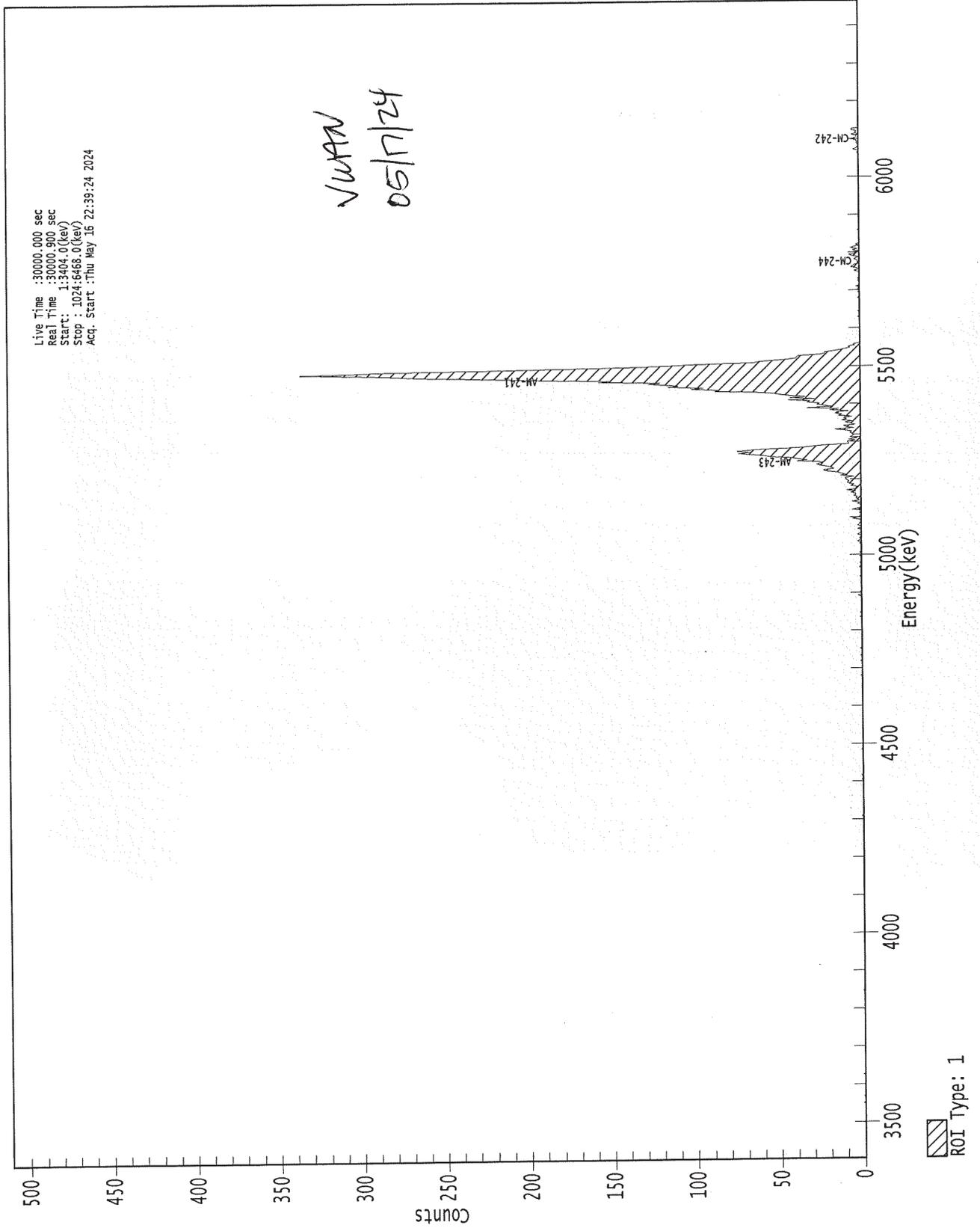
Sample Size: 1.000 unit  
 Sample Date/Time: 4/4/2024 10:30:13 PM  
 Acquisition Date/Time: 5/16/2024 10:39:24 PM  
 Acquisition Live Time: 500.0 minutes  
 Acquisition Real Time: 500.0 minutes

-----  
 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

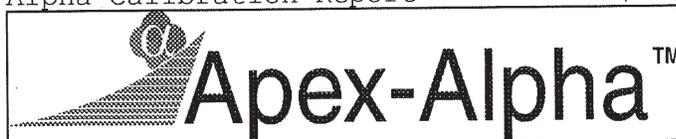
Activity reported as of : 5/16/24 10:39:24 PM

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 Efcals 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



Sample Description: \\V79W-7\AlphaRoot\Data\0000272956.cnf  
Spectrum File:  
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



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

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

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

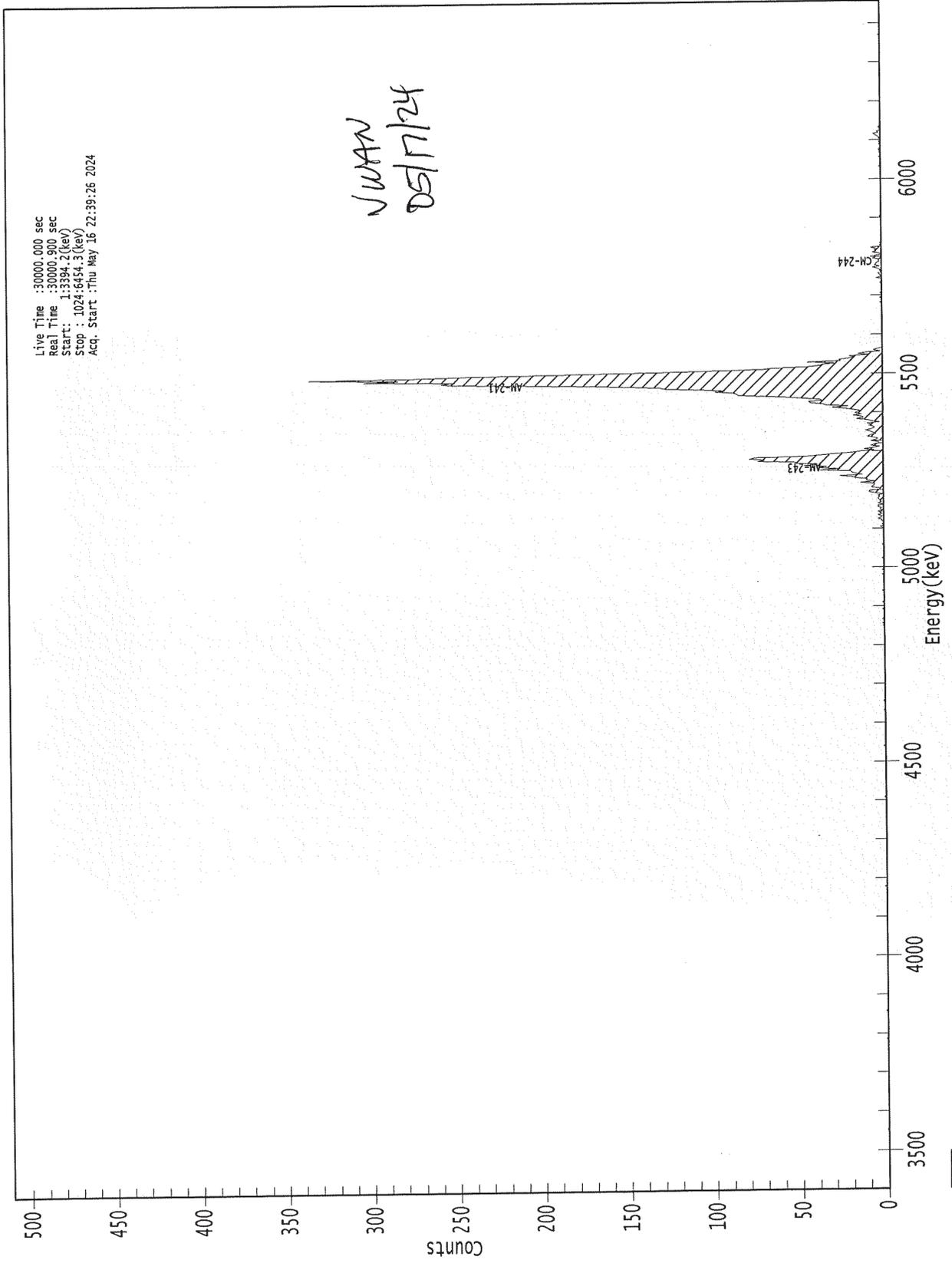
Sample Size: 1.000 unit  
 Sample Date/Time: 4/4/2024 10:30:13 PM  
 Acquisition Date/Time: 5/16/2024 10:39:26 PM  
 Acquisition Live Time: 500.0 minutes  
 Acquisition Real Time: 500.0 minutes

-----  
 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

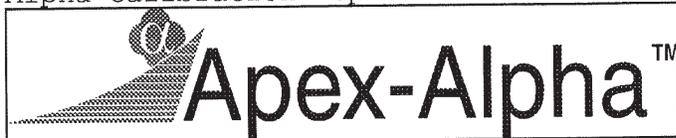
Activity reported as of : 5/16/24 10:39:26 PM

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 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



Sample Description: \\V79W-7\AlphaRoot\Data\0000272957.cnf  
Spectrum File:  
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

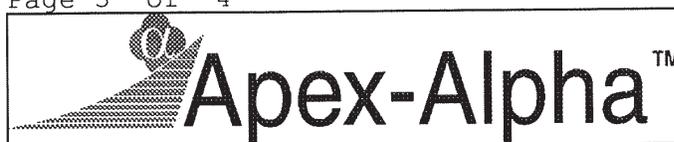
Peak Match Tolerance: 0.400 MeV

-----  
----- 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



Sample Description: \\V79W-7\AlphaRoot\Data\0000272957.cnf  
Spectrum File:  
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  
 Page 4 of 4

5/17/2024 1:55:39 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

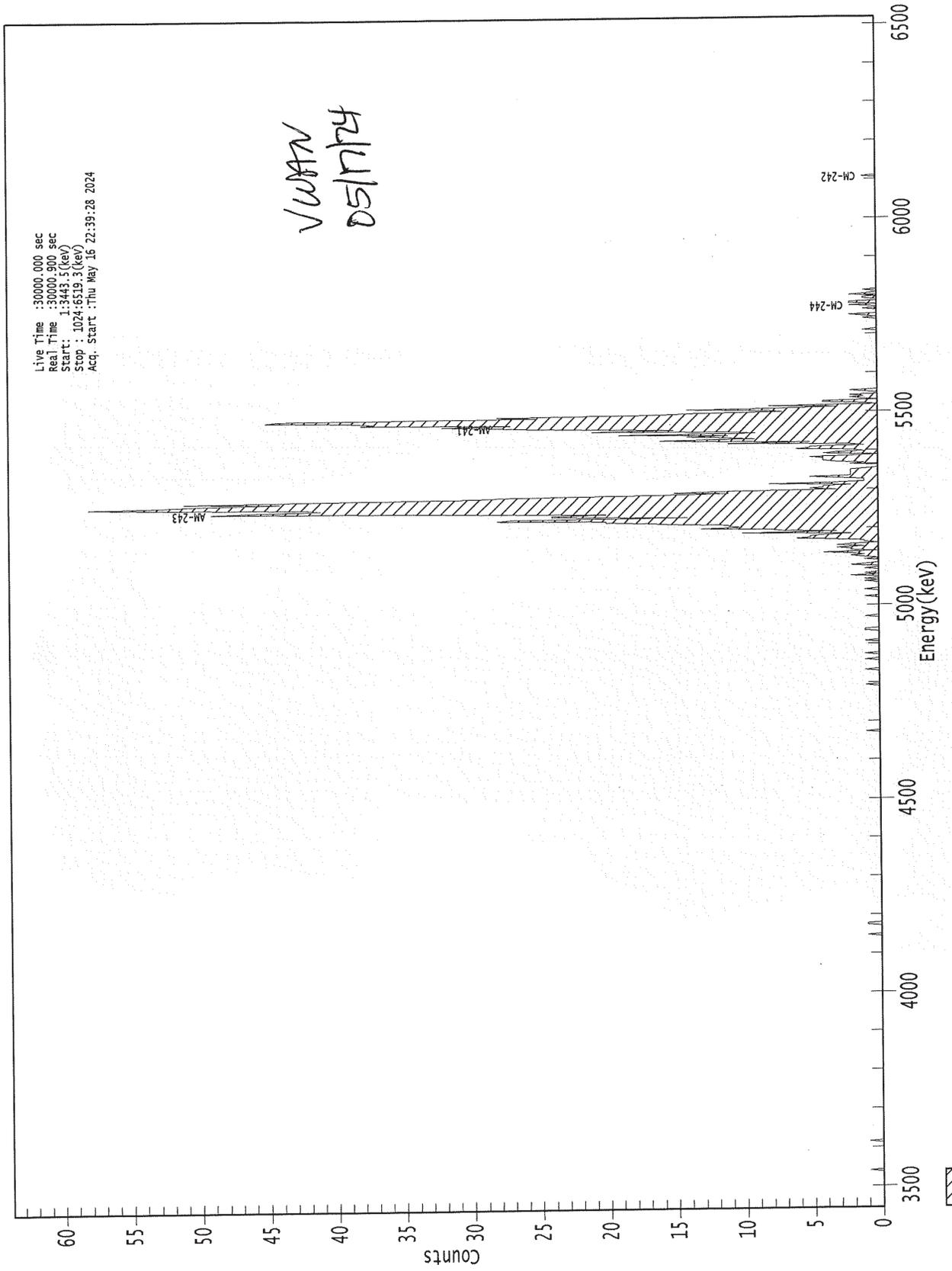
Sample Size: 1.000 unit  
 Sample Date/Time: 4/4/2024 10:30:13 PM  
 Acquisition Date/Time: 5/16/2024 10:39:28 PM  
 Acquisition Live Time: 500.0 minutes  
 Acquisition Real Time: 500.0 minutes

-----  
 NUCLIDE 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  
*WAN 05/17/24*

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

*2nd Review*  
*EW 5/17/24*

Item	Lab Id	A	B	C	D1	D2	D3	D	E	F
		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%	0.10	10.0	10.0	0.10	0.00100	1000
2	LCS24E14JT2	0.50	50.0	100.0%	0.10	10.0	10.0	0.10	0.00100	1000
3	718821	0.50	50.0	100.0%	0.10	10.0	10.0	0.10	0.00100	1000
4	718821D	0.50	50.0	100.0%	0.10	10.0	10.0	0.10	0.00100	1000
5	718822	0.50	50.0	100.0%	0.10	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)

LCS Duplicate Evaluation RPD Dup Eval 1sig	
N/A	N/A Np237

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

Item	Lab Id	Date Analyzed	TRACER		FWHM	Nuclide	Act	Raw pCi/planchet		ERR	Report pCi/ml		TV	%r	Relative Bias	
			Nuclide	Rec %				TPU	MDC		TPU (2s)	MDC				ERR (2s)
1	PB24E14KE2	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	LCS24E14JT2	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	2737.3	PB < 3*TPU
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	3.33E+01	RPD	98.2% Dup Eval 1 sig
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	93.8	1.8 Pass
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 =  $(\text{Sample-Duplicate}) / \sqrt{(\text{TPUsample}^2) + (\text{TPUdup}^2)} \leq 3$   
 K = G \* F  
 L = H \* F  
 M = I \* F  
 N = J \* F

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						
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	Alpha to Beta x-talk	End of Sample Elution
PB24E14KE2	0.50	50.0	100.0%	0.01000	0.10	0.00100	1000.00	1.000	1.000	0.0	53.9%	30.0%	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%	30.0%	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%	30.0%	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%	30.0%	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%	30.0%	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

Analyzed	Matrix	Analysis Midpoint	G			H			I			J		
			Time (min)	Beta (cpm)	Error (cpm)	Alpha (cpm)	Beta Act	TPU (2s)	MDC	TV	%r	Corr. Act	%r	
PB24E14KE2	Liquid	5/16/24 19:19	30	38.454	1.132	1.033	31557.0	4256.34	405.85	41192.0	76.6%	33599.3	81.6%	
LCS24E14JT2	Liquid	5/16/24 19:50	30	44.185	1.213	2.599	35951.5	4827.39	405.85	41192.0	87.3%	38521.3	93.5%	
718821	Liquid	5/16/24 20:20	30	45.518	1.232	1.333	37381.4	4960.76	405.85	41192.0	90.7%	40299.7	97.8%	
718821D	Liquid	5/16/24 20:51	30	48.650	1.273	1.566	39938.8	5272.19	405.85	41192.0	97.0%	43330.2	105.2%	
718822	Liquid	5/16/24 21:21	30	44.618	1.219	1.066	36696.6	4870.57	405.85	41192.0	89.1%	40057.4	97.2%	

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

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

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

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

Standard ID	Beta		Alpha		Net		%Eff
	Activity	Error	Activity	Error	Beta	DPM	
Cal std 1	51.150	1.306	25.891	43.04	82.66	52.07%	
Cal std 2	55.681	1.362	26.091	47.51	85.13	55.81%	
<b>Average Efficiency:</b>						<b>53.94%</b>	

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

# Alpha/Beta Count Results

## Sample Activity Report

### PIC IPC 650 - A

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	

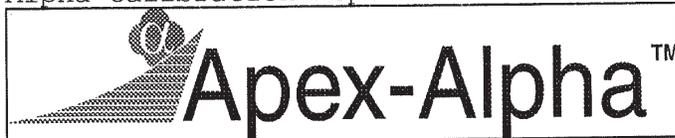
\* Note: Decay Corrected

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  
20240514-0006  
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 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



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

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



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

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

Detector Name: ALPHA\_006  
Chamber Serial Number: 05010224B  
Detector Serial Number: 159382

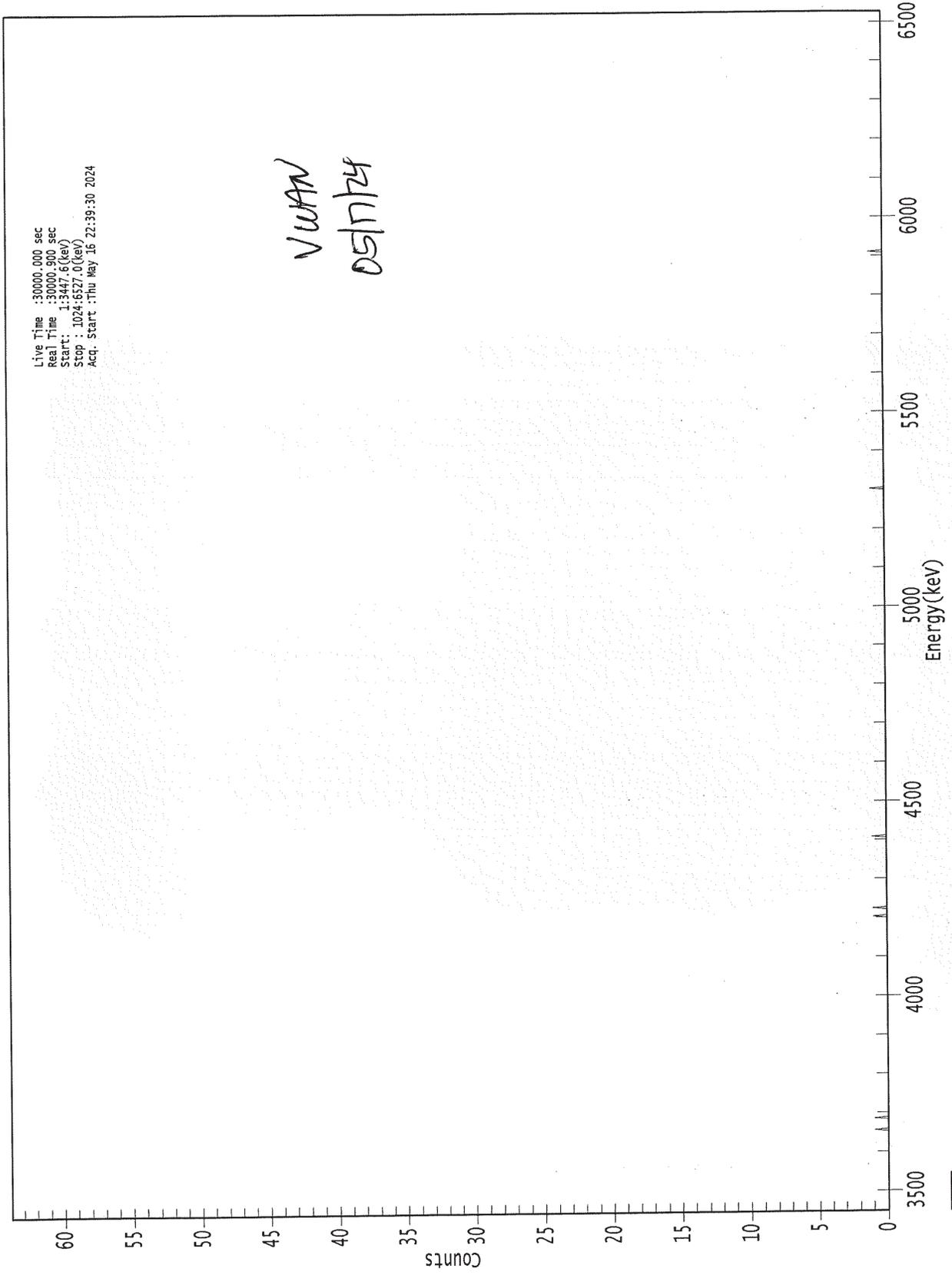
Sample Size: 1.000 unit  
Sample Date/Time: 5/14/2024 10:33:52 PM  
Acquisition Date/Time: 5/16/2024 10:39:30 PM  
Acquisition Live Time: 500.0 minutes  
Acquisition Real Time: 500.0 minutes

-----  
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 -----  
 -----

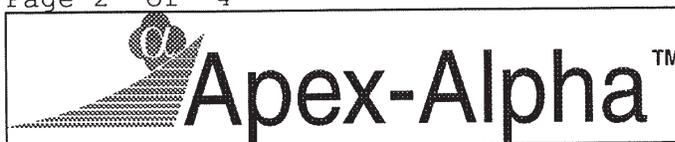
Version: Alpha Encal v1.1  
 Energy = 3.454 MeV + 3.0107E-003\*ch  
 FWHM = 3.2699E-002 MeV  
 Low Tail = 4.5379E-003 MeV

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



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

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



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

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

Detector Name: ALPHA\_007  
Chamber Serial Number: 05010225A  
Detector Serial Number: 42347

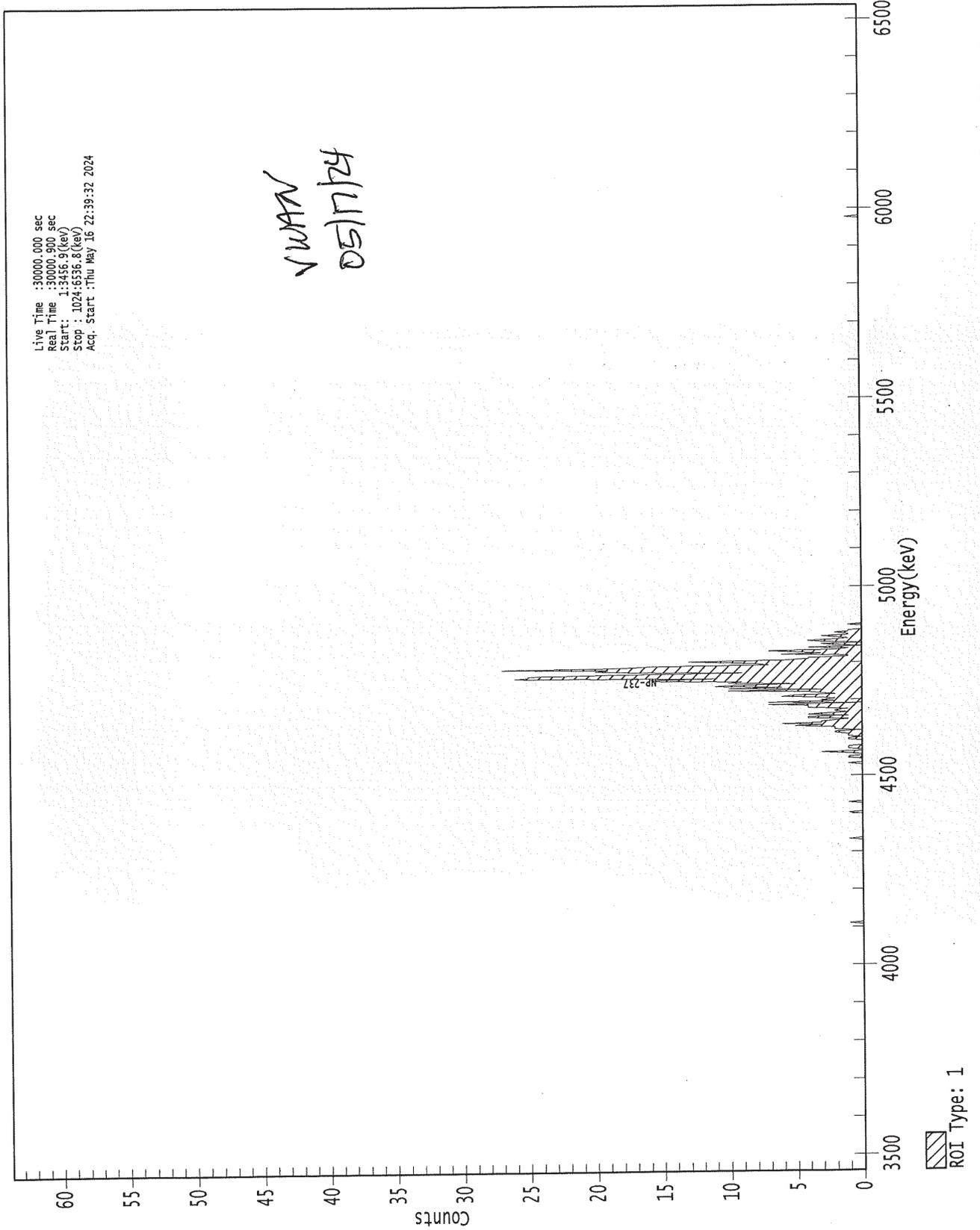
Sample Size: 1.000 unit  
Sample Date/Time: 5/14/2024 10:33:52 PM  
Acquisition Date/Time: 5/16/2024 10:39:32 PM  
Acquisition Live Time: 500.0 minutes  
Acquisition Real Time: 500.0 minutes

-----  
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

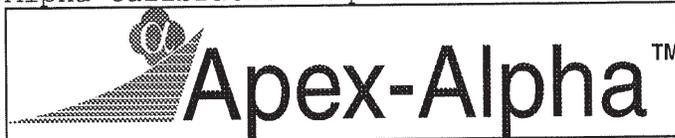
Activity reported as of : 5/16/24 10:39:32 PM

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 Efcals 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



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

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



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

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

Detector Name: ALPHA\_008  
Chamber Serial Number: 05010225B  
Detector Serial Number: 42348

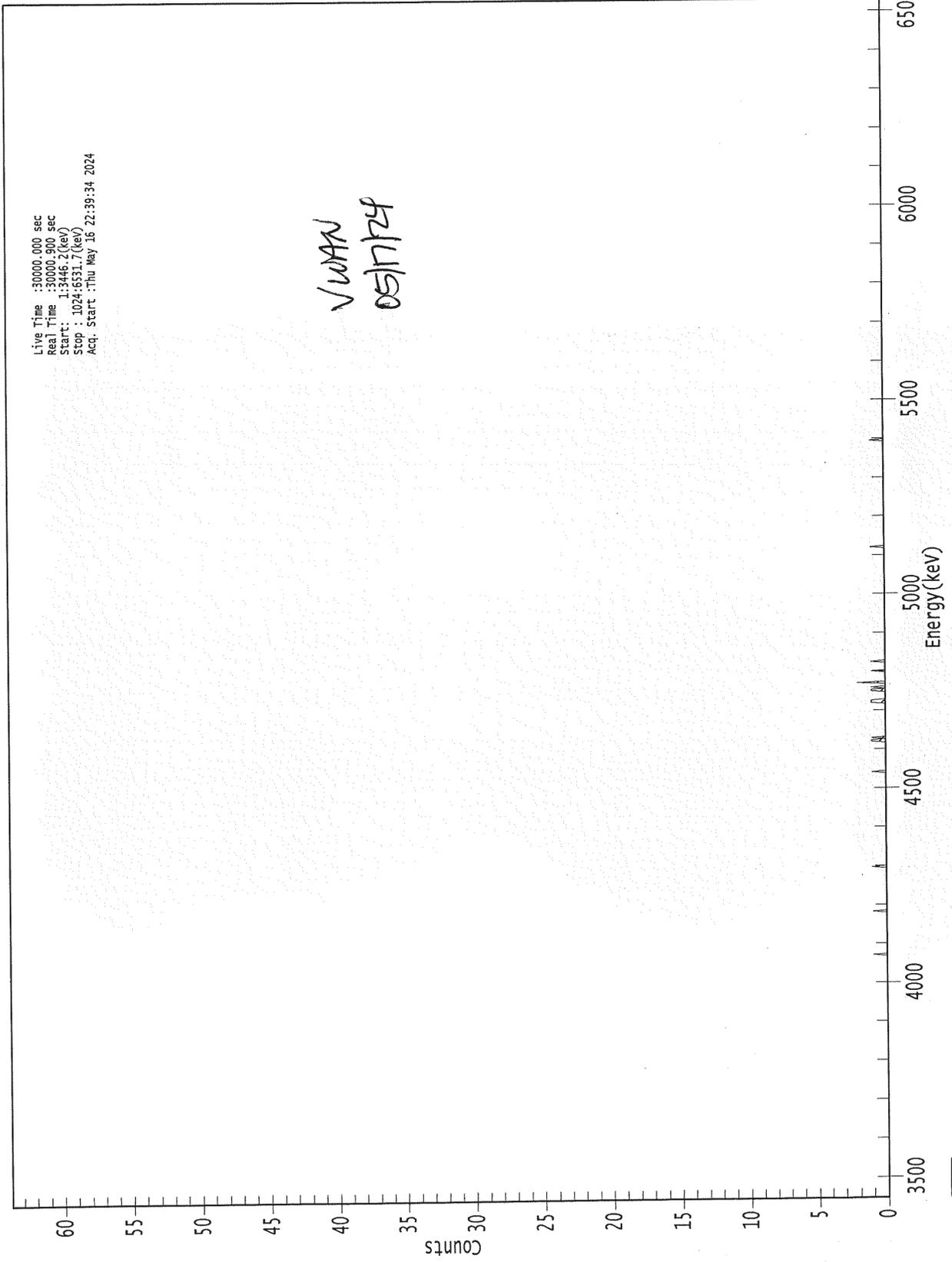
Sample Size: 1.000 unit  
Sample Date/Time: 4/4/2024 10:33:52 PM  
Acquisition Date/Time: 5/16/2024 10:39:34 PM  
Acquisition Live Time: 500.0 minutes  
Acquisition Real Time: 500.0 minutes

-----  
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

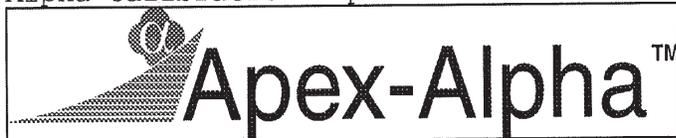
Activity reported as of : 5/16/24 10:39:34 PM

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 Efcals 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: \\V79W-7\AlphaRoot\Data\0000272951.cnf  
 Spectrum File:  
 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



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

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 5/17/2024 1:50:16 PM  
 Page 4 of 4



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

Detector Name: ALPHA\_011  
 Chamber Serial Number: 13000554A  
 Detector Serial Number: 20314

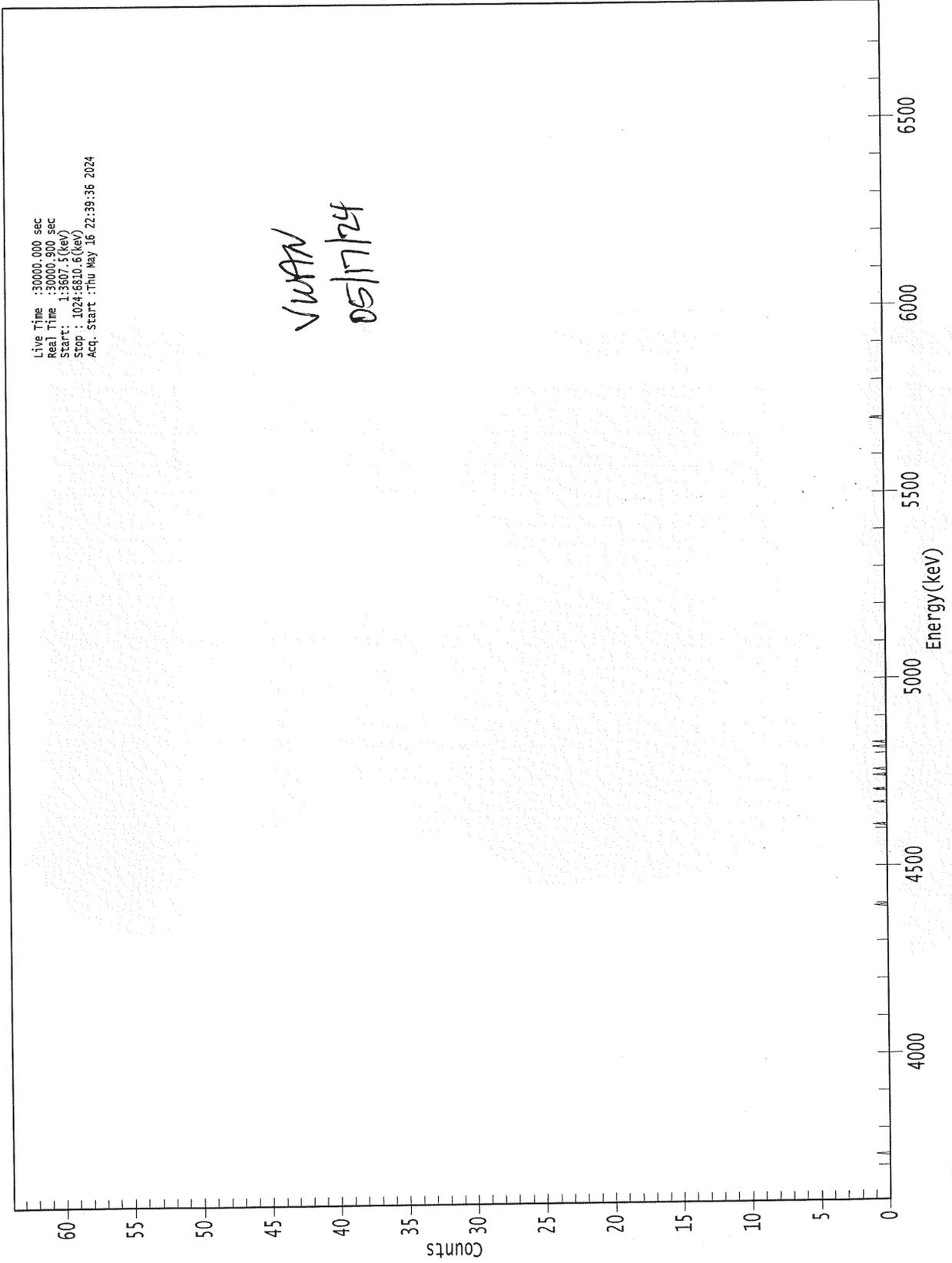
Sample Size: 1.000 unit  
 Sample Date/Time: 4/4/2024 10:33:52 PM  
 Acquisition Date/Time: 5/16/2024 10:39:36 PM  
 Acquisition Live Time: 500.0 minutes  
 Acquisition Real Time: 500.0 minutes

-----  
 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

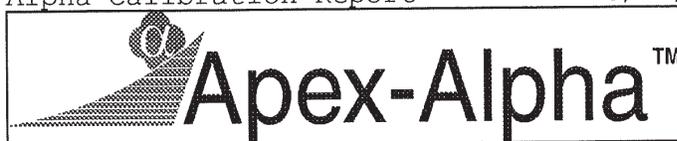
0000272951.CNF



ROI Type: 1

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 Efcals 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: \\V79W-7\AlphaRoot\Data\0000272952.cnf  
Spectrum File:  
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



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

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

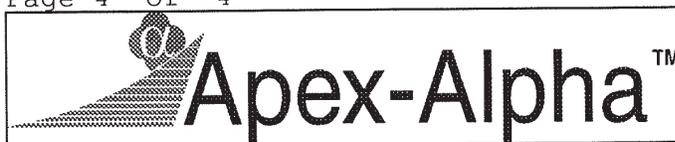
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 -----  
 NUCLIDE ACTIVITY REPORT  
 -----  
 -----

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  
 Page 4 of 4

5/17/2024 1:50:58 PM



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

Detector Name: ALPHA 012  
 Chamber Serial Number: 13000554B  
 Detector Serial Number: 165851

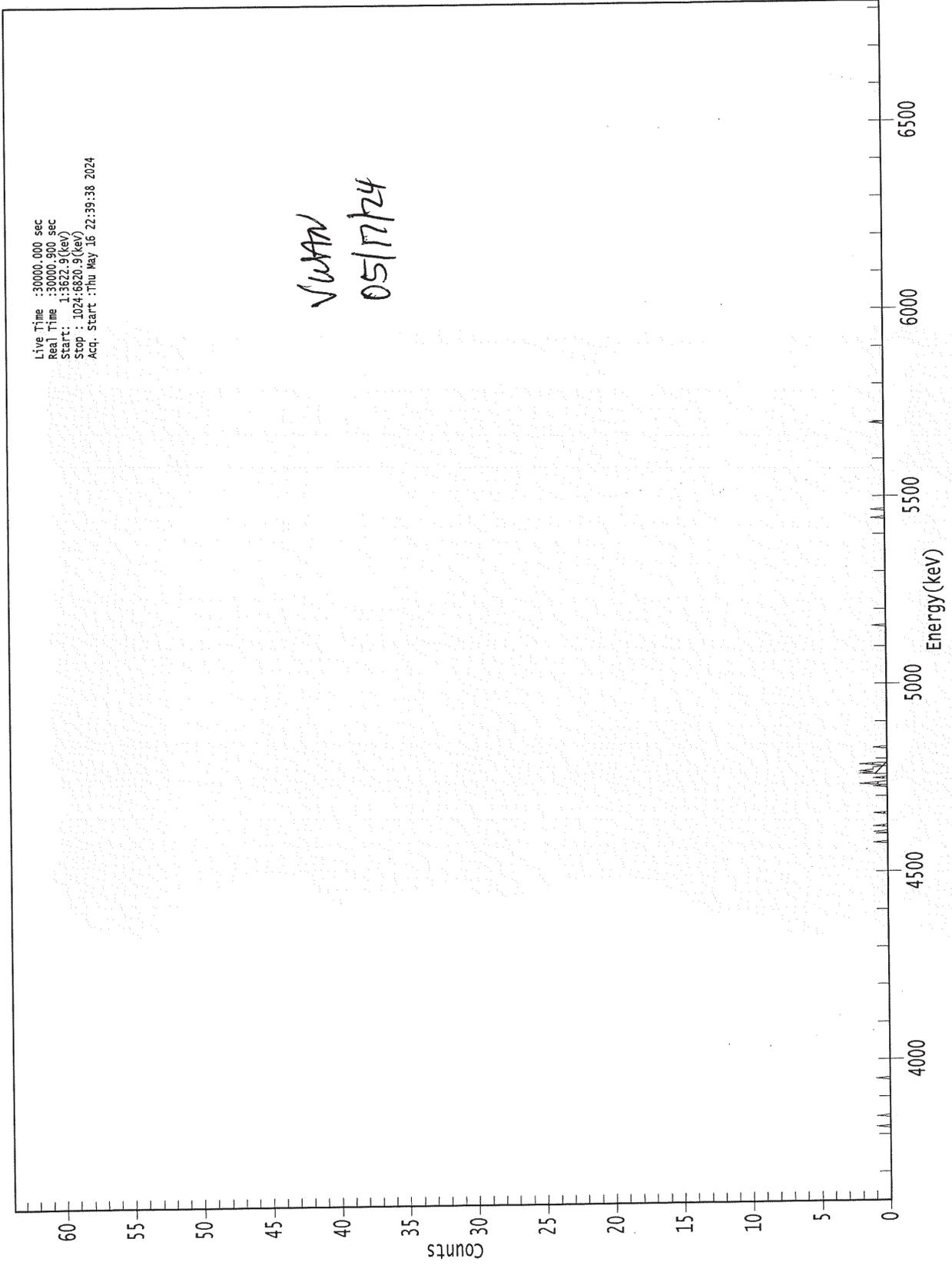
Sample Size: 1.000 unit  
 Sample Date/Time: 4/4/2024 10:33:52 PM  
 Acquisition Date/Time: 5/16/2024 10:39:38 PM  
 Acquisition Live Time: 500.0 minutes  
 Acquisition Real Time: 500.0 minutes

-----  
 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*  
*5/21/24*

*WAN 05/21/24*

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%	0.010	15.0	15.0	0.0100	0.00010	10000.0
2	LCS24E14JT1	0.50	50.0	100.0%	0.010	15.0	15.0	0.0100	0.00010	10000.0
3	718819	0.50	50.0	100.0%	0.00250	15.0	15.0	0.0025	0.00003	40000.0
4	718820	0.50	50.0	100.0%	0.00250	15.0	15.0	0.0025	0.00003	40000.0
5	718821	0.50	50.0	100.0%	0.010	15.0	15.0	0.0100	0.00010	10000.0
6	718821D	0.50	50.0	100.0%	0.010	15.0	15.0	0.0100	0.00010	10000.0
7	718822	0.50	50.0	100.0%	0.0020	15.0	15.0	0.0020	0.00002	50000.0
8	718825	0.50	50.0	100.0%	0.00250	15.0	15.0	0.0025	0.00003	40000.0
9	718826	0.50	50.0	100.0%	0.00250	15.0	15.0	0.0025	0.00003	40000.0
10	718827	0.50	50.0	100.0%	0.0020	15.0	15.0	0.0020	0.00002	50000.0
11	718828	0.50	50.0	100.0%	0.00250	15.0	15.0	0.0025	0.00003	40000.0
12	718829	0.50	50.0	100.0%	0.00250	15.0	15.0	0.0025	0.00003	40000.0
13	718830	0.50	50.0	100.0%	0.00250	15.0	15.0	0.0025	0.00003	40000.0
14	718852	0.50	50.0	100.0%	0.00250	15.0	15.0	0.0025	0.00003	40000.0
15	718853	0.50	50.0	100.0%	0.00250	15.0	15.0	0.0025	0.00003	40000.0
16	718854	0.50	50.0	100.0%	0.0020	15.0	15.0	0.0020	0.00002	50000.0
17	718855	0.50	50.0	100.0%	0.0100	15.0	15.0	0.0025	0.00003	40000.0
18	718856	0.50	50.0	100.0%	0.00250	15.0	15.0	0.0025	0.00003	40000.0
19	718857	0.50	50.0	100.0%	0.00250	15.0	15.0	0.0025	0.00003	40000.0
20	718858	0.50	50.0	100.0%	0.00250	15.0	15.0	0.0025	0.00003	40000.0
21	718859	0.50	50.0	100.0%	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		
Standard ID:	074RadSol4	Pu238 RL:	750.0
Activity (pCi/ml):	49.992	Pu239 RL:	750.0
Half-Life (yrs):	24110	Pu244 RL:	750.0
Reference Date:	8-Jun-09		
Analysis Date:	5/15/2024		
Decay Corrected TV:	49.971		
Volume Used (ml):	0.050	Volume Used (ml):	N/A

LCS Duplicate Evaluation	
RPD	Dup Eval 1 sig
N/A	N/A Pu239

Item/ Lab Id	Date Analyzed	TRACER		FWHM	Nuclide	Raw pCi/ planchet		ERR		Act	Report pCi/ml		TV	%r	Relative Bias
		Nuclide	Rec %			Act	TPU	MDC	ERR		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
		Pu239/240			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		PB < 3*TPU
		Pu-242			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			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		PB < 3*TPU
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		
		Pu239/240			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		117.6%
		Pu-242			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			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	4.45E+03	2.23E+03	1.39E+03	2.11E+03		
		Pu239/240			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			Pu-242	3.88E+00	2.63E-01	3.48E-02	1.39E-01	1.55E+05	2.11E+04	1.39E+03	1.11E+04		
		Pu-244			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+03	2.16E+03	1.61E+03	2.07E+03		
		Pu239/240			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			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			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			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			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			Pu-244	5.13E-03	7.26E-03	3.92E-02	7.26E-03	5.13E+03	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	5.33E-02	5.40E-02	5.76E+03	1.33E+03	5.33E+02	1.08E+03		0.8 Pass
		Pu239/240			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		4.1 Fail
		Pu-242			Pu-242	3.88E+00	2.64E-01	5.33E-02	1.40E-01	3.88E+04	5.28E+03	5.33E+02	2.79E+03		
		Pu-244			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		0.4 Pass
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		
		Pu239/240			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			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			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			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			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			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	5.20E+03	2.25E+03	4.49E+03
						PU-242	3.88E+00	2.65E-01	3.63E-02	1.42E-01	1.94E+05	2.65E+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	1.61E+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 =

$$K = G * F$$

$$L = H * F$$

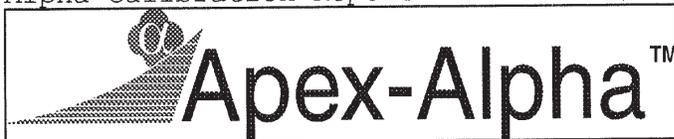
$$M = I * F$$

$$N = J * F$$

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

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 Efcad 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



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

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



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

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  
 Page 4 of 4



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

Detector Name: ALPHA\_001  
 Chamber Serial Number: 05010114A  
 Detector Serial Number: 91232

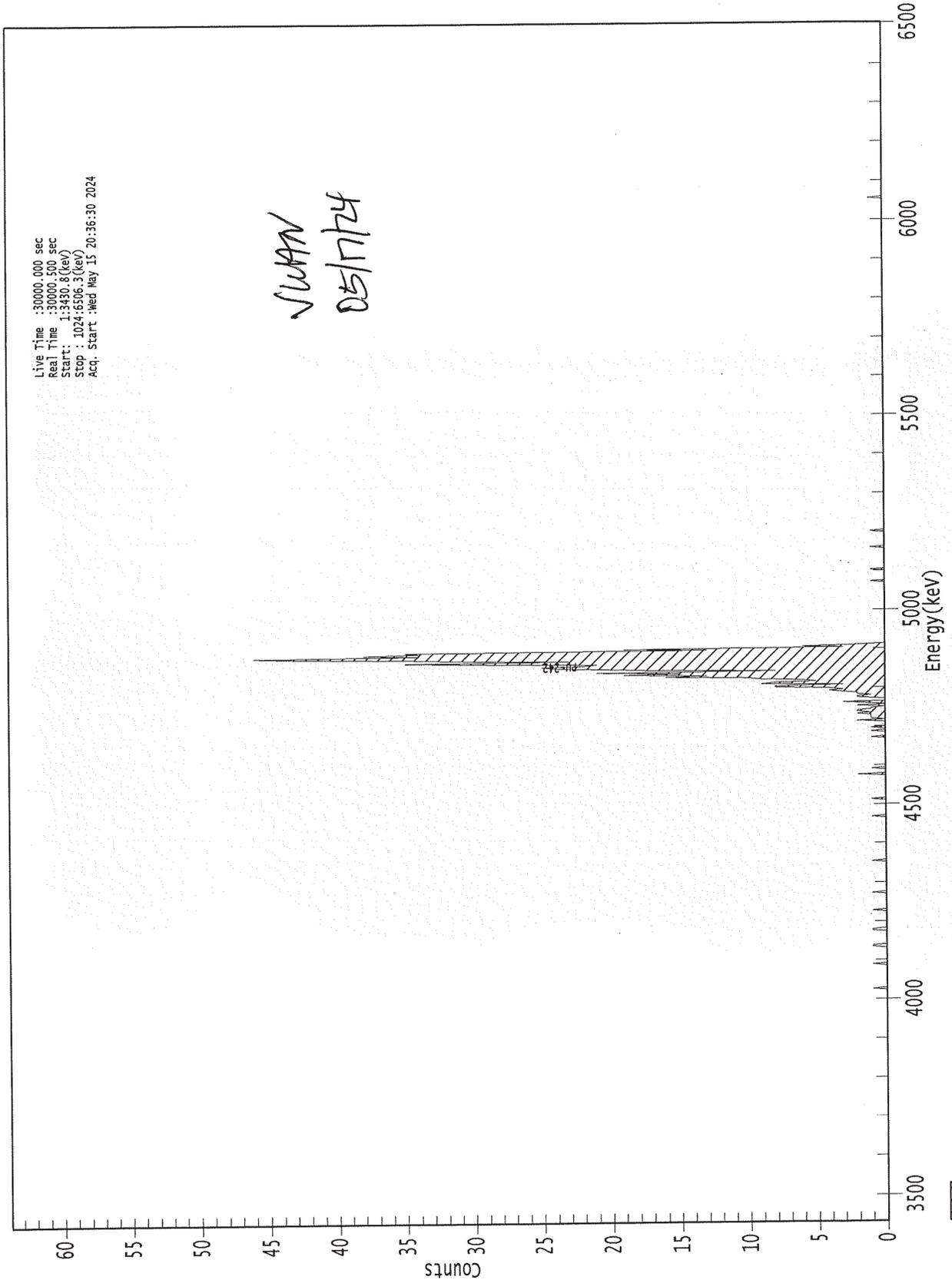
Sample Size: 1.000 unit  
 Sample Date/Time: 5/14/2024 8:06:50 PM  
 Acquisition Date/Time: 5/15/2024 8:36:30 PM  
 Acquisition Live Time: 500.0 minutes  
 Acquisition Real Time: 500.0 minutes

-----  
 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

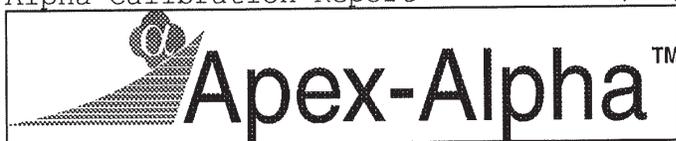
Activity reported as of : 5/15/24 8:36:30 PM

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 Efcals 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



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 -----  
-----

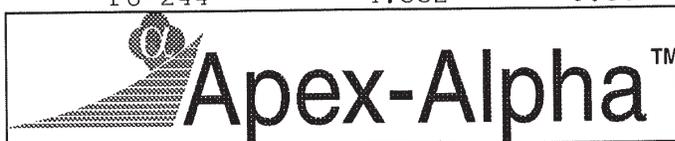
Nuclide	Energy (MeV)	Net Pk Area	Pk Area Error %	Ambient Backgnd	Reagent Backgnd	FWHM (keV)
PU-238	5.458	0.50	223.61	0.50	0.00E+000	3.0
PU-239	5.100	474.00	4.60	0.00	0.00E+000	5.5
PU-242 T	4.842	626.00	4.00	1.00	0.00E+000	28.4

Alpha Analysis Report

5/16/2024 1:29:10 PM

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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 5/16/2024 1:29:10 PM  
 Page 4 of 4



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

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

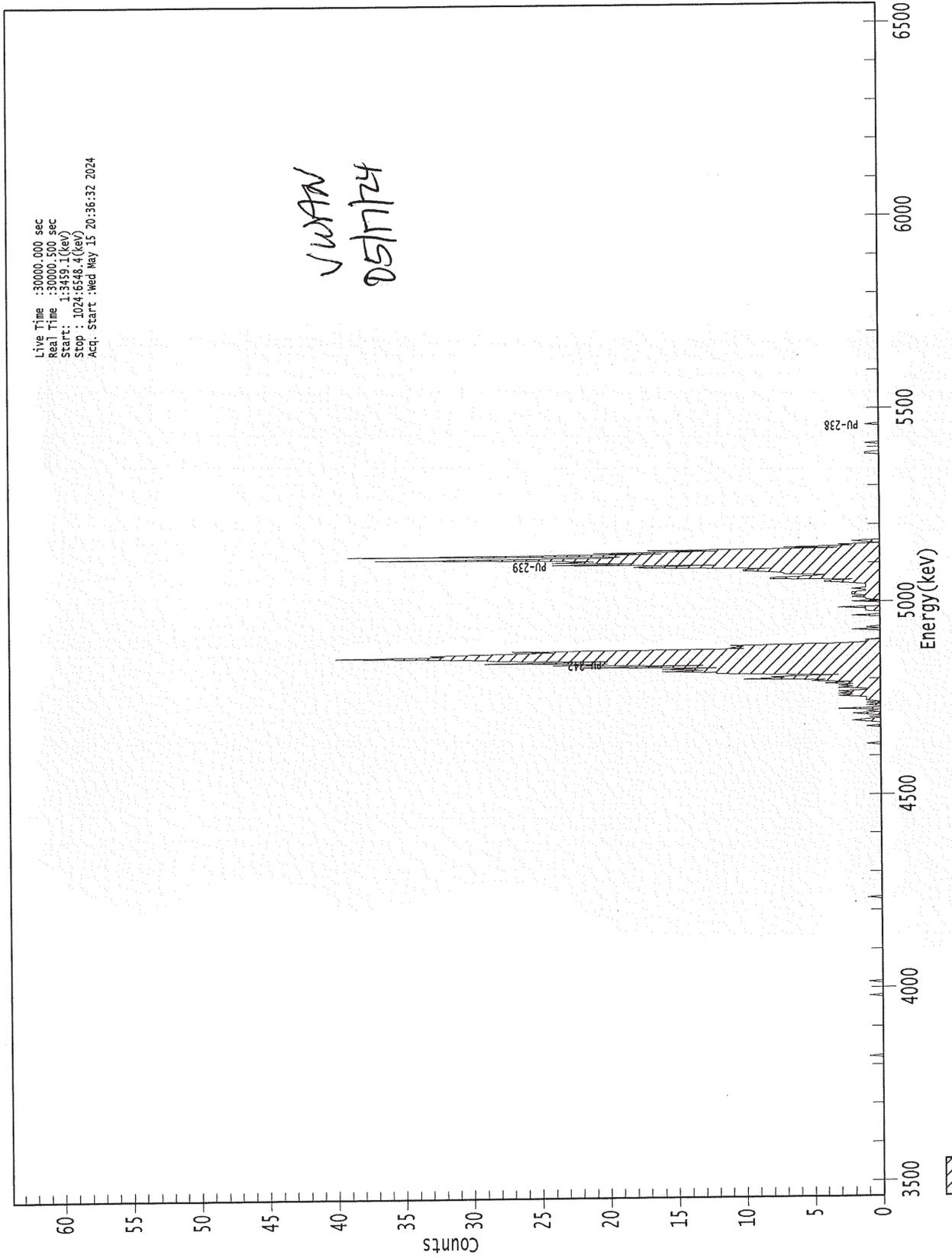
Sample Size: 1.000 unit  
 Sample Date/Time: 5/14/2024 8:06:50 PM  
 Acquisition Date/Time: 5/15/2024 8:36:32 PM  
 Acquisition Live Time: 500.0 minutes  
 Acquisition Real Time: 500.0 minutes

-----  
 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

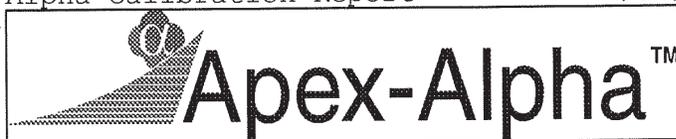
Activity reported as of : 5/15/24 8:36:32 PM

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 Efcals 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



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



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

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	5.487	1.3617E-001	20.49	3.4795E-002	6.80
PU-239	5.148	4.7294E-001	12.32	3.4799E-002	6.80
PU-242	4.891	3.8762E+000	6.80	3.4764E-002	6.80
PU-244	4.581	4.9472E-003	141.58	3.7846E-002	6.80

Errors quoted at 1.000 sigma

Alpha NID Report 5/16/2024 1:30:22 PM  
Page 4 of 4



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

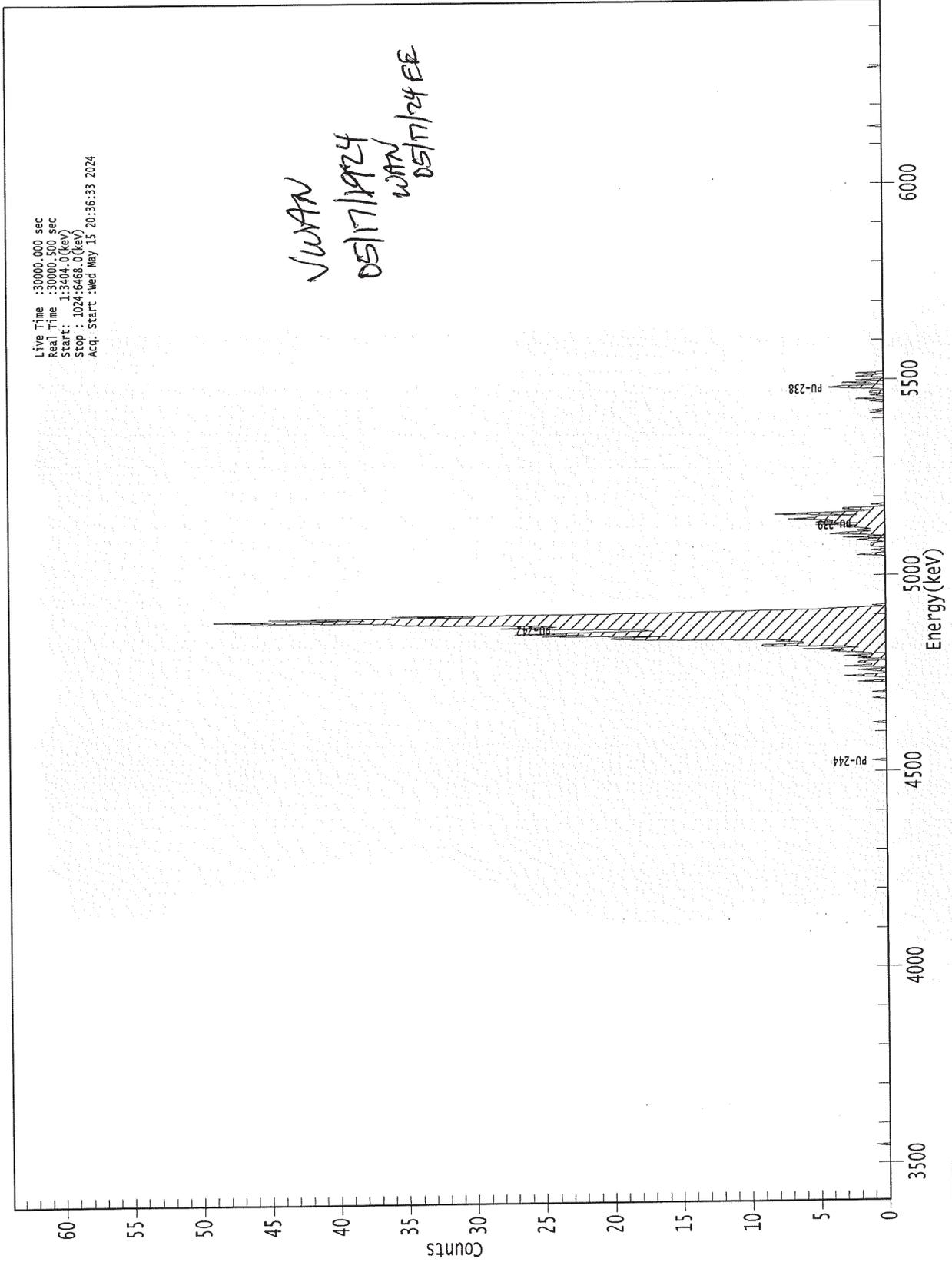
Sample Size: 1.000 unit  
Sample Date/Time: 4/4/2024 8:06:50 PM  
Acquisition Date/Time: 5/15/2024 8:36:33 PM  
Acquisition Live Time: 500.0 minutes  
Acquisition Real Time: 500.0 minutes

-----  
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

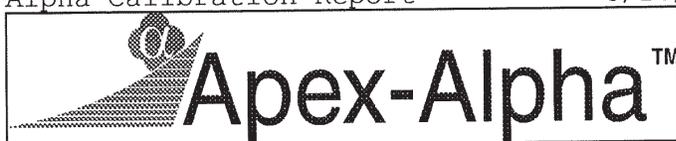
Activity reported as of : 5/15/24 8:36:33 PM

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



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

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



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

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

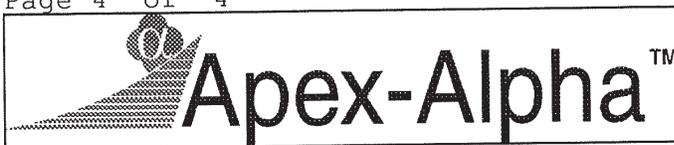
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 -----  
 NUCLIDE ACTIVITY REPORT  
 -----  
 -----

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

Errors quoted at 1.000 sigma

Alpha NID Report  
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5/16/2024 1:31:29 PM



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

Detector Name: ALPHA\_004  
 Chamber Serial Number: 02068349B  
 Detector Serial Number: 165823

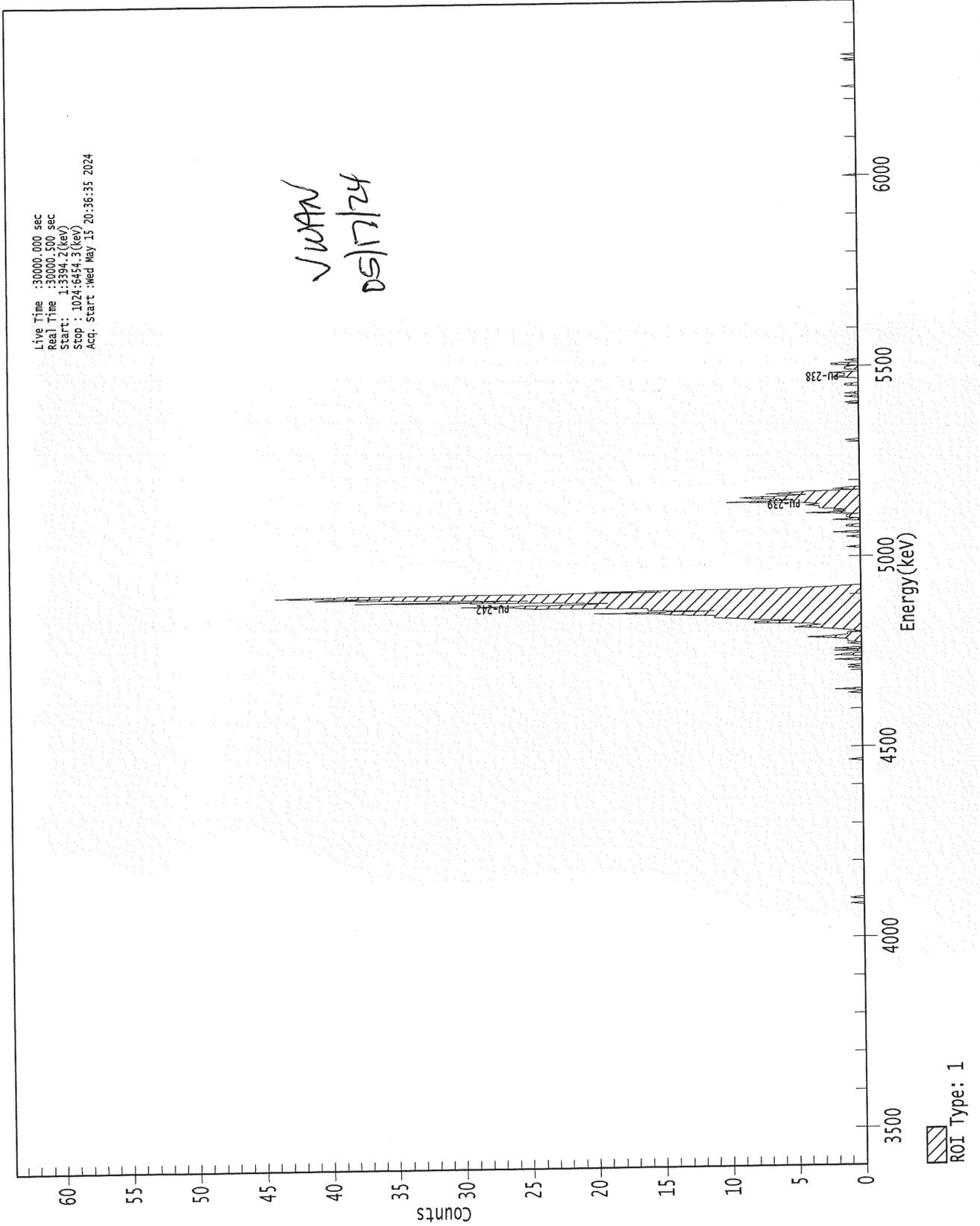
Sample Size: 1.000 unit  
 Sample Date/Time: 4/4/2024 8:06:50 PM  
 Acquisition Date/Time: 5/15/2024 8:36:35 PM  
 Acquisition Live Time: 500.0 minutes  
 Acquisition Real Time: 500.0 minutes

-----  
 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

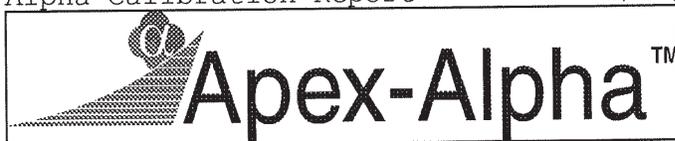
Activity reported as of : 5/15/24 8:36:35 PM

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 Efcacal 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



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

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



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

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	5.487	5.0581E-001	12.20	3.6085E-002	6.83
PU-239	5.148	2.1981E+000	8.37	3.9288E-002	6.83
PU-242	4.891	3.8762E+000	6.83	3.6053E-002	6.83
PU-244	4.581	5.1306E-003	141.59	3.9249E-002	6.83

Errors quoted at 1.000 sigma

Alpha NID Report 5/16/2024 1:32:42 PM  
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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

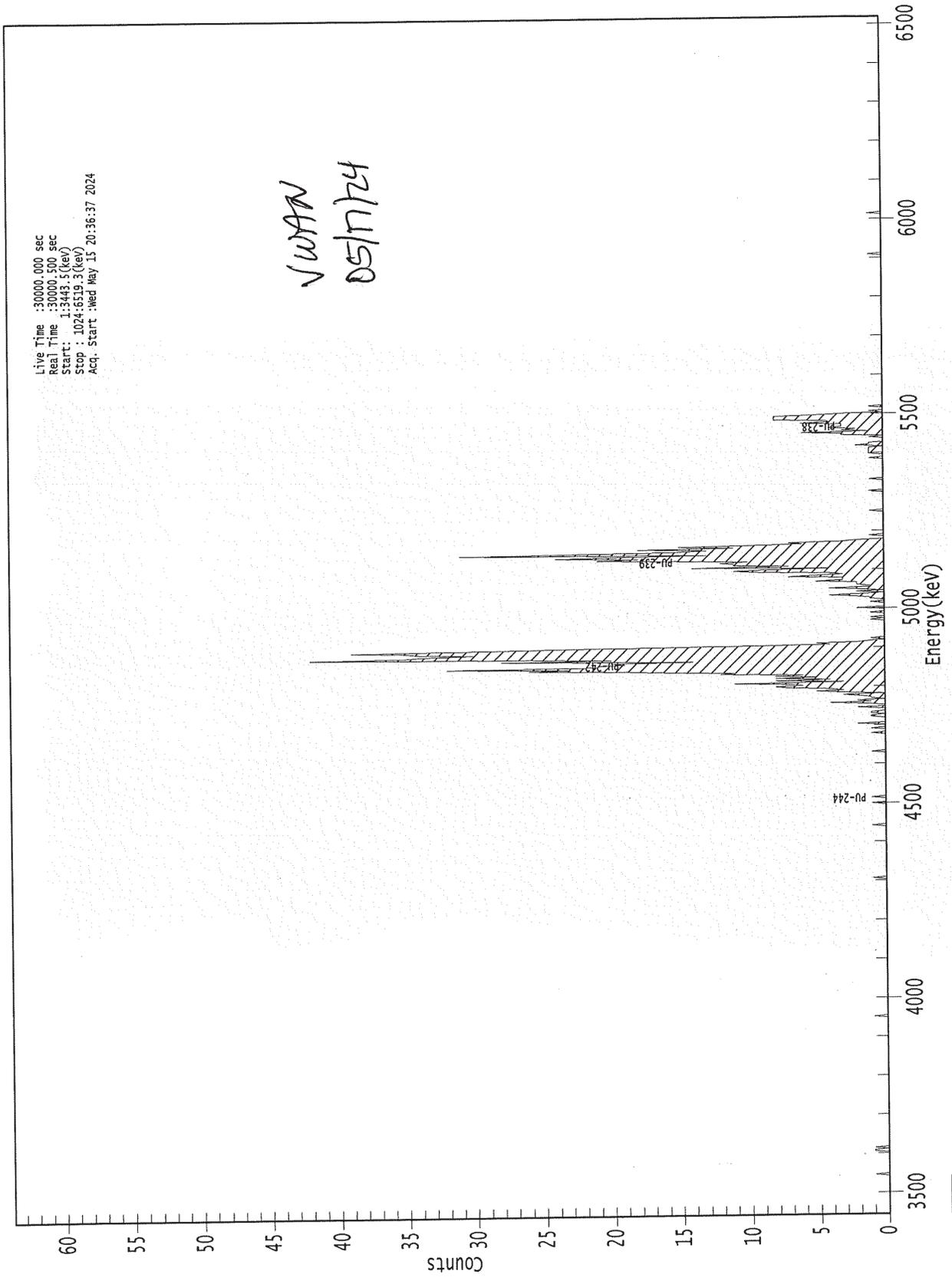
Sample Size: 1.000 unit  
Sample Date/Time: 4/4/2024 8:06:50 PM  
Acquisition Date/Time: 5/15/2024 8:36:37 PM  
Acquisition Live Time: 500.0 minutes  
Acquisition Real Time: 500.0 minutes

-----  
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 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

5/16/2024 1:34:45 PM



Sample Description: \\V79W-7\AlphaRoot\Data\0000272922.cnf  
Spectrum File: 240515PUX  
Batch Identification: 718821D  
Sample Identification: Shelf 2  
Sample Geometry: Pu with 242 - 500min  
Procedure Description:

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



Sample Description: \\V79W-7\AlphaRoot\Data\0000272922.cnf  
 Spectrum File: 240515PUX  
 Batch Identification: 718821D  
 Sample Identification: Shelf 2  
 Sample Geometry: Pu with 242 - 500min  
 Procedure Description:

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	5.487	5.7578E-001	11.59	3.5336E-002	6.81
PU-239	5.148	3.5607E+000	7.78	3.8474E-002	6.81
PU-242	4.891	3.8762E+000	6.81	3.5305E-002	6.81
PU-244	4.581	1.0048E-002	86.87	3.8435E-002	6.81

Errors quoted at 1.000 sigma

Alpha NID Report  
 Page 4 of 4

5/16/2024 1:34:46 PM



Sample Description: \\V79W-7\AlphaRoot\Data\0000272922.cnf  
 Spectrum File: 240515PUX  
 Batch Identification: 718821D  
 Sample Identification: Shelf 2  
 Sample Geometry: Pu with 242 - 500min  
 Procedure Description:

Detector Name: ALPHA 006  
 Chamber Serial Number: 05010224B  
 Detector Serial Number: 159382

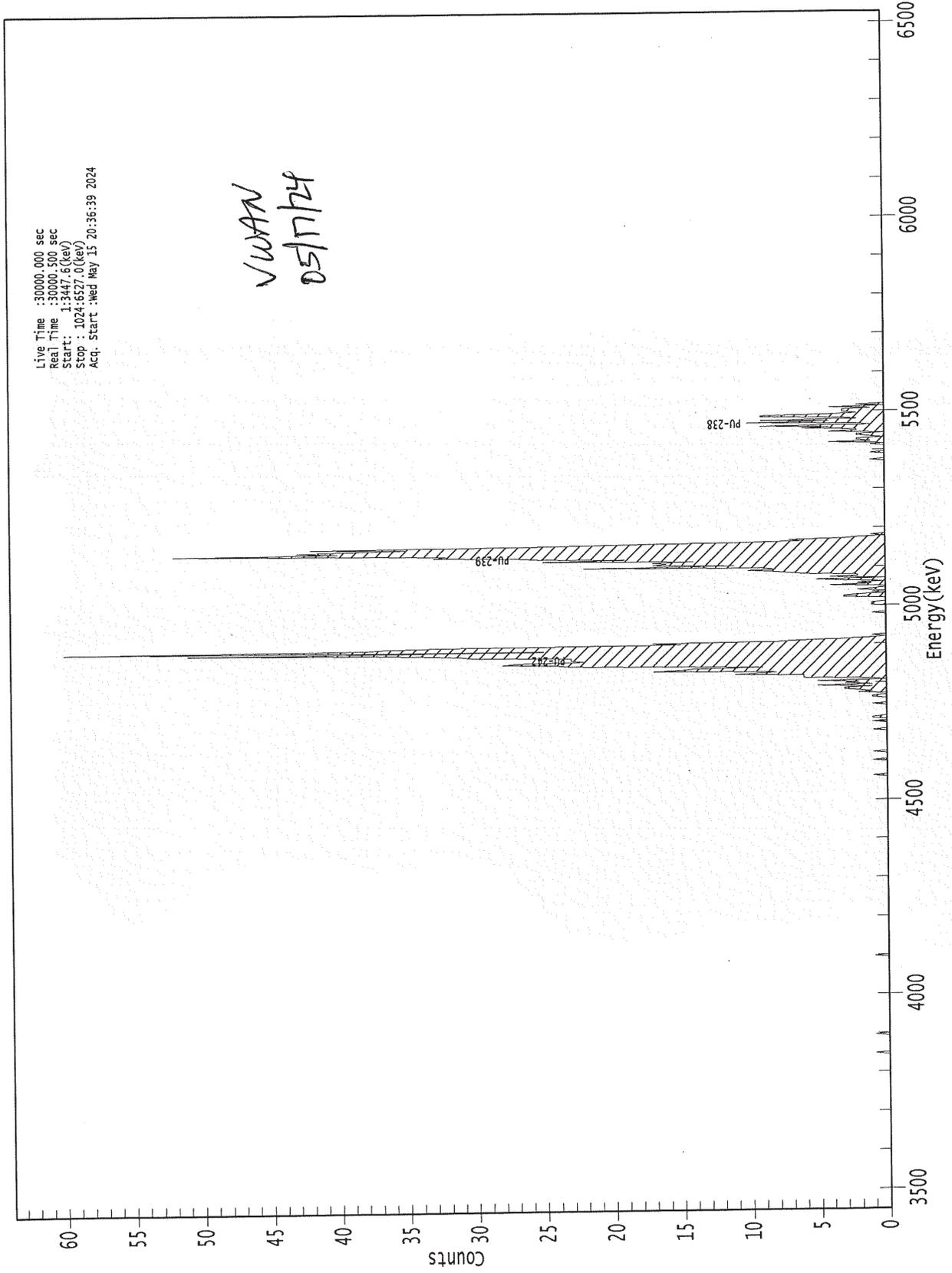
Sample Size: 1.000 unit  
 Sample Date/Time: 4/4/2024 8:06:50 PM  
 Acquisition Date/Time: 5/15/2024 8:36:39 PM  
 Acquisition Live Time: 500.0 minutes  
 Acquisition Real Time: 500.0 minutes

-----  
 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 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

5/16/2024 1:35:45 PM



Sample Description: \\V79W-7\AlphaRoot\Data\0000272923.cnf  
Spectrum File: 240515PUX  
Batch Identification: 718822  
Sample Identification: Shelf 2  
Sample Geometry: Pu with 242 - 500min  
Procedure Description:

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

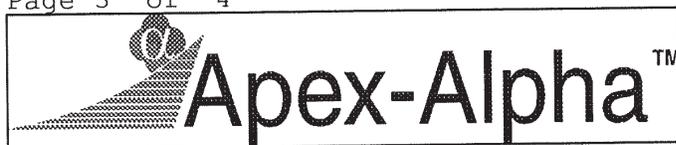
Peak Match Tolerance: 0.200 MeV

-----  
----- 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



Sample Description: \\V79W-7\AlphaRoot\Data\0000272923.cnf  
Spectrum File:  
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 5/16/2024 1:35:45 PM  
 Page 4 of 4



Sample Description: \\V79W-7\AlphaRoot\Data\0000272923.cnf  
 Spectrum File: 240515PUX  
 Batch Identification: 718822  
 Sample Identification: Shelf 2  
 Sample Geometry: Pu with 242 - 500min  
 Procedure Description:

Detector Name: ALPHA\_007  
 Chamber Serial Number: 05010225A  
 Detector Serial Number: 42347

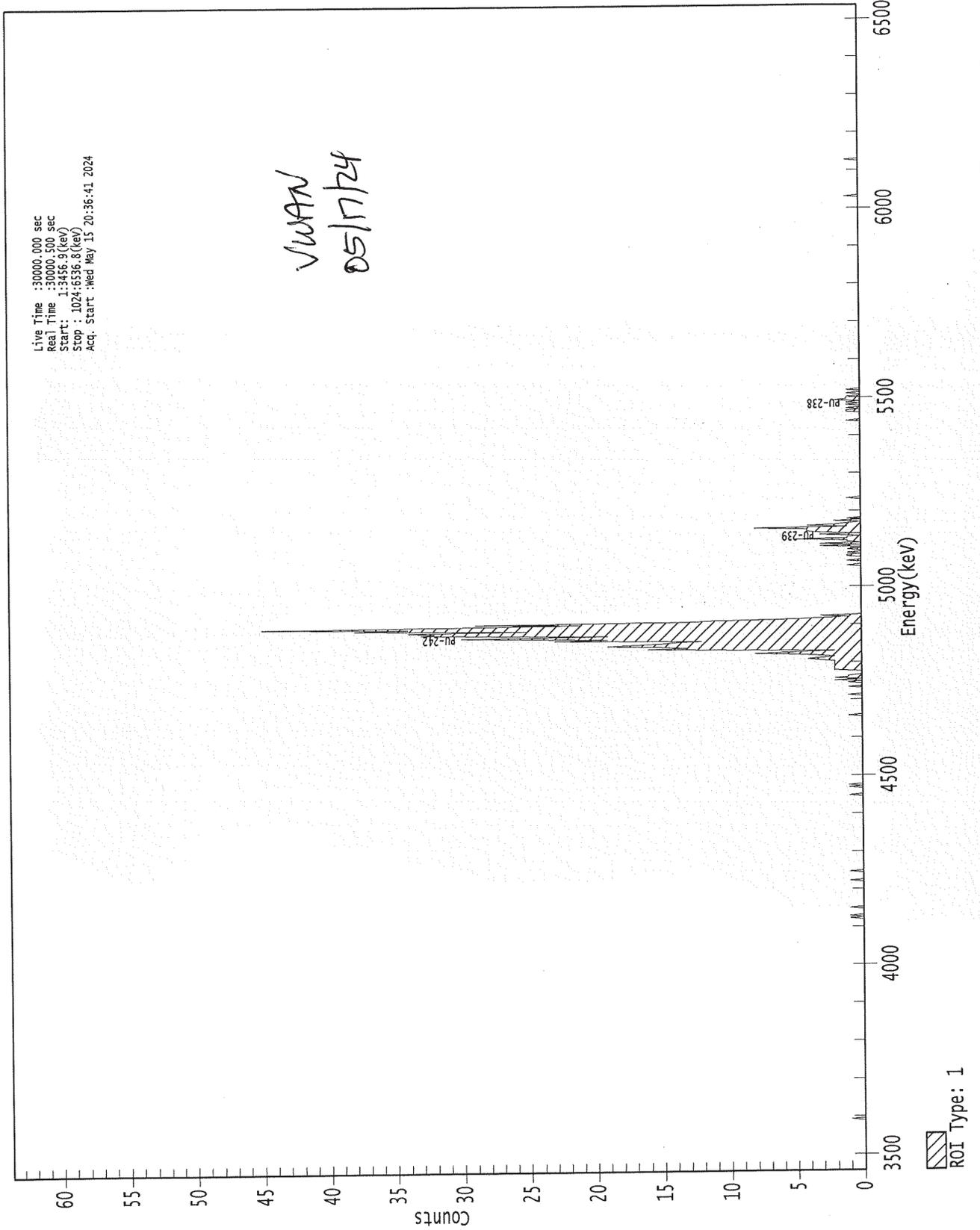
Sample Size: 1.000 unit  
 Sample Date/Time: 4/4/2024 8:06:50 PM  
 Acquisition Date/Time: 5/15/2024 8:36:41 PM  
 Acquisition Live Time: 500.0 minutes  
 Acquisition Real Time: 500.0 minutes

-----  
 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

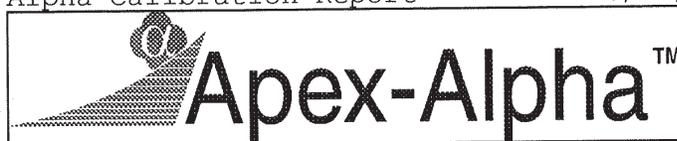
Activity reported as of : 5/15/24 8:36:41 PM

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 Efcals 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  
 Page 2 of 4

5/16/2024 1:36:51 PM



Sample Description: \\V79W-7\AlphaRoot\Data\0000272924.cnf  
 Spectrum File: 240515PUX  
 Batch Identification: 718825  
 Sample Identification: Shelf 2  
 Sample Geometry: Pu with 242 - 500min  
 Procedure Description:

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



Sample Description: \\V79W-7\AlphaRoot\Data\0000272924.cnf  
 Spectrum File: 240515PUX  
 Batch Identification: 718825  
 Sample Identification: Shelf 2  
 Sample Geometry: Pu with 242 - 500min  
 Procedure Description:

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: \\V79W-7\AlphaRoot\Data\0000272924.cnf  
 Spectrum File: 240515PUX  
 Batch Identification: 718825  
 Sample Identification: Shelf 2  
 Sample Geometry: Pu with 242 - 500min  
 Procedure Description:

Detector Name: ALPHA\_008  
 Chamber Serial Number: 05010225B  
 Detector Serial Number: 42348

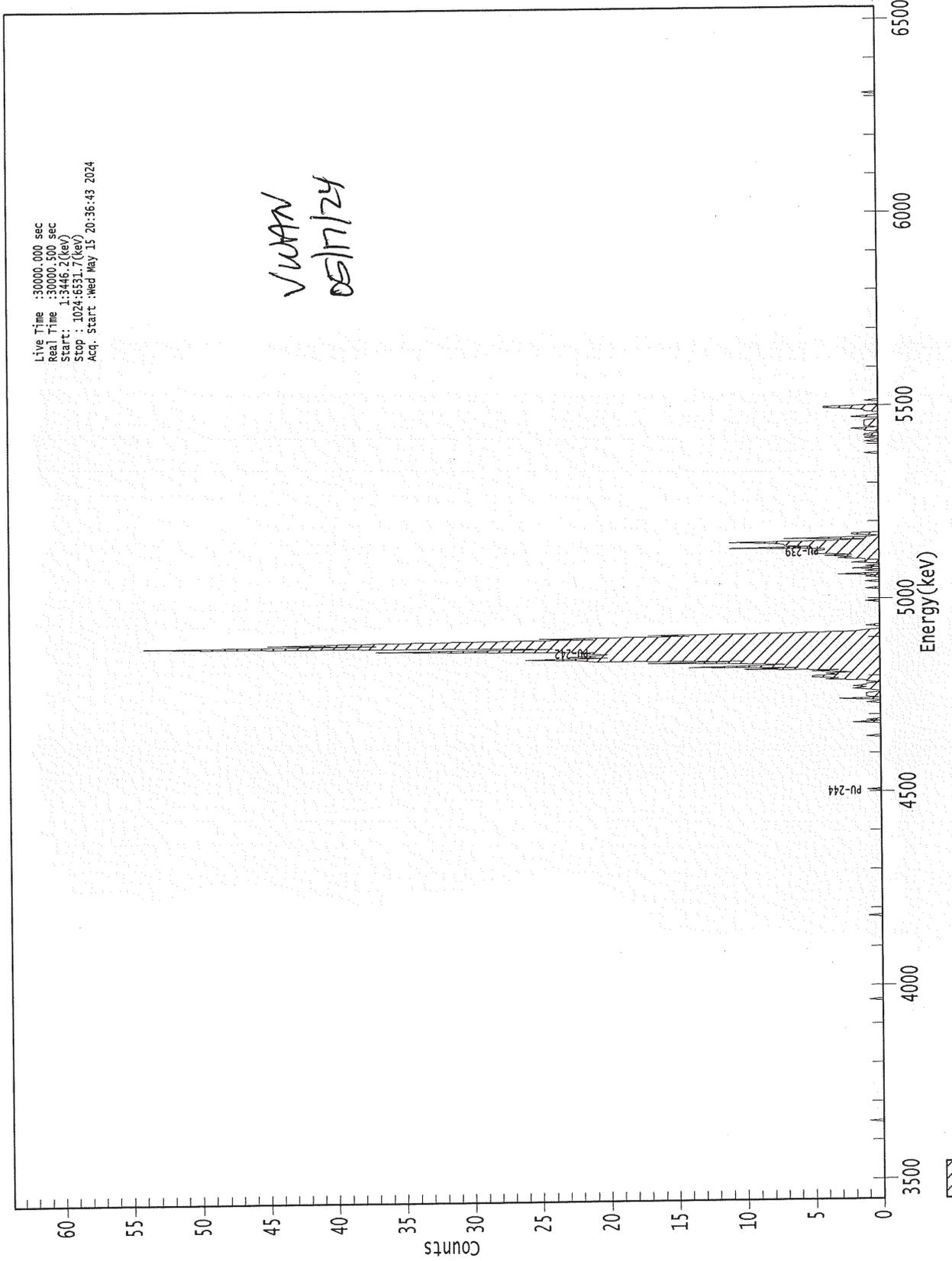
Sample Size: 1.000 unit  
 Sample Date/Time: 4/4/2024 8:06:50 PM  
 Acquisition Date/Time: 5/15/2024 8:36:43 PM  
 Acquisition Live Time: 500.0 minutes  
 Acquisition Real Time: 500.0 minutes

-----  
 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

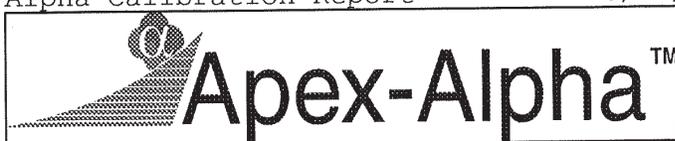
Activity reported as of : 5/15/24 8:36:43 PM

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 Efcals 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



Sample Description: \\V79W-7\AlphaRoot\Data\0000272925.cnf  
 Spectrum File: 240515PUX  
 Batch Identification: 718826  
 Sample Identification: Shelf 2  
 Sample Geometry: Pu with 242 - 500min  
 Procedure Description:

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



Sample Description: \\V79W-7\AlphaRoot\Data\0000272925.cnf  
Spectrum File: 240515PUX  
Batch Identification: 718826  
Sample Identification: Shelf 2  
Sample Geometry: Pu with 242 - 500min  
Procedure Description:

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

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

Nuclide	Energy (MeV)	Activity (pCi/unit)	Activity Error %	MDA (pCi/unit)	MDA Error %
PU-238	5.487	1.2645E-001	21.69	4.3981E-002	6.82
PU-239	5.148	5.4887E-001	11.80	3.5548E-002	6.82
PU-242	4.891	3.8762E+000	6.82	5.5864E-002	6.82
PU-244	4.581	0.0000E+000	0.00	3.8661E-002	6.82

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

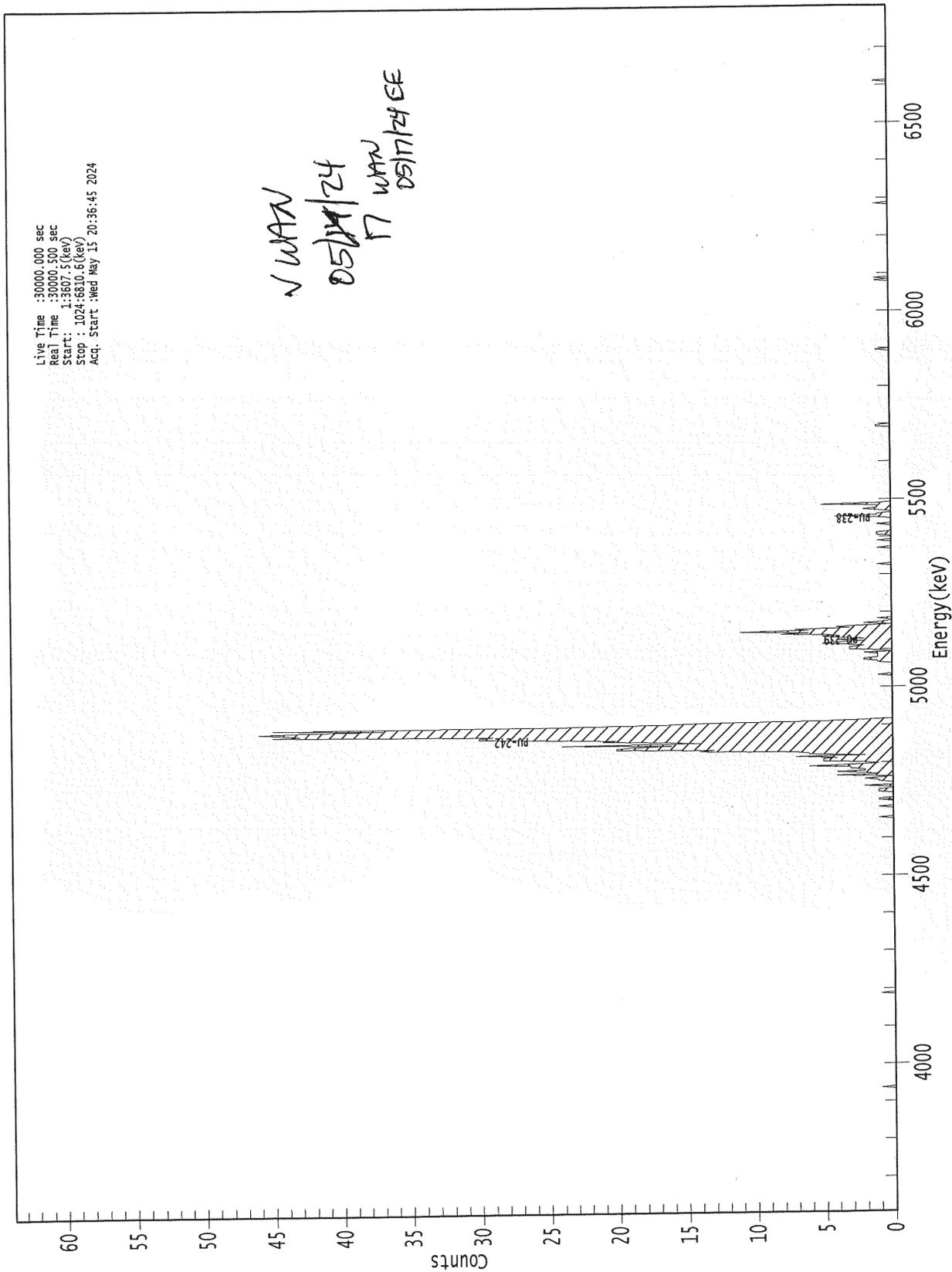
Sample Size: 1.000 unit  
Sample Date/Time: 4/4/2024 8:06:50 PM  
Acquisition Date/Time: 5/15/2024 8:36:45 PM  
Acquisition Live Time: 500.0 minutes  
Acquisition Real Time: 500.0 minutes

-----  
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

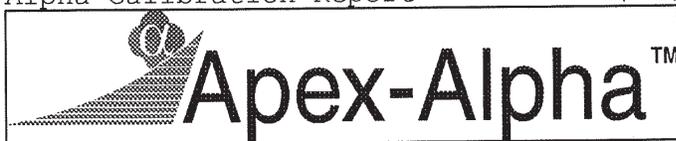
Activity reported as of : 5/15/24 8:36:45 PM

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



Sample Description: \\V79W-7\AlphaRoot\Data\0000272926.cnf  
 Spectrum File: 240515PUX  
 Batch Identification: 718827  
 Sample Identification: Shelf 2  
 Sample Geometry: Pu with 242 - 500min  
 Procedure Description:

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



Sample Description: \\V79W-7\AlphaRoot\Data\0000272926.cnf  
 Spectrum File: 240515PUX  
 Batch Identification: 718827  
 Sample Identification: Shelf 2  
 Sample Geometry: Pu with 242 - 500min  
 Procedure Description:

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  
Page 4 of 4

5/16/2024 1:39:06 PM



Sample Description: \\V79W-7\AlphaRoot\Data\0000272926.cnf  
Spectrum File: 240515PUX  
Batch Identification: 718827  
Sample Identification: Shelf 2  
Sample Geometry: Pu with 242 - 500min  
Procedure Description:

Detector Name: ALPHA\_012  
Chamber Serial Number: 13000554B  
Detector Serial Number: 165851

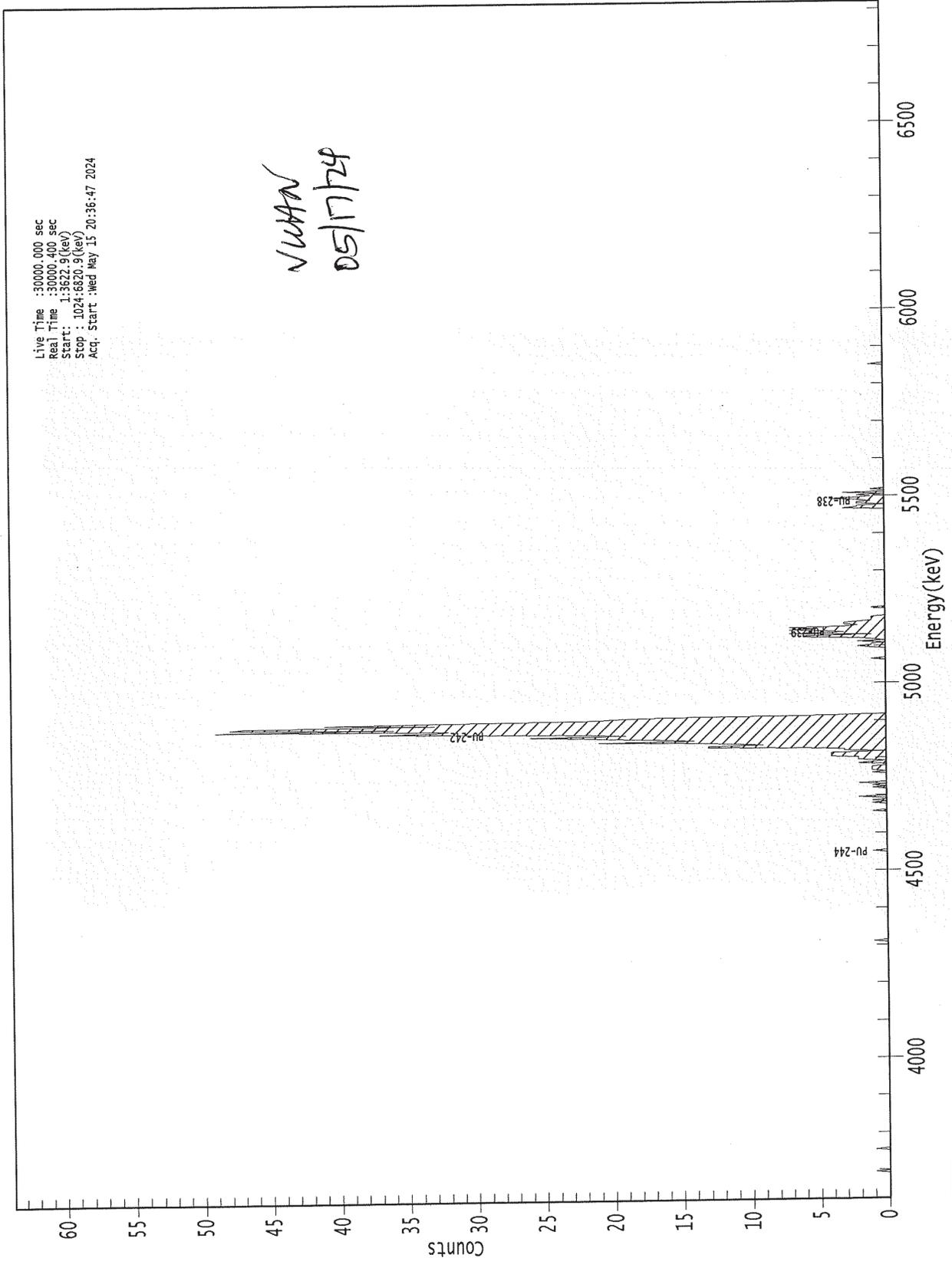
Sample Size: 1.000 unit  
Sample Date/Time: 4/4/2024 8:06:50 PM  
Acquisition Date/Time: 5/15/2024 8:36:47 PM  
Acquisition Live Time: 500.0 minutes  
Acquisition Real Time: 500.0 minutes

-----  
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

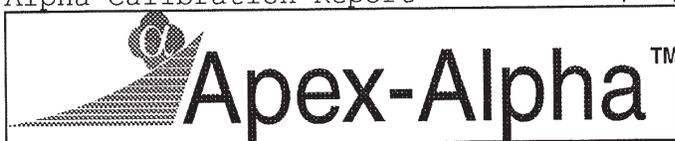
Activity reported as of : 5/15/24 8:36:47 PM

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  
 Page 2 of 4

5/16/2024 1:40:07 PM



Sample Description: \\V79W-7\AlphaRoot\Data\0000272927.cnf  
 Spectrum File:  
 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



Sample Description: \\V79W-7\AlphaRoot\Data\0000272927.cnf  
Spectrum File: 240515PUX  
Batch Identification: 718828  
Sample Identification: Shelf 2  
Sample Geometry: Pu with 242 - 500min  
Procedure Description:

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: \\V79W-7\AlphaRoot\Data\0000272927.cnf  
 Spectrum File: 240515PUX  
 Batch Identification: 718828  
 Sample Identification: Shelf 2  
 Sample Geometry: Pu with 242 - 500min  
 Procedure Description:

Detector Name: ALPHA\_018  
 Chamber Serial Number: 03963051B  
 Detector Serial Number: 159388

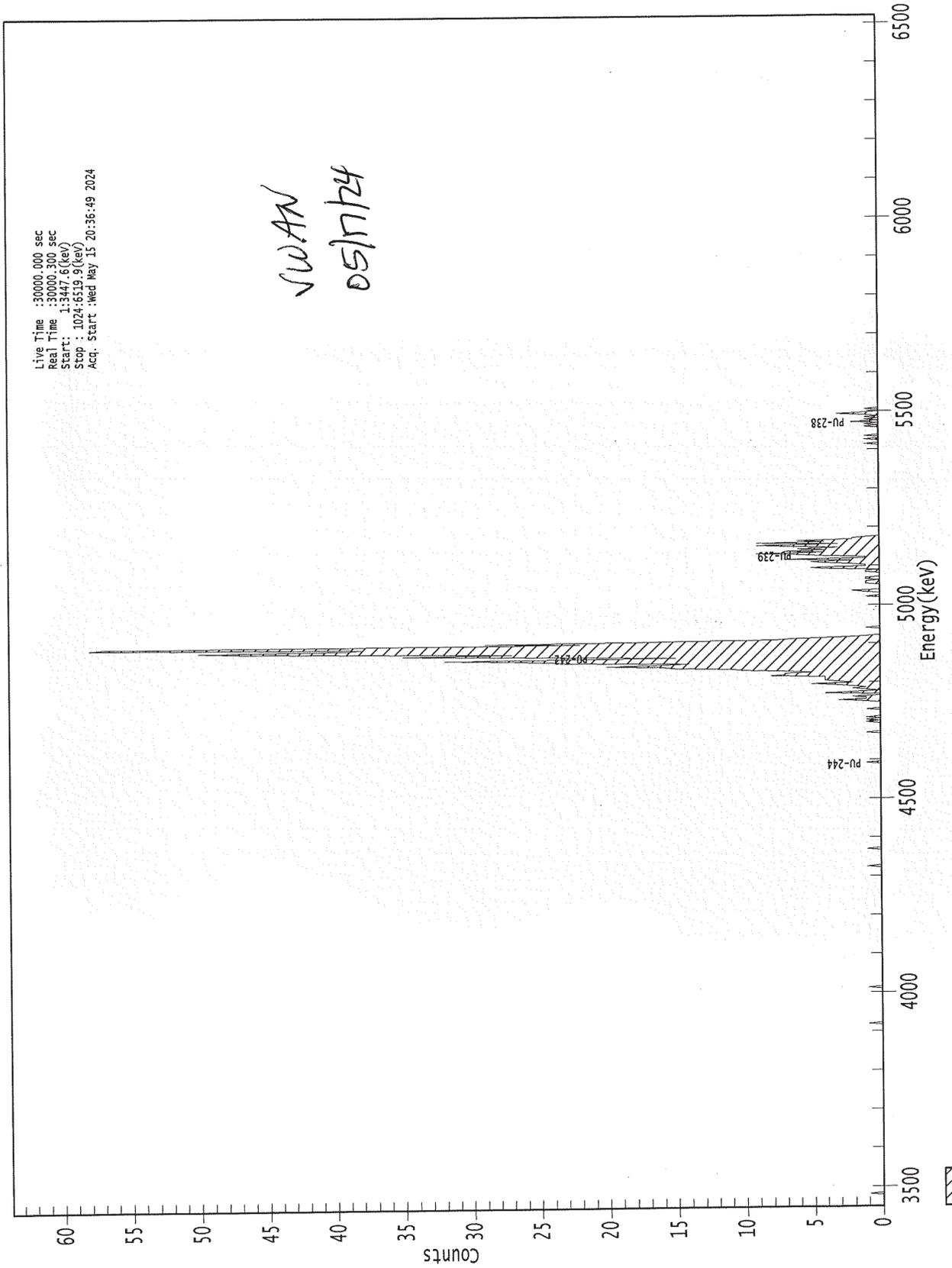
Sample Size: 1.000 unit  
 Sample Date/Time: 4/4/2024 8:06:50 PM  
 Acquisition Date/Time: 5/15/2024 8:36:49 PM  
 Acquisition Live Time: 500.0 minutes  
 Acquisition Real Time: 500.0 minutes

-----  
 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

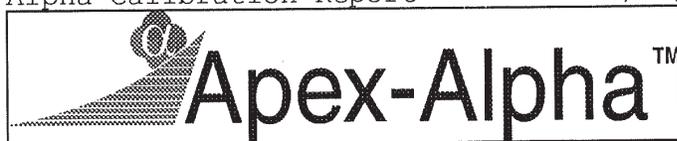
Activity reported as of : 5/15/24 8:36:49 PM

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



Sample Description: \\V79W-7\AlphaRoot\Data\0000272928.cnf  
Spectrum File: 240515PUX  
Batch Identification: 718829  
Sample Identification: Shelf 2  
Sample Geometry: Pu with 242 - 500min  
Procedure Description:

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

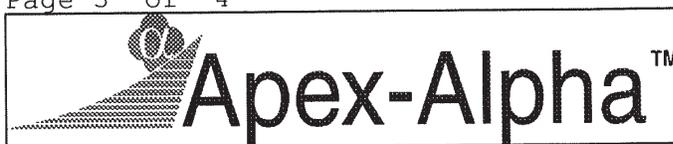
Peak Match Tolerance: 0.200 MeV

-----  
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



Sample Description: \\V79W-7\AlphaRoot\Data\0000272928.cnf  
 Spectrum File: 240515PUX  
 Batch Identification: 718829  
 Sample Identification: Shelf 2  
 Sample Geometry: Pu with 242 - 500min  
 Procedure Description:

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: \\V79W-7\AlphaRoot\Data\0000272928.cnf  
Spectrum File: 240515PUX  
Batch Identification: 718829  
Sample Identification: Shelf 2  
Sample Geometry: Pu with 242 - 500min  
Procedure Description:

Detector Name: ALPHA\_019  
Chamber Serial Number: 02068348A  
Detector Serial Number: 165864

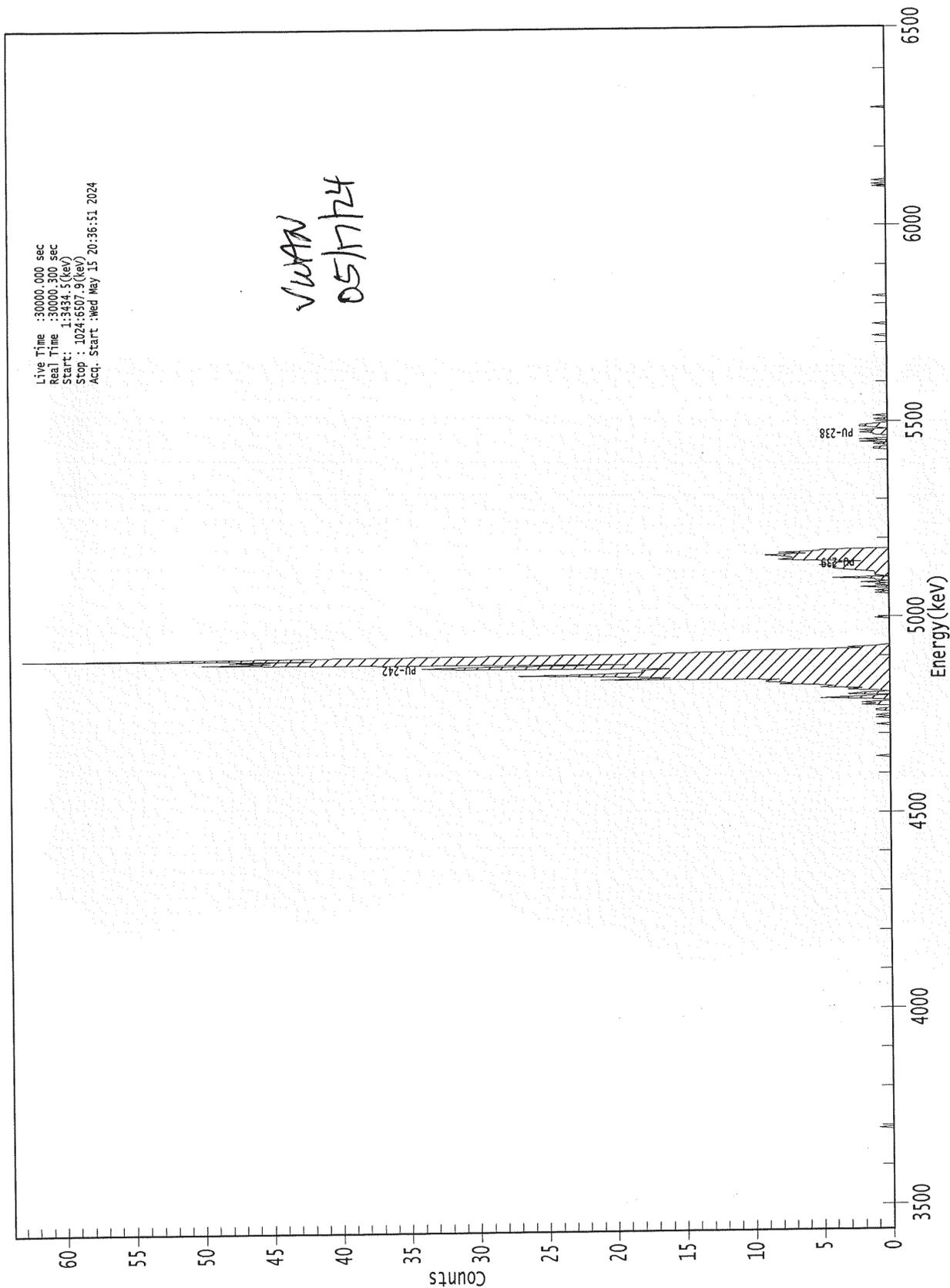
Sample Size: 1.000 unit  
Sample Date/Time: 4/4/2024 8:06:50 PM  
Acquisition Date/Time: 5/15/2024 8:36:51 PM  
Acquisition Live Time: 500.0 minutes  
Acquisition Real Time: 500.0 minutes

-----  
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

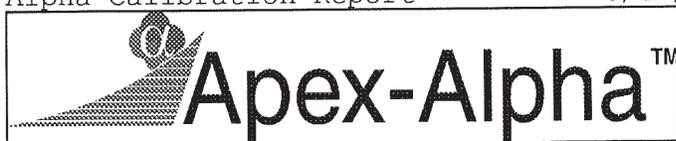
Activity reported as of : 5/15/24 8:36:51 PM

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



Sample Description: \\V79W-7\AlphaRoot\Data\0000272929.cnf  
Spectrum File: 240515PUX  
Batch Identification: 718830  
Sample Identification: Shelf 2  
Sample Geometry: Pu with 242 - 500min  
Procedure Description:

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



Sample Description: \\V79W-7\AlphaRoot\Data\0000272929.cnf  
 Spectrum File: 240515PUX  
 Batch Identification: 718830  
 Sample Identification: Shelf 2  
 Sample Geometry: Pu with 242 - 500min  
 Procedure Description:

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	5.487	1.1772E-001	22.03	3.5200E-002	6.81
PU-239	5.148	5.2602E-001	11.94	3.8325E-002	6.81
PU-242	4.891	3.8762E+000	6.81	3.5168E-002	6.81
PU-244	4.581	0.0000E+000	0.00	3.8286E-002	6.81

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

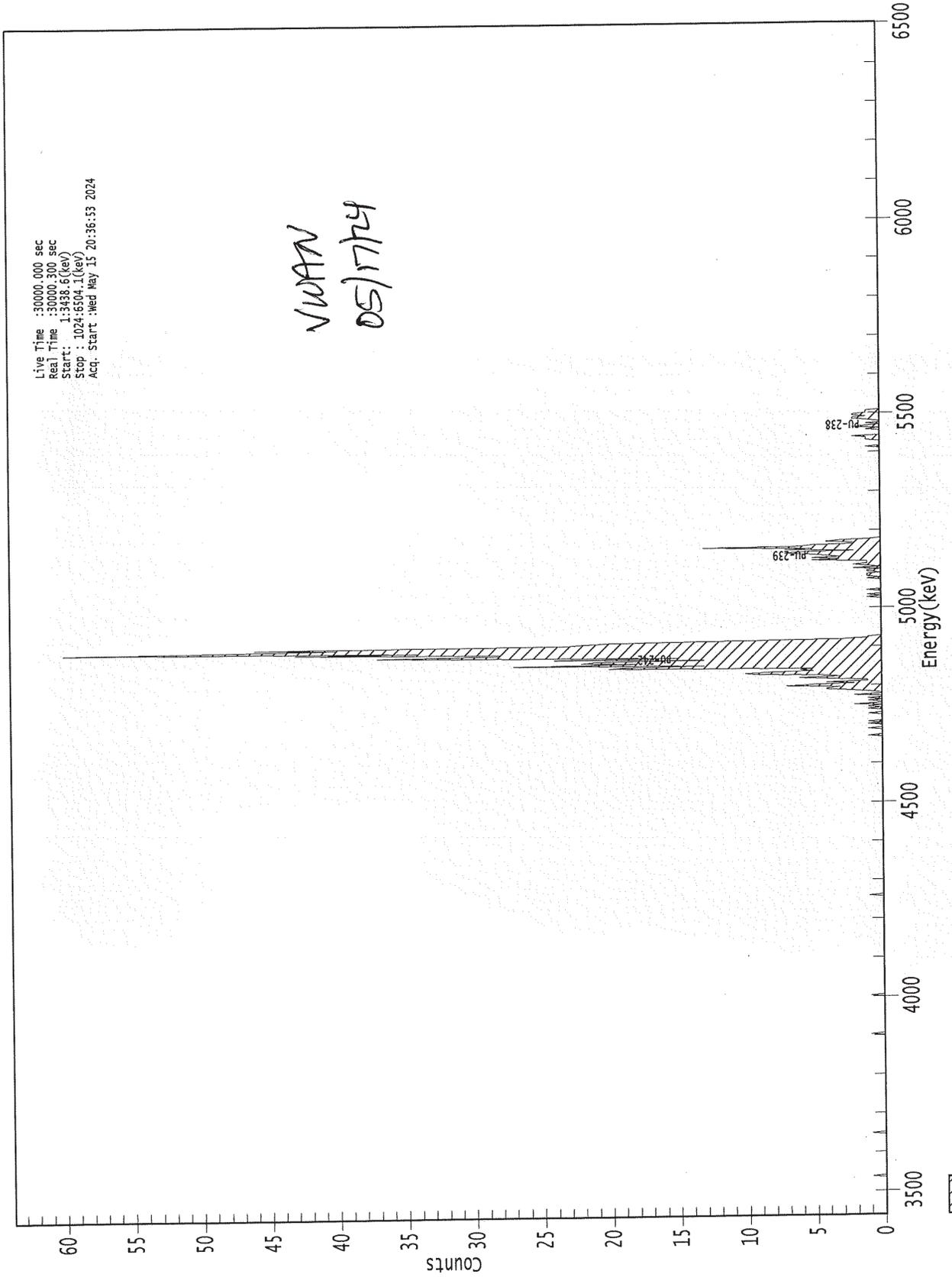
Sample Size: 1.000 unit  
Sample Date/Time: 4/4/2024 8:06:50 PM  
Acquisition Date/Time: 5/15/2024 8:36:53 PM  
Acquisition Live Time: 500.0 minutes  
Acquisition Real Time: 500.0 minutes

-----  
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

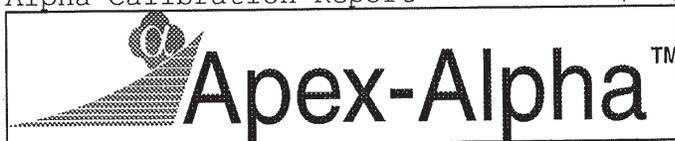
Activity reported as of : 5/15/24 8:36:53 PM

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

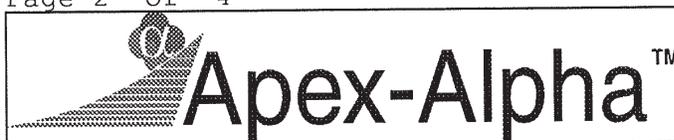
-----  
EFFICIENCY CALIBRATION  
-----

Version: Alpha Efcac 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  
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5/16/2024 1:45:15 PM



Sample Description: \\V79W-7\AlphaRoot\Data\0000272930.cnf  
Spectrum File:  
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



Sample Description: \\V79W-7\AlphaRoot\Data\0000272930.cnf  
 Spectrum File: 240515PUX  
 Batch Identification: 718852  
 Sample Identification: Shelf 2  
 Sample Geometry: Pu with 242 - 500min  
 Procedure Description:

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

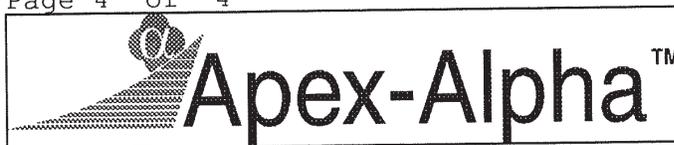
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 -----  
 NUCLIDE ACTIVITY REPORT  
 -----  
 -----

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  
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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

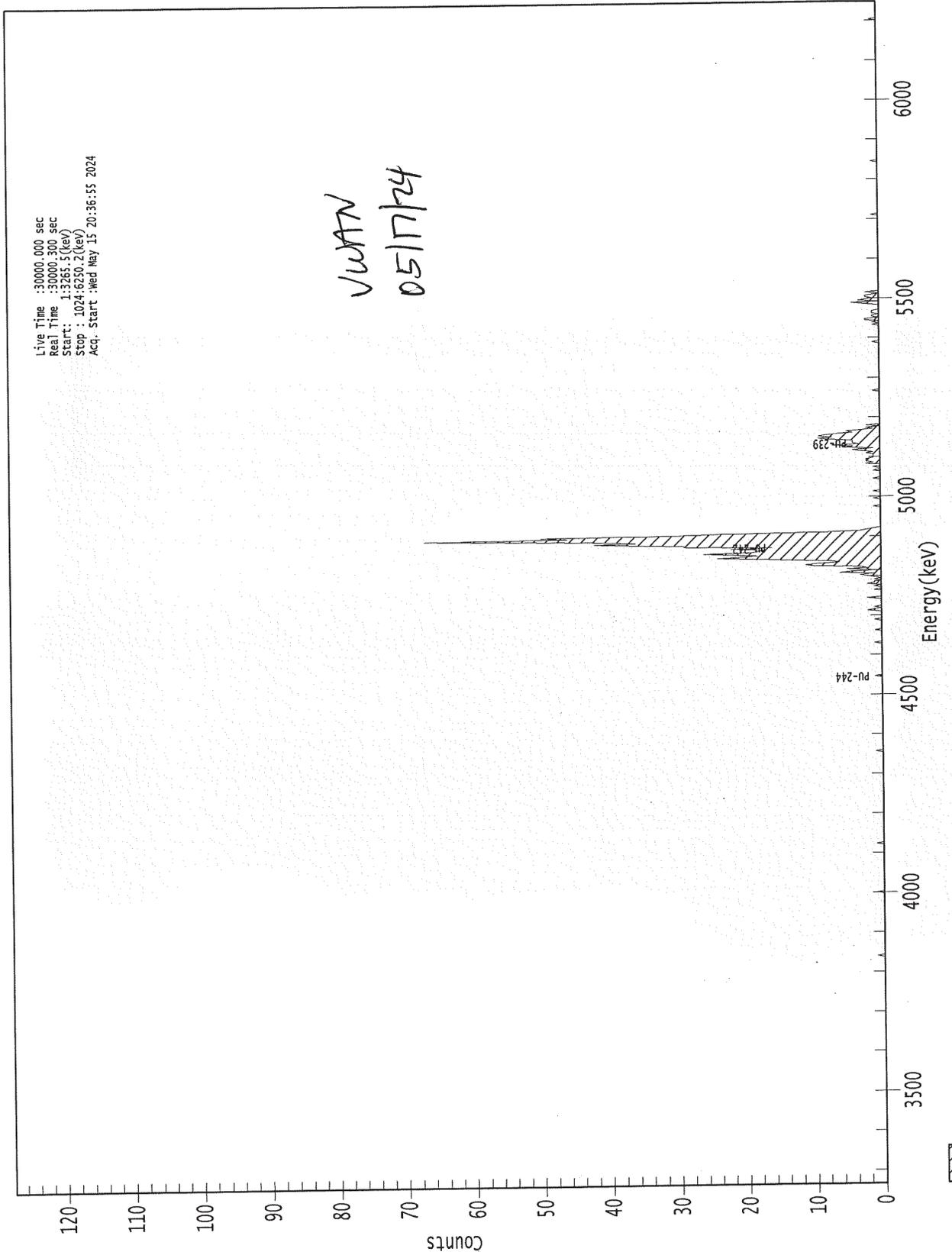
Sample Size: 1.000 unit  
Sample Date/Time: 4/4/2024 8:06:50 PM  
Acquisition Date/Time: 5/15/2024 8:36:55 PM  
Acquisition Live Time: 500.0 minutes  
Acquisition Real Time: 500.0 minutes

-----  
NUCLIDE 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

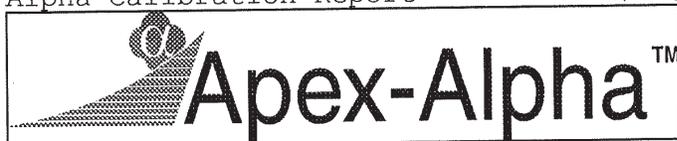
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0000272930.CNF



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 Efcad 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



Sample Description: \\V79W-7\AlphaRoot\Data\0000272931.cnf  
Spectrum File: 240515PUX  
Batch Identification: 718853  
Sample Identification: Shelf 2  
Sample Geometry: Pu with 242 - 500min  
Procedure Description:

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

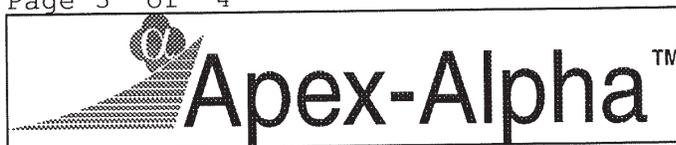
Peak Match Tolerance: 0.200 MeV

-----  
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



Sample Description: \\V79W-7\AlphaRoot\Data\0000272931.cnf  
Spectrum File: 240515PUX  
Batch Identification: 718853  
Sample Identification: Shelf 2  
Sample Geometry: Pu with 242 - 500min  
Procedure Description:

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

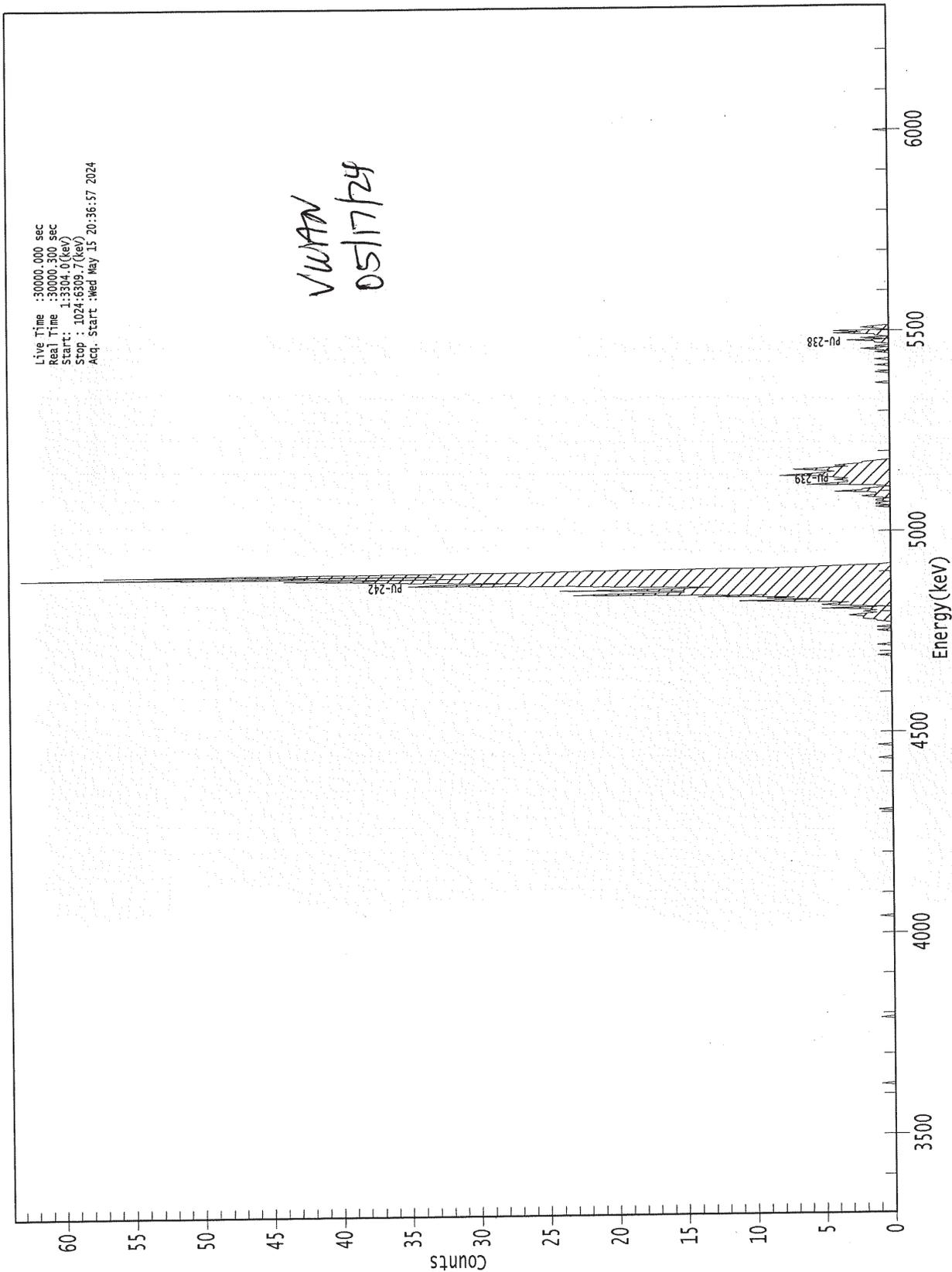
Sample Size: 1.000 unit  
 Sample Date/Time: 4/4/2024 8:06:50 PM  
 Acquisition Date/Time: 5/15/2024 8:36:57 PM  
 Acquisition Live Time: 500.0 minutes  
 Acquisition Real Time: 500.0 minutes

-----  
 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

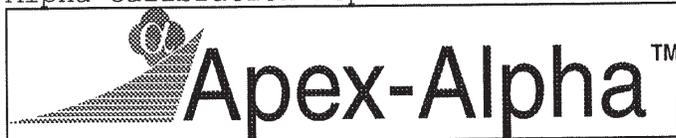
Activity reported as of : 5/15/24 8:36:57 PM

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 Efcacal 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



Sample Description: \\V79W-7\AlphaRoot\Data\0000272932.cnf  
 Spectrum File: 240515PUX  
 Batch Identification: 718854  
 Sample Identification: Shelf 2  
 Sample Geometry: Pu with 242 - 500min  
 Procedure Description:

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: \\V79W-7\AlphaRoot\Data\0000272932.cnf  
Spectrum File: 240515PUX  
Batch Identification: 718854  
Sample Identification: Shelf 2  
Sample Geometry: Pu with 242 - 500min  
Procedure Description:

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  
-----

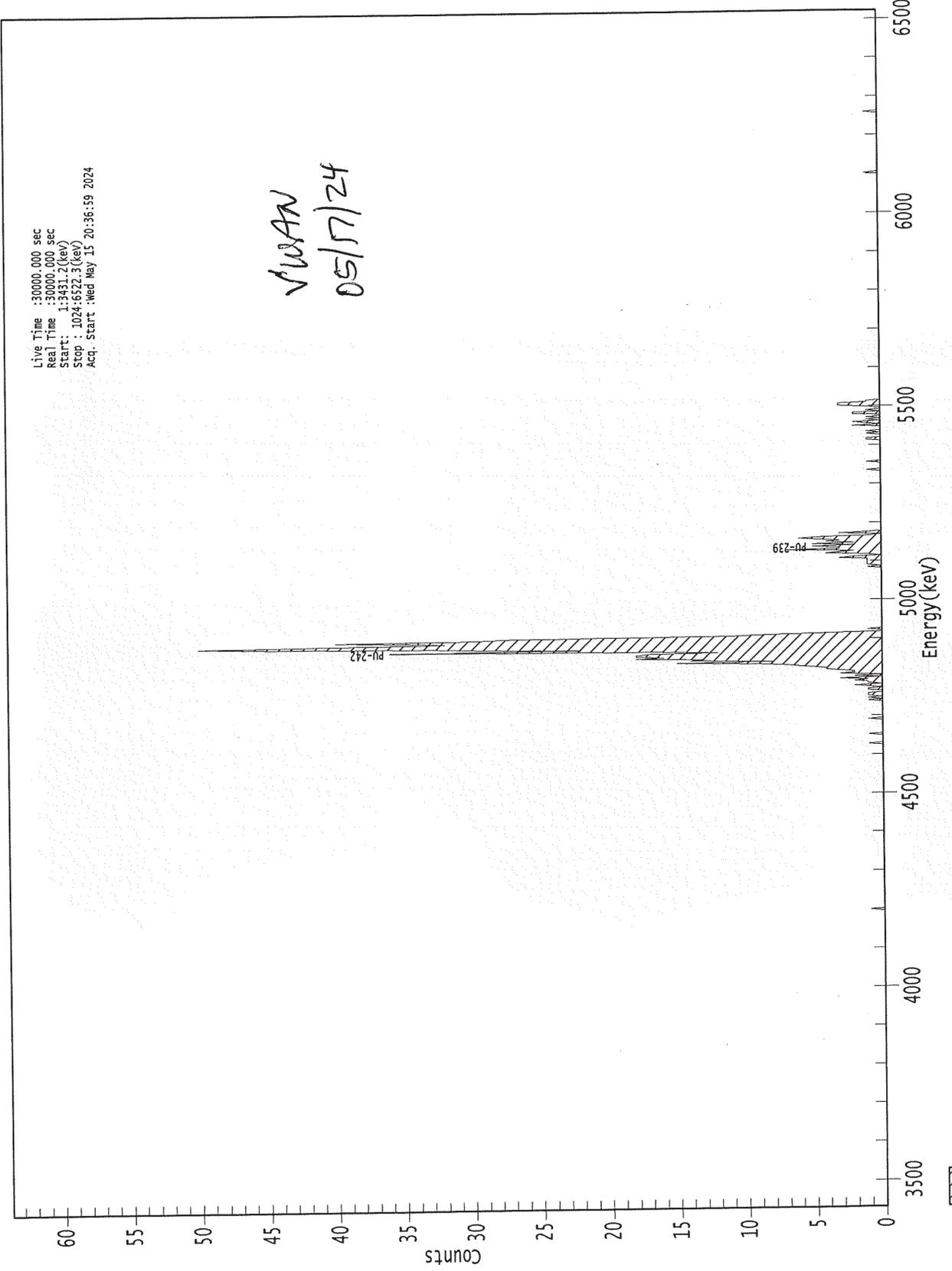
Nuclide Name	Id Conf.	Energy (keV)	Activity (pCi/unit )	MDA (pCi/unit )
PU-238	0.999	5487.10*	1.548E-001 +/- 3.393E-002	7.377E-002 +/- 5.122E-003
PU-239	1.000	5147.70*	4.359E-001 +/- 5.873E-002	4.388E-002 +/- 3.046E-003
PU-242	0.999	4890.70*	3.876E+000 +/- 2.691E-001	4.026E-002 +/- 2.796E-003
PU-244	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

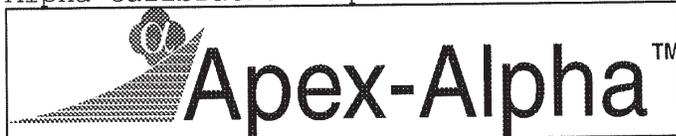
Live Time : 30000.000 sec  
Real Time : 30000.000 sec  
Start : 1:33:31.7 (keV)  
Stop : 1024:6322.3 (keV)  
Acq. Start : Wed May 13 20:36:59 2024

VULCAN  
05/17/24



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  
Page 2 of 4

5/16/2024 1:48:19 PM



Sample Description: \\V79W-7\AlphaRoot\Data\0000272933.cnf  
Spectrum File: 240515PUX  
Batch Identification: 718855  
Sample Identification: Shelf 2  
Sample Geometry: Pu with 242 - 500min  
Procedure Description:

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



Sample Description: \\V79W-7\AlphaRoot\Data\0000272933.cnf  
Spectrum File: 240515PUX  
Batch Identification: 718855  
Sample Identification: Shelf 2  
Sample Geometry: Pu with 242 - 500min  
Procedure Description:

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  
Page 4 of 4

5/16/2024 1:48:20 PM



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

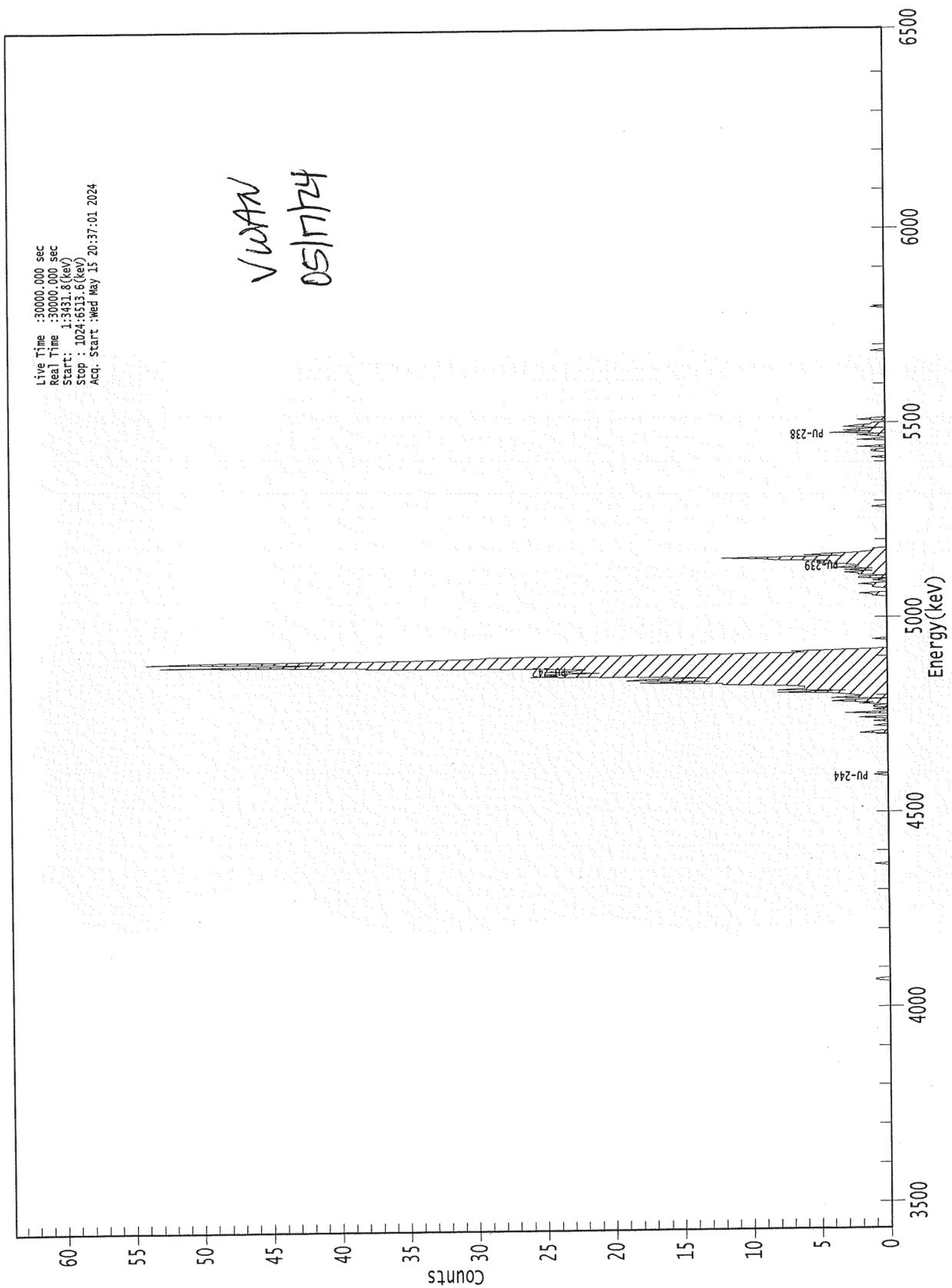
Sample Size: 1.000 unit  
Sample Date/Time: 4/4/2024 8:06:50 PM  
Acquisition Date/Time: 5/15/2024 8:37:01 PM  
Acquisition Live Time: 500.0 minutes  
Acquisition Real Time: 500.0 minutes

-----  
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

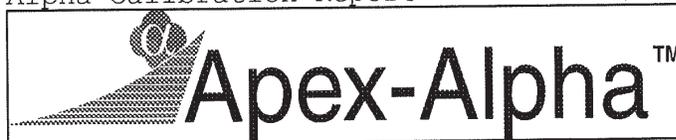
Activity reported as of : 5/15/24 8:37:01 PM

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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5/16/2024 1:49:01 PM



Sample Description: \\V79W-7\AlphaRoot\Data\0000272934.cnf  
Spectrum File: 240515PUX  
Batch Identification: 718856  
Sample Identification: Shelf 2  
Sample Geometry: Pu with 242 - 500min  
Procedure Description:

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

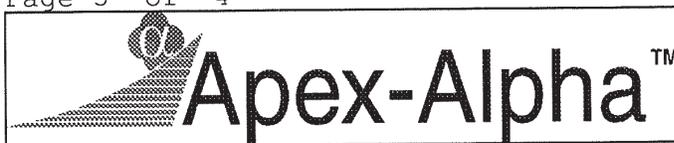
Peak Match Tolerance: 0.200 MeV

-----  
----- 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



Sample Description: \\V79W-7\AlphaRoot\Data\0000272934.cnf  
 Spectrum File: 240515PUX  
 Batch Identification: 718856  
 Sample Identification: Shelf 2  
 Sample Geometry: Pu with 242 - 500min  
 Procedure Description:

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

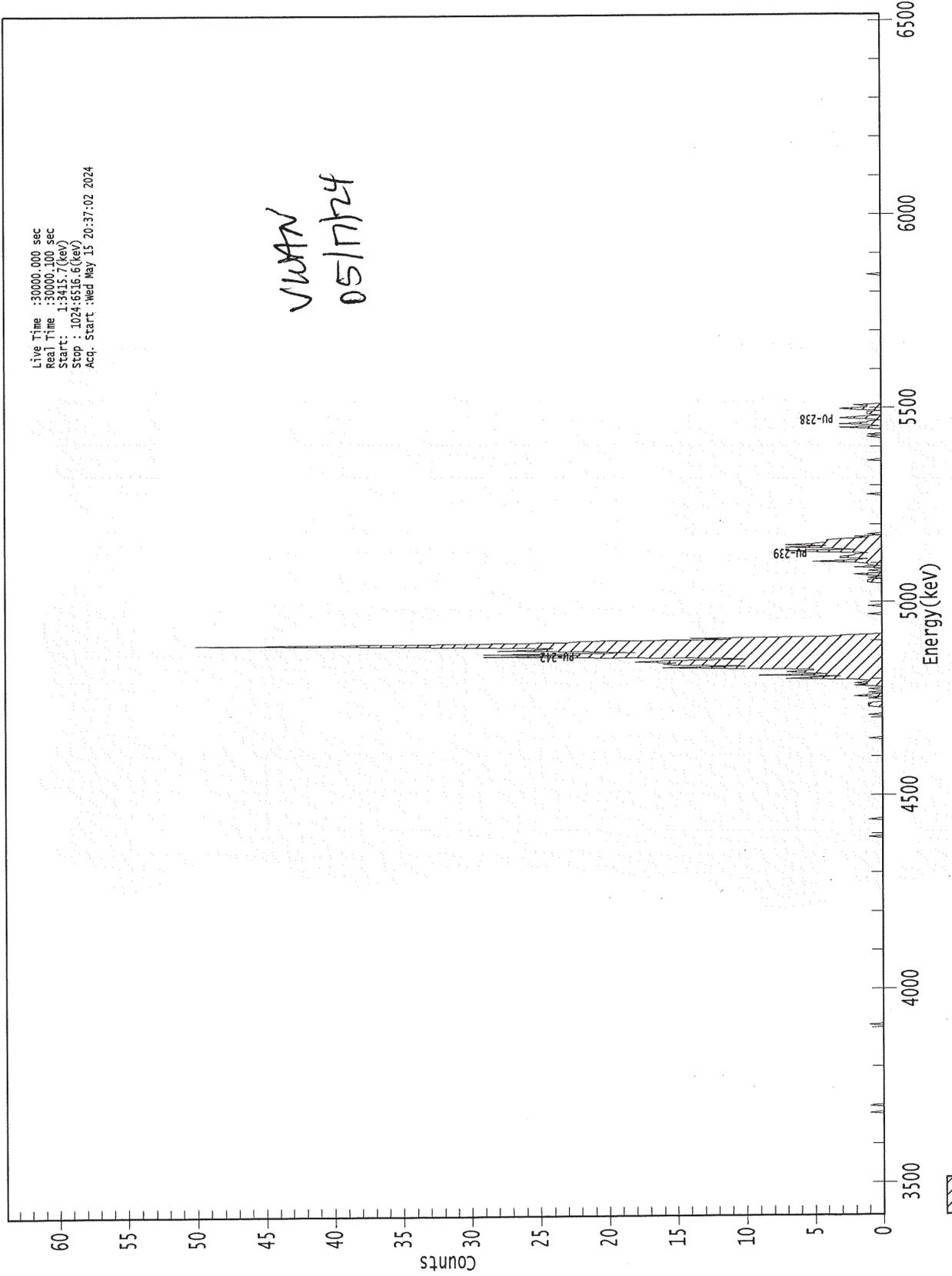
Sample Size: 1.000 unit  
Sample Date/Time: 4/4/2024 8:06:50 PM  
Acquisition Date/Time: 5/15/2024 8:37:02 PM  
Acquisition Live Time: 500.0 minutes  
Acquisition Real Time: 500.0 minutes

-----  
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  
-----

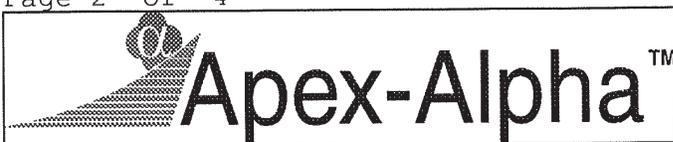
Version: Alpha Encal v1.1  
Energy = 3.415 MeV + 3.0304E-003\*ch  
FWHM = 2.5469E-002 MeV  
Low Tail = 3.1508E-003 MeV

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 Efcals 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



Sample Description: \\V79W-7\AlphaRoot\Data\0000272935.cnf  
Spectrum File:  
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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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

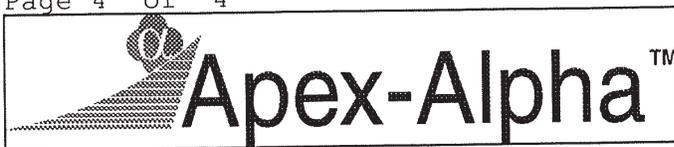
Sample Size: 1.000 unit  
Sample Date/Time: 4/4/2024 8:06:50 PM  
Acquisition Date/Time: 5/15/2024 8:37:04 PM  
Acquisition Live Time: 500.0 minutes  
Acquisition Real Time: 500.0 minutes

-----  
----- NUCLIDE 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 5/16/2024 1:50:49 PM  
 Page 4 of 4



Sample Description: \\V79W-7\AlphaRoot\Data\0000272935.cnf  
 Spectrum File:  
 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

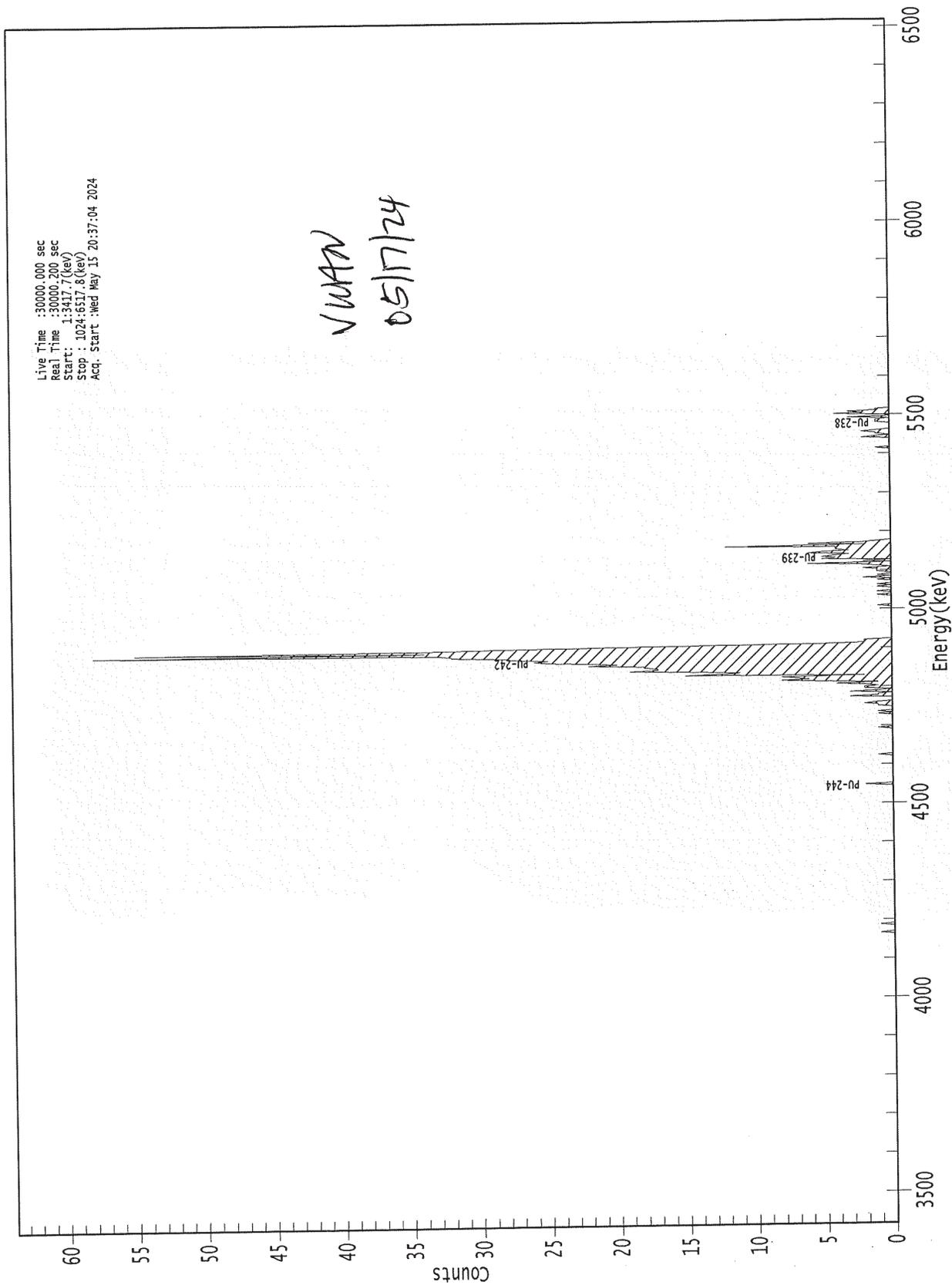
Sample Size: 1.000 unit  
 Sample Date/Time: 4/4/2024 8:06:50 PM  
 Acquisition Date/Time: 5/15/2024 8:37:04 PM  
 Acquisition Live Time: 500.0 minutes  
 Acquisition Real Time: 500.0 minutes

-----  
 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

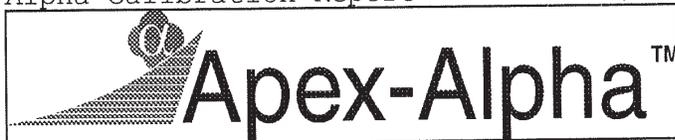
Activity reported as of : 5/15/24 8:37:04 PM

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 Efcad 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  
Page 2 of 4

5/16/2024 1:53:39 PM



Sample Description: \\V79W-7\AlphaRoot\Data\0000272936.cnf  
Spectrum File: 240515PUX  
Batch Identification: 718858  
Sample Identification: Shelf 2  
Sample Geometry: Pu with 242 - 500min  
Procedure Description:

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



Sample Description: \\V79W-7\AlphaRoot\Data\0000272936.cnf  
 Spectrum File: 240515PUX  
 Batch Identification: 718858  
 Sample Identification: Shelf 2  
 Sample Geometry: Pu with 242 - 500min  
 Procedure Description:

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	5.487	1.4402E-001	19.16	3.4430E-002	6.71
PU-239	5.148	5.6715E-001	11.18	3.4434E-002	6.71
PU-242	4.891	3.8762E+000	6.71	3.4400E-002	6.71
PU-244	4.581	0.0000E+000	0.00	3.4400E-002	6.71

Errors quoted at 1.000 sigma

Alpha NID Report  
Page 4 of 4

5/16/2024 1:53:40 PM



Sample Description: \\V79W-7\AlphaRoot\Data\0000272936.cnf  
Spectrum File: 240515PUX  
Batch Identification: 718858  
Sample Identification: Shelf 2  
Sample Geometry: Pu with 242 - 500min  
Procedure Description:

Detector Name: ALPHA 047  
Chamber Serial Number: 13000767A  
Detector Serial Number: 94697

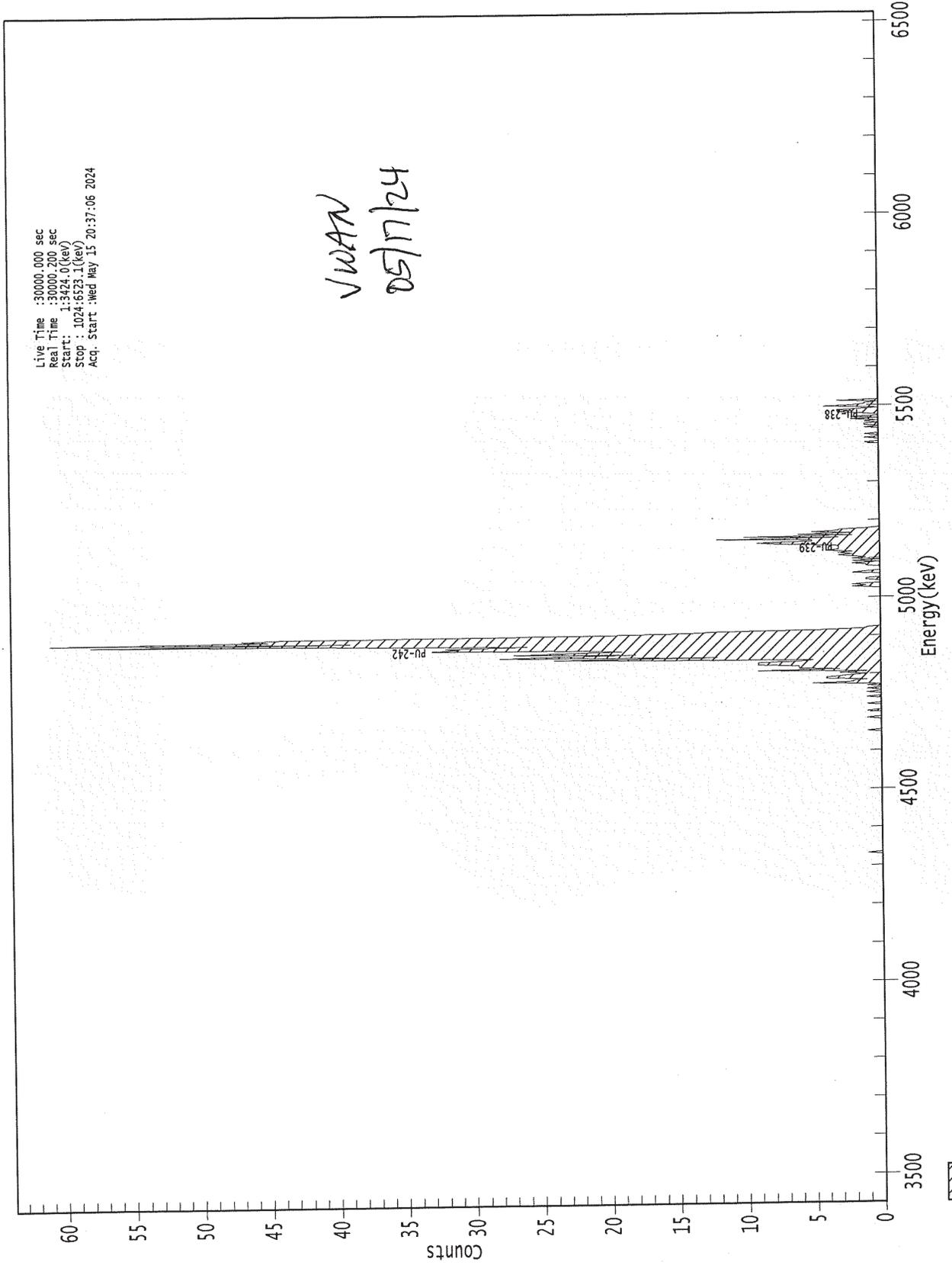
Sample Size: 1.000 unit  
Sample Date/Time: 4/4/2024 8:06:50 PM  
Acquisition Date/Time: 5/15/2024 8:37:06 PM  
Acquisition Live Time: 500.0 minutes  
Acquisition Real Time: 500.0 minutes

-----  
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

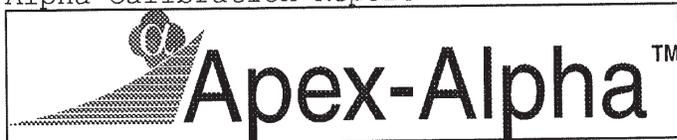
Activity reported as of : 5/15/24 8:37:06 PM

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  
 -----

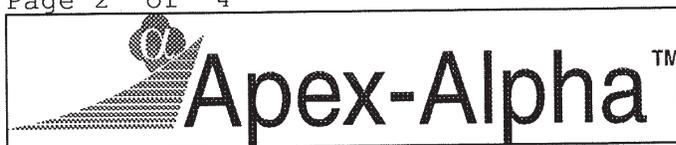
Version: Alpha Encal v1.1  
 Energy = 3.423 MeV + 3.0310E-003\*ch  
 FWHM = 2.8419E-002 MeV  
 Low Tail = 3.9832E-003 MeV

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 Efcad 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



Sample Description: \\V79W-7\AlphaRoot\Data\0000272937.cnf  
 Spectrum File:  
 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  
 Page 3 of 4

5/16/2024 1:54:17 PM



Sample Description: \\V79W-7\AlphaRoot\Data\0000272937.cnf  
 Spectrum File: 240515PUX  
 Batch Identification: 718859  
 Sample Identification: Shelf 2  
 Sample Geometry: Pu with 242 - 500min  
 Procedure Description:

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 5/16/2024 1:54:18 PM  
 Page 4 of 4



Sample Description: \\V79W-7\AlphaRoot\Data\0000272937.cnf  
 Spectrum File: 240515PUX  
 Batch Identification: 718859  
 Sample Identification: Shelf 2  
 Sample Geometry: Pu with 242 - 500min  
 Procedure Description:

Detector Name: ALPHA 048  
 Chamber Serial Number: 13000767B  
 Detector Serial Number: 94698

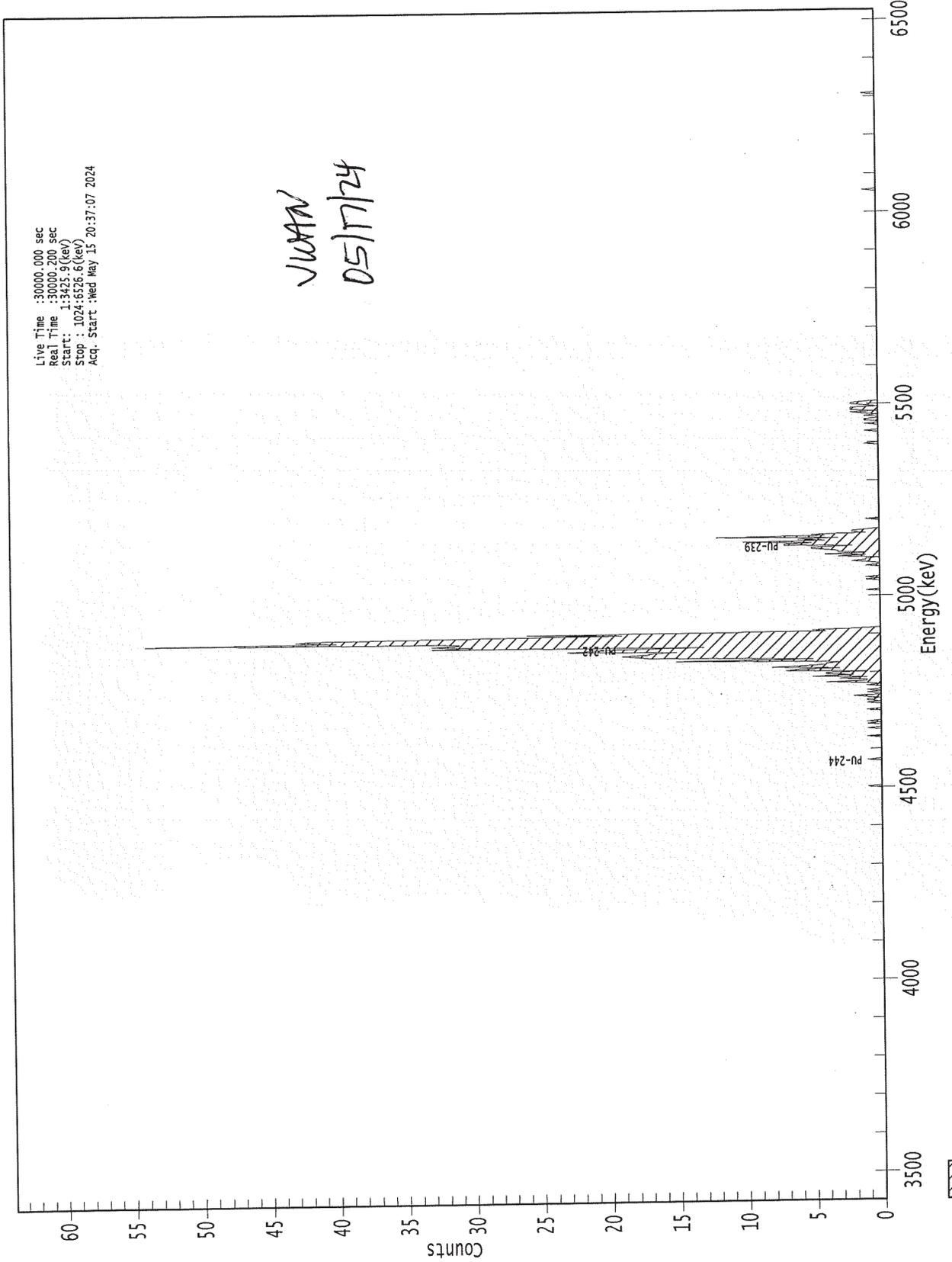
Sample Size: 1.000 unit  
 Sample Date/Time: 4/4/2024 8:06:50 PM  
 Acquisition Date/Time: 5/15/2024 8:37:07 PM  
 Acquisition Live Time: 500.0 minutes  
 Acquisition Real Time: 500.0 minutes

-----  
 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

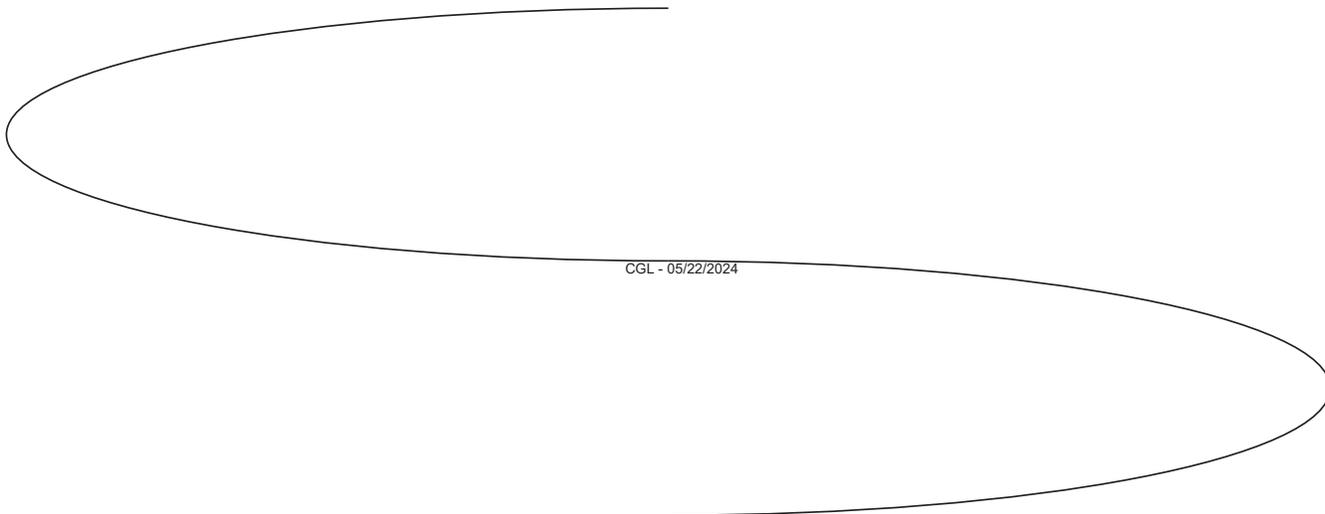
Southwest Research Institute  
 San Antonio, Texas 78238

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

# Preparation Log



Southwest Research Institute  
San Antonio, Texas 78238

RadChem

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: \_\_\_\_\_

# 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 AIN3O9 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

# Preparation Log



A38037

Southwest Research Institute  
San Antonio, Texas 78238

Metals, RadChem

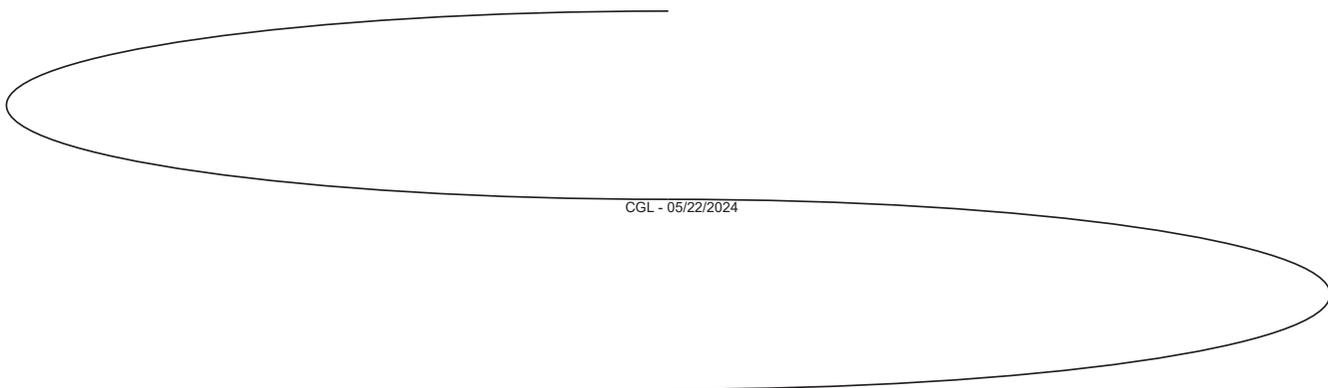
Batch: 20240514-P005 (Ver. 1)

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<br/>Vol (mL)</u> | <u>Dig Final<br/>Vol (mL)</u> |
|---|------------------------------|-----------|---------------------------------|-------------------------------|
| ① spiked 0.100 mL of Cl# 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 Cl# 245585 Plutonium-242 124RadSol4 (Lot# 22470021, 4334j, Source: Fisher Scientific, NIST, Exp: 10/16/2024)<br>Tracer Witness: PEREZ, BENITO  |                              |           |                                 |                               |
| ② spiked 0.050 mL of Cl# 176328 Americium-241 058RadSol4 (Lot# 75783-327, Source: Eckert & Ziegler Isotope Product, Exp: 10/25/2024) and 0.100 mL of Cl# 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 Cl# 187516 Plutonium-239 074RadSol4 v2 (Lot# 7879909-327, 205499, Source: Fisher Scientific, Analytics, Eckert & Ziegler, Exp: 04/13/2025) and 0.100 mL of Cl# 245585 Plutonium-242 124RadSol4 (Lot# 22470021, 4334j, Source: Fisher Scientific, NIST, Exp: 10/16/2024)<br>Spike Witness: PEREZ, BENITO<br>Tracer Witness: PEREZ, BENITO |                              |           |                                 |                               |
| ③ spiked 0.100 mL of Cl# 245585 Plutonium-242 124RadSol4 (Lot# 22470021, 4334j, Source: Fisher Scientific, NIST, Exp: 10/16/2024)<br>Tracer Witness: PEREZ, BENITO  |                              |           |                                 |                               |
| ④ prepared in batch 20240514-P003   |                              |           |                                 |                               |

Comments: NA



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

# Preparation Log

Metals, RadChem



Batch: 20240515-P002 (Ver. 1)  
Status: CONSUMED

Southwest Research Institute  
San Antonio, Texas 78238

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 NH4HC2O4 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)
PB24E14KE2	NA	10	NA	NA	23	23	15	15
LCS24E14JT1	NA	10	NA	NA	23	23	15	15
718819	T1155-A-2-A	10	NA	NA	NA	NA	15	15
718820	T1155-B-10-A	10	NA	NA	NA	NA	15	15
718821	T1155-EFF-Comp	10	NA	NA	23	23	15	15
718821D	T1155-EFF-Comp	10	NA	NA	23	23	15	15
718822	T1155-Feed-Comp	10	NA	NA	23	23	15	15
718825	T1155-A-11-A	10	NA	NA	NA	NA	15	15
718826	T1155-A-17-A	10	NA	NA	NA	NA	15	15
718827	T1155-A-21-A	10	NA	NA	NA	NA	15	15
718828	T1155-B-22-A	10	NA	NA	NA	NA	15	15
718829	T1155-B-24-A	10	NA	NA	NA	NA	15	15
718830	T1155-A-9-A	10	NA	NA	NA	NA	15	15
718852	T1155-A-13-A	10	NA	NA	NA	NA	15	15
718853	T1155-A-15-A	10	NA	NA	NA	NA	15	15
718854	T1155-A-19-A	10	NA	NA	NA	NA	15	15
718855	T1155-A-5-A	10	NA	NA	NA	NA	15	15
718856	T1155-A-7-A	10	NA	NA	NA	NA	15	15
718857	T1155-B-18-A	10	NA	NA	NA	NA	15	15
718858	T1155-B-2-A	10	NA	NA	NA	NA	15	15
718859	T1155-B-5-A	10	NA	NA	NA	NA	15	15

CGL - 05/22/2024

Prepared by: TUTOR, JAMES

Date: 05/15/2024

Reviewed by: NAEGELI, WARREN

Date: 05/17/2024

Disposal Int/Date/Loc: WN / 05/17/2024 / NA - Consumed

# Preparation Log

Metals, RadChem



Batch: 20240515-P002 (Ver. 1)  
Status: CONSUMED

Southwest Research Institute  
San Antonio, Texas 78238

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, 2M HNO3 261298, 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

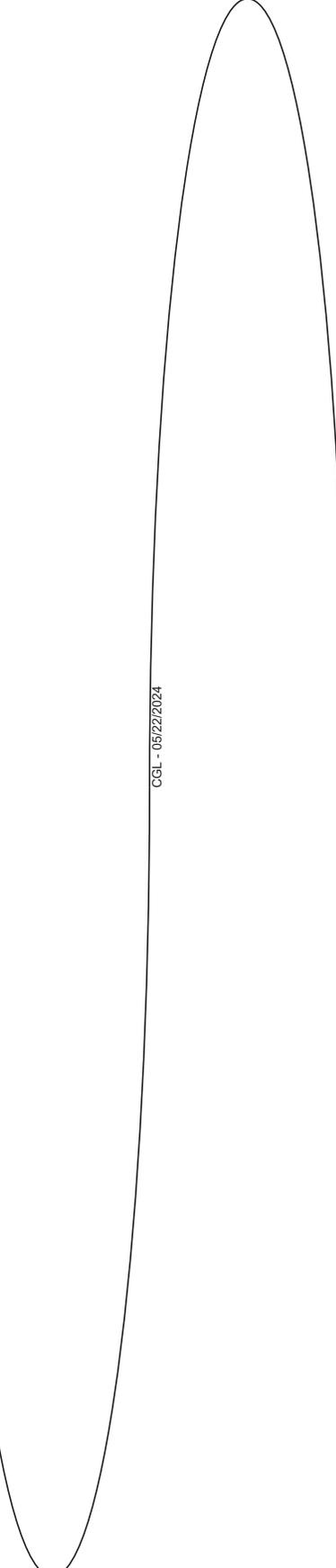
Temperature (C): 95-160

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)
CGL - 05/22/2024								

① prepared in batch 20240514-P005

Comments: NA



Prepared by: TUTOR, JAMES

Date: 05/15/2024

Reviewed by: NAEGELI, WARREN

Date: 05/17/2024

Disposal Int/Date/Loc: WN / 05/17/2024 / NA - Consumed

# 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)

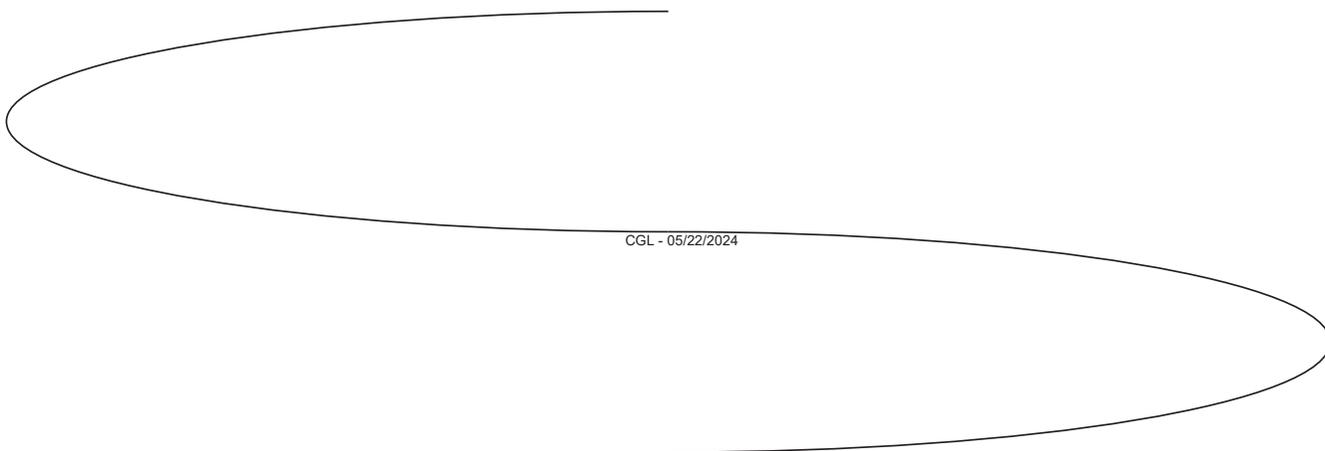
Tracer Witness: PEREZ, BENITO

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

Page 1 of 1

Program version(8/11/2011)

# Preparation Log



A38064

Southwest Research Institute  
San Antonio, Texas 78238

Metals, RadChem

Batch: 20240516-P004 (Ver. 1)

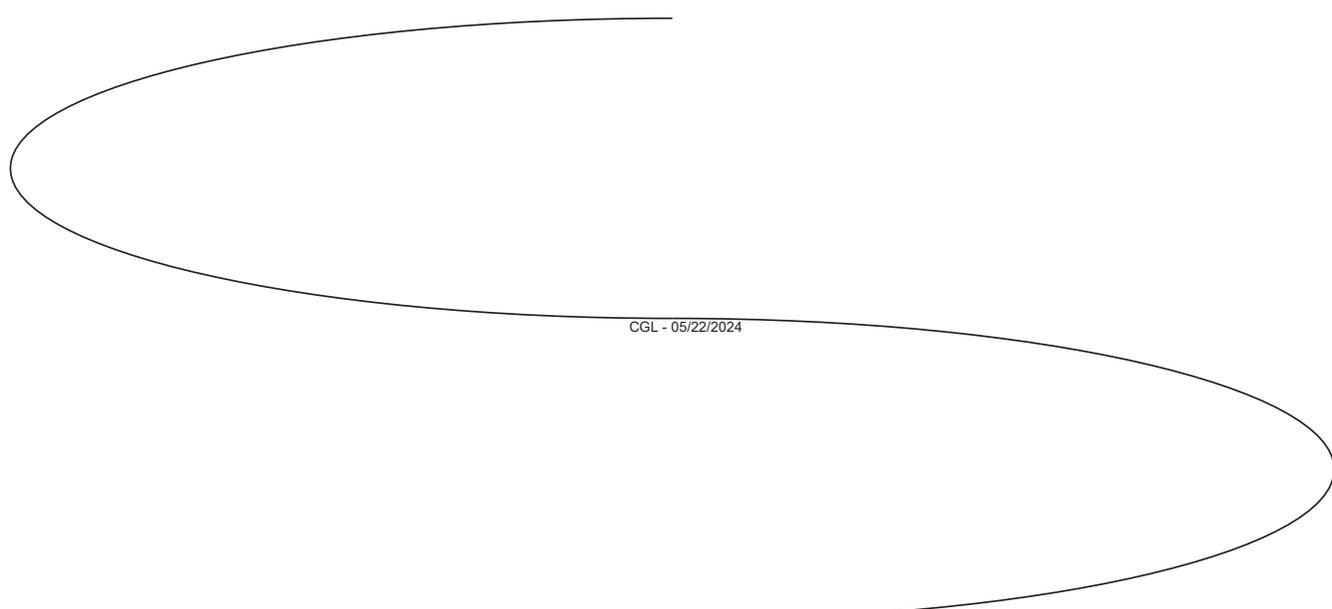
Status: CONSUMED

Client(s): <u>Battelle Memorial Institute PNNL</u>
Task Order(s): <u>240405-6</u>
SDG(s): <u>718819</u>
Case(s): <u>733437</u>
Project(s): <u>27927.13.001</u>
Method(s): <u>Np/Th water sep (TAP: 01-0411-070)</u>
Matrix(s): <u>Liquid</u>
Reagent(s): <u>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</u>
Balance(s): <u>Bal #88 (AN:014981)</u>
Pipette(s): <u>200-4, 1000-4, 5000-16</u>
Equipment: <u>CT 20240510-Q003, Tubes 197195, Tips 199864, Planchets 243363, Syringe 258546, Syringe Filter 250846, Resolve Filters 258396</u>
Heating Device: <u>HotPlate#7</u>
Temperature (C): <u>95-160</u>
Time In: <u>05/16/2024 12:30:00</u>
Elution Start Time: <u>05/16/2024 14:12:00</u>

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

**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**









24937 Avenue Tibbitts  
Valencia, California 91355

Tel 661•309•1010  
Fax 661•257•8303

## CERTIFICATE OF CALIBRATION ALPHA STANDARD SOLUTION

<b>Radionuclide:</b> Am-243	<b>Customer:</b> SOUTHWEST RESEARCH INSTITUTE
<b>Half-life:</b> (2.690 ± 0.008)E+06 days	<b>P.O. No.:</b> P36850MM
<b>Catalog No.:</b> 7243	<b>Reference Date:</b> 1-Mar-21 12:00 PST
<b>Source No.:</b> 2199-65	<b>Contained Radioactivity:</b> 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 <sub>3</sub> 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 µCi/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:	± 0.2 %
B. Type B (systematic) uncertainty:	± 3.0 %
C. Uncertainty in aliquot weighing:	± 0.2 %
D. Total uncertainty at the 99% confidence level:	± 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 Dalsen  
Quality Control

15-Feb-21  
Date

EZIP Ref. No.: 2199-65

ISO 9001 CERTIFIED



Standards Verification Form				Date Analyzed: 10/17/2023			
Tracer				Count Time (minutes):	1000	Instrument ID:	Alpha
Pu239				Prep Batch:	N/A	Analytical Batch:	231017PUX
Logbook ID: 074RadSol4				Pu242			
CIMS# 187516				Logbook ID: 124RadSol4			
				CIMS# 245585			
	Read	TV		Read	Corrected	TV	
ID	Counts	pCi	Tracer Corrected Efficiency	Counts	pCi	pCi	%R
1	3734	9.994	16.8%	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%
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		
							CRITERIA
							95%-105%
							< 10%
							< 10%





# National Institute of Standards & Technology

## Certificate

### Standard Reference Material<sup>®</sup> 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. Unterweger, 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

<b>Radionuclide</b>	<b>Plutonium-242</b>
<b>Reference time</b>	<b>1200 EST, 09 August 2017</b>
<b>Massic activity of the solution</b>	<b>26.08 Bq•g<sup>-1(a)</sup></b>
<b>Relative expanded uncertainty (<math>k = 2</math>)</b>	<b>0.51 %<sup>(b)</sup></b>

<sup>(a)</sup> Both SRM 4334j and SRM 4334i (a previous issue of <sup>242</sup>Pu) 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  $\pm 0.12$  %.

<sup>(b)</sup> 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 <sup>-1</sup> HNO <sub>3</sub>
Solution density	(1.099 ± 0.002) g•mL <sup>-1</sup> at 24.4 °C <sup>(a)</sup>
Solution mass	(5.499 ± 0.003) g <sup>(a)</sup>
Alpha-particle- emitting impurities	<sup>241</sup> Am: (0.0021 ± 0.0003) Bq•g <sup>-1(a,b,c,d)</sup>
Beta-particle- emitting impurities	<sup>241</sup> Pu: (0.039 ± 0.009) Bq•g <sup>-1(a,d)</sup>
Photon-emitting impurities	None detected <sup>(e)</sup> , excepting <sup>241</sup> Am
Half-lives used [6]	<sup>242</sup> Pu: (3.73 ± 0.03) × 10 <sup>5</sup> a <sup>(f)</sup> <sup>241</sup> Pu: (14.33 ± 0.04) a <sup>240</sup> Pu: (6 561 ± 7) a <sup>239</sup> Pu: (24 100 ± 11) a <sup>238</sup> Pu: (87.74 ± 0.03) a <sup>241</sup> Am: (432.6 ± 0.6) a
Calibration methods (and instruments)	The certified massic activity for <sup>242</sup> Pu was obtained by 4π $\alpha$ 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 <sup>242</sup>Pu was chemically purified 07 June 1994 at the Lawrence Livermore National Laboratory (LLNL). Americium-241, the daughter of <sup>241</sup>Pu, was removed but has been growing in since that time. Photonic emission measurements of the <sup>241</sup>Am 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<sup>-1</sup>•g<sup>-1</sup> for energies less than 3.1 MeV,  
0.03 s<sup>-1</sup>•g<sup>-1</sup> for energies between 3.1 MeV and 4.4 MeV, and  
0.003 s<sup>-1</sup>•g<sup>-1</sup> for energies greater than 5.0 MeV
- (d) The <sup>242</sup>Pu 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
<sup>242</sup> Pu	1	1	1
<sup>241</sup> Pu	--	(3.5 ± 0.4) × 10 <sup>-3(1,2)</sup>	(3.6 ± 1.1) × 10 <sup>-3(1,5)</sup>
<sup>240</sup> Pu + <sup>239</sup> Pu	< 10 <sup>-6</sup> (3)	(2.0 ± 2.1) × 10 <sup>-5(1,4)</sup>	--
<sup>238</sup> Pu + <sup>241</sup> Am	< 1.6 × 10 <sup>-5</sup> (3)	(9 ± 16) × 10 <sup>-6(1,4)</sup>	--
<sup>241</sup> Am	--	assumed 0 <sup>(2)</sup>	assumed 0 <sup>(5)</sup>

- 1) The stated uncertainty is the standard uncertainty.
- 2) The <sup>241</sup>Pu activity was calculated from a gamma-ray measurement of the <sup>241</sup>Am ingrowth as of 25 November 1998, assuming that <sup>241</sup>Am 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 <sup>241</sup>Pu activity was calculated from a gamma-ray measurement of the <sup>241</sup>Am ingrowth as of 01 September 2017, assuming that <sup>241</sup>Am 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<sup>-3</sup> s<sup>-1</sup>•g<sup>-1</sup> for energies between 20 keV and 35 keV,  
6 × 10<sup>-4</sup> s<sup>-1</sup>•g<sup>-1</sup> for energies between 40 keV and 50 keV,  
5 × 10<sup>-4</sup> s<sup>-1</sup>•g<sup>-1</sup> for energies between 55 keV and 95 keV,  
4 × 10<sup>-4</sup> s<sup>-1</sup>•g<sup>-1</sup> for energies between 100 keV and 600 keV  
4 × 10<sup>-4</sup> s<sup>-1</sup>•g<sup>-1</sup> for energies between 610 keV and 1440 keV  
6 × 10<sup>-4</sup> s<sup>-1</sup>•g<sup>-1</sup> for energies between 1450 keV and 1480 keV, and  
3 × 10<sup>-4</sup> s<sup>-1</sup>•g<sup>-1</sup> 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 <sup>242</sup>Pu, <sup>241</sup>Pu, or <sup>241</sup>Am.
- (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 <sup>(a)</sup>	Relative standard uncertainty contribution on massic activity of <sup>242</sup> 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	<sup>242</sup> Pu decay corrections for half-life uncertainty of 0.22 %.	B	< 10 <sup>-10</sup>
8	Potential alpha- and photon-emitting impurities	B	0.1
<b>Relative combined standard uncertainty</b>			<b>0.26</b>
<b>Relative expanded uncertainty (k = 2)</b>			<b>0.51</b>

<sup>(a)</sup> 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](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](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](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, <sup>242</sup>Pu*; (June 2009); available at [http://www.nuclide.org/DDEP\\_WG/Nuclides/Pu-242\\_tables.pdf](http://www.nuclide.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 [srmmstds@nist.gov](mailto:srmmstds@nist.gov); or via the Internet at <https://www.nist.gov/srm>.*



Standards Verification Form				Date Analyzed: 10/25/2023			
<b>Tracer</b>				Count Time (minutes):	1000	Instrument ID:	Alpha
<b>Am243</b>				Prep Batch:	N/A	Analytical Batch:	231025AM
Logbook ID: 106RadSol4				Logbook ID: 058RadSol4			
CIMS# 236972				CIMS# 176328			
	Read	TV	Tracer Corrected Efficiency	Read	Corrected	TV	%R
Replicate	Counts	pCi		Counts	pCi	pCi	
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		
							<b>95%-105% &lt; 10% &lt; 10%</b>

CRITERIA







1380 Seaboard Industrial Blvd.  
Atlanta, Georgia 30318  
Tel 404-352-8677  
Fax 404-352-2837  
www.analytixinc.com

SwRI Chem ID: 32811

### 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:  $\gamma$ -impurities <0.1%  
 $\alpha$ -impurities <0.04%

INORGANIC LABS/RADCHEM LABS	
DATE RECEIVED:	8/22/07
DATE EXPIRED:	8/22/2008
DATE OPENED:	10/1/07
INORG:	6674
PO:	798703MM

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

SwRI Chem ID: 32811

SwRI Chem ID: 32811

ALL RIGHTS RESERVED



Standards Verification Form				Date Analyzed: 4/11/2024			
Tracer				Count Time (minutes):	1000	Instrument ID: Alpha	
Am241				Prep Batch:	N/A	Analytical Batch: 240411PUX	
Logbook ID: 058RadSol4				Pu239			
CIMS# 176328				Logbook ID: 074RadSol4			
				CIMS# 187516			
	Read	TV		Read	Corrected	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	Average	102.7%
Reference Activity (pCi)		50.1006		Reference Activity (pCi)	49.992	Std Deviation	1.73%
Tracer Volume (ml)		0.20		Standardr Volume (ml)	0.20	Conf Interval	1.69%
Decay Corrected Value:		48.780		Pu239 Decay Corrected Value:	49.971		
							CRITERIA
							95%-105%
							< 10%
							< 10%







INORGANIC LABS/RADCHEM LABS  
DATE RECEIVED: 6/11/09  
DATE EXPIRED: 6/11/2019 DMZ  
DATE OPENED: 6/12/09  
INORG: 7584 PO: A45476A

rd Industrial Blvd.  
rgia 30318  
•8677  
•2837  
icsinc.com

SwRI Chem ID: 33721

### 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

SwRI Chem ID: 33721

**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 HNO<sub>3</sub> 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

SwRI Chem ID: 33721

End of Certificate



Standards Verification Form				Date Analyzed: 8/2/2023			
Tracer				Count Time (minutes):	1000	Instrument ID:	Alpha
Am243				Prep Batch:	N/A	Analytical Batch:	230802NP
Logbook ID: 106RadSol4				Np237			
CIMS# 236972				Logbook ID: 090RadSol4			
				CIMS# 218204			
	Read	TV		Read	Corrected	TV	
Replicate	Counts	pCi	Tracer Corrected Efficiency	Counts	pCi	pCi	%R
1	4386	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%
Reference Activity (pCi) 51.49				Reference Activity (pCi)	21.8983	Std Deviation	2.64%
Tracer Volume (ml) 0.20				Standardr Volume (ml)	0.50	Conf Interval	2.58%
Decay Corrected Value: 51.488				Np237 Decay Corrected Value:	21.891		
							CRITERIA
							95%-105%
							< 10%
							< 10%







# National Institute of Standards & Technology

## Certificate

### Standard Reference Material<sup>®</sup> 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. Unterweger, 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

<b>Radionuclide</b>	<b>Neptunium-237<sup>(a)</sup></b>
<b>Reference time</b>	<b>1200 EST, 01 September 2012</b>
<b>Massic activity of the solution</b>	<b>152.3 Bq·g<sup>-1(b)</sup></b>
<b>Relative expanded uncertainty (<i>k</i> = 2)</b>	<b>0.94 %<sup>(c)</sup></b>

<sup>(a)</sup> The <sup>237</sup>Np stock solution used to prepare this SRM was obtained from the National Physical Laboratory (NPL; Middlesex, UK) as part of the EUROMET action 416 (<sup>237</sup>Np 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 <sup>237</sup>Np decay and has been growing in since that time. Users should not assume that the <sup>233</sup>Pa daughter will remain in radioactive equilibrium with <sup>237</sup>Np in the SRM solution when aliquots are removed from the ampoule.

<sup>(b)</sup> The certified massic activity of SRM 4341a, as obtained from the 4π $\alpha$  $\beta$  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 <sup>237</sup>Np measurement comparison. NIST confirmatory standardizations of the <sup>237</sup>Np massic activity for SRM 4341a were performed by live-timed anticoincidence (LTAC) 4π $\alpha$  $\beta$ (LS) -  $\gamma$ (NaI) measurements and by high-resolution HPGe gamma-ray spectrometry ( $\gamma$ -spec). A direct LS comparison of this SRMs standardization was also made with previous issue of <sup>237</sup>Np (SRM 4341) that was first disseminated in 1993. The results of these comparisons follow:

	Massic activity (Bq·g <sup>-1</sup> )	Relative Standard Uncertainty (%)	Difference (%)
SRM 4341a (LS)	152.3	0.46	---
LTAC	152.0	0.22	-0.20
$\gamma$ -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

<sup>(c)</sup>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

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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 <sup>-1</sup> HNO <sub>3</sub>
Solution density	(1.067 ± 0.002) g•mL <sup>-1</sup> at 16.3 °C <sup>(a)</sup>
Solution mass	(5.320 ± 0.003) g <sup>(a)</sup>
Photon-Emitting Impurities	None detected <sup>(b)</sup>
Total alpha-emitting impurity activity ratio to <sup>237</sup> Np	0.0015 ± 0.0005 [6]
Half-lives used	<sup>237</sup> Np: (2.144 ± 0.007) × 10 <sup>6</sup> a [7] <sup>(c)</sup> <sup>233</sup> Pa: 26.98 ± 0.02 d [8] <sup>(c)</sup>
Calibration methods (and instruments)	The certified massic activity for <sup>237</sup> 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 <sup>3</sup> 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.

<sup>(a)</sup> The stated uncertainty is two times the standard uncertainty. See reference 5.

<sup>(b)</sup> The estimated lower limits of detection for photon-emitting impurities, expressed as massic photon emission rate, in October 2012 are:

- 200 s<sup>-1</sup>•g<sup>-1</sup> for energies between 30 keV and 115 keV,
- 100 s<sup>-1</sup>•g<sup>-1</sup> for energies between 120 keV and 290 keV,
- 250 s<sup>-1</sup>•g<sup>-1</sup> for energies between 295 keV and 320 keV,
- 100 s<sup>-1</sup>•g<sup>-1</sup> for energies between 330 keV and 360 keV,
- 100 s<sup>-1</sup>•g<sup>-1</sup> for energies between 370 keV and 430 keV, and
- 20 s<sup>-1</sup>•g<sup>-1</sup> 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 <sup>237</sup>Np or progeny.

<sup>(c)</sup> The stated uncertainty is the standard uncertainty. See reference 5.

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Table 3. Uncertainty Evaluation for the Massic Activity of SRM 4341a

Uncertainty component		Assessment Type <sup>(a)</sup>	Relative standard uncertainty contribution on massic activity of <sup>237</sup> 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 $\alpha$ -detection inefficiency for <sup>237</sup> Np	B	<0.01
5	Gravimetric (mass) determinations for LS sources, dilution factors and counting source preparations	B	0.17
6	Decay corrections for <sup>237</sup> Np and <sup>233</sup> Pa; half-life uncertainties of 0.07 % and 0.33 %, respectively [6]	B	$2 \times 10^{-7}$
7	Assumed radioactive equilibrium between <sup>237</sup> Np and <sup>233</sup> Pa in the LS sources after 33 days of decay; wholly embodied in component 1	B	---
8	Uncertainty in massic activity for the <sup>3</sup> H efficiency monitor; includes that for the <sup>3</sup> H standard of 0.36 % and decay corrections for <sup>3</sup> H half-life uncertainty of 0.16 % [6]	B	0.06
9	Calculated beta efficiency for <sup>233</sup> Pa, including uncertainties in decay scheme data	B	0.4
10	Impurities, report of alpha impurity activity ratio to <sup>237</sup> Np of 0.0015 (5) from the 1997 EUROMET measurement comparison [6] of the master solution. No photon-emitting impurities were found. No <sup>241</sup> Am was found, indicating that beta-emitting <sup>241</sup> Pu was not present.	B	0.05
<b>Relative combined standard uncertainty</b>			<b>0.47</b>
<b>Relative expanded uncertainty (<math>k = 2</math>)</b>			<b>0.94</b>

<sup>(a)</sup> Letter A, denotes evaluation by statistical methods; B denotes evaluation by other methods.

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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](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](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](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 <sup>237</sup>Np Exercise EUROMET Action 416*, NPL Report CIRM 43, p 76 (2001); available at [http://publications.npl.co.uk/npl\\_web/pdf/CIRM43.pdf](http://publications.npl.co.uk/npl_web/pdf/CIRM43.pdf) (accessed Mar 2013)
- [7] Chechev, V.P.; Kuzmenko N.K.; *July 2010, <sup>237</sup>Np*; LNE-LNHB/CEA Table of Radionuclides, available at [http://www.nucleide.org/DDEP\\_WG/Nuclides/Np-237\\_tables.pdf](http://www.nucleide.org/DDEP_WG/Nuclides/Np-237_tables.pdf) (accessed Mar 2013).
- [8] Chechev, V.P.; Kuzmenko N.K.; *July 2010, <sup>233</sup>Pa*; LNE-LNHB/CEA Table of Radionuclides, available at [http://www.nucleide.org/DDEP\\_WG/Nuclides/Pa-233\\_tables.pdf](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](mailto: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

Project(s): 27927.13.001  
Manager(s): Ranger, Jacqueline  
To Client: 05/22/24

SDG: 718819  
RECEIVED: 04/04/24  
TON: 733437

SRR #s: 70993  
Client(s): Battelle Memorial Institute PNNL

Instructions
<p>Contract: 660825 Mod 1. PNNL Task Order: 733437 18 overall RAD LIQUID samples were received on 04/04/2024, which are ALL listed here.</p> <p>SOLUTION VOLUME IS SHARED WITH ALL REQUIRED TESTS. RAD ACTIVITY: At Sample Receipt LOGIN _ samples ranged from 50-160mR/hr.</p> <p>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</p> <p>***** Services to be completed in compliance with DOECAP-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.</p> <p>LEVEL 4 DATA PACKAGE REQUIRED The final report will reference the contract number. Final reports shall be submitted to PNNL as PDF ONLY.</p> <p>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</p> <p>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.</p>

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	Holding: 180 days from CED						
Section: RADCHEM	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	Holding: 180 days from CED						
Section: RADCHEM	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

Project(s): 27927.13.001  
Manager(s): Ranger, Jacqueline  
To Client: 05/22/24

SDG: 718819  
RECEIVED: 04/04/24  
TON: 733437

SRR #s: 70993  
Client(s): Battelle Memorial Institute PNNL

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

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



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	
Reid A Peterson	Digitally signed by Reid A Peterson	
Receipt Acknowledgement	Date: 2024.03.18 11:23:08 -07'00'	
Date	Received by	
04.04.24	David Harner / 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 2 of 2 0322

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

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

<b>Final Sample Disposition:</b> Dispose on-site	If samples are to be preserved, identify requirements here.	
<b>Project Approval</b>		
Date	Approved by	
	<b>Reid A Peterson</b>	Digitally signed by Reid A Peterson
		Date: 2024.03.18 11:23:08 -07'00'
<b>Receipt Acknowledgement</b>		
Date	Received by	
04-04-24	<i>David Martin / SWI</i>	

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

*David Glare*

Southwest Research Institute

Traffic Report

Sample Custodian Signature: \_\_\_\_\_



- 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 14<sup>th</sup>, 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:

<b>SwRI ID</b>	<b>Sample Number</b>	<b>Analysis</b>
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  $\pm 2$  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
T1155-EFF-Comp	718821
T1155-EFF-CompD	718821D
T1155-EFF-CompMS	718821MS
T1155-Feed-Comp	718822

Comments:

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)	RL - SwRI Reporting Limit	MS2 - ICP-MS PE NexION/SW-846
N - Matrix spike and/or matrix spike duplicate criteria was not met	DF - Dilution Factor	Method 6020B
X - Analytical spike criteria was not met	M - Instrument	NA - Not Applicable
E - Result is estimated due to interferences		
D - Result is reported from a dilution		
* - Duplicate criteria was not met		
& - See narrative		

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)	RL - SwRI Reporting Limit	MS2 - ICP-MS PE NexION/SW-846
N - Matrix spike and/or matrix spike duplicate criteria was not met	DF - Dilution Factor	Method 6020B
X - Analytical spike criteria was not met	M - Instrument	NA - Not Applicable
E - Result is estimated due to interferences		
D - Result is reported from a dilution		
* - Duplicate criteria was not met		
& - See narrative		

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)	RL - SwRI Reporting Limit	MS2 - ICP-MS PE NexION/SW-846
N - Matrix spike and/or matrix spike duplicate criteria was not met	DF - Dilution Factor	Method 6020B
X - Analytical spike criteria was not met	M - Instrument	NA - Not Applicable
E - Result is estimated due to interferences		
D - Result is reported from a dilution		
* - Duplicate criteria was not met		
& - See narrative		

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

<b><i>Instruments/Methods (M)</i></b>
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

<b>Instruments/Methods (M)</b>
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

<b>Data Reporting Qualifiers (Qual)</b>	<b>Instruments/Methods (M)</b>
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 ICSA	Limit ICSAB
	Sol. ICSA	Sol. ICSAB	Sol. ICSA	%Rec	Sol. ICSAB	%Rec		
Technetium-99	0.0085	0.0285	0.00716	-	0.0284	99.5%	-0.00150 to 0.0185	80%-120%

**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.

<b>Data Reporting Qualifiers (Qual)</b>	<b>Columns</b>	<b>Instruments/Methods (M)</b>
U - Result is less than the SwRI Reporting Limit (RL)	M - Instrument	MS2 - ICP-MS PE NexlON/SW-846
N - Matrix spike and/or matrix spike duplicate criteria was not met	MS - Matrix Spike	Method 6020B
X - Analytical spike criteria was not met	MSD - Matrix Spike Duplicate	NA - Not Applicable
E - Result is estimated due to interferences	Q - Qualifier	
D - Result is reported from a dilution	RPD - Relative Percent Difference	
* - Duplicate criteria was not met		

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	

Data Reporting Qualifiers (Qual)	Columns	Instruments/Method (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 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

<b>Instruments/Methods (M)</b>
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)	MS2 - ICP-MS PE NexION/SW-846 Method 6020B
U - Result is less than the SwRI Reporting Limit (RL)	NA - Not Applicable
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	

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

<b>Columns</b>
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\*

Batch: 20240514-P002 (Ver. 1)

Status: APPROVED

Southwest Research Institute  
San Antonio, Texas 78238

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

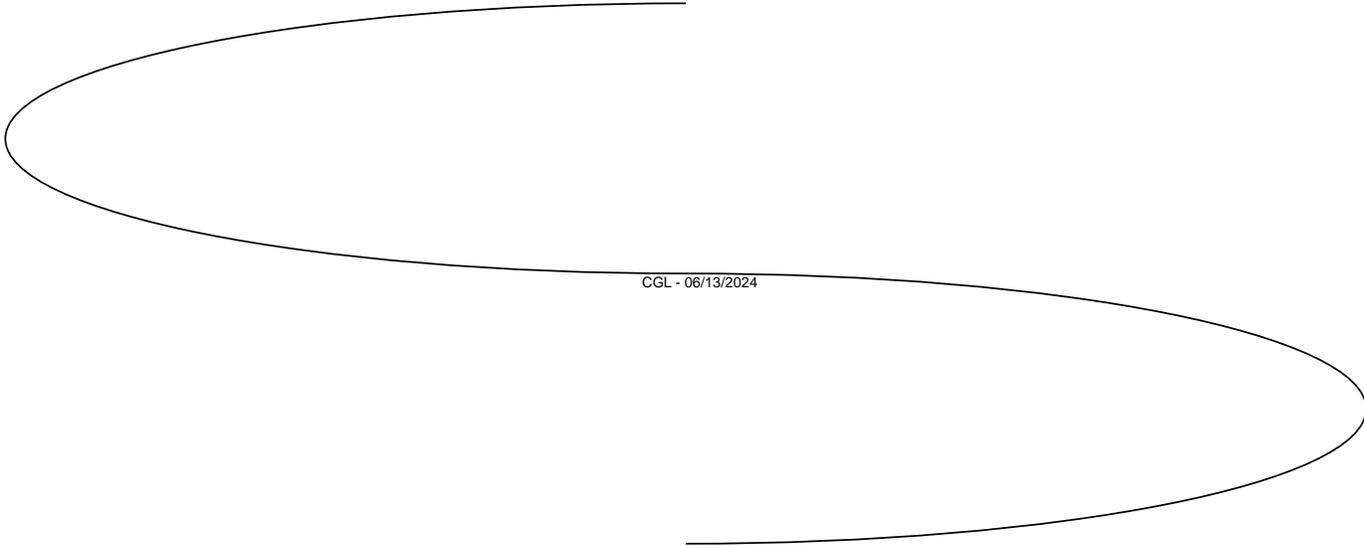
① spiked 0.2 mL of Cl# 94145 Technetium-99 002RadSol4 (Lot# SRM4288A, Source: NIST, Exp: 03/14/2025)

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: \_\_\_\_\_

# Preparation Log

Metals

**\*A38154\***

A38154

Batch: 20240523-P005 (Ver. 2)

Status: APPROVED

Southwest Research Institute  
San Antonio, Texas 78238

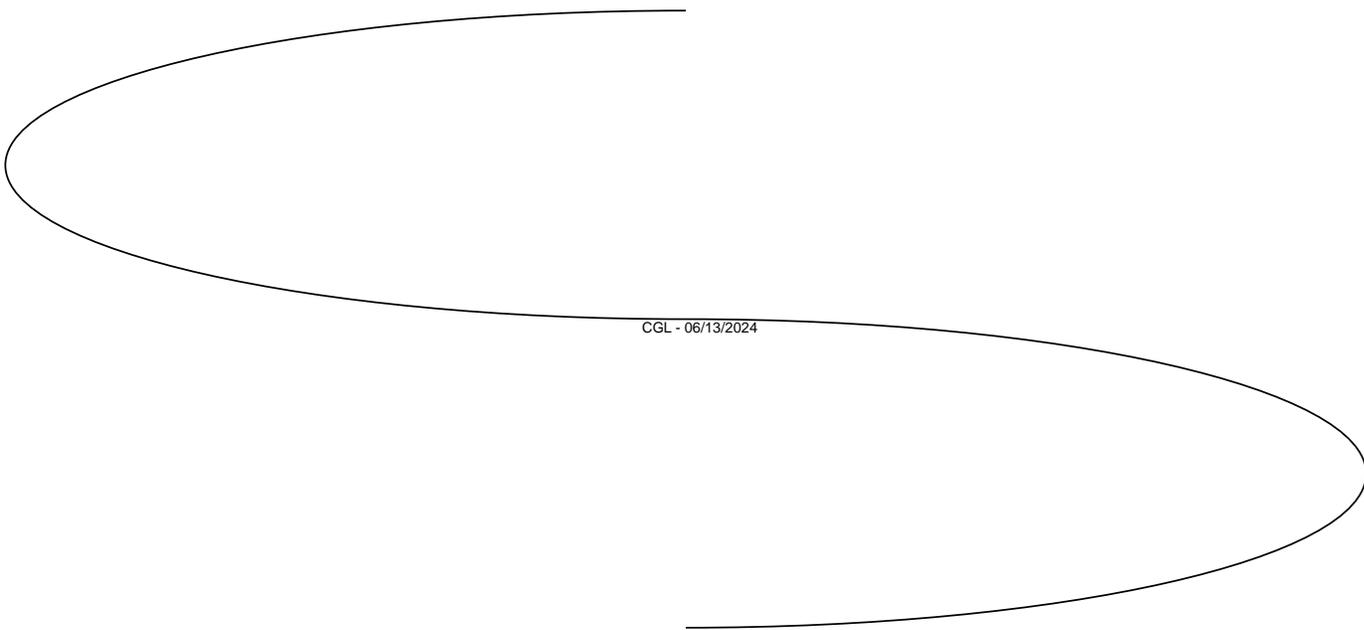
Client(s): Battelle Memorial Institute PNNL  
Task Order(s): 240405-6  
SDG(s): 718819  
Case(s): 733437  
Project(s): 27927.13.001  
Method(s): Tc99 (TAP: )  
Matrix(s): Liquid  
Instrument(s): ICP-MS  
Reagent(s): TEVA resin 229672, 0.1M HNO3 248619, 0.01M HNO3 236015, 0.5M HF/0.02M HNO3 247176, 1% 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: \_\_\_\_\_

**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:

$$A = I / 1000$$

$$10 \quad 20$$

DF includes DF100 at instrument and DF2 (10mL digestate to FV20mL) for column separation prep

$$E = (A * D * B) / C$$

*JK*  
6/13/27

**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 \_\_\_\_\_

**ICP-MS CALIB. STD. ID's**

SO	<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

**ANALYSIS**

Tc99

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**

- DF2 2.5mL sample + 2.5mL Matrix \_\_\_%HNO<sub>3</sub>\_\_\_%HCl \_\_\_\_\_
- DF5 1.0mL sample + 4.0mL Matrix \_\_\_%HNO<sub>3</sub>\_\_\_%HCl \_\_\_\_\_
- DF10 0.5mL sample + 4.5mL Matrix \_\_\_%HNO<sub>3</sub>\_\_\_%HCl \_\_\_\_\_
- DF20 0.25mL sample + 4.75mL Matrix \_\_\_%HNO<sub>3</sub>\_\_\_%HCl \_\_\_\_\_
- DF25 0.2mL sample + 4.8mL Matrix \_\_\_%HNO<sub>3</sub>\_\_\_%HCl \_\_\_\_\_
- DF50 0.1mL sample + 4.9mL Matrix \_\_\_%HNO<sub>3</sub>\_\_\_%HCl \_\_\_\_\_
- DF100 0.05mL sample + 4.95mL Matrix \_\_\_%HNO<sub>3</sub>\_\_\_%HCl \_\_\_\_\_
- DF200 0.025mL sample + 4.975mL Matrix \_\_\_%HNO<sub>3</sub>\_\_\_%HCl \_\_\_\_\_
- DF250 0.02mL sample + 4.98mL Matrix \_\_\_%HNO<sub>3</sub>\_\_\_%HCl \_\_\_\_\_
- DF \_\_\_ mL sample + \_\_\_mL Matrix \_\_\_%HNO<sub>3</sub>\_\_\_%HCl \_\_\_\_\_
- DF \_\_\_ mL sample + \_\_\_mL Matrix \_\_\_%HNO<sub>3</sub>\_\_\_%HCl \_\_\_\_\_
- DF \_\_\_ mL sample + \_\_\_mL Matrix \_\_\_%HNO<sub>3</sub>\_\_\_%HCl \_\_\_\_\_

**10mL Final Volume**

- DF2 5.0mL sample + 5.0mL Matrix \_\_\_%HNO<sub>3</sub>\_\_\_%HCl \_\_\_\_\_
- DF5 2.0mL sample + 8.0mL Matrix \_\_\_%HNO<sub>3</sub>\_\_\_%HCl \_\_\_\_\_
- DF10 1.0mL sample + 9.0mL Matrix \_\_\_%HNO<sub>3</sub>\_\_\_%HCl \_\_\_\_\_
- DF20 0.5mL sample + 9.5mL Matrix \_\_\_%HNO<sub>3</sub>\_\_\_%HCl \_\_\_\_\_
- DF25 0.4mL sample + 9.6mL Matrix \_\_\_%HNO<sub>3</sub>\_\_\_%HCl \_\_\_\_\_
- DF50 0.2mL sample + 9.8mL Matrix \_\_\_%HNO<sub>3</sub>\_\_\_%HCl \_\_\_\_\_
- DF100 0.1mL sample + 9.9mL Matrix 13%HNO<sub>3</sub>\_\_\_%HCl 0.0137%HF
- DF200 0.05mL sample + 9.95mL Matrix \_\_\_%HNO<sub>3</sub>\_\_\_%HCl \_\_\_\_\_
- DF250 0.04mL sample + 9.96mL Matrix \_\_\_%HNO<sub>3</sub>\_\_\_%HCl \_\_\_\_\_
- DF500 0.02mL sample + 9.98mL Matrix 13%HNO<sub>3</sub>\_\_\_%HCl 0.0137%HF
- DF \_\_\_ mL sample + \_\_\_mL Matrix \_\_\_%HNO<sub>3</sub>\_\_\_%HCl \_\_\_\_\_
- DF \_\_\_ mL sample + \_\_\_mL Matrix \_\_\_%HNO<sub>3</sub>\_\_\_%HCl \_\_\_\_\_
- DF \_\_\_ mL sample + \_\_\_mL Matrix \_\_\_%HNO<sub>3</sub>\_\_\_%HCl \_\_\_\_\_

- \_\_\_ mL Final Volume Sample Spiked With (A)
  - 0.020mL Multielement Solution 1 #253320
  - 0.020mL Multielement Solution 2 #253323
  - 0.020mL Multielement Solution 3 #253324
  - 0.020mL Multielement Solution 4 #253325
  - \_\_\_ mL \_\_\_\_\_
  - \_\_\_ 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

*JZ*  
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

*[Handwritten 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

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6/13/24

### Instrument Mass Calibration Report

File Name: Default.tun  
File Path: C:\Users\Public\Documents\PerkinElmer Syngistix\ICPMS\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	

### Southwest Research Institute

#### 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	<b>250.000000</b>	2.567	1.027	ng/L
Rh	103		16636084.916				ng/L
Rh-IS	103		16636084.916	<b>98.922469</b>	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	<b>95.738890</b>	0.762	0.796	ng/L
[> Rh	103		13342048.591				ng/L
Rh-IS	103		13342048.591	<b>79.335276</b>	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	<b>0.614977</b>	0.133	21.679	ng/L
[> Rh 103	16871550.992					ng/L
Rh-IS 103	16871550.992		<b>100.322611</b>	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\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 5.0.658

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		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	<b>4.636828</b>	0.224	4.828	ng/L
Rh	103		17044915.193				ng/L
Rh-IS	103		17044915.193	<b>101.353479</b>	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\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\ICSA.659

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	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		<b>7.164917</b>	0.402	5.608	ng/L
Rh	103	10880997.073					ng/L
Rh-IS	103	10880997.073		<b>64.701226</b>	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\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\ICSAB.660

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	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		<b>28.355826</b>	0.080	0.283	ng/L
Rh	103	11183643.100					ng/L
Rh-IS	103	11183643.100		<b>66.500838</b>	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\ZZZZZ.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	0.000
Ru	101		226.668		8.915	0.000	0.000	0.000
Ru	102		-3023.066		1.347	0.000	0.000	0.000
[ Tc	99		16862.281		1.706	0.000	0.000	0.000
[> Rh	103		13333560.417		0.717	0.000	0.000	0.000
Rh-IS	103		13333560.417		0.717	0.000	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	<b>95.739891</b>	2.249	2.349	ng/L
[> Rh	103		13333560.417				ng/L
Rh-IS	103		13333560.417	<b>79.284803</b>	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	<b>-1.033120</b>	0.049	4.727	ng/L
[> Rh	103	16542688.527					ng/L
Rh-IS	103	16542688.527		<b>98.367109</b>	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\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\718821 DF100.664  
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	-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		<b>56.437424</b>	0.304	0.539	ng/L
Rh	103	16956226.219					ng/L
Rh-IS	103	16956226.219		<b>100.826112</b>	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		<b>53.898296</b>	0.738	1.369	ng/L
[> Rh	103	16733479.166					ng/L
Rh-IS	103	16733479.166		<b>99.501600</b>	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\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\718821L DF500.666

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		-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	<b>10.641838</b>	0.294	2.767	ng/L
[> Rh	103	16932900.950					ng/L
Rh-IS	103	16932900.950		<b>100.687414</b>	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		<b>60.002128</b>	0.931	1.551	ng/L
[> Rh	103	16815374.424					ng/L
Rh-IS	103	16815374.424		<b>99.988570</b>	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		<b>61.058064</b>	1.087	1.781	ng/L
Rh	103	16845588.723					ng/L
Rh-IS	103	16845588.723		<b>100.168232</b>	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	<b>108.415189</b>	1.257	1.160	ng/L
Rh	103		13244590.799				ng/L
Rh-IS	103		13244590.799	<b>78.755766</b>	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	<b>96.672522</b>	0.102	0.106	ng/L
[> Rh	103		13263934.092				ng/L
Rh-IS	103		13263934.092	<b>78.870787</b>	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**



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# N/A				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		
							CRITERIA
							95%-105% < 10% < 10%







# 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	<b>(0.998 ± 0.002) g·mL<sup>-1</sup> at 21 °C [b]*</b>		
Solution mass	<b>(4.998 ± 0.002) g [b]</b>		
Chemical Properties:			
Solution composition	Chemical Formula	Concentration (mol·L <sup>-1</sup> )	Mass Fraction (g·g <sup>-1</sup> )
	H <sub>2</sub> O	55	1.00
	KOH	0.001	0.00006
	K <sup>99</sup> TcO <sub>4</sub>	0.0005	0.0001
Radiological Properties:			
Radionuclide	Technetium-99		
Reference time	1200 EST, 1 September 1996		
Massic activity of the solution [c]	<b>32.61 kBq·g<sup>-1</sup></b>		
Relative expanded uncertainty (k=2)	<b>1.14% [d] [e]</b>		
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 <sup>5</sup> 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]<sup>\*</sup>

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$ $(x_i/y)$ [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 0.0000003
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 $4\pi\beta(\text{LS})\gamma$ -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-emitting 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, $k$				$\frac{x.2}{1.14}$
Relative Expanded Uncertainty of the Output Quantity, $U_y$ , (%)				1.14

SRM 4286A, 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  $\mu\text{Sv}$  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:  
 $2 \times 10^{-4} \gamma \cdot \text{s}^{-1} \cdot \text{g}^{-1}$  for energies between 20 and 85 keV,  
 $2 \times 10^{-5} \gamma \cdot \text{s}^{-1} \cdot \text{g}^{-1}$  for energies between 93 and 503 keV,  
 $1 \times 10^{-5} \gamma \cdot \text{s}^{-1} \cdot \text{g}^{-1}$  for energies between 519 and 1457 keV, and  
 $5 \times 10^{-6} \gamma \cdot \text{s}^{-1} \cdot \text{g}^{-1}$  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  $\lambda$  (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 massic 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

Project(s): 27927.13.001  
Manager(s): Ranger, Jacqueline  
To Client: 05/22/24

SDG: 718819  
RECEIVED: 04/04/24  
TON: 733437

SRR #s: 70993  
Client(s): Battelle Memorial Institute PNNL

## 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

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Project(s): 27927.13.001  
Manager(s): Ranger, Jacqueline  
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RECEIVED: 04/04/24  
TON: 733437

SRR #s: 70993  
Client(s): Battelle Memorial Institute PNNL

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

Project(s): 27927.13.001  
Manager(s): Ranger, Jacqueline  
To Client: 05/22/24

SDG: 718819  
RECEIVED: 04/04/24  
TON: 733437

SRR #'s: 70993  
Client(s): Battelle Memorial Institute PNNL

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

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Project(s): 27927.13.001  
Manager(s): Ranger, Jacqueline  
To Client: 05/22/24

SDG: 718819  
RECEIVED: 04/04/24  
TON: 733437

SRR #s: 70993  
Client(s): Battelle Memorial Institute PNNL

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  
**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

### 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

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

Project Sample Transfer Form (PSTF)

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)				ICP-AES	Alpha Spec (Am, Cm, Np, & Pu)	ICP-MS (Cs, I, & Tc)	IC (total fusion)	TOC	TIC	Alpha Spec (Am, Cm, Np, & Pu)	Matrix	Comments
Sample Identification		# Cont.										
PNNL REQ# 733437, Task Order 733437 SWRI Master Agreement 660825											Amy.Westesen@pnl.gov 509-371-7908	
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

shipment 1 of 3

Project Sample Transfer Form (PSTF)

Page 2 of 2

031

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

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)				ICP-AES	Alpha Spec (Am, Cm, Np, & Pu)	ICP-MS (Cs, I, & Tc)	IC (total fusion)	TOC	TIC	Alpha Spec (Am, Cm, Np, & Pu)	Matrix	Comments
Sample Identification		# Cont.										
PNNL REQ# 733437, Task Order 733437 SWRI Master Agreement 660825											Amy.Westesen@pnnl.gov 509-371-7908	
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

Shipment 2 of 3

Project Sample Transfer Form (PSTF)

Page 2 of 2 0322

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

0333

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)				ICP-AES	Alpha Spec (Am, Cm, Np, & Pu)	ICP-MS (Cs, I, & Tc)	IC (total fusion)	TOC	TIC	Alpha Spec (Am, Cm, Np, & Pu)	Matrix	Comments
Sample Identification		# Cont.										
PNNL REQ# 733437, Task Order 733437 SWRI Master Agreement 660825										Amy.Westesen@pnnl.gov 509-371-7908		
TI155-Feed-Comp		1			X	X					Aqueous	pH = 14
TI155-EFF-Comp		1			X	X					Aqueous	pH = 14
TI155-A-2-A		1			X	X					Aqueous	pH = 14
TI155-B-10-A		1			X	X					Aqueous	pH = 14

Shipment 3 of 3

Project Sample Transfer Form (PSTF)

Page 2 of 2

<b>Final Sample Disposition:</b> Dispose on-site	<b>If samples are to be preserved, identify requirements here.</b>
<b>Project Approval</b>	
Date	Approved by
Reid A Peterson	Digitally signed by Reid A Peterson Date: 2024.03.18 11:23:08 -07'00'
<b>Receipt Acknowledgement</b>	
Date	Received by
04-04-24	Joel 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

Southwest Research Institute  
Traffic Report  
Sample Custodian Signature: *David Glau*



- 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: 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. ( $\mu\text{g/mL}$ )	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

# **Pacific Northwest National Laboratory**

902 Battelle Boulevard  
P.O. Box 999  
Richland, WA 99354  
1-888-375-PNNL (7665)

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