facility 439136
project 10243

Isotopic Polonium

Case Narrative

COGCC

PW NORM 2017 – 10048

Work Order Number: 1705202

1. This report consists of the analytical results and supporting documentation for one water sample received by ALS on 05/09/2017.

2. This sample was prepared according to the current revisions of SOP 776 and SOP 711.

3. The sample was analyzed for the presence of Polonium-210 according to the current revision of SOP 714. The analyses were completed on 05/18/2017.

4. The analysis results for this sample are reported in units of pCi/L. The water sample was filtered prior to analysis.

5. Results of this analysis are decay-corrected to the sampling date, based on the 138.4 day half-life of Po-210. This decay correction makes no assumptions as to the equilibrium state of Po-210 with the Pb-210 parent nuclide, which has a half-life of 22.3 years.

6. Polonium-210 activity is reported in the associated method blank above the minimum detectable concentration value, as indicated with a “B3” qualifier on the final reports. The measured blank activity is below the requested MDC. Results are acceptable according to the current revision of SOP 715, and are submitted without further qualification.

7. The requested MDC was not met for sample 1705202-1, due to a reduced aliquot of the sample taken for analysis due to potential matrix interferences. The sample was counted for a maximum count time of 1000 minutes. The results are flagged with an “M” qualifier on final reports. Results are submitted without further qualification.

8. ALS uses the following convention for reporting significant digits in the TPU and MDC results. The TPU value is rounded to two significant digits. The MDC value is rounded to the same decimal place as the TPU value. In practice, this could result in an MDC reported value of zero for samples with significant activity, including the batch laboratory control sample.

9. No further anomalous situations were encountered during the preparation or analysis of this sample. All remaining quality control criteria were met.

The data contained in the following report have been reviewed and approved by the personnel listed below. In addition, ALS certifies that the analyses reported herein are true, complete and correct within the limits of the methods employed.

Pik Yee Yuen — 5/25/17
Radiochemistry Primary Data Reviewer — Date

Radiochemistry Final Data Reviewer — 5/25/17
Date

Section 1

CHAIN OF CUSTODY

ALS -- Fort Collins

Sample Number(s) Cross-Reference Table

OrderNum: 1705202
Client Name: COGCC
Client Project Name: PW NORM 2017
Client Project Number: 10048
Client PO Number: CT 2017-3066

Client Sample Number	Lab Sample Number	COC Number	Matrix	Date Collected	Time Collected
439136	1705202-1		WATER	09-May-17	12:50
439136	1705202-2		WATER	09-May-17	12:50

ALS Environmental

225 Commerce Drive, Fort Collins, Colorado 80524
TF: (800) 443-1511 PH: (970) 490-1511 FX: (970) 490-1522

Chain-of-Custody

Turnaround time for samples received after 2 p.m. will be calculated beginning from the next business day.
Turnaround time for samples received Saturday will be calculated beginning from the next business day.

ALS WORKORDER # 1705202

PAGE of

DISPOSAL BY LAB or RETURN

PROJECT NAME	PW NORM 2017	TURNAROUND TIME	45 days
PROJECT No.	10048	SITE ID	
		EDD FORMAT	COGCC
COMPANY NAME	COGCC	PURCHASE ORDER	CT 2017-3066
SEND REPORT TO	Peter Cintantas	BILL TO COMPANY	
ADDRESS	1120 Lincoln St., Suite 801	INVOICE ATTN TO	
CITY / STATE / ZIP	Denver, CO 80203	ADDRESS	
PHONE	719-679-1326	CITY / STATE / ZIP	
FAX		PHONE	
E-MAIL		FAX	
		E-MAIL	

SAMPLER: Robert Young

PARAMETER/METHOD REQUEST FOR ANALYSIS

A	total metals SW6010/6020
B	dissolved metals SW6010
C	SW9040A pH
D	SM2510B specific conductance
E	SM2320C total, bicarb & carb alkalinity
F	SM2540C dissolved solids
G	SM2540D suspended solids
H	SW9056 ~~SW9~~ (Br, Cl, F, SO_4)
I	SAR calc.
J	

LAB ID	FIELD ID	MATRIX	SAMPLE DATE	SAMPLE TIME	# OF BOTTLES	PRESERVATIVE	QC	A	B	C	D	E	F	G	H	I	J	SEE NOTES SECTION
1	439136	W	5/9/17	1250	1	2	X	X										
↓	439136	W	↓	↓	2	7	X		X	X	X	X	X	X	X	X		

*Time Zone (Circle): EST CST MST PST Matrix: O = oil S = soil NS = non-soil solid W = water L = liquid E = extract F = filter

NOTES

REPORT LEVEL / QC REQUIRED	
	Summary (Standard QC)
	LEVEL II (Standard QC)
	LEVEL III (Std QC + forms)
	LEVEL IV (Std QC + forms + raw)

PRESERVATION KEY: 1-HCl 2-HNO3 3-H2SO4 4-NaOH 5-NaOH/ZnAcetate 6-NaHSO4 7-4°C 8-Other

Form 202r9

	SIGNATURE	PRINTED NAME	DATE	TIME
RELINQUISHED BY		Robert Young	5/9/17	1642
RECEIVED BY		Joshua Griffith	5/9/17	1642
RELINQUISHED BY				
RECEIVED BY				
RELINQUISHED BY				
RECEIVED BY				

ALS Environmental

225 Commerce Drive, Fort Collins, Colorado 80524
TF: (800) 443-1511 PH: (970) 490-1511 FX: (970) 490-1522

Chain-of-Custody

Turnaround time for samples received after 2 p.m. will be calculated beginning from the next business day.

Turnaround time for samples received Saturday will be calculated beginning from the next business day.

ALS WORKORDER # 1705202

PAGE of

DISPOSAL BY LAB or RETURN

PROJECT NAME	PW NORM 2017	TURNAROUND TIME	45 day
PROJECT No.	10048	SITE ID	
		EDD FORMAT	COGCC
COMPANY NAME	COGCC	PURCHASE ORDER	CT2017-3066
SEND REPORT TO	Peter Gintautas	BILL TO COMPANY	
ADDRESS		INVOICE ATTN TO	
CITY / STATE / ZIP		ADDRESS	
PHONE	719 6791326	CITY / STATE / ZIP	
FAX		PHONE	
E-MAIL		FAX	
		E-MAIL	
		SAMPLER	Robert Young

PARAMETER/METHOD REQUEST FOR ANALYSIS

A	gross alpha/gross beta
B	210 Pb
C	210 Po
D	222 Rn
E	224 Ra + 226 Ra
F	228 Ra
G	gamma emitters
H	* isotopic U
I	* isotopic Th
J	

LAB ID	FIELD ID	MATRIX	SAMPLE DATE	SAMPLE TIME	# OF BOTTLES	PRESERVATIVE	QC	A	B	C	D	E	F	G	H	I	J	SEE NOTES SECTION
	439136	W	5/9/17	1250	3	2		X	X	X		X	X	X	*	*		
	439136	W	"	"	3	7					X							

*Time Zone (Circle): EST CST MST PST Matrix: O = oil S = soil NS = non-soil solid W = water L = liquid E = extract F = filter

NOTES	REPORT LEVEL / QC REQUIRED
* iso U only if 6020 "total" U > 3 ug/L	Summary (Standard QC)
* " Th " " " " Th > 3 ug/L	LEVEL II (Standard QC)
	LEVEL III (Std QC + forms)
	LEVEL IV (Std QC + forms + raw)

PRESERVATION KEY: 1-HCl 2-HNO3 3-H2SO4 4-NaOH 5-NaOH/ZnAcetate 6-NaHSO4 7-4°C 8-Other

Form 202r9

	SIGNATURE	PRINTED NAME	DATE	TIME
RELINQUISHED BY	Robert T. Young	Robert Young	5/8/17	1642
RECEIVED BY		JOSHUA JS	5/9/17	1642
RELINQUISHED BY				
RECEIVED BY				
RELINQUISHED BY				
RECEIVED BY				

ALS Environmental - Fort Collins
CONDITION OF SAMPLE UPON RECEIPT FORM

Client: COGCC Workorder No: 1705202

Project Manager: SS Initials: CAT Date: 5-10-17

1. Does this project require any special handling in addition to standard ALS procedures?		YES	(NO)
2. Are custody seals on shipping containers intact?	(NONE)	YES	NO
3. Are Custody seals on sample containers intact?	(NONE)	YES	NO
4. Is there a COC (Chain-of-Custody) present or other representative documents?		(YES)	NO
5. Are the COC and bottle labels complete and legible?		(YES)	NO
6. Is the COC in agreement with samples received? (IDs, dates, times, no. of samples, no. of containers, matrix, requested analyses, etc.)		(YES)	NO
7. Were airbills / shipping documents present and/or removable?	(DROP OFF)	YES	NO
8. Are all aqueous samples requiring preservation preserved correctly? (excluding volatiles)	N/A	YES	(NO)
9. Are all aqueous non-preserved samples pH 4-9?	N/A	(YES)	NO
10. Is there sufficient sample for the requested analyses?		(YES)	NO
11. Were all samples placed in the proper containers for the requested analyses?		(YES)	NO
12. Are all samples within holding times for the requested analyses?		(YES)	NO
13. Were all sample containers received intact? (not broken or leaking, etc.)		(YES)	NO
14. Are all samples requiring no headspace (VOC, GRO, RSK/MEE, Rx CN/S, radon) headspace free? Size of bubble: ____ < green pea ____ > green pea	N/A	(YES)	NO
15. Do any water samples contain sediment? Amount Amount of sediment: ____ dusting ____ moderate ____ heavy	N/A	YES	(NO)
16. Were the samples shipped on ice?		(YES)	(NO)
17. Were cooler temperatures measured at 0.1-6.0°C? IR gun used*: (#2) #4	RAD ONLY	(YES)	(NO)

Cooler #:	1	2							
Temperature (°C):	6.0	Amb							
No. of custody seals on cooler:	0	0							
DOT Survey/ Acceptance Information: External µR/hr reading:	NA	NA							
Background µR/hr reading:	NA								

Were external µR/hr readings ≤ two times background and within DOT acceptance criteria? YES / NO (NA) (If no, see Form 008.)

Additional Information: PROVIDE DETAILS BELOW FOR A NO RESPONSE TO ANY QUESTION ABOVE, EXCEPT #1 AND #16.

All RAD Samples in the Amb Cooler.

Added 3.5 ml HNO_3 to EA. RAD and Total metals bottle. Final pH < 2. HNO_3 lot no. 152495.

If applicable, was the client contacted? YES / NO / NA Contact: _____ Date/Time: _____

Project Manager Signature / Date: Shiloh Summy

*IR Gun #2: Oakton, SN 29922500201-0066
*IR Gun #4: Oakton, SN 2372220101-0002

Form 201r24.xls (06/04/2012)

Section 2

SAMPLE RESULTS SUMMARY

Polonium-210 by Alpha Spectroscopy Sample Results Summary

Client Name: COGCC
Client Project Name: PW NORM 2017
Client Project Number: 10048
Laboratory Name: **ALS -- Fort Collins**
PAI Work Order: 1705202

Reported on: Tuesday, May 23, 2017
10:15:11 AM

Lab Sample ID	Client Sample ID	Sample Type	Nuclide	Result +/- 2 s TPU	MDC	DL	Units	Matrix	Prep Batch	Date Analyze	Flags
1705202-1	439136	Sample	Po-210	5E-01 +/- 1E+00	1.9E+00	NA	pCi/l	WATER	PL170516-1	5/18/2017	U,M

Comments:

Data Package ID: *PL1705202-1*

Qualifiers/Flags:

U - Result is less than the sample specific MDC.

LT - Result is less than Requested MDC, greater than sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

Section 3

QC RESULTS SUMMARY ❸

Polonium-210 by Alpha Spectroscopy

PAI 714 Rev 13

Method Blank Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1705202
Client Name: COGCC
ClientProject ID: PW NORM 2017 10048

Lab ID: PL170516-1MB

Sample Matrix: WATER
Prep SOP: PAI 711 Rev 10
Date Collected: 16-May-17
Date Prepared: 16-May-17
Date Analyzed: 18-May-17

Prep Batch: PL170516-1
QCBatchID: PL170516-1-1
Run ID: PL170516-1A
Count Time: 1000 minutes

Final Aliquot: 500 ml
Result Units: pCi/l
File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-52-7	Po-210	9E-03 +/- 1.5E-02	8E-03	5E-01	NA	B3

Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Po-209	9.950E+00	8.7E+00	pCi/l	87.2	30 - 110 %	

Comments:

Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

LT - Result is less than Requested MDC, greater than sample specific MDC.

Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

M - Requested MDC not met.

B - Analyte concentration greater than MDC.

B3 - Analyte concentration greater than MDC but less than Requested MDC.

DL - Decision Level

Data Package ID: *PL1705202-1*

Polonium-210 by Alpha Spectroscopy

PAI 714 Rev 13

Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins
Work Order Number: 1705202
Client Name: COGCC
ClientProject ID: PW NORM 2017 10048

Lab ID: PL170516-1LCS

Sample Matrix: WATER
Prep SOP: PAI 711 Rev 10
Date Collected: 16-May-17
Date Prepared: 16-May-17
Date Analyzed: 18-May-17

Prep Batch: PL170516-1
QCBatchID: PL170516-1-1
Run ID: PL170516-1A
Count Time: 480 minutes

Final Aliquot: 500 ml
Result Units: pCi/l
File Name: Spectrum #1

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
13981-52-7	Po-210	1.15E+01 +/- 1.8E+00	0E+00	1.070E+01	108	83 - 117	P

Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Po-209	9.950E+00	8.5E+00	pCi/l	85.0	30 - 110 %	

Comments:

Qualifiers/Flags:

U - Result is less than the sample specific MDC.

LT - Result is less than Requested MDC, greater than sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS Recovery within control limits.

M - The requested MDC was not met.

M3 - The requested MDC was not met, but thereported activity is greater than the reported MDC.

Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Minimum Detectable Concentration

Data Package ID: *PL1705202-1*

Section 4

INDIVIDUAL SAMPLE RESULTS

Polonium-210 by Alpha Spectroscopy

PAI 714 Rev 13

Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1705202
Client Name: COGCC
ClientProject ID: PW NORM 2017 10048

Field ID: 439136
Lab ID: 1705202-1

Sample Matrix: WATER
Prep SOP: PAI 711 Rev 10
Date Collected: 09-May-17
Date Prepared: 16-May-17
Date Analyzed: 18-May-17

Prep Batch: PL170516-1
QCBatchID: PL170516-1-1
Run ID: PL170516-1A
Count Time: 1000 minutes
Report Basis: Filtered

Final Aliquot: 25.0 ml
Prep Basis: Filtered
Moisture(%): NA
Result Units: pCi/l
File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13981-52-7	Po-210	5E-01 +/- 1E+00	1.9E+00	5E-01	NA	U,M

Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Po-209	1.990E+02	7.8E+01	pCi/l	39.2	30 - 110 %	

Comments: This sample was filtered prior to analysis.

Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

LT - Result is less than Requested MDC, greater than sample specific MDC.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

M - The requested MDC was not met.

Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *PL1705202-1*

Section 5

RAW DATA

Polonium-210 by Alpha Spectroscopy Raw Data Report

Laboratory Name: ALS -- Fort Collins
PAI Work Order: 1705202
Prep SOP: PAI 711
Analytical SOP: PAI 714
Reported on: Friday, May 19, 2017 4:01:40 PM

Sample ID / QC Type	Nuclide / Type	Sample Date/Time	Prep Batch / QCBatchID	Ingrowth Date /Time	Decay Date/Time	Matrix / %Moist.	Samp Alq / Analy Alq	Inst ID / Det ID	AnRunID / File Name	Count Date/Time	Net Cnts / Bkg Cnts	BaseEff / Bkg(min)	CntDur(min) / Yield	Activity +/- 2 s TPU	MDC / DecLev	ReportUnits / ReportBasis	DER / RPD	%Spk. Recov / Flags
1705202-1	Po-209	5/9/2017	PL170516-1	NA	5/17/2017	WATER	50 ml	AlphaSpec2	PL170516-1A	5/18/2017	1336.000	30.84%	1000	7.8E+01	1E+00	pCi/l	NA	
SMP	Tracer	12:50:00 PM	PL170516-1-1	NA	3:50:00 PM	NA	25 ml	72	Spectrum #1	10:05 AM	2.000	1000	39.2%	1.2E+01		Filtered	NA	
1705202-1	Po-210	5/9/2017	PL170516-1	NA	5/17/2017	WATER	50 ml	AlphaSpec2	PL170516-1A	5/18/2017	3.000	30.84%	1000	5E-01	1.9E+00	pCi/l	NA	
SMP	Trg. Analyte	12:50:00 PM	PL170516-1-1	NA	3:50:00 PM	NA	25 ml	72	Spectrum #1	10:05 AM	4.000	1000	39.2%	1E+00		Filtered	NA	U,M
PL170516-1	Po-209	5/16/2017	PL170516-1	NA	5/17/2017	WATER	1000 ml	AlphaSpec2	PL170516-1A	5/18/2017	3223.000	33.46%	1000	8.7E+00	0E+00	pCi/l	NA	
MB	Tracer	1:03:24 PM	PL170516-1-1	NA	3:50:00 PM	NA	500 ml	104	Spectrum #1	10:11 AM	2.000	1000	87.2%	1.2E+00		Unfiltered	NA	
PL170516-1	Po-210	5/16/2017	PL170516-1	NA	5/17/2017	WATER	1000 ml	AlphaSpec2	PL170516-1A	5/18/2017	3.000	33.46%	1000	9E-03	8E-03	pCi/l	NA	
MB	Trg. Analyte	1:03:24 PM	PL170516-1-1	NA	3:50:00 PM	NA	500 ml	104	Spectrum #1	10:11 AM	0.000	1000	87.2%	1.5E-02		Unfiltered	NA	B3
PL170516-1	Po-209	5/16/2017	PL170516-1	NA	5/17/2017	WATER	1000 ml	AlphaSpec2	PL170516-1A	5/18/2017	1456.560	32.34%	480	8.5E+00	0E+00	pCi/l	NA	
LCS	Tracer	1:03:24 PM	PL170516-1-1	NA	3:50:00 PM	NA	500 ml	105	Spectrum #1	10:10 AM	3.000	1000	85.0%	1.3E+00		Unfiltered	NA	
PL170516-1	Po-210	5/16/2017	PL170516-1	NA	5/17/2017	WATER	1000 ml	AlphaSpec2	PL170516-1A	5/18/2017	1688.040	32.34%	480	1.15E+01	0E+00	pCi/l	NA	108
LCS	Trg. Analyte	1:03:24 PM	PL170516-1-1	NA	3:50:00 PM	NA	500 ml	105	Spectrum #1	10:10 AM	2.000	1000	85.0%	1.8E+00		Unfiltered	NA	P

Comments:

Data Package ID: *PL1705202-1*

Qualifiers/Flags:

U - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

W - DER is greater than Warning Limit of 1.42

D - DER is greater than Control Limit of 2.13

+ - Duplicate RPD not within limits.

LT - Result is less than Request MDC, greater than sample specific MDC

* - Aliquot Basis is 'As Received' while the Report Basis is 'Dry Weight'

- Aliquot Basis is 'Dry Weight' while the Report Basis is 'As Received'

M - Requested MDC not met.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS, Matrix Spike Recovery within control limits.

N - Matrix Spike Recovery outside control limits

NC - Not Calculated for duplicate results less than 5 times MDC

B - Analyte concentration greater than MDC.

B3 - Analyte concentration greater than MDC but less than Requested MDC.

Notes:

1) The Tracer results are not yield corrected (i.e. activity measured not activity added).

2) Where sample time is not available, 12:00 PM (Mountain) is used for decay correction.

Abbreviations:

TR- Tracer TA - Target Analyte

TPU - Total Propagated Uncertainty

MDC - Minimum Detectable Concentration

DER - Duplicate Error Ratio

BDL - Below Detection Limit

16 14 54

ALS Laboratory Group - Fort Collins

Alpha-Spectroscopy Analysis Report

Sample

Sample: 1705202-1
Spectrum #1 Analysis #1

Sample Size : 0.03

Acquisition

Detector: 72
Batch Name: PL170516-1_A
Nuclide Library: Polonium
Analysis Method: ROI Analysis, Set Name = Po-210
ROI Set: Po-210

Acquisition Start Date: 5/18/2017 10:05:15AM
Live Time: 1,000.00 min.
Real Time: 1,000.01 min.
Dead Time: 0.00 %

Calibration

Bkgd Info: Sample: B17051072; Det: 72; Spectrum #1; 5/10/2017 10:44:24 AM

Calibration Date: 5/10/2017 10:09:56AM

Efficiency Calibration: C17051072

Efficiency: 30.84% +/- 0.20% TPU(2 sigma)

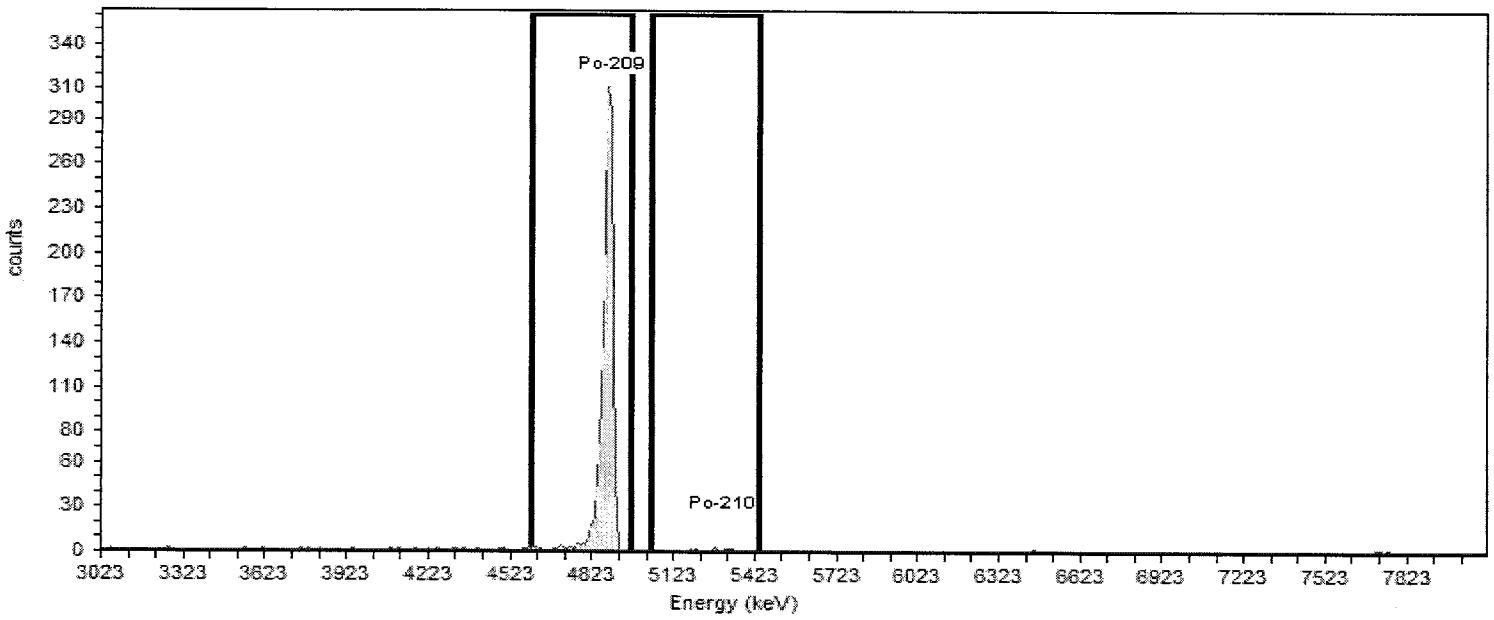
Energy Calibration: C17051072

Energy Cal: Gain = 9.9784 keV / Ch
Offset = 3,013.21 keV
Quadratic = 0.0000 keV / Ch^2

Tracer

Tracer Name: 1045.4243.07_Po-209
Tracer Activity: 22.23 DPM/mL x (Vol.)0.50 mL = 11.11 DPM

Tracer Nuclide: Po-209
Tracer Recovery: 39.32%



Nuclide Summary (ROI)

Nuclide	Peak Energy keV	ROI Start keV	ROI End keV	FWHM keV	B.R. %.	Gross Counts	Bkgd Counts	Net Counts	Activity pCi/L	1.00Sigma TPU pCi/L	Critical Level pCi/L	MDA pCi/L
Po-209	4889.2	4599.8	4969.0	60.8	99.7	1,338.00	2.00	1,336.00	7.9E+001	2.2E+000	4.9E-001	1.4E+000
Po-210	5308.3	5038.8	5438.0	172.9	100.0	7.00	4.00	3.00	4.5E-001	4.9E-001	6.9E-001	1.8E+000

Reviewed By: JA

All activity values and tracer recoveries are estimated values. The LIMS reporting system uses the count results to calculate all sample activity results. Thus, all activity values on this report may not be directly comparable to actual results on LIMS forms. The LIMS forms contain the actual true activity results for this sample.

Analyst: user 10:52:31AM 5/19/2017

Sample

Sample: PL170516-1MB Type: Sample
Spectrum #1 Analysis #1
:
Sample Collection Date:
Comment:

Sample Volume : 0.50 Sample Units: L
First Stage Dilution: N/A
Aliquot: N/A Aliquot Fraction: N/A
Dilution 2: N/A
Lab Preparation:

Batch

Batch Name: PL170516-1_A
:
Description:

Client Name: Undefined
Client Contact:

Tracer

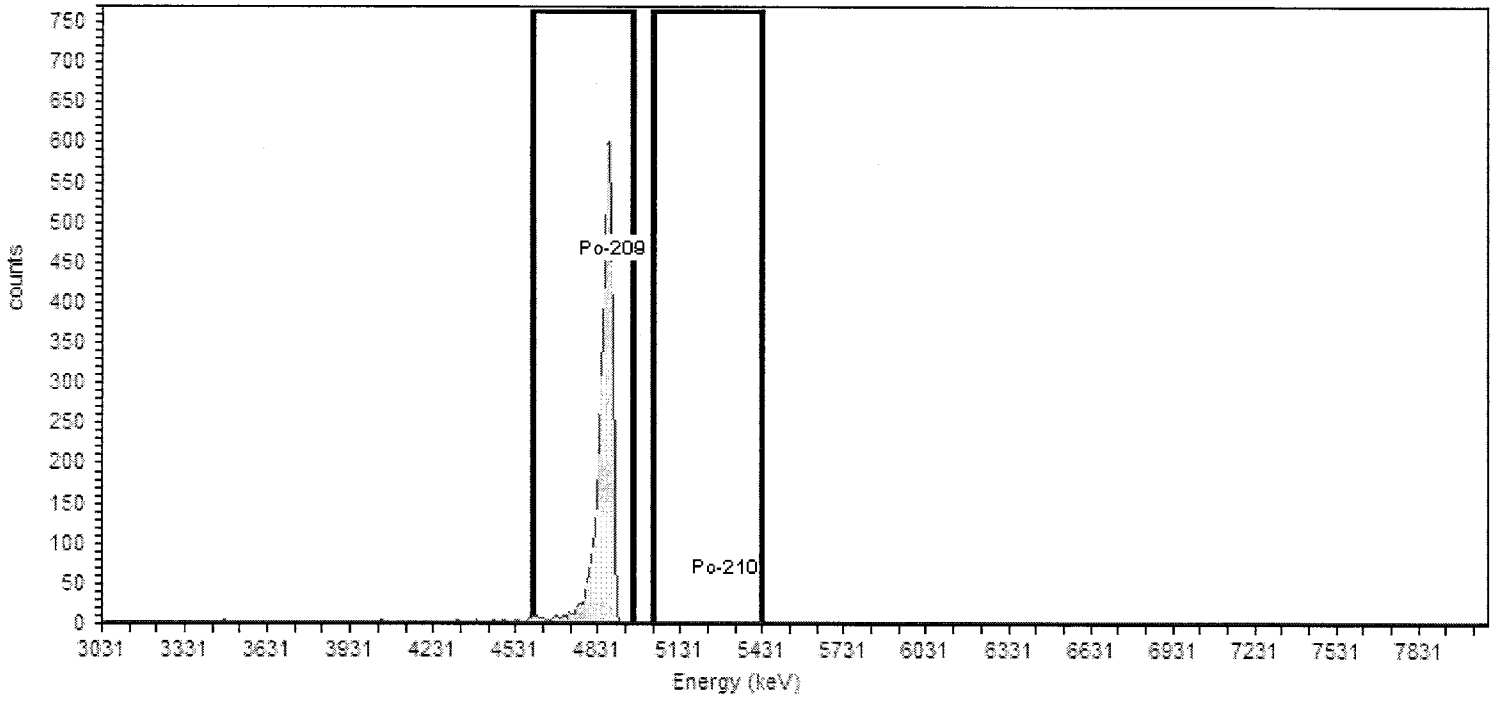
Tracer Name: 1045.4243.07 Po-209
Tracer Activity: 22.23 DPM / mL x (Vol.) 0.50 mL = 11.11 DPM
Tracer Ref. Date: 6/8/2016 10:00:00AM

Tracer Nuclide: Po-209
Tracer Recovery: 87.44%

Acquisition

Detector: 104, SN: 5505337, ID: 104
Acquisition Start Date: 5/18/2017 10:11:28AM
Live Time: 1,000.00 min.
Real Time: 1,000.01 min.
Background Date: 5/9/2017 12:41:48PM
Bkgd Info: Sample: B170509104; Det: 104; Spectrum #1; 5/9/2017 12:41:48 PM; Live Time: 1000.000(min.); ID: 104

Energy Calibration: C170509104A
Efficiency Calibration:C170509104A
Calibration Date: 5/9/2017 12:37:31PM
Energy Cal: Gain = 9.9003 keV / Ch
Offset = 3,021.28 keV
Quadratic = 0.0000 keV / Ch^2
Efficiency: 33.46% +/- 2.06% TPU(2 sigma)



General Analysis

Analysis Method: ROI Analysis, Set Name = Po-210
Decay Correction:5/18/2017 10:10:58AM
MDA Constants: Kα = 1.64 , Kβ = 1.64

Nuclide Library: Polonium
MDA Source: Background

Nuclide Summary (ROI)

Nuclide	Peak Energy keV	ROI Start keV	ROI End keV	FWHM keV	B.R. %	Gross Counts	Bkgd Counts	Net Counts	Activity pCi/L	1.00Sigma TPU pCi/L	Critical Level pCi/L	MDA pCi/L
Po-209	4882.533	4595.425	4961.735	62.8	99.7	3,225.00	2.0000	3223.00	8.756E+000	3.109E-001	1.022E-002	2.885E-002
Po-210	5298.345	5031.037	5427.048	0.0	100.0	3.00	0.0000	3.00	9.237E-003	6.191E-003	0.000E+000	8.332E-003

JA

Analyst: user 10:52:39AM 5/19/2017

Sample

Sample: PL170516-1LCS Type: Sample
Spectrum #1 Analysis #1
:
Sample Collection Date:
Comment:

Sample Volume : 0.50 Sample Units: L
First Stage Dilution: N/A
Aliquot: N/A Aliquot Fraction: N/A
Dilution 2: N/A
Lab Preparation:

Batch

Batch Name: PL170516-1_B
:
Description:

Client Name: Undefined
Client Contact:

Tracer

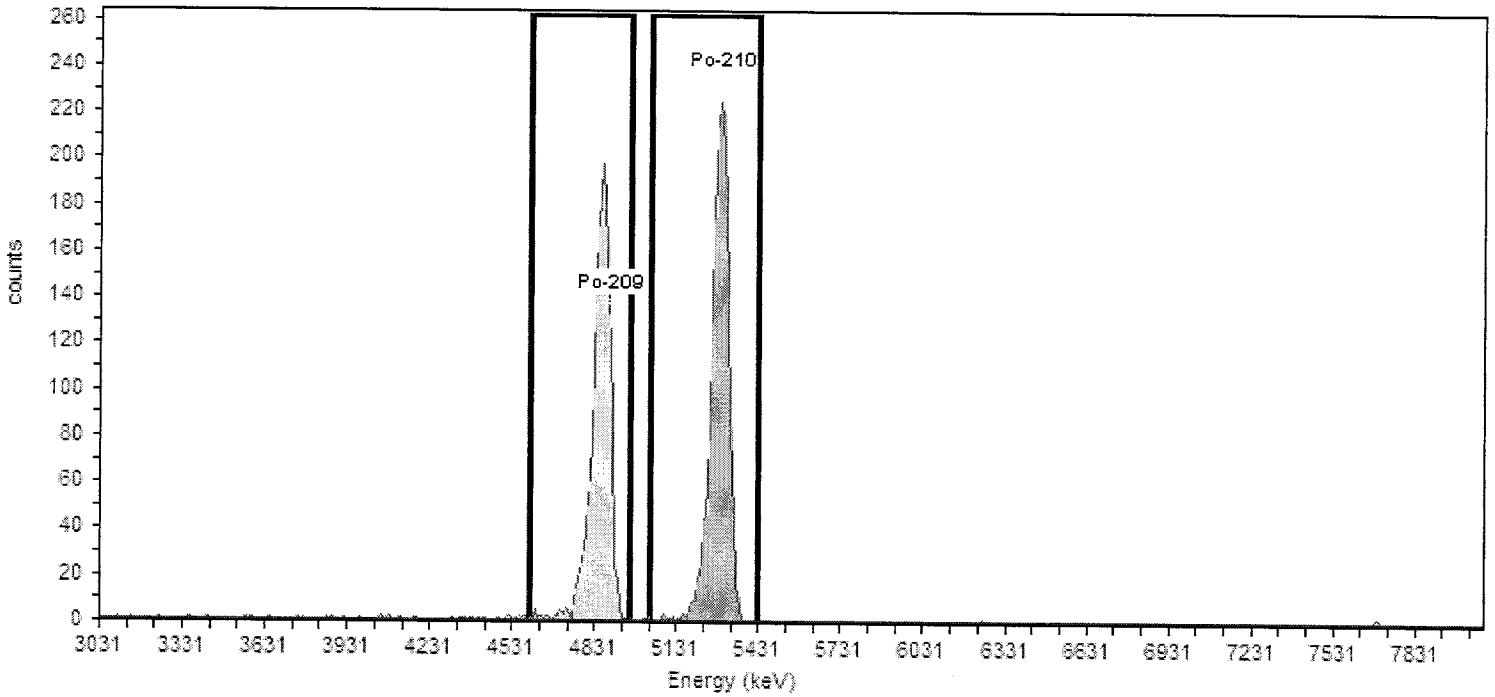
Tracer Name: 1045.4243.07 Po-209
Tracer Activity: 22.23 DPM / mL x (Vol.) 0.50 mL = 11.11 DPM
Tracer Ref. Date: 6/8/2016 10:00:00AM

Tracer Nuclide: Po-209
Tracer Recovery: 85.17%

Acquisition

Detector: 105, SN: 5505338, ID: 105
Acquisition Start Date: 5/18/2017 10:10:27AM
Live Time: 480.00 min.
Real Time: 480.01 min.
Background Date: 5/9/2017 12:41:48PM
Bkgd Info: Sample: B170509105; Det: 105; Spectrum #1; 5/9/2017 12:41:48 PM; Live Time: 1000.000(min.); ID: 105

Energy Calibration: C170509105
Efficiency Calibration:C170509105
Calibration Date: 5/9/2017 11:49:04AM
Energy Cal: Gain = 9.9003 keV / Ch
Offset = 3,021.28 keV
Quadratic = 0.0000 keV / Ch²
Efficiency: 32.34% +/- 1.33% TPU(2 sigma)



General Analysis

Analysis Method: ROI Analysis, Set Name = Po-210
Decay Correction:5/18/2017 10:08:51AM
MDA Constants: Kα = 1.64 , Kβ = 1.64

Nuclide Library: Polonium
MDA Source: Background

Nuclide Summary (ROI)

Nuclide	Peak Energy keV	ROI Start keV	ROI End keV	FWHM keV	B.R. %	Gross Counts	Bkgd Counts	Net Counts	Activity pCi/L	1.00Sigma TPU pCi/L	Critical Level pCi/L	MDA pCi/L
Po-209	4882.533	4595.425	4961.735	74.0	99.7	1,458.00	1.4400	1456.56	8.529E+000	2.846E-001	1.651E-002	5.162E-002
Po-210	5298.345	5031.037	5427.048	73.9	100.0	1,689.00	0.9600	1688.04	1.150E+001	7.828E-001	1.336E-002	4.516E-002

ALS

SOP 714;FORM 746r8.xls (10/2/07)

Alpha Spectrometer Instrument Run Log

Date: 5/18/17

Detector	Batch ID	Sample ID	Iso/Matrix	Duration	Initial
117	VAS170515-2-B	1704600-2	V/W	360	JP
118	↓	-3	↓	↓	↓
119		-4			
120		-5			
121		-6			
122		-7			
123		-8			
124		-9			
125		-10			
126		-11			
127		-12			
128		-13			
129		-14			
130		AS170515ZMB			
131	↓	LCS	↓	↓	↓
65	PL170516-1_A	1705158-1	Po/W	1000	JA
67	↓	1705177-1	↓	↓	↓
69		-2			
70		-3			
72		1705202-1			
74	↓	1705203-1		↓	
75	B	1705237-1		480	
77	A	1705240-1		1000	
78	↓	1705242-1	↓	↓	↓

Detector	Batch ID	Sample ID	Iso/Matrix	Duration	Initial
79	PL170516-1_A	1705243-1	Po/W	1000	JA
80	B	1705269-4	↓	480	↓
102	↓	1705269-4D		↓	
103		1705319-4			
104	A	PL170516-1MB		1000	
105	B	↓ -LCS	↓	480	↓
81	RAS170517-1_A	RAS170517-1MB	Ra/W	1000	JA
82	↓	↓ -LCS	↓	↓	↓
83		1705319-1			
84		-10			
85		-2			
86		-3			
87		-4			
88		1705350-1			
89		-2			
90		-3			
91		1705376-1			
92		-3			
93		-5			
94		-7			
95		1705369-1			
117		-3			
118	↓	-3D	↓	↓	↓

JmA 5/18/17

Notes:

Reviewed by: JmA
Date: 6/18/17

Section 6

QUALITY ASSURANCE SUMMARY REPORTS

No *NON-CONFORMANCE REPORTS* or *QUALITY ASSURANCE SUMMARY SHEETS* are included in this data package.

Section 7

LABORATORY BENCH SHEETS

Radiochemistry Instrument Worksheet

ALS -- Fort Collins

JA 5/18/17

Prep Batch: PL170516-1

Prep Procedure: Po210 158, 177, 202, 203, 240, 242, 243, ~~MB~~ MB → 1000 min. 237, 269, 319, LCS - 480 min.

Analytical QASS / NCR? Y (N) NA

Prep Num	LabID	QC Type	Init Alq	Fin Alq	Units	Report Units	Cnt 1 File	Cnt 1 Inst/Det	Cnt 1 Pos Chk By	Cnt 2 File	Cnt 2 Inst/Det	Cnt 2 Pos Chk By	Cnt 3 File	Cnt 3 Inst/Det	Cnt 3 Pos Chk By	Notes
5/26	1705158-1	SMP	50	25	ml	pCi/l	_51581	65 JA		_51581			_51581			A
1	1705177-1	SMP	50	25	ml	pCi/l	_51771	67		_51771			_51771			
1	1705177-2	SMP	50	25	ml	pCi/l	_51772	69		_51772			_51772			
1	1705177-3	SMP	50	25	ml	pCi/l	_51773	70		_51773			_51773			
5/30 1	1705202-1	SMP	50	25	ml	pCi/l	_52021	72		_52021			_52021			
1	1705203-1	SMP	50	25	ml	pCi/l	_52031	74		_52031			_52031			
6/23 1	1705237-1	SMP	187.755	93.878	ml	pCi/l	_52371	75		_52371			_52371			B
1	1705240-1	SMP	50	25	ml	pCi/l	_52401	77		_52401			_52401			A
1	1705242-1	SMP	50	25	ml	pCi/l	_52421	78		_52421			_52421			
1	1705243-1	SMP	50	25	ml	pCi/l	_52431	79		_52431			_52431			
6/23 1	1705269-4	SMP	188	94	ml	pCi/l	_52694	80		_52694			_52694			B
1	1705269-4	DUP	188	94	ml	pCi/l	_52694D	102		_52694D			_52694D			
6/30 1	1705319-4	SMP	188	94	ml	pCi/l	_53194	103		_53194			_53194			
1	PL170516-1	MB	1000	500	ml	pCi/l	_170511B	104		_170511B			_170511B			A
1	PL170516-1	LCS	1000	500	ml	pCi/l	_170511L	105		_170511L			_170511L			B

JA 5/22/17

JA 5/22/17

Tracer/Carrier Solution Information

Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
T1	Po-209	1045.4243.07		22.087	DPM/ml	05/16/17	1	ml	AW026

Spike Solution Information

Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
S1	Pb-210	899.4095.66		95.129	DPM/ml	05/16/17	0.25	ml	AW016
S1	Po-210	899.4095.66		95.129	DPM/ml	05/16/17	0.25	ml	AW016

Sample Barcodes

1705158-1
PL170516-1PS1

1705177-1
PL170516-1PS2

1705177-2
PL170516-1PS3

1705177-3
PL170516-1PS4

1705202-1
PL170516-1PS5

1705203-1
PL170516-1PS6

1705237-1
PL170516-1PS7

1705240-1
PL170516-1PS8

1705242-1
PL170516-1PS9

1705243-1
PL170516-1PS10

1705269-4
PL170516-1PS11

1705269-4DUP
PL170516-1PS12

ALS -- Fort Collins

Radiochemistry Instrument Worksheet

Prep Batch: PL170516-1

Prep Procedure: Po210

Analytical QASS / NCR? Y / N _____

Prep Num	LabID	QC Type	Init Alq	Fin Alq	Units	Report Units	Cnt 1 File	Cnt 1 Inst/Det	Cnt 1 Pos Chk By	Cnt 2 File	Cnt 2 Inst/Det	Cnt 2 Pos Chk By	Cnt 3 File	Cnt 3 Inst/Det	Cnt 3 Pos Chk By	Notes
1705319-4 PL170516-1PS13										PL170516-1MB PL170516-1PS14						PL170516-1LCS PL170516-1PS15

Reporting Units

LabID	TstGrpName	RptUnits
1705243-1	Po210	pCi/l
1705242-1	Po210	pCi/l
1705240-1	Po210	pCi/l
1705237-1	Po210_USGS	pCi/l
1705203-1	Po210	pCi/l
1705202-1	Po210	pCi/l
1705177-1	Po210	pCi/l
1705158-1	Po210	pCi/l
1705177-2	Po210	pCi/l
1705177-3	Po210	pCi/l
1705319-4	Po210_USGS	pCi/l
1705269-4	Po210_USGS	pCi/l

Radiochemistry Prep Worksheet

ALS -- Fort Collins

Prep Batch: PL170516-1

Prep Procedure: Po210

Reviewed By: jsj JSJ **Review Date:** 5/18/2017

Non-Routine Pre-Treatment? Y / (N) **Batch:** N/A **Re-Prep? Y / (N)** **Batch:** N/A **Prep QASS / NCR? (Y) / N** 421943

Prep SOP: PAI 711 **Rev:** 10
Prep SOP: NONE
Matrix Class: liquid

Prep Analyst: Jeremy S. Jones JSJ
Prep Date: 5/16/2017
Prep Dept: AP

Balance:
Balance:

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Alq ml	Fin Alq ml	Prep Basis	Total Digestate Vol(ml)	Digestate Vol Taken(ml)	Decay Date/Time	Standards	Prep Notes
1	1	1705158-1	SMP		50	25	Unfiltered	0	0	05/17/17 15:50	T1	
2	1	1705177-1	SMP		50	25	Filtered	0	0	05/17/17 15:50	T1	
3	1	1705177-2	SMP		50	25	Filtered	0	0	05/17/17 15:50	T1	
4	1	1705177-3	SMP		50	25	Filtered	0	0	05/17/17 15:50	T1	
5	1	1705202-1	SMP		50	25	Filtered	0	0	05/17/17 15:50	T1	
6	1	1705203-1	SMP		50	25	Unfiltered	0	0	05/17/17 15:50	T1	
7	1	1705237-1	SMP		187.7551	93.87755	As Received	980	200	05/17/17 15:50	T1	
8	1	1705240-1	SMP		50	25	Unfiltered	0	0	05/17/17 15:50	T1	
9	1	1705242-1	SMP		50	25	Unfiltered	0	0	05/17/17 15:50	T1	
10	1	1705243-1	SMP		50	25	Filtered	0	0	05/17/17 15:50	T1	
11	1	1705269-4	SMP		188	94	As Received	1000	200	05/17/17 15:50	T1	
12	1	1705269-4	DUP		188	94	As Received	1000	200	05/17/17 15:50	T1	
13	1	1705319-4	SMP		188	94	As Received	1000	200	05/17/17 15:50	T1	
14	1	PL170516-1	MB		1000	500	As Received	0	0	05/17/17 15:50	T1	
15	1	PL170516-1	MB		1000	500	Unfiltered	0	0	05/17/17 15:50	T1	
16	1	PL170516-1	LCS		1000	500	As Received	0	0	05/17/17 15:50	T1,S1	
17	1	PL170516-1	LCS		1000	500	Unfiltered	0	0	05/17/17 15:50	T1,S1	

JSJ 5/18/17

Comments
Due to potential matrix interferences, reduced aliquots were taken.

Spiked By: Jeremy S. Jones **Date:** 5/16/2017

Witnessed By: Hunter C. Jordan **Date:** 5/16/2017

Tracer/Carrier Solution Information

Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
T1	Po-209	1045.4243.07		22.087	DPM/ml	05/16/17	1	ml	AW026

Spike Solution Information

Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
S1	Pb-210	899.4095.66		95.129	DPM/ml	05/16/17	0.25	ml	AW016
S1	Po-210	899.4095.66		95.129	DPM/ml	05/16/17	0.25	ml	AW016

Radiochemistry Prep Worksheet

ALS -- Fort Collins

Prep Batch: PL170516-1

Prep Procedure: Po210

Prep Batch Not Validated!!!

Reviewed By:

Review Date:

Non-Routine Pre-Treatment? Y / N **Batch:** _____ **Re-Prep? Y / N** **Batch:** _____ **Prep QASS / NCR? Y / N** _____

Prep SOP: PAI 711 **Rev:** 10
Prep SOP: NONE
Matrix Class: liquid

Prep Analyst: Jeremy S. Jones
Prep Date: 5/16/2017
Prep Dept: AP

Balance:
Balance:

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Alq ml	Fin Alq ml	Prep Basis	Total Digestate Vol(ml)	Digestate Vol Taken(ml)	Decay Date/Time	Standards	Prep Notes
1	1	1705158-1	SMP		50	50	Unfiltered	0	0	5/17/17 1550	T1	
2	1	1705177-1	SMP		50	50	Unfiltered	0	0		T1	
3	1	1705177-2	SMP		50	50	Unfiltered	0	0		T1	
4	1	1705177-3	SMP		50	50	Unfiltered	0	0		T1	
5	1	1705202-1	SMP		50	50	Unfiltered	0	0		T1	
6	1	1705203-1	SMP		50	50	Unfiltered	0	0		T1	
7	1	1705237-1	SMP		920	187.7551	As Received	980	200		T1	
8	1	1705240-1	SMP		50	50	Unfiltered	0	0		T1	
9	1	1705242-1	SMP		50	50	Unfiltered	0	0		T1	
10	1	1705243-1	SMP		50	50	Unfiltered	0	0		T1	
11	1	1705269-4	SMP		940	188	As Received	1000	200		T1	
12	1	1705269-4	SMP		940	188	Unfiltered	1000	200		T1	
13	1	1705269-4	DUP		940	188	As Received	1000	200		T1	
14	1	1705269-4	DUP		940	188	Unfiltered	1000	200		T1	
15	1	1705319-4	SMP		940	188	As Received	1000	200		T1	
16	1	PL170516-1	MB		1000	1000	As Received	0	0		T1	
17	1	PL170516-1	MB		1000	1000	Unfiltered	0	0		T1	
18	1	PL170516-1	LCS		1000	1000	As Received	0	0		T1,S1	
19	1	PL170516-1	LCS		1000	1000	Unfiltered	0	0		T1,S1	

Comments

Due to potential matrix interferences, reduced aliquots were taken.

Spiked By: JSJ **Date:** 5/16/17

Witnessed By: HCS **Date:** 5/16/17

Tracer/Carrier Solution Information

Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
T1	Po-209	1045.4243.07	8-3-17	22.087	DPM/ml	05/16/17	1	ml	AW026

Spike Solution Information

Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
S1	Pb-210	899.4095.66	10-21-2017	95.129	DPM/ml	05/16/17	0.25	ml	AW016
S1	Po-210	899.4095.66	↓	95.129	DPM/ml	05/16/17	0.25	ml	AW016

Sample Condition Form (Liquid)

Analyst: JSJ

Analysis Date: 5/16/17 Method: Prep

		Sample Condition (Visual Appearance of Analysis Aliquot at Time of Prep)		
Work Order	Sample ID	pH	Color	Remarks
1705158	1	12	Clear	None
1705177	1			Smelly sample (Sediment fluted filtered)
↓	2			↓
↓	3			↓
1705202	1			Sediment fluted filtered
1705203	1			None
1705240	1			↓
1705242	1			↓
17052413	1			Sediment fluted filtered
1705237	1			None
1705269	4			↓
1705319	4	↓	↓	↓
				JSJ
				5/16/17

I:\Oprtns\RAD\FORMS\sample condition form (Liquid)

Batch: PL170516-1

Po Solid

Reagent	Lot #
1N Hydrochloric Acid	L04039
Ascorbic Acid	K09637, K37647
Amyl Acetate	K09465
Flexible Colloidian	G19602

Po Liquid

Reagent	Lot #
Conc. Hydrochloric Acid	L09031
1N Hydrochloric Acid	L04039
Ascorbic Acid	K09637, K37647
Amyl Acetate	K09465
Flexible Colloidian	G19602

Section 8

STANDARDS TRACEABILITY DOCUMENTS

TE 7/31/16

Prepare a working dilution of RSO# 1045

1. Density of 2M HCl, lot # 0000128723
   Mass of 100mL vol. flask: 56.4426g Balance # 12
   Mass of flask & 100mL acid: 159.7513g Balance# 12
   Net Mass: 103.3087g
   Density: 1.03309g/mL

2. Mass of RSO#1045 transferred:
   Mass of open empty nalgene: 74.8232g Balance# 12
   Mass of nalgene & standard: 79.8830g Balance# 12
   Net mass of standard transferred: 5.0598g

TE 7/31/16 TE 7/31/16

3. Dilute to final volume:
   Mass of nalgene, standard, & diluent: 1171.2g Balance# 26
   Mass of empty nalgene (from above): 74.8232g Balance# 12
   Net mass of new dilution: 1096.3768g

4. Final activity calculation:

$$400.3\,Bq\,\frac{(1.03309\,g/mL)}{(1096.3768\,g)}\,\frac{(5.0598\,g)}{(5.1515\,g)}\,\frac{(60\,dpm/1\,Bq)}{} = 22.23\,dpm/mL$$

TE 7/31/16

Stnd ID: **1045.4243.07**

Description:	**Po-209**	
Expiration:	**8/3/2017**	
Activity:	**22.23**	**dpm/ml**
2s Uncertainty:	**0.44**	**dpm/ml**
Ref. Date:	**6/8/2016**	
Ref Time:	**N/A**	
Prep Date:	**7/31/2016**	***Prep by:*** **TE**
Matrix/Comp.	**2.0 M HCl**	
Half Life (y):	**1.02E+02**	

Reverification Log

Analysis Date	Initials	Expiration Date

Continued on Page

TE Signed 7/31/16 Date Read and Understood By Signed 08/08/16 Date

RSO # 1049 Rec'd 6-10-16

Eckert & Ziegler
Analytics

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

CERTIFICATE OF CALIBRATION
Standard Reference Source

SRS Number: 103361
Source Description: 5 mL Liquid in Flame Sealed Vial
Product Code: 8209
Customer: ALS Laboratory Group
P.O. Number: FC001053, Item 1

This standard radionuclide source was prepared gravimetrically from a master solution calibrated by Eckert & Ziegler Analytics (EZA). The master solution was calibrated by liquid scintillation counting. Radionuclide calibration and purity were checked by germanium gamma-ray spectrometry, liquid scintillation counting, and/or alpha spectrometry, as applicable. The nuclear decay rate and reference date for this source are given below. EZA maintains traceability to the National Institute of Standards and Technology (NIST) through a Measurements Assurance Program as described in USNRC Regulatory Guide 4.15, Revision 2, July 2007, and compliance with ANSI N42.22-1995, "Traceability of Radioactive Sources to NIST."

Reference Date: 08-June-2016 12:00 PM EST

Isotope	Half-Life, d	Activity, Bq	Uncertainty u_A, %	Uncertainty u_B, %	Uncertainty U, %*	Calibration Method**
Po-209	3.726E+04	4.003E+02	0.3	1.0	2.0	4π LS

***Uncertainty:** U - Relative expanded uncertainty, k = 2. See NIST Technical Note 1297, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results." ****Calibration Methods:** 4π LS - 4π Liquid Scintillation Counting, HPGe - High Purity Germanium Gamma-Ray Spectrometer, IC - Ionization Chamber.

(Certificate continued on reverse side)

SRS Number: 103361

Comments:

5.15159 g 2 M HCl solution, carrier free

Impurities:

γ-impurities < 0.1%, α-impurities < 0.1%

This source was wipe tested in its inactive areas with leak test results < 185 Bq (5 nCi) of removable activity per ISO 9978:1992.

Source Prepared by: _____

K. Eardley, Radiochemist

QC Approved by: _____ Date: 02-JUN-16

J. Lahr, Spectroscopist

Project Pb-210 899.4095.66 working standard

Continued from Page

TE 12/8/14

Prepare a working dilution of 899.3610.42

1. Density of 1M HNO_3, lot # 000008417G
   Mass of 100mL vol. flask: 56.4468g Balance # 12
   Mass of flask & 100mL acid: 159.4521g Balance# 12
   Net Mass: 103.0053g
   Density: 1.0301 g/mL

2. Mass of 899.3610.42 transferred:
   Mass of open empty nalgene: 74.5139g Balance# 12
   Mass of nalgene & standard: 77.1985g Balance# 12
   Net mass of standard transferred: 2.6846g Balance# NA

TE 12/8/14

TE 12/8/14

3. Dilute to final volume:
   Mass of nalgene, standard, & diluent: 1147.7g Balance# 26
   Mass of empty nalgene (from above): 74.5139g Balance# 12
   Net mass of new dilution: 1073.186g Balance# NA

4. Final activity calculation:

$$46{,}996.4\ \text{dpm/g} \times \frac{(1.0301\ \text{g/mL})(2.6846\ \text{g})}{(1073.186\ \text{g})} = 121.10\ \text{dpm/mL}$$

TE 12/8/14

JP 11/3/15

Stnd ID: **899.4095.66**

Description:	**Pb-210**	
Expiration:	**10/26/2016**	
Activity:	**121.10**	**dpm/ml**
2s Uncertainty:	**3.39**	**dpm/ml**
Ref. Date:	**8/10/2009**	
Ref Time:	**N/A**	
Prep Date:	**12/8/2014**	***Prep by:*** **TE**
Matrix/Comp.	**1 M HNO3**	
Half Life (y):	**2.22E+01**	

Reverification Log

Analysis Date	Initials	Expiration Date
10/21/2016	JP	10/21/2017

JP 11/3/15

Continued on Page

1 Elut 12/8/14 Read and Understood By 11/3/15

Signed Date Signed Date

Eckert & Ziegler
Analytics

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

RSO# 899 rec 8-14-09

CERTIFICATE OF CALIBRATION
Standard Radionuclide Source

80328-307

Pb-210 5 mL Liquid in Flame Sealed Vial

Customer: ALS Laboratory Group / Fort Collins
P.O. No.: 73625 07-24-09, Item 1

This standard radionuclide source was prepared gravimetrically from a calibrated master solution. The master solution was calibrated by liquid scintillation counting. Radionuclide purity and calibration were checked by germanium gamma-ray spectrometry and liquid scintillation counting. The nuclear decay rate and assay date for this source are given below. Eckert & Ziegler Analytics (EZA) maintains traceability to the National Institute of Standards and Technology through a Measurements Assurance Program as described in USNRC Regulatory Guide 4.15, Revision 1, February, 1979, and compliance with ANSI N42.22-1995, "Traceability of Radioactive Sources to NIST." EZA is accredited by the Health Physics Society (HPS) for the production of NIST-traceable sources, and this source was produced in accordance with the HPS accreditation requirements. Customers may report any concerns with the accreditation program to the HPS Secretariat, 1313 Dolley Madison Blvd., Ste. 402, McLean, VA 22101.

Isotope	Half-Life, Days	Activity (Bq)	Uncertainty* , % Type u_A	u_B	U	Reference Date (12:00 PM EST)
Pb-210	8145.1	4.078E+04	0.1	1.4	2.8	08/10/2009

***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: gamma-impurities <0.1%, alpha-impurities (other than decay products) <0.01%. 52.06357 grams 1M HNO3 solution, carrier free.

Source Prepared by: N. Kasate
N. E. Kasate, Radiochemist

QA Approved: D.M. Montgomery
D. M. Montgomery, QA Manager

Date: 8-13-09

ACCREDITED SOURCE CALIBRATION LABORATORY — HEALTH PHYSICS SOCIETY — FOUNDED 1956

Section 9

ADDITIONAL SUPPORTING DOCUMENTATION

Alpha Spectroscopy

Quality Control Data

Weekly Background, Energy, and Efficiency Calibrations

Calibration Data Summary

Laboratory Name: ALS -- Fort Collins
PAI Work Order: 1705202

Prep SOP: PAI 711
Analytical SOP: PAI 714

Reported on: Friday, May 19, 2017 4:01:40 PM

Lab Sample ID Spectrum Analysis Date	QC Type	Batch ID Analysis Run	Test Name	Detector Id	Eff Spectrum Bkg Spectrum Egy Spectrum	Eff Date Bkg Date Egy Date	**RESULTS** %Efficiency Bkg CPM Energy keV	FLAGS Efficiency Background Energy	**LCL** %Efficiency Bkg CPM Energy keV	**LWL** %Efficiency Bkg CPM Energy keV	**UWL** %Efficiency Bkg CPM Energy keV	**UCL** %Efficiency Bkg CPM Energy keV
1705202-1	SMP	PL170516-1	Po210	72	C17051072	5/10/2017	30.84	Pass	28.94	29.51	31.53	32.05
Spectrum #1		PL170516-1A			B17051072	5/10/2017	0.0210	Pass	0.0000	0.0100	0.1000	0.1500
5/18/2017					C17051072	5/10/2017	5567.7	Pass	5517.7	5527.7	5607.7	5617.7
PL170516-1	MB	PL170516-1	Po210	104	C170509104A	5/9/2017	33.46	Pass	31.21	31.77	33.94	34.50
Spectrum #1		PL170516-1A			B170509104	5/9/2017	0.0180	Pass	0.0000	0.0100	0.1000	0.1500
5/18/2017					C170509104A	5/9/2017	5555.8	Pass	5506.0	5516.0	5596.0	5606.0
PL170516-1	LCS	PL170516-1	Po210	105	C170509105	5/9/2017	32.34	Pass	31.09	31.65	33.81	34.37
Spectrum #1		PL170516-1A			B170509105	5/9/2017	0.0160	Pass	0.0000	0.0100	0.1000	0.1500
5/18/2017					C170509105	5/9/2017	5555.8	Pass	5506.0	5516.0	5596.0	5606.0

Data Package ID: *PL1705202-1*

Abbreviations:
Eff - Efficiency; Bkg - Background; LCL - Lower Control Limit; UWL - Upper Warning Limit
Egy - Energy; CPM - Counts per Minute; LWL - Lower Warning Limi; UCL - Upper Control Limit; CI - The Analysis Date exceeds the Calibration Date by more than 14 days.

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Alpha Spec Calibration Source Re-Certification

Recalibration performed by Isotope Products Laboratories

Primary Certified Source

Source PA ID: 190
Planchet Label: 9
Recalibrated on: 10/4/2016
Received by ALS on: 10/18/2013

Values from certificate		
Source ID:	92MIX223027	
Total Activity:	3745.2	dpm
Ref. Date:	10/15/2013	

Nuclide	Act (Bq)	Act (dpm)	Half-Life (yrs)	Decay Corrected
U-234:	49.54	2972.4	2.48E+05	2972.38 dpm
U-235:	1.09	65.58	7.04E+08	65.58 dpm
Am-241:	11.79	707.4	432.17	704.04 dpm
			TOTAL	3741.99 dpm

Efficiency Determination for Detector: 129

Source Serial#	PA ID	Sequential #	Count Date	Am-241 net cts	U-234 net cts	U-235 net cts	count dur (s)	Total cpm	Known dpm	Detector efficiency
92MIX223027	190	97-19-103-09	10/4/16	7502	32112	1070	2100	1162.40	3741.99	31.06%

Sources 1 through 8 activity determination

Source Serial#	PA ID	Sequential #	Count Date	Am-241 net cts	U-234 net cts	U-235 net cts	count dur (s)	Detector Efficiency	**Am-241 dpm**	**U-234 dpm**	**U-235 dpm**	**Combined dpm**
92MIX2203026	182	97-19-103-01	10/4/16	12981	79837	2777	2100	31.06%	**1193.95**	**7343.17**	**255.42**	**8792.54**
92MIX2203028	183	97-19-103-02	10/4/16	15085	148128	3863	2100	31.06%	**1387.47**	**13624.37**	**355.31**	**15367.15**
92MIX2203024	184	97-19-103-03	10/4/16	67474	70483	2608	2100	31.06%	**6206.06**	**6482.82**	**239.88**	**12928.75**
92MIX2203021	185	97-19-103-04	10/4/16	21961	60440	2557	2100	31.06%	**2019.91**	**5559.09**	**235.19**	**7814.18**
92MIX2203025	186	97-19-103-05	10/4/16	97883	114458	3780	2100	31.06%	**9002.99**	**10527.51**	**347.67**	**19878.16**
92MIX2203022	187	97-19-103-06	10/4/16	72777	79883	2564	2100	31.06%	**6693.81**	**7347.40**	**237.67**	**14278.88**
92MIX2203023	188	97-19-103-07	10/4/16	43617	68953	2043	2100	31.06%	**4011.76**	**6342.09**	**187.91**	**10541.76**
92MIX2203029	189	97-19-103-08	10/4/16	33966	214074	7195	2100	31.06%	**3124.09**	**19689.89**	**661.77**	**23475.75**

Efficiency Verification

Source Serial#	PA ID	Sequential #	Count Date	Am-241 net cts	U-234 net cts	U-235 net cts	Count dur (s)	Total cpm	Known dpm	Detector efficiency	RPD	FLAG
92MIX223027	190	97-19-103-09	10/5/16	7807	32611	1278	2100	1191.31	3741.99	31.84%	-2.46%	**PASS**

Sources 1 through 8 activity re-verification

Source Serial#	PA ID	Sequential #	Combined Obseved dpm	Combined Certified dpm*	Percent Difference %	Within 5% of Certified value?
92MIX2203026	182	97-19-103-01	8792.54	8849.86	-0.65%	**Yes**
92MIX2203028	183	97-19-103-02	15367.15	15992.35	-3.91%	**Yes**
92MIX2203024	184	97-19-103-03	12928.75	13503.77	-4.26%	**Yes**
92MIX2203021	185	97-19-103-04	7814.18	8161.24	-4.25%	**Yes**
92MIX2203025	186	97-19-103-05	19878.16	20979.95	-5.25%	**No**
92MIX2203022	187	97-19-103-06	14278.88	15285.63	-6.59%	**No**
92MIX2203023	188	97-19-103-07	10541.76	10723.95	-1.70%	**Yes**
92MIX2203029	189	97-19-103-08	23475.75	23593.84	-0.50%	**Yes**

* Certificate values decay corrected to the count date

Data from certificates

Reference Date	U-234 (Bq)	U-234 (dpm)	U-235 (Bq)	U-235 (dpm)	Am-241 (Bq)	Am-241 (dpm)
5/1/2003	124.10	7446.00	2.43	145.74	21.43	1285.80
5/1/2003	239.30	14358.00	4.20	252.00	23.55	1413.00
5/1/2003	119.40	7164.00	1.93	115.56	106.00	6360.00
4/1/2003	101.00	6060.00	1.26	75.84	34.50	2070.00
4/1/2003	203.00	12180.00	3.41	204.72	146.40	8784.00
4/1/2003	132.90	7974.00	3.17	189.96	121.30	7278.00
4/1/2003	107.10	6426.00	0.93	55.54	72.26	4335.60
5/1/2003	334.80	20088.00	6.55	393.18	53.02	3181.20

OK JP 10/5/16

Expires 10/4/2017

AlphaVision v6.0 **Alpha-Spectroscopy Calibration Report**

Analyst: ORTEC

Detector: 129 9:14:40AM 10/5/2016

Calibration

Energy Calibration: SOURCE190_10.04.16 (#9)
Description:

Analysis Date: 10/4/2016 12:09:56PM
Calibration Type: Energy And Efficiency

Source Info

Certificate ID: A9 RSO#190
Prepared by: Isotope Product Laboratories
Description:

Certification Date: 10/15/2013 10:44:40AM

Acquisition

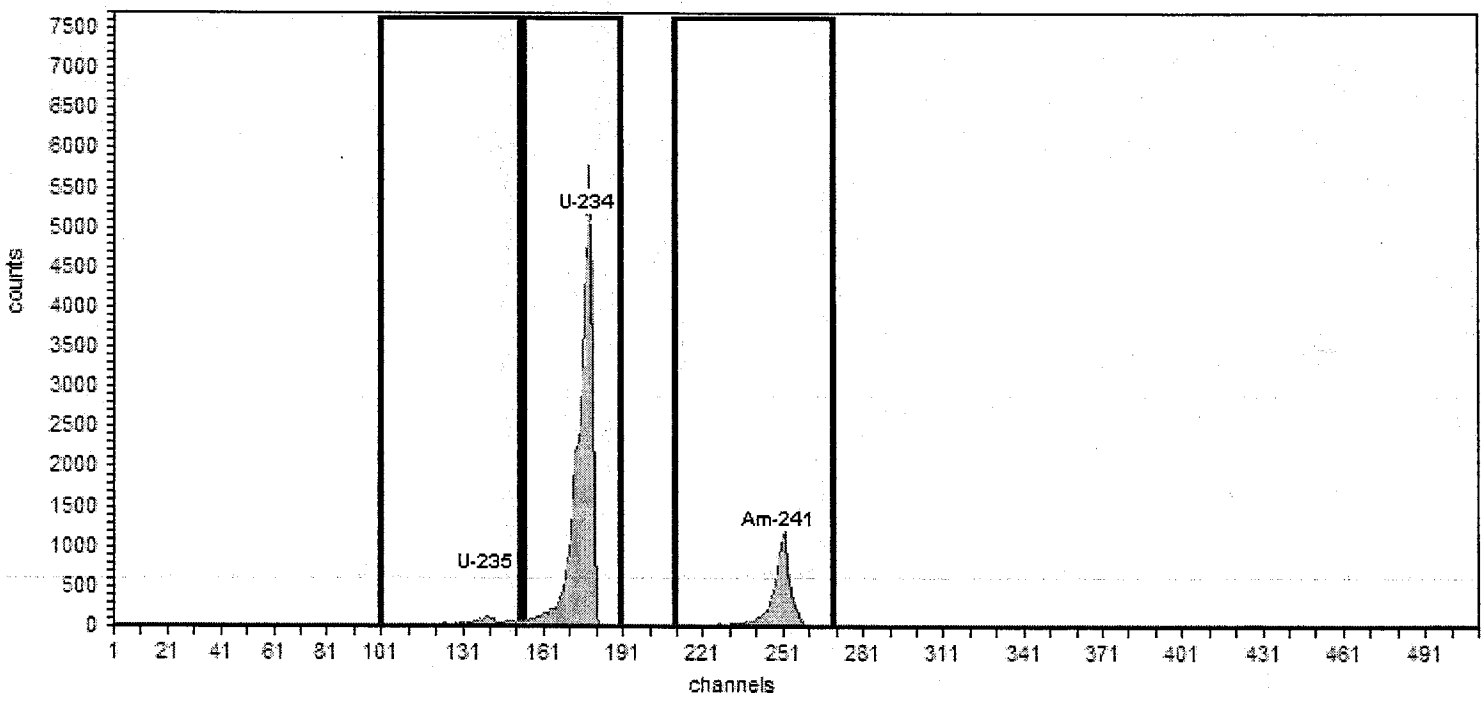
Detector: 129, SN:5505430, ID: 129
Acquisition Start Date: 10/4/2016 11:26:06AM

Live Time: 35.00 min.
Real Time: 35.01 min.

Efficiency Calibration Name: SOURCE190_10.04.16 (#9)

Energy Calibration Equation:
Gain = 9.9003 keV / Ch
Offset = 3,021.28 keV
Quadratic = 0.0000 keV / Ch²

Efficiency: 33.86% +/- 1.39% TPU(2 sigma)



General Analysis

Method: Manual (ROI)
Algorithm: Linear

Initial Calibration: Yes
Shelf: 0

Nuclide Activity Summary

Nuclide	Peak Channel	Peak Energy keV	ROI Start Channel	ROI End Channel	Peak FWHM keV	Gross Counts	Net Count Rate (cpm)
U-235	139	4,396.00	100	152	0.00	1,070.00	33.71
U-234	177	4,775.80	153	190	68.12	32,112.00	953.94
Am-241	249	5,485.70	210	270	71.83	7,502.00	221.80

JP 10/4/16

AlphaVision v6.0 *Alpha-Spectroscopy Calibration Report*

Analyst: ORTEC

Detector: 129 12:49:08PM 10/4/2016

Calibration

Energy Calibration: SOURCE182_10.04.16 (#1)
Description:

Analysis Date: 10/4/2016 12:47:23PM
Calibration Type: Energy And Efficiency

Source Info

Certificate ID: A1 RSO#182
Prepared by: Isotope Product Laboratories
Description:

Certification Date: 5/1/2003 10:27:02AM

Acquisition

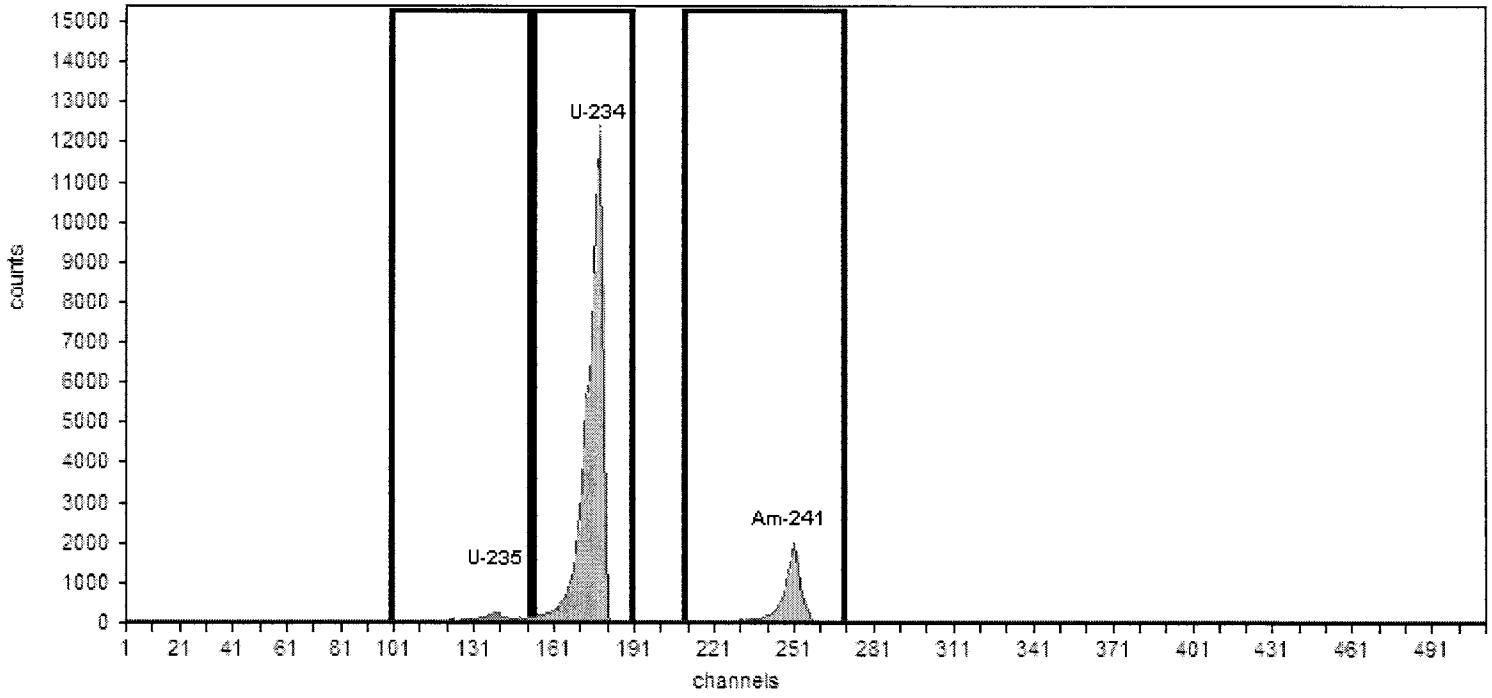
Detector: 129, SN:5505430, ID: 129
Acquisition Start Date: 10/4/2016 12:11:42PM

Live Time: 35.00 min.
Real Time: 35.02 min.

Efficiency Calibration Name: SOURCE182_10.04.16 (#1)

Energy Calibration Equation:
Gain = 9.9003 keV / Ch
Offset = 3,021.28 keV
Quadratic = 0.0000 keV / Ch^2

Efficiency: 33.04% +/- 2.03% TPU(2 sigma)



General Analysis

Method: Manual (ROI)
Algorithm: Linear

Initial Calibration: Yes
Shelf: 0

Nuclide Activity Summary

Nuclide	Peak Channel	Peak Energy keV	ROI Start Channel	ROI End Channel	Peak FWHM keV	Gross Counts	Net Count Rate (cpm)
U-235	139	4,396.00	100	152	84.43	2,777.00	79.34
U-234	177	4,775.80	153	190	71.29	79,837.00	2,281.06
Am-241	249	5,485.70	210	270	72.86	12,981.00	370.89

JM 10/4/16

AlphaVision v6.0 **Alpha-Spectroscopy Calibration Report**

Analyst: ORTEC

Detector: 129 1:25:35PM 10/4/2016

Calibration

Energy Calibration: SOURCE183_10.04.16 (#2)
Description:

Analysis Date: 10/4/2016 1:25:29PM
Calibration Type: Energy And Efficiency

Source Info

Certificate ID: A2 RSO#183
Prepared by: Isotope Product Laboratories
Description:

Certification Date: 5/1/2003 10:33:40AM

Acquisition

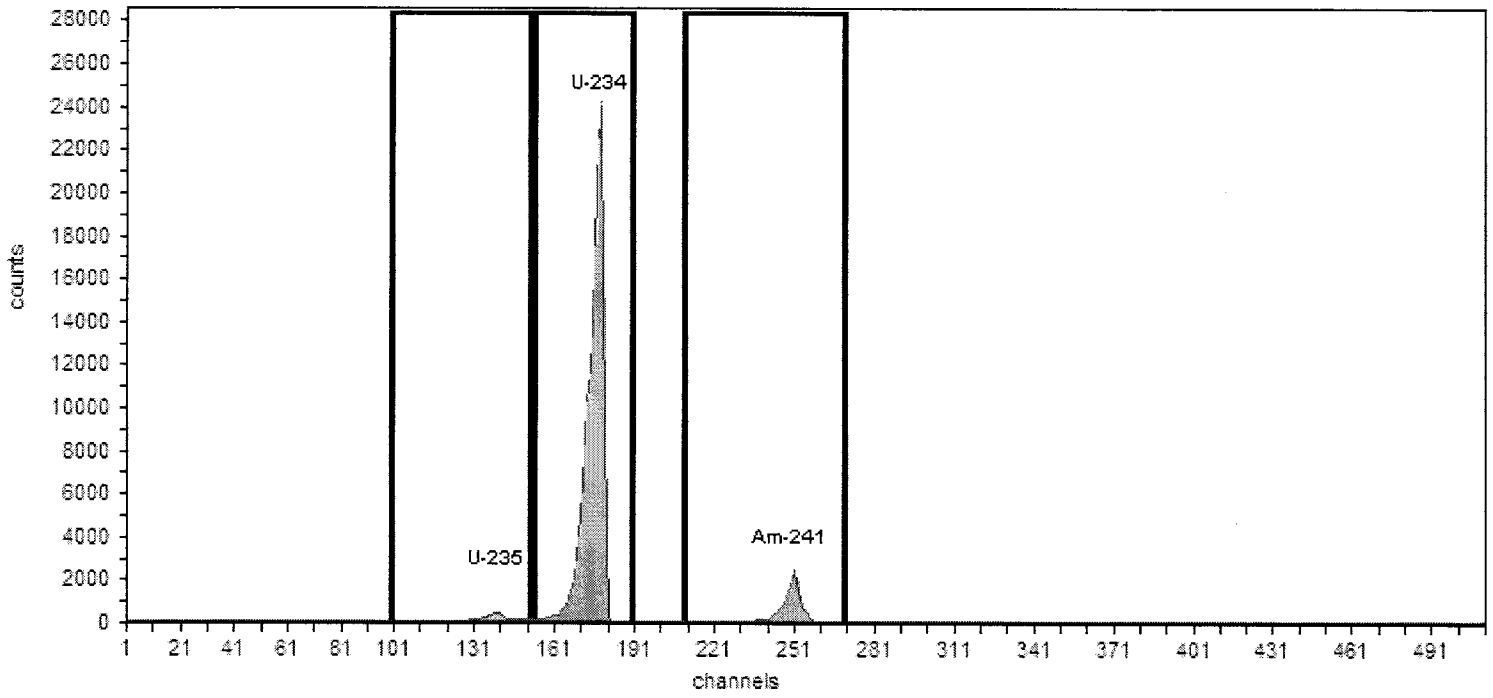
Detector: 129, SN:5505430, ID: 129
Acquisition Start Date: 10/4/2016 12:49:04PM

Live Time: 35.00 min.
Real Time: 35.03 min.

Efficiency Calibration Name: SOURCE183_10.04.16 (#2)

Energy Calibration Equation:
Gain = 9.9003 keV / Ch
Offset = 3,021.28 keV
Quadratic = 0.0000 keV / Ch²

Efficiency: 32.74% +/- 1.25% TPU(2 sigma)



General Analysis

Method: Manual (ROI)
Algorithm: Linear

Initial Calibration: Yes
Shelf: 0

Nuclide Activity Summary

Nuclide	Peak Channel	Peak Energy keV	ROI Start Channel	ROI End Channel	Peak FWHM keV	Gross Counts	Net Count Rate (cpm)
U-235	139	4,396.00	100	152	75.93	3,863.00	110.37
U-234	177	4,775.80	153	190	69.70	148,128.00	4,232.23
Am-241	249	5,485.70	210	270	73.20	15,085.00	431.00

JP 10/4/16

AlphaVision v6.0 **Alpha-Spectroscopy Calibration Report**

Analyst: ORTEC

Detector: 129 2:17:25PM 10/4/2016

Calibration

Energy Calibration: SOURCE184_10.04.16 (#3)
Description:

Analysis Date: 10/4/2016 2:16:56PM
Calibration Type: Energy And Efficiency

Source Info

Certificate ID: A3 RSO#184
Prepared by: Isotope Product Laboratories
Description:

Certification Date: 5/1/2003 10:36:52AM

Acquisition

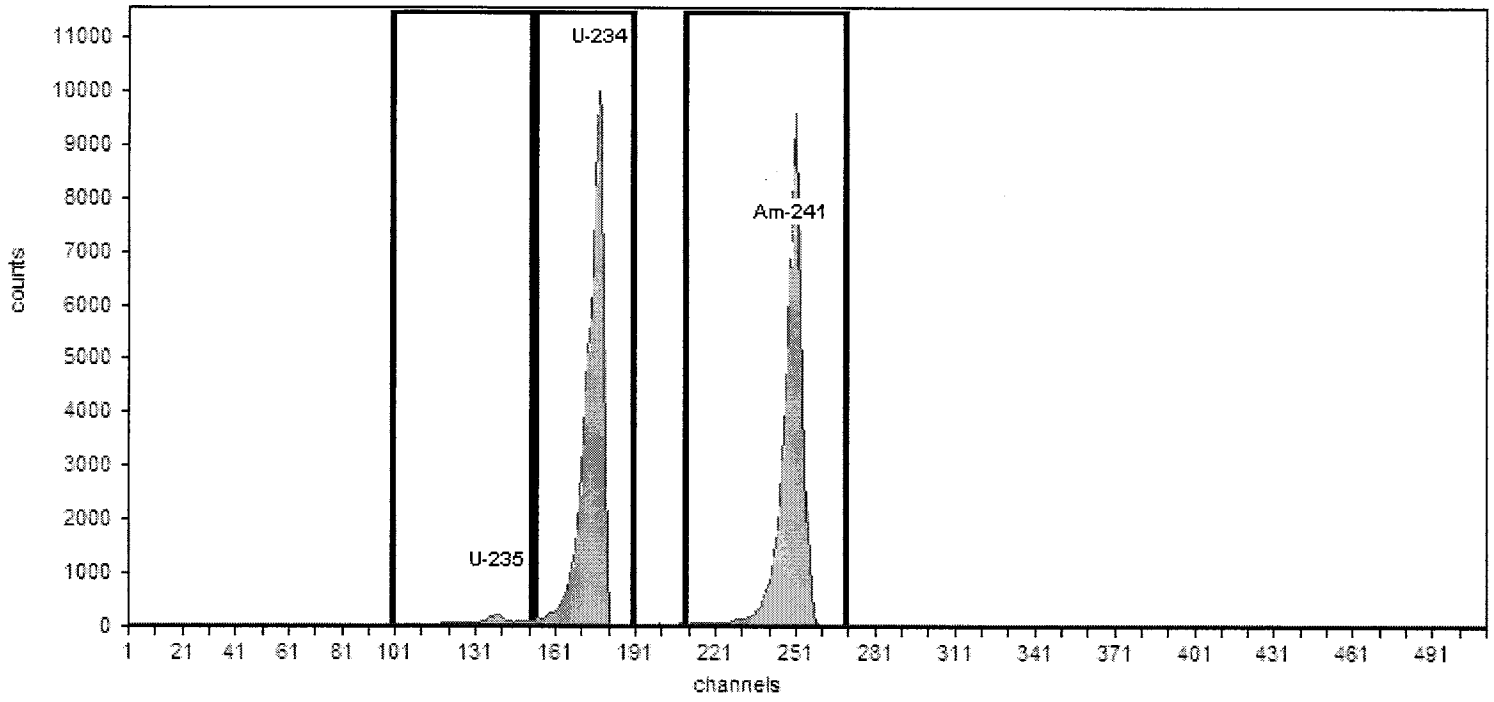
Detector: 129, SN:5505430, ID: 129
Acquisition Start Date: 10/4/2016 1:26:53PM

Live Time: 35.00 min.
Real Time: 35.03 min.

Efficiency Calibration Name: SOURCE184_10.04.16 (#3)

Energy Calibration Equation:
Gain = 9.9003 keV / Ch
Offset = 3,021.28 keV
Quadratic = 0.0000 keV / Ch²

Efficiency: 31.83% +/- 1.26% TPU(2 sigma)



General Analysis

Method: Manual (ROI)
Algorithm: Linear

Initial Calibration: Yes
Shelf: 0

Nuclide Activity Summary

Nuclide	Peak Channel	Peak Energy keV	ROI Start Channel	ROI End Channel	Peak FWHM keV	Gross Counts	Net Count Rate (cpm)
U-235	139	4,396.00	100	152	0.00	2,608.00	74.51
U-234	177	4,775.80	153	190	74.20	70,483.00	2,013.80
Am-241	249	5,485.70	210	270	74.76	67,474.00	1,927.83

JP 10/4/16

AlphaVision v6.0 **Alpha-Spectroscopy Calibration Report**

Analyst: ORTEC

Detector: 129 9:00:58AM 10/5/2016

Calibration

Energy Calibration: SOURCE185_10.04.16 (#4)
Description:

Analysis Date: 10/4/2016 2:53:33PM
Calibration Type: Energy And Efficiency

Source Info

Certificate ID: A4 RSO#185
Prepared by: Isotope Product Laboratories
Description:

Certification Date: 4/1/2003 10:38:09AM

Acquisition

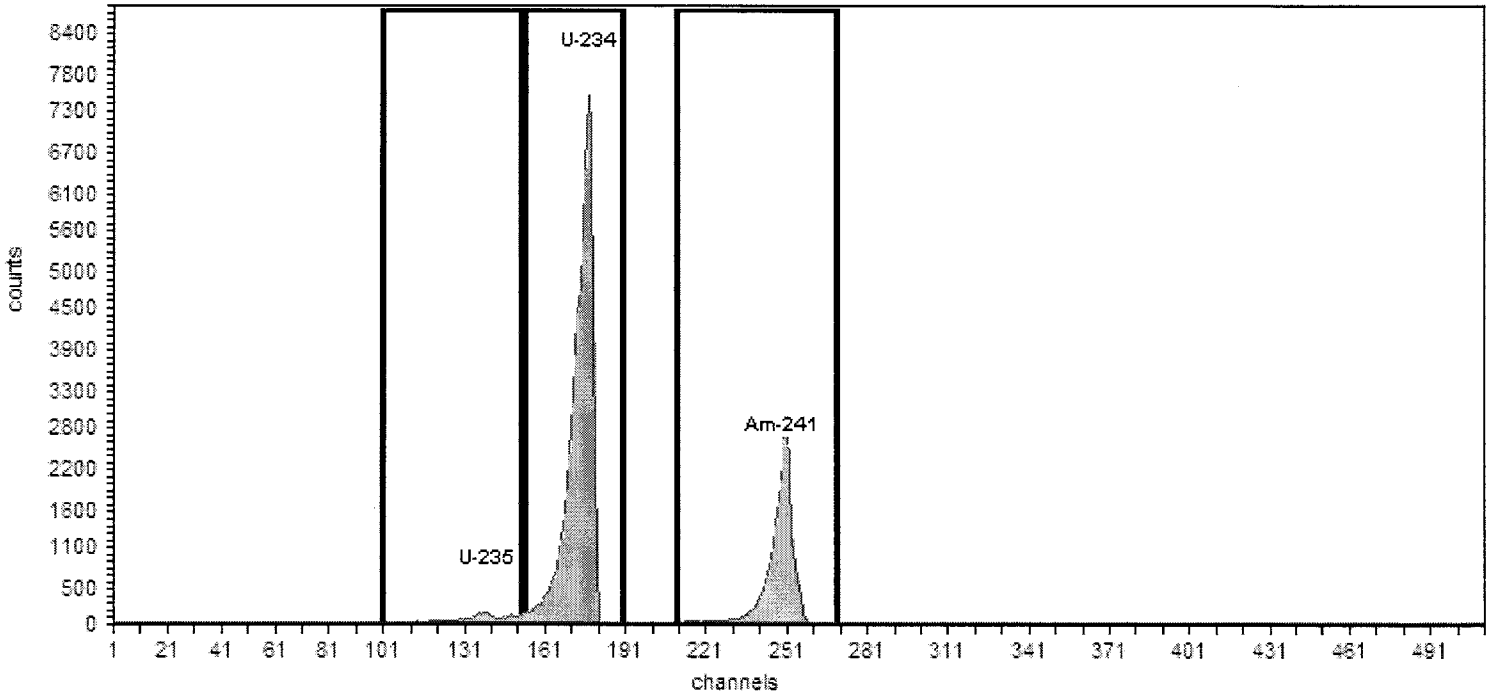
Detector: 129, SN:5505430, ID: 129
Acquisition Start Date: 10/4/2016 2:18:14PM

Live Time: 35.00 min.
Real Time: 35.02 min.

Efficiency Calibration Name: SOURCE185_10.04.16 (#4)

Energy Calibration Equation:
Gain = 9.9003 keV / Ch
Offset = 3,021.28 keV
Quadratic = 0.0000 keV / Ch²

Efficiency: 31.73% +/- 1.30% TPU(2 sigma)



General Analysis

Method: Manual (ROI)
Algorithm: Linear

Initial Calibration: Yes
Shelf: 0

Nuclide Activity Summary

Nuclide	Peak Channel	Peak Energy keV	ROI Start Channel	ROI End Channel	Peak FWHM keV	Gross Counts	Net Count Rate (cpm)
U-235	139	4,396.00	100	152	79.20	2,557.00	73.06
U-234	177	4,775.80	153	190	80.97	60,440.00	1,726.86
Am-241	249	5,485.70	210	270	77.99	21,961.00	627.46

JP 10/4/16

AlphaVision v6.0 **Alpha-Spectroscopy Calibration Report**

Analyst: ORTEC

Detector: 129 7:04:12AM 10/5/2016

Calibration

Energy Calibration: SOURCE188_10.04.16 (#7)
Description:

Analysis Date: 10/5/2016 7:03:07AM
Calibration Type: Energy And Efficiency

Source Info

Certificate ID: A7 RSO#188
Prepared by: Isotope Product Laboratories
Description:

Certification Date: 4/1/2003 10:42:01AM

Acquisition

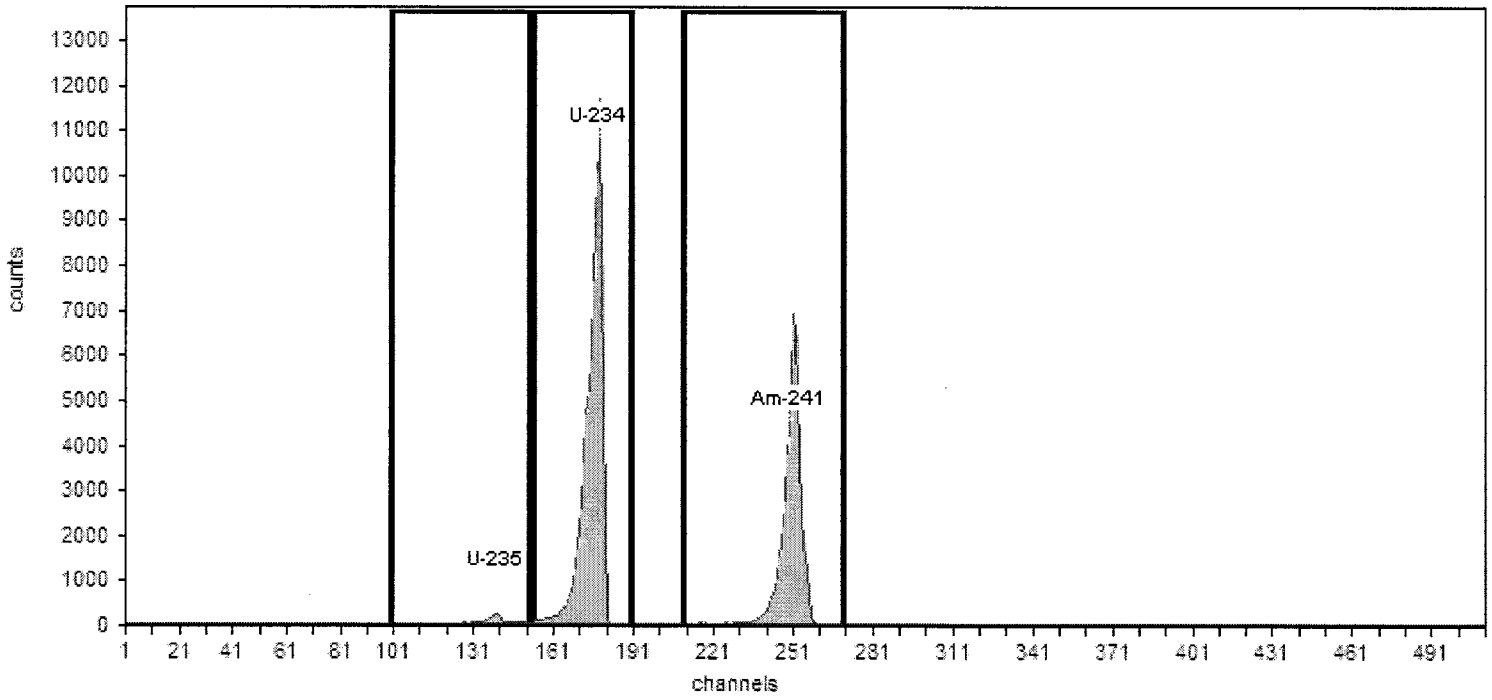
Detector: 129, SN:5505430, ID: 129
Acquisition Start Date: 10/5/2016 6:13:44AM

Live Time: 35.00 min.
Real Time: 35.02 min.

Efficiency Calibration Name: SOURCE188_10.04.16 (#7)

Energy Calibration Equation:
Gain = 9.9003 keV / Ch
Offset = 3,021.28 keV
Quadratic = 0.0000 keV / Ch²

Efficiency: 31.88% +/- 1.31% TPU(2 sigma)



General Analysis

Method: Manual (ROI)
Algorithm: Linear

Initial Calibration: Yes
Shelf: 0

Nuclide Activity Summary

Nuclide	Peak Channel	Peak Energy keV	ROI Start Channel	ROI End Channel	Peak FWHM keV	Gross Counts	Net Count Rate (cpm)
U-235	139	4,396.00	100	152	77.73	2,043.00	58.37
U-234	177	4,775.80	153	190	69.01	68,953.00	1,970.09
Am-241	249	5,485.70	210	270	71.83	43,617.00	1,246.20

10/4/16

AlphaVision v6.0 *Alpha-Spectroscopy Calibration Report*

Analyst: ORTEC
Detector: 129 7:44:05AM 10/5/2016

Calibration

Energy Calibration: SOURCE189_10.04.16 (#8)
Description:

Analysis Date: 10/5/2016 7:43:56AM
Calibration Type: Energy And Efficiency

Source Info

Certificate ID: A8 RSO#189
Prepared by: Isotope Product Laboratories
Description:

Certification Date: 5/1/2003 10:43:18AM

Acquisition

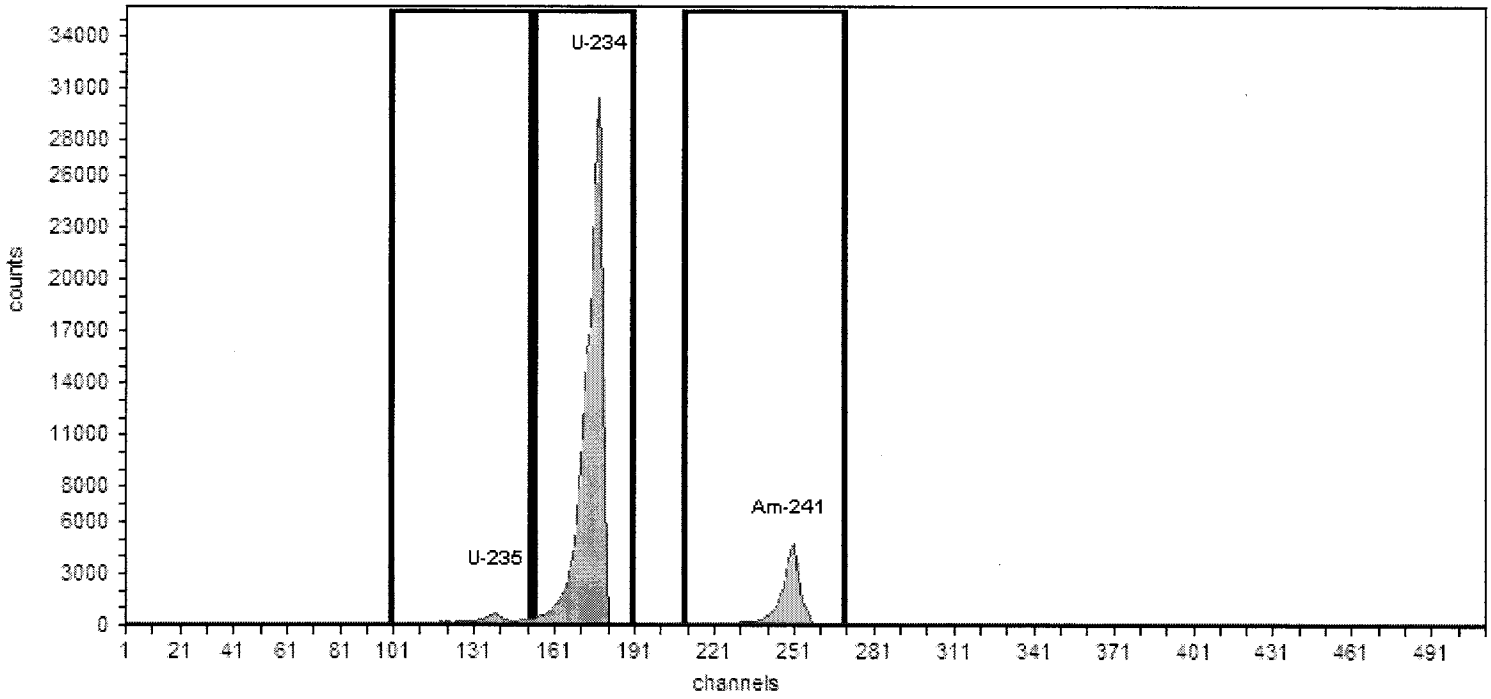
Detector: 129, SN:5505430, ID: 129
Acquisition Start Date: 10/5/2016 7:04:08AM

Live Time: 35.00 min.
Real Time: 35.05 min.

Efficiency Calibration Name: SOURCE189_10.04.16 (#8)

Energy Calibration Equation:
Gain = 9.9003 keV / Ch
Offset = 3,021.28 keV
Quadratic = 0.0000 keV / Ch²

Efficiency: 33.82% +/- 1.28% TPU(2 sigma)



General Analysis

Method: Manual (ROI)
Algorithm: Linear

Initial Calibration: Yes
Shelf: 0

Nuclide Activity Summary

Nuclide	Peak Channel	Peak Energy keV	ROI Start Channel	ROI End Channel	Peak FWHM keV	Gross Counts	Net Count Rate (cpm)
U-235	139	4,396.00	100	152	87.84	7,195.00	205.57
U-234	177	4,775.80	153	190	74.72	214,074.00	6,116.40
Am-241	249	5,485.70	210	270	74.87	33,966.00	970.46

10/4/16

AlphaVision v6.0 **Alpha-Spectroscopy Calibration Report**

Analyst: ORTEC

Detector: 129 8:36:03AM 10/5/2016

Calibration

Energy Calibration: SOURCE190A_10.04.16 (#9)
Description:

Analysis Date: 10/5/2016 8:35:09AM
Calibration Type: Energy And Efficiency

Source Info

Certificate ID: A9 RSO#190
Prepared by: Isotope Product Laboratories
Description:

Certification Date: 10/15/2013 10:44:40AM

Acquisition

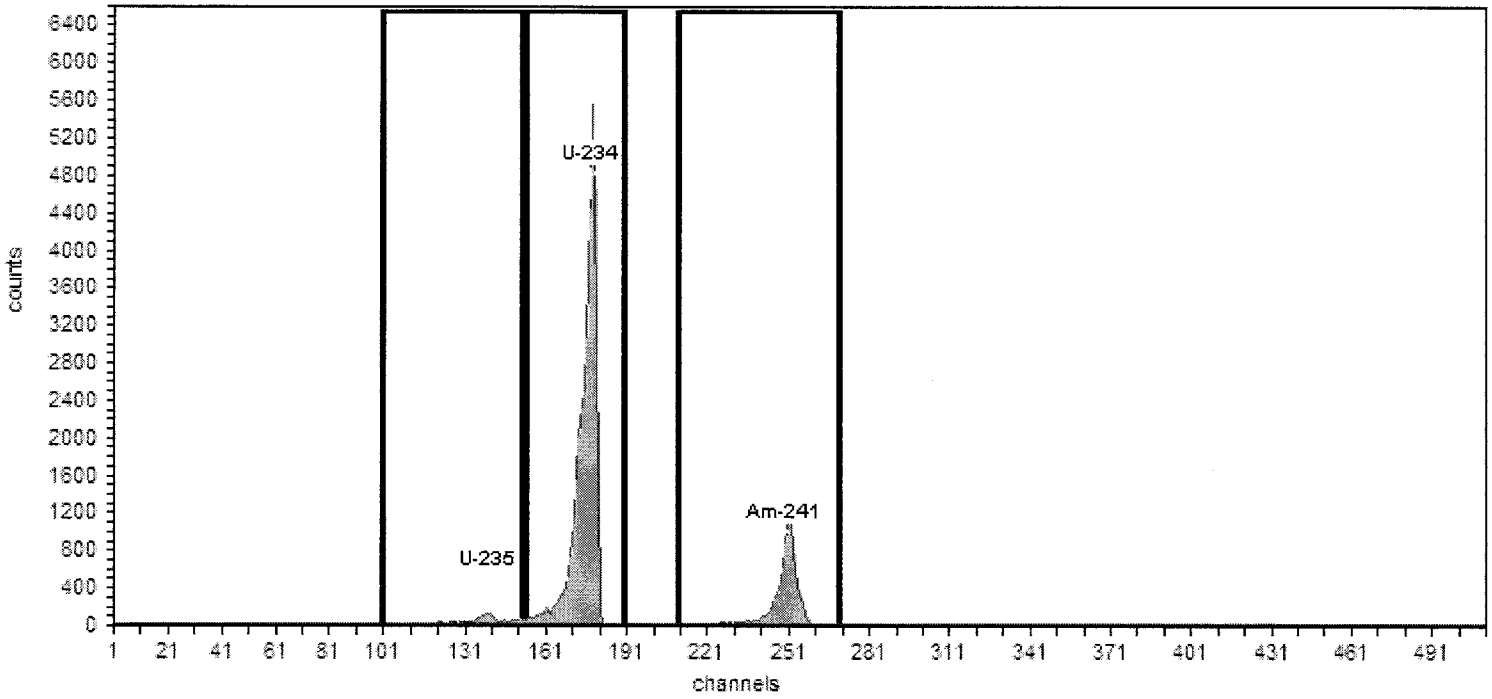
Detector: 129, SN:5505430, ID: 129
Acquisition Start Date: 10/5/2016 7:45:09AM

Live Time: 35.00 min.
Real Time: 35.01 min.

Efficiency Calibration Name: SOURCE190A_10.04.16 (#9)

Energy Calibration Equation:
Gain = 9.9003 keV / Ch
Offset = 3,021.28 keV
Quadratic = 0.0000 keV / Ch^2

Efficiency: 33.67% +/- 1.38% TPU(2 sigma)



General Analysis

Method: Manual (ROI)
Algorithm: Linear

Initial Calibration: Yes
Shelf: 0

Nuclide Activity Summary

Nuclide	Peak Channel	Peak Energy keV	ROI Start Channel	ROI End Channel	Peak FWHM keV	Gross Counts	Net Count Rate (cpm)
U-235	139	4,396.00	100	152	0.00	1,278.00	36.51
U-234	177	4,775.80	153	190	68.47	32,611.00	931.74
Am-241	249	5,485.70	210	270	71.17	7,807.00	223.06

10/4/16

Eckert & Ziegler
Isotope Products

24937 Avenue Tibbitts
Valencia, California 91355

Tel 661•309•1010
Fax 661•257•8303

#190
Received 10/18/13

CERTIFICATE OF CALIBRATION
MIXED ALPHA STANDARD SOURCE

Radionuclide:	U-234	**Customer:**	ALS LABORATORY
Radionuclide:	U-235	**P.O. No.:**	FC 3595 / R5576
Radionuclide:	Am-241	**Catalog No.:**	*SOURCE-RECAL-STD
Half-life (U-234):	(2.454 ± 0.006)E+05 years	**Reference Date:**	15-Oct-13 12:00 PST
Half-life (U-235):	(7.037 ± 0.011)E+08 years	**Source No.:**	92MIX223027
Half-life (Am-241):	432.17 ± 0.66 years		

Contained Radioactivity:

U-234:	1.339	nCi,	49.54	Bq	Am-241:	0.3187	nCi,	11.79	Bq
U-235:	0.02954	nCi,	1.093	Bq	Total Activity:	1.687	nCi,	62.42	Bq

Physical Description:

A. Capsule type:	Disk (22 mm OD x 0.79 mm THK)
B. Nature of active deposit:	Electrodeposited and diffusion bonded oxide
C. Active diameter/volume:	19 mm
D. Backing:	Stainless steel
E. Cover:	None

Radioimpurities: Not determined

Method of Calibration:

This source was assayed using a windowless internal gas flow proportional counter for total alpha activity. Individual nuclide ratios were taken from those determined in May 2001.

Uncertainty of Measurement:

A. Type A (random) uncertainty:	±	0.5	%
B. Type B (systematic) uncertainty:	±	3.0	%
C. Uncertainty in aliquot weighing:	±	0.0	%
D. Total uncertainty at the 99% confidence level:	±	3.0	%

Notes:

- See reverse side for leak test(s) performed on this source.
- IPL 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 "Table of Radioactive Isotopes", edited by Virginia Shirley, 1986.
- This source has a working life of 2 years.
- This source had a total alpha surface emission rate of 1893 α/min in 2π on 20-Sep-13.

Daniel James Van Dalsem
Quality Control

2-OCT-13
Date

IPL Ref. No.: 987-28

Re Calibrated 10/4/16
New Exp Date 10/4/2017

PAI 187 TM 10/5/16
recalibrated 4-1503

Isotope Products Laboratories
An Eckert & Ziegler Company

24937 Avenue Tibbitts
Valencia, California 91355

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CERTIFICATE OF CALIBRATION
MIXED ALPHA STANDARD SOURCE

Radionuclide A:	U-234	**Customer:**	PARAGON ANALYTICS, INC.
Radionuclide B:	U-235	**P.O. No.:**	EW040203/R2193
Radionuclide C:	Am-241	**Catalog No.:**	MISC-STD
Half Life (U-234):	(2.454 ± 0.006)E+05 years	**Reference Date:**	1-May-03 12:00 PST
Half Life (U-235):	(7.037 ± 0.011)E+08 years	**Source No.:**	92MIX2203026
Half Life (Am-241):	432.17 ± 0.66 years		

Contained Radioactivity:

U-234:	3.354	nCi	(124.1 Bq)	Am-241:	0.5793	nCi	(21.43 Bq)
U-235:	0.06566	nCi	(2.429 Bq)	Total Activity:	3.999	nCi	(148.0 Bq)

Physical description:

A. Capsule type:	Disk (22 mm OD X 0.79 mm THK)
B. Nature of active deposit:	Electrodeposited and diffusion bonded oxides
C. Active Diameter:	19 mm
D. Backing:	Stainless steel
E. Cover:	None

Radioimpurities: Not determined

Method of Calibration:

This source was assayed using a windowless internal gas flow proportional counter for total alpha activity. Individual nuclide ratios were taken from those determined in Mar 1998.

Uncertainty of Measurement:

A. Type A (random) uncertainty:	± 0.7%
B. Type B (systematic) uncertainty:	± 3.0%
C. Uncertainty in aliquot weighing:	± 0.0%
D. Total uncertainty at the 99% confidence level:	± 3.1%

Notes:

- See reverse side for leak test(s) performed on this source.
- IPL 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 "Table of Radioactive Isotopes", edited by Virginia Shirley, 1986.
- This source has a working life of 2 years.
- This source had a total alpha surface emission rate of 4483 α/min in 2π on 11 Apr 03.

Daniel James Van Dalsem
Quality Control

15-Apr-03
Date Signed

IPL Ref. No.: 987-7

Re-Calibrated 10/4/16
New Exp Date 10/4/2017
PAI 183
Recalibrated 4-15-03

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CERTIFICATE OF CALIBRATION
MIXED ALPHA STANDARD SOURCE

Radionuclide A:	U-234	**Customer:**	PARAGON ANALYTICS, INC.
Radionuclide B:	U-235	**P.O. No.:**	EW040203/R2193
Radionuclide C:	Am-241	**Catalog No.:**	MISC-STD
Half Life (U-234):	(2.454 ± 0.006)E+05 years	**Reference Date:**	1-May-03 12:00 PST
Half Life (U-235):	(7.037 ± 0.011)E+08 years	**Source No.:**	92MIX2203028
Half Life (Am-241):	432.17 ± 0.66 years		

Contained Radioactivity:

U-234:	6.467	nCi	(239.3 Bq)	Am-241:	0.6366	nCi	(23.55 Bq)
U-235:	0.1135	nCi	(4.200 Bq)	Total Activity:	7.217	nCi	(267.1 Bq)

Physical description:

A. Capsule type:	Disk (22 mm OD X 0.79 mm THK)
B. Nature of active deposit:	Electrodeposited and diffusion bonded oxides
C. Active Diameter:	19 mm
D. Backing:	Stainless steel
E. Cover:	None

Radioimpurities: Not determined

Method of Calibration:

This source was assayed using a windowless internal gas flow proportional counter for total alpha activity. Individual nuclide ratios were taken from those determined in Aug 1992.

Uncertainty of Measurement:

A. Type A (random) uncertainty:	± 0.7%
B. Type B (systematic) uncertainty:	± 3.0%
C. Uncertainty in aliquot weighing:	± 0.0%
D. Total uncertainty at the 99% confidence level:	± 3.1%

Notes:

- See reverse side for leak test(s) performed on this source.
- IPL 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 "Table of Radioactive Isotopes", edited by Virginia Shirley, 1986.
- This source has a working life of 2 years.
- This source had a total alpha surface emission rate of 8091 α/min in 2π on 11 Apr 03.

Daniel James Van Dalsen
Quality Control

15-Apr-03
Date Signed

IPL Ref. No.: 987-7

Re-Calibrated 10/14/16
New Exp Date 10/4/2017
10/5/16
PAT F.D 184
recalibrated 4-1503

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CERTIFICATE OF CALIBRATION
MIXED ALPHA STANDARD SOURCE

Radionuclide A:	U-234	**Customer:**	PARAGON ANALYTICS, INC.
Radionuclide B:	U-235	**P.O. No.:**	EW040203/R2193
Radionuclide C:	Am-241	**Catalog No.:**	MISC-STD
Half Life (U-234):	(2.454 ± 0.006)E+05 years	**Reference Date:**	1-May-03 12:00 PST
Half Life (U-235):	(7.037 ± 0.011)E+08 years	**Source No.:**	92MIX2203024
Half Life (Am-241):	432.17 ± 0.66 years		

Contained Radioactivity:

U-234:	3.227	nCi	(119.4 Bq)	Am-241:	2.866	nCi	(106.0 Bq)
U-235:	0.05205	nCi	(1.926 Bq)	Total Activity:	6.145	nCi	(227.3 Bq)

Physical description:

A. Capsule type:	Disk (22 mm OD X 0.79 mm THK)
B. Nature of active deposit:	Electrodeposited and diffusion bonded oxides
C. Active Diameter:	19 mm
D. Backing:	Stainless steel
E. Cover:	None

Radioimpurities: Not determined

Method of Calibration:

This source was assayed using a windowless internal gas flow proportional counter for total alpha activity. Individual nuclide ratios were taken from those determined in Aug 1992.

Uncertainty of Measurement:

A. Type A (random) uncertainty:	± 0.6%
B. Type B (systematic) uncertainty:	± 3.0%
C. Uncertainty in aliquot weighing:	± 0.0%
D. Total uncertainty at the 99% confidence level:	± 3.1%

Notes:

- See reverse side for leak test(s) performed on this source.
- IPL 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 "Table of Radioactive Isotopes", edited by Virginia Shirley, 1986.
- This source has a working life of 2 years.
- This source had a total alpha surface emission rate of 6889 α/min In 2π on 11 Apr 03.

Daniel James Van Dalsem
Quality Control

15-Apr-03
Date Signed

IPL Ref. No.: 987-7

ReCalibrated 10/4/16
New Exp Date 10/4/2017
JM 10/5/16

PAI ID 00185
rec'd from recalibrator
3-28-03

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CERTIFICATE OF CALIBRATION
ALPHA STANDARD SOURCE

Radionuclide A:	U-234	**Customer:**	PARAGON ANALYTICS, INC.
Radionuclide B:	U-235	**P.O. No.:**	EW030603/R2155
Radionuclide C:	Am-241	**Catalog No.:**	MISC-STD
Half Life (U-234):	(2.454 ± 0.006)E+05 years	**Reference Date:**	1-Apr-03 12:00 PST
Half Life (U-235):	(7.037 ± 0.011)E+08 years	**Source No.:**	92MIX2203021
Half Life (Am-241):	432.17 ± 0.66 years		

Contained Radioactivity:

U-234:	2.731	nCi	(101.0 Bq)	Am-241:	0.9325	nCi	(34.50 Bq)
U-235:	0.03416	nCi	(1.264 Bq)	Total Activity:	3.698	nCi	(136.8 Bq)

Physical description:

A. Capsule type:	Disk (22 mm OD X 0.79 mm THK)
B. Nature of active deposit:	Electrodeposited and diffusion bonded oxides
C. Active Diameter:	19 mm
D. Backing:	Stainless steel
E. Cover:	None

Radioimpurities: Not determined

Method of Calibration:

This source was assayed using a windowless internal gas flow proportional counter for total alpha activity. Individual nuclide ratios were taken from those determined in Aug 1992.

Uncertainty of Measurement:

A. Type A (random) uncertainty:	± 0.8%
B. Type B (systematic) uncertainty:	± 3.1%
C. Uncertainty in aliquot weighing:	± 0.0%
D. Total uncertainty at the 99% confidence level:	± 3.2%

Notes:

- See reverse side for leak test(s) performed on this source.
- IPL 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 "Table of Radioactive Isotopes", edited by Virginia Shirley, 1986.
- This source has a working life of 2 years.
- This source had a total alpha surface emission rate of 4145 α/min in 2π on 18 Mar 03.

Daniel James Van Dalsem
Quality Control

19-Mar-03
Date Signed

IPL Ref. No.: 987-2

Re Calibrated 10/4/16
New Exp Date 10/4/2017
JP 10/5/16

PAIP 188
recd for recalibration
3-28-03

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CERTIFICATE OF CALIBRATION
ALPHA STANDARD SOURCE

Radionuclide A:	U-234	**Customer:**	PARAGON ANALYTICS, INC.
Radionuclide B:	U-235	**P.O. No.:**	EW030603/R2155
Radionuclide C:	Am-241	**Catalog No.:**	MISC-STD
Half Life (U-234):	(2.454 ± 0.006)E+05 years	**Reference Date:**	1-Apr-03 12:00 PST
Half Life (U-235):	(7.037 ± 0.011)E+08 years	**Source No.:**	92MIX2203023
Half Life (Am-241):	432.17 ± 0.66 years		

Contained Radioactivity:

U-234:	2.895 nCi	(107.1 Bq)	Am-241:	1.953 nCi	(72.26 Bq)
U-235:	0.02502 nCi	(0.9257 Bq)	Total Activity:	4.873 nCi	(180.3 Bq)

Physical description:

A. Capsule type:	Disk (22 mm OD X 0.79 mm THK)
B. Nature of active deposit:	Electrodeposited and diffusion bonded oxides
C. Active Diameter:	19 mm
D. Backing:	Stainless steel
E. Cover:	None

Radioimpurities: Not determined

Method of Calibration:

This source was assayed using a windowless internal gas flow proportional counter for total alpha activity. Individual nuclide ratios were taken from those determined in Aug 1992.

Uncertainty of Measurement:

A. Type A (random) uncertainty:	± 0.8%
B. Type B (systematic) uncertainty:	± 3.1%
C. Uncertainty in aliquot weighing:	± 0.0%
D. Total uncertainty at the 99% confidence level:	± 3.2%

Notes:

- See reverse side for leak test(s) performed on this source.
- IPL 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 "Table of Radioactive Isotopes", edited by Virginia Shirley, 1986.
- This source has a working life of 2 years.
- This source had a total alpha surface emission rate of 5463 α/min in 2π on 18 Mar 03.

Daniel James Van Dalsem
Quality Control

19-Mar-03
Date Signed

IPL Ref. No.: 987-2

Recalibrated 10/4/16
New Exp. Date 10/4/2017
JP 10/5/16

PAI, ID 189
recd 4-2-03
recalibrated 4-15-03

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CERTIFICATE OF CALIBRATION
MIXED ALPHA STANDARD SOURCE

Radionuclide A: U-234
Radionuclide B: U-235
Radionuclide C: Am-241
Half Life (U-234): (2.454 ± 0.006)E+05 years
Half Life (U-235): (7.037 ± 0.011)E+08 years
Half Life (Am-241): 432.17 ± 0.66 years

Customer: PARAGON ANALYTICS, INC.
P.O. No.: EW040203/R2193
Catalog No.: MISC-STD
Reference Date: 1-May-03 12:00 PST
Source No.: 92MIX2203029

Contained Radioactivity:

U-234:	9.048	nCi	(334.8 Bq)	Am-241:	1.433	nCi	(53.02 Bq)
U-235:	0.1771	nCi	(6.553 Bq)	Total Activity:	10.66	nCi	(394.4 Bq)

Physical description:

A. Capsule type:	Disk (22 mm OD X 0.79 mm THK)
B. Nature of active deposit:	Electrodeposited and diffusion bonded oxides
C. Active Diameter:	19 mm
D. Backing:	Stainless steel
E. Cover:	None

Radioimpurities: Not determined

Method of Calibration:

This source was assayed using a windowless internal gas flow proportional counter for total alpha activity. Individual nuclide ratios were taken from those determined in Mar 1998.

Uncertainty of Measurement:

A. Type A (random) uncertainty:	± 0.5%
B. Type B (systematic) uncertainty:	± 3.0%
C. Uncertainty in aliquot weighing:	± 0.0%
D. Total uncertainty at the 99% confidence level:	± 3.0%

Notes:

- See reverse side for leak test(s) performed on this source.
- IPL 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 "Table of Radioactive Isotopes", edited by Virginia Shirley, 1986.
- This source has a working life of 2 years.
- This source had a total alpha surface emission rate of 11950 α/min in 2π on 11 Apr 03.

Daniel James Van Dalsem
Quality Control

15-Apr-03
Date Signed

IPL Ref. No.: 987-7