



facility 149017
project 10243

Isotopic Polonium Case Narrative

COGCC

PW NORM 2017 – 10048

Work Order Number: 1705158

1. This report consists of the analytical results and supporting documentation for one water sample received by ALS on 05/08/2017.
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 not 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 1705158-1, due to a reduced aliquot of the sample taken due to potential matrix interferences. The sample was counted for a maximum count time of 1000 minutes. This sample is identified with an “M” flag on the 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.

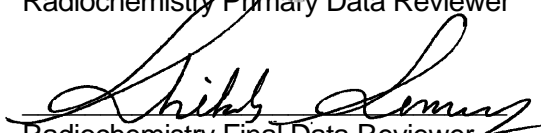


9. No further anomalous situations were encountered during the preparation or analysis of this sample. All remaining quality control criteria were met.

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
Radiochemistry Primary Data Reviewer

5/23/17
Date


Radiochemistry Final Data Reviewer

5/24/17
Date

Section 1

CHAIN OF CUSTODY

ALS -- Fort Collins

Sample Number(s) Cross-Reference Table

OrderNum: 1705158

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
149017 Wellington Rapid Infiltrati	1705158-1		WATER	08-May-17	10:40
149017 Wellington Rapid Infiltrati	1705158-2		WATER	08-May-17	10:40



TF: (800) 443-1511 PH: (970) 490-1511 FX: (970) 490-1522

ALS WORKORDER #

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

Time Zone (Circle):	MST	Matrix: O = oil S = soil NS = non-soil solid W = water L = liquid E = extract F = filter	Form 2029		
NOTES	SIGNATURE			DATE	TIME
GAB prepped (coprecip) and counted within 4 days of sampling	RELINQUISHED BY	<i>[Signature]</i>	RAUSEN	5/8/17	11:00
224Ra prepped and counted within 4 days of sampling	RECEIVED BY	<i>[Signature]</i>	C Trumble	5-8-17	1110
"Iso U only if 6020 "total" U > 3µg/l	RELINQUISHED BY				
"Iso Th only if 6020 "total" Th > 3µg/l	RECEIVED BY				
	RELINQUISHED BY				
	RECEIVED BY				
	RELINQUISHED BY				
	RECEIVED BY				
PRESERVATION KEY	1-HCl 2-HNO3 3-H2SO4 4-HNO3 5-NaOH/2-Acetate 6-Ha/HSO4 7-4°C 8-Other				



ALS Environmental - Fort Collins
CONDITION OF SAMPLE UPON RECEIPT FORM

Client: COGCC

Workorder No: 1705158

Project Manager: SS

Initials: ES Date: 5-8-17

1. Does this project require any special handling in addition to standard ALS procedures?		YES	<u>NO</u>
2. Are custody seals on shipping containers intact?	<u>NONE</u>	YES	NO
3. Are Custody seals on sample containers intact?	<u>NONE</u>	YES	NO
4. Is there a COC (Chain-of-Custody) present or other representative documents?		<u>YES</u>	NO
5. Are the COC and bottle labels complete and legible?		<u>YES</u>	NO
6. Is the COC in agreement with samples received? (IDs, dates, times, no. of samples, no. of containers, matrix, requested analyses, etc.)		<u>YES</u>	NO
7. Were airbills / shipping documents present and/or removable?	<u>DROP OFF</u>	YES	NO
8. Are all aqueous samples requiring preservation preserved correctly? (excluding volatiles)	N/A	<u>YES</u>	NO
9. Are all aqueous non-preserved samples pH 4-9?	N/A	<u>YES</u>	NO
10. Is there sufficient sample for the requested analyses?		<u>YES</u>	NO
11. Were all samples placed in the proper containers for the requested analyses?		<u>YES</u>	NO
12. Are all samples within holding times for the requested analyses?		<u>YES</u>	NO
13. Were all sample containers received intact? (not broken or leaking, etc.)		<u>YES</u>	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	<u>YES</u>	NO
15. Do any water samples contain sediment? Amount Amount of sediment: ____ dusting ____ moderate ____ heavy	N/A	YES	<u>NO</u>
16. Were the samples shipped on ice?		<u>YES</u>	NO
17. Were cooler temperatures measured at 0.1-6.0°C? IR gun used*: <u>#2</u> #4 RAD ONLY		<u>YES</u>	NO
Cooler #: <u>1</u>			
Temperature (°C): <u>4.6</u>			
No. of custody seals on cooler: <u>0</u>			
External µR/hr reading: <u>NA</u>			
Background µR/hr reading: <u>NA</u>			
Were external µR/hr readings ≤ two times background and within DOT acceptance criteria? YES / NO <u>NA</u> (If no, see Form 008.)			

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

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

Project Manager Signature / Date: Shiloh Lemay

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: 1705158

Page: 1 of 1
Reported on: Tuesday, May 23, 2017
8:54:47 AM

Lab Sample ID	Client Sample ID	Sample Type	Nuclide	Result +/- 2 s TPU	MDC	DL	Units	Matrix	Prep Batch	Date Analyze	Flags
1705158-1	149017 Wellington Rapid Infiltration Basin	Sample	Po-210	3.4E-01 +/- 4.2E-01	6.4E-01	NA	pCi/l	WATER	PL170516-1	5/18/2017	U,M

Comments:

Data Package ID: PL1705158-1

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

Date Printed: Tuesday, May 23, 2017

ALS -- Fort Collins
LIMS Version: 6.842

Page 1 of 1

Section 3

QC RESULTS SUMMARY

3

Polonium-210 by Alpha Spectroscopy

PAI 714 Rev 13

Method Blank Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1705158

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: PL1705158-1

Polonium-210 by Alpha Spectroscopy

PAI 714 Rev 13

Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1705158

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: PL1705158-1

Section 4

INDIVIDUAL SAMPLE RESULTS



Polonium-210 by Alpha Spectroscopy

PAI 714 Rev 13

Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1705158

Client Name: COGCC

ClientProject ID: PW NORM 2017 10048

Field ID: 149017 Wellington Rapid In
Lab ID: 1705158-1

Sample Matrix: WATER

Prep SOP: PAI 711 Rev 10

Date Collected: 08-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: Unfiltered

Final Aliquot: 25.0 ml

Prep Basis: Unfiltered

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	3.4E-01 +/- 4.2E-01	6.4E-01	5E-01	NA	U,M

Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Po-209	1.990E+02	1.81E+02	pCi/l	90.7	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.

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: PL1705158-1

Section 5

RAW DATA

5

Polonium-210 by Alpha Spectroscopy Raw Data Report

Laboratory Name: ALS -- Fort Collins

Prep SOP: PAI 711

Reported on: Friday, May 19, 2017

PAI Work Order: 1705158

Analytical SOP: PAI 714

4:01:40 PM

Sample ID QC Type	Nuclide Type	Sample Date/Time	Prep Batch QC Batch ID	Ingrowth Date /Time	Decay Date/Time	Matrix %Moist.	Samp Aliq Analy Aliq	Inst ID Det ID	AnRunID File Name	Count Date/Time	Net Cnts Bkg Cnts	BaseEff Bkg(min)	CndDur(min) Yield	Activity +/- 2 s TPU	MDC DeclEv	ReportUnits ReportBasis	DER RPD	%Spk. Recov Flags
1705158-1	Po-209 Tracer	5/8/2017 10:40:00 AM	PL170516-1 PL170516-1-1	NA NA	5/17/2017 3:50:00 PM	WATER NA	50 ml 25 ml	AlphaSpec2 65	PL170516-1A Spectrum #1	5/18/2017 10:05 AM	3044.000 1.000	30.38% 1000	1000 90.7%	1.81E+02 2.6E+01	0E+00	pCi/l Unfiltered	NA NA	
1705158-1	Po-210 Trg. Analyte	5/8/2017 10:40:00 AM	PL170516-1 PL170516-1-1	NA NA	5/17/2017 3:50:00 PM	WATER NA	50 ml 25 ml	AlphaSpec2 65	PL170516-1A Spectrum #1	5/18/2017 10:05 AM	5.000 2.000	30.38% 1000	1000 90.7%	3.4E-01 4.2E-01	6.4E-01	pCi/l Unfiltered	NA NA	U,M
PL170516-1	Po-209 Tracer	5/16/2017 1:03:24 PM	PL170516-1 PL170516-1-1	NA NA	5/17/2017 3:50:00 PM	WATER NA	1000 ml 500 ml	AlphaSpec2 104	PL170516-1A Spectrum #1	5/18/2017 10:11 AM	3223.000 2.000	33.46% 1000	1000 87.2%	8.7E+00 1.2E+00	0E+00	pCi/l Unfiltered	NA NA	
PL170516-1	Po-210 Trg. Analyte	5/16/2017 1:03:24 PM	PL170516-1 PL170516-1-1	NA NA	5/17/2017 3:50:00 PM	WATER NA	1000 ml 500 ml	AlphaSpec2 104	PL170516-1A Spectrum #1	5/18/2017 10:11 AM	3.000 0.000	33.46% 1000	1000 87.2%	9E-03 1.5E-02	8E-03	pCi/l Unfiltered	NA NA	B3
PL170516-1	Po-209 Tracer	5/16/2017 1:03:24 PM	PL170516-1 PL170516-1-1	NA NA	5/17/2017 3:50:00 PM	WATER NA	1000 ml 500 ml	AlphaSpec2 105	PL170516-1A Spectrum #1	5/18/2017 10:10 AM	1456.560 3.000	32.34% 1000	480 85.0%	8.6E+00 1.3E+00	0E+00	pCi/l Unfiltered	NA NA	
PL170516-1	Po-210 Trg. Analyte	5/16/2017 1:03:24 PM	PL170516-1 PL170516-1-1	NA NA	5/17/2017 3:50:00 PM	WATER NA	1000 ml 500 ml	AlphaSpec2 105	PL170516-1A Spectrum #1	5/18/2017 10:10 AM	1688.040 2.000	32.34% 1000	480 85.0%	1.15E+01 1.8E+00	0E+00	pCi/l Unfiltered	NA NA	108 P

Comments:

Data Package ID: PL1705158-1

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

ALS Laboratory Group - Fort Collins

Alpha-Spectroscopy Analysis Report

Sample: 1705158-1
Spectrum #1 Analysis #1

Sample Size : 0.03

Detector: 65
Batch Name: PL170516-1_A
Nuclide Library: Polonium
Analysis Method: ROI Analysis, Set Name = Po-210
ROI Set: Po-210

Acquisition

Acquisition Start Date: 5/18/2017 10:05:16AM
Live Time: 1,000.00 min.
Real Time: 1,000.01 min.
Dead Time: 0.00 %

Calibration

Bkgd Info: Sample: B17051065; Det: 65; Spectrum #1; 5/10/2017 10:44:23 AM

Calibration Date: 5/10/2017 10:08:54AM

Efficiency Calibration: C17051065

Efficiency: 30.38% +/- 0.20% TPU(2 sigma)

Energy Calibration: C17051065

Energy Cal: Gain = 9.8810 keV / Ch

Offset = 3,028.21 keV

Quadratic = 0.0000 keV / Ch²

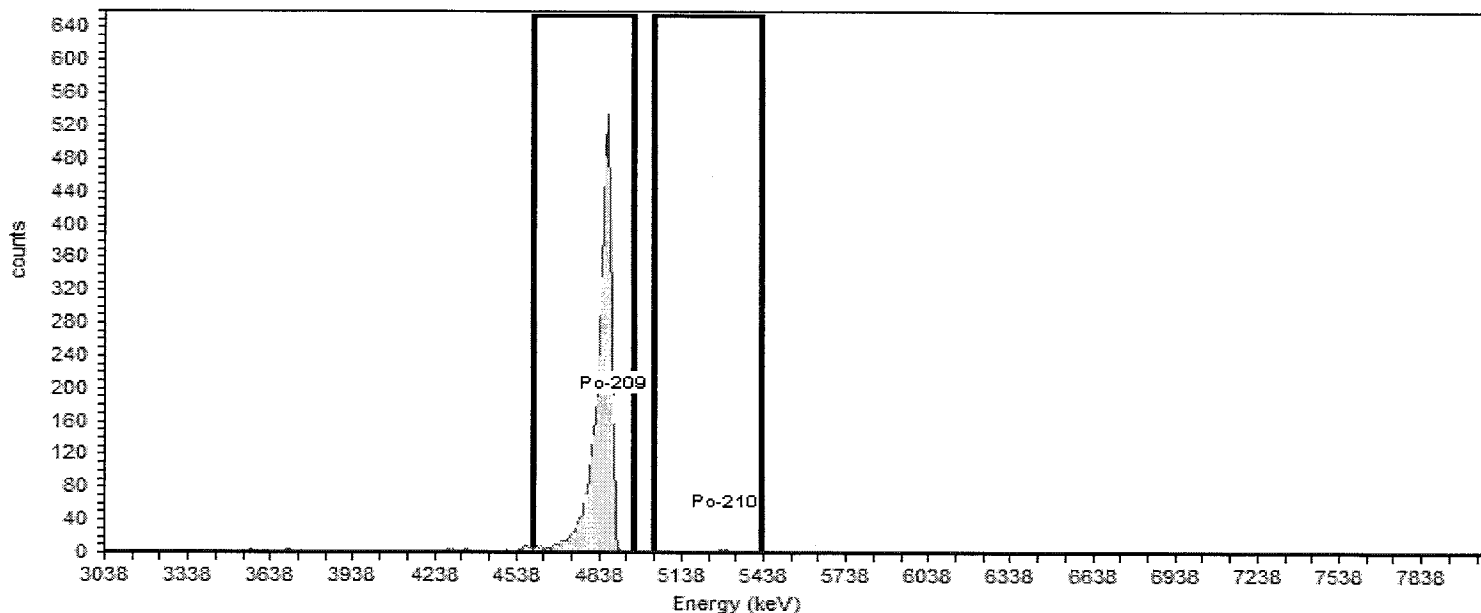
Tracer

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: 90.95%



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	4885.8	4599.3	4964.9	64.9	99.7	3,045.00	1.00	3,044.00	1.8E+002	3.4E+000	1.5E-001	4.8E-001
Po-210	5300.8	5034.0	5429.3	116.8	100.0	7.00	2.00	5.00	3.3E-001	2.0E-001	2.1E-001	6.1E-001

Reviewed By:  

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.

Print Date: 5/19/2017
10:25:45AM

AlphaVision v5.3

Custom Report Iteration: 05/21/09

Page 1 of 1
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Analyst: user

10:52:31AM 5/19/2017

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

Sample

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 Name: PL170516-1_A

Batch

Client Name: Undefined
 Client Contact:

Description:

Tracer

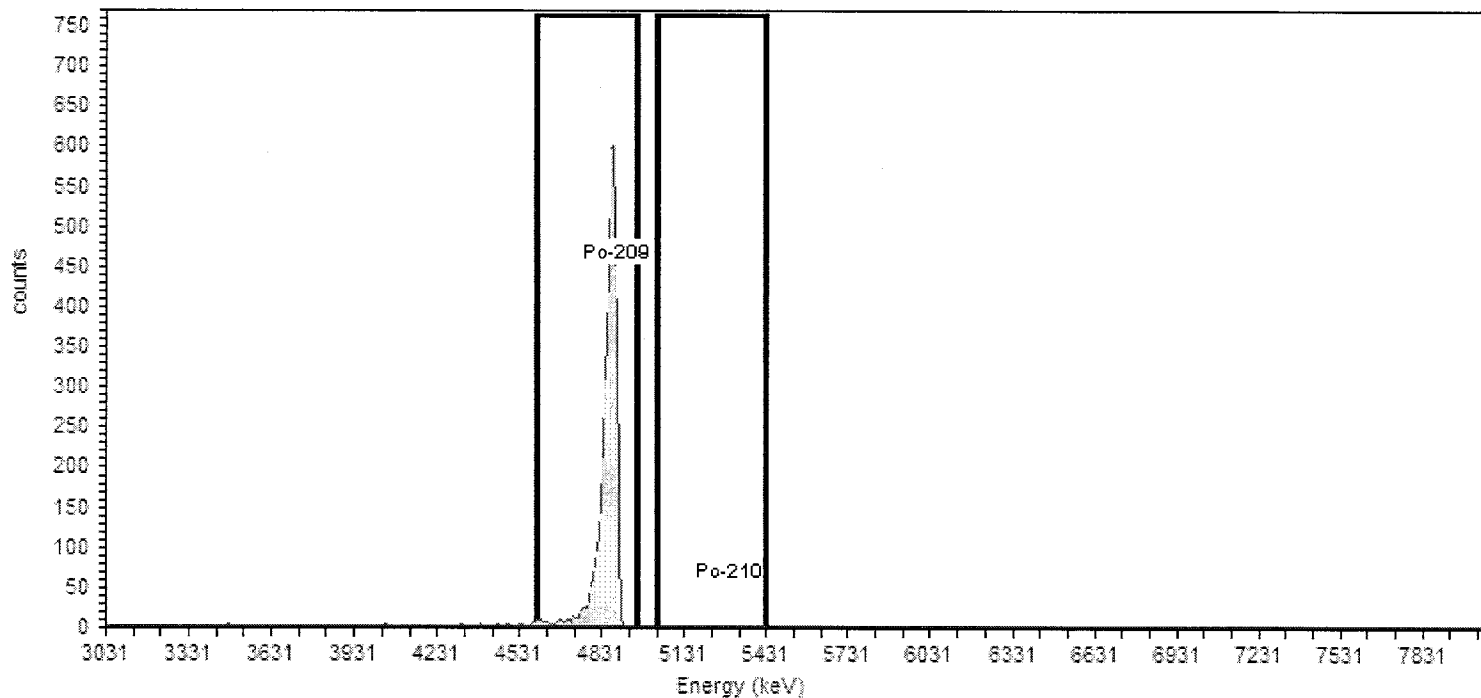
Tracer Name: 1045.4243.07 Po-209
 Tracer Activity: 22.23 DPM / mL x (Vol.) 0.50 mL = 11.11 DPM
 Tracer Ref. Date: 6/8/2016 10:00:00AM

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 / Ch²
 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: $K\alpha = 1.64$, $K\beta = 1.64$

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

JP

JA

Analyst: user

10:52:39AM 5/19/2017

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

Type: Sample

Sample

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 Name: PL170516-1_B

Batch

Client Name: Undefined
Client Contact:

Description:

Tracer

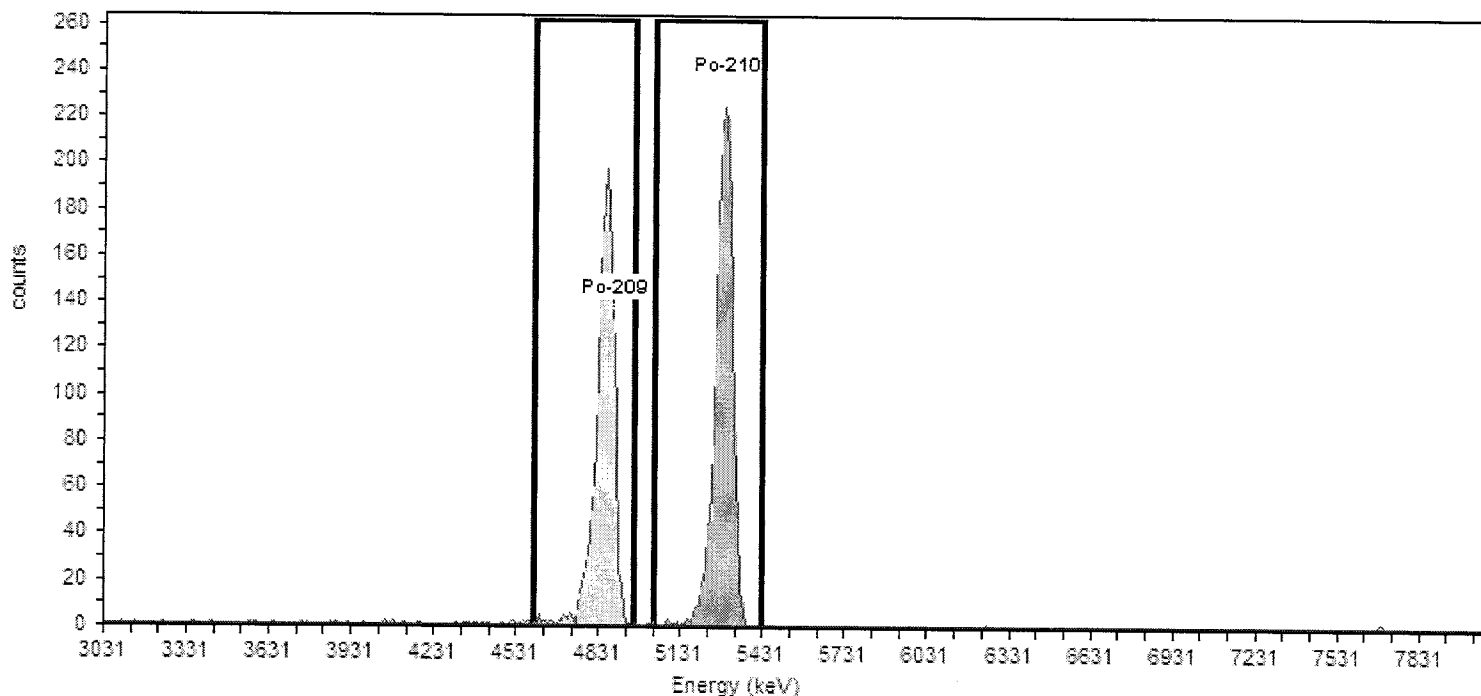
Tracer Name: 1045.4243.07 Po-209
Tracer Activity: 22.23 DPM / mL x (Vol.) 0.50 mL = 11.11 DPM
Tracer Ref. Date: 6/8/2016 10:00:00AM

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: $K\alpha = 1.64$, $K\beta = 1.64$

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 746-8.xls (10/2/07)

Alpha Spectrometer Instrument Run Log

Date: 5/18/17

Detector	Batch ID	Sample ID	Iso/Matrix	Duration	Initial
117	VAS1705152-B	1704600-Z	V/W	360	W
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		AS1705152MB			
131		LCS			
65	PL170516-1-A	1705158-1	P/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			
79	PL170516-1-A	1705243-1	P/W	1000	JA
80		1705269-4		480	
102		1705269-40			
103		1705319-4			
104		A PL170516-1MB		1000	
105		B -LCS		480	
81	RAS170517-1-A	170517-1MB	P/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		-30			

Notes:

JMA 5/18/17

Reviewed by: JMA

Date: 5/18/17

471144

Section 6

QUALITY ASSURANCE SUMMARY REPORTS

6

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

Prep Batch: PL170516-1

Prep Procedure: Po210

158, 177, 202, 203, 240, 242, 243, MB → 1000 mld.
237, 269, 319, LCS - 480 mld.

Analytical QASS / NCR? Y **QNA**

Prep Num	LabID	QC Type	Init Aliq	Fin Aliq	Report Units	Cnt 1 File	Cnt 1 Pos Chk By	Cnt 1 Inst/Det	Cnt 2 File	Cnt 2 Pos Chk By	Cnt 2 Inst/Det	Cnt 3 File	Cnt 3 Pos Chk By	Notes
510	1705158-1	SMP	50	25	ml	pCil	51581	6.5 JA	51581			51581		
1	1705177-1	SMP	50	25	ml	pCil	51771	6.7	51771			51771		
1	1705177-2	SMP	50	25	ml	pCil	51772	6.9	51772			51772		
1	1705177-3	SMP	50	25	ml	pCil	51773	7.0	51773			51773		
510	1705202-1	SMP	50	25	ml	pCil	52021	7.2	52021			52021		
1	1705203-1	SMP	50	25	ml	pCil	52031	7.4	52031			52031		
423	1705237-1	SMP	187.755	93.878	ml	pCil	52371	7.5	52371			52371		
1	1705240-1	SMP	50	25	ml	pCil	52401	7.7	52401			52401		
1	1705242-1	SMP	50	25	ml	pCil	52421	7.8	52421			52421		
1	1705243-1	SMP	50	25	ml	pCil	52431	7.9	52431			52431		
423	1705269-4	SMP	188	94	ml	pCil	52694	8.0	52694			52694		
1	1705269-4	DUP	188	94	ml	pCil	52694D	10.2	52694D			52694D		
1	1705319-4	SMP	188	94	ml	pCil	53194	10.3	53194			53194		
1	PL170516-1	MB	1000	500	ml	pCil	170511B	10.4	170511B			170511B		
1	PL170516-1	LCS	1000	500	ml	pCil	170511L	10.5	170511L			170511L		

Tracer/Carrier Solution Information

Soln #	Nuclide	SolnID	Exo 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	Exo 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

Radiochemistry Instrument Worksheet

ALS -- Fort Collins

Prep Batch: PL170516-1

Prep Procedure: Po210

Analytical QASS / NCR? Y / N

Prep Num	LabID	QC Type	Init Aliq	Fin Aliq	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

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
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	1705168-1	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	

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:

Prep QASS / NCR? Y / N

Batch:

Re-Prep? Y / N

Batch:

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	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	1705158-1	SMP		50	50	Unfiltered	0	0	5/16/17 1550	T1	
2	1705177-1	SMP		50	50	Unfiltered	0	0		T1	
3	1705177-2	SMP		50	50	Unfiltered	0	0		T1	
4	1705177-3	SMP		50	50	Unfiltered	0	0		T1	
5	1705202-1	SMP		50	50	Unfiltered	0	0		T1	
6	1705203-1	SMP		50	50	Unfiltered	0	0		T1	
7	1705237-1	SMP		920	187.7551	As Received	980	200		T1	
8	1705240-1	SMP		50	50	Unfiltered	0	0		T1	
9	1705242-1	SMP		50	50	Unfiltered	0	0		T1	
10	1705243-1	SMP		50	50	Unfiltered	0	0		T1	
11	1705269-4	SMP		940	188	As Received	1000	200		T1	
12	1705269-4	SMP		940	188	Unfiltered	1000	200		T1	
13	1705269-4	DUP		940	188	As Received	1000	200		T1	
14	1705269-4	DUP		940	188	Unfiltered	1000	200		T1	
15	1705319-4	SMP		940	188	As Received	1000	200		T1	
16	PL170516-1	MB		1000	1000	As Received	0	0		T1	
17	PL170516-1	MB		1000	1000	Unfiltered	0	0		T1	
18	PL170516-1	LCS		1000	1000	As Received	0	0		T1,S1	
19	PL170516-1	LCS		1000	1000	Unfiltered	0	0		T1,S1	

Comments

Due to potential matrix interferences, reduced aliquots were taken.

Spiked By: JSS 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: JSS

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	22	Clear	None
1705177	1			Smelly sample (Sediment fluted filtered)
↓	2			↓
	3			
1705202	1			Sediment fluted filtered
1705203	1			None
1705240	1			↓
1705242	1			
1705243	1			Sediment fluted filtered
1705237	1			None
1705269	4			↓
1705319	4	✓	↓	↓
JSS 5/16/17				

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



Po-209 working std. 1045.4243.07

Prepare a working dilution of RSO#1045

1. Density of 2M HCl, lot # 0606128723

Mass of 100mL vol. flask:

Mass of flask & 100mL acid:

Net Mass:

Density:

56.4426g

159.7513g

103.3087g

1.03309g/mL

Balance # 12

Balance # 12

2. Mass of RSO#1045 transferred:

Mass of open empty nalgene:

Mass of nalgene & standard:

Net mass of standard transferred:

74.8232g

79.8830g

5.0598g

Balance# 12

Balance# 12

3. Dilute to final volume:

Mass of nalgene, standard, & diluent:

Mass of empty nalgene (from above):

Net mass of new dilution:

1171.2g

74.8232g

1096.3768g

Balance# 26

Balance# 12

4. Final activity calculation:

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

Std 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

Signed

Date

Read and Understood By

Signed

Date

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Eckert & Ziegler

Analytics

RSO #
1045

Rec'd
6-10-16

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			Calibration Method**
			u_A , %	u_B , %	U , %*	
Po-209	3.726E+04	4.003E+02	0.3	1.0	2.0	4 π 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:** 4 π LS - 4 π 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:

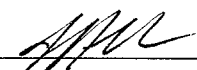
γ -impurities < 0.1%, α -impurities < 0.1%

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. Bardley, Radiochemist

QC Approved by:


J. Lahr, Spectroscopist

Date: 02-JUN-16

Pb-210 899.4095.66 working standard

Prepare a working dilution of 899.3610.42

1. Density of 1M HNO₃, lot # 0000084176
 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
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: 1073.1861g Balance # NA

4. Final activity calculation:

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

$$(1073.1861 \text{ g})$$

Std 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

Continued on Page

Signed

Date

Read and Understood By

Signed

Date 34 of 54



Eckert & Ziegler

Analytics

R508
899
rec
8-14-09

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

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*, %			Reference Date (12:00 PM EST)
			u_A	u_B	U	
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. E. Kasate
N. E. Kasate, Radiochemist

QA Approved:

D. M. Montgomery
D. M. Montgomery, QA Manager

Date: 8-13-09



Corporate Office

24937 Avenue Tibbitts Valencia, California 91355

Laboratory

1380 Seaboard Industrial Blvd. Atlanta, Georgia, 30318

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: 1705158

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
1705158-1 Spectrum #1 5/18/2017	SMP	PL170516-1 PL170516-1A	Po210	65	C17051065 B17051065 C17051065	5/10/2017 5/10/2017 5/10/2017	30.38 0.0110 5557.7	Pass Pass Pass	28.79 0.0000 5505.8	29.33 0.0100 5515.8	30.39 0.1000 5595.8	31.93 0.1500 5605.8
PL170516-1 Spectrum #1 5/18/2017	MB	PL170516-1 PL170516-1A	Po210	104	C170509104A B170509104 C170509104A	5/9/2017 5/9/2017 5/9/2017	33.46 0.0180 5555.8	Pass Pass Pass	31.21 0.0000 5506.0	31.77 0.0100 5516.0	33.94 0.1000 5596.0	34.50 0.1500 5606.0
PL170516-1 Spectrum #1 5/18/2017	LCS	PL170516-1 PL170516-1A	Po210	105	C170509105 B170509105 C170509105	5/9/2017 5/9/2017 5/9/2017	32.34 0.0160 5555.8	Pass Pass Pass	31.09 0.0000 5506.0	31.65 0.0100 5516.0	33.81 0.1000 5596.0	34.37 0.1500 5606.0

Data Package ID: PL1705158-1

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

Date Printed: Tuesday, May 23, 2017

ALS -- Fort Collins

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LIMS Version: 6.842

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Alpha Spec Calibration Source Re-Certification

Recalibration performed by Isotope Products Laboratories

Primary Certified Source

Source PA ID: 180
 Planchet Label: 9
 Recalibrated on: 10/4/2016
 Received by ALS on: 10/19/2013

Values from certificate	
Source ID: 92MX223027	
Total Activity: 3745.2 dpm	
Ref. Date: 10/15/2013	

Nuclide	Act (Bq)	Act (dpm)	Half-life (yrs)	Decay Corrected
U-234:	40.54	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
92MX223027	180	97-18-103-09	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
92MX2230326	182	97-18-103-01	10/4/16	12981	79837	2777	2100	31.06%	1193.95	7343.17	255.42	8792.54
92MX2230328	183	97-18-103-02	10/4/16	15085	148128	3863	2100	31.06%	1387.47	13824.37	355.31	15367.15
92MX2230324	184	97-18-103-03	10/4/16	67474	70483	2608	2100	31.06%	6206.06	6482.82	239.88	12928.75
92MX2230321	185	97-18-103-04	10/4/16	21961	60440	2557	2100	31.06%	2019.91	5559.09	235.19	7814.18
92MX2230325	186	97-18-103-05	10/4/16	97983	114458	3780	2100	31.06%	9002.99	10527.51	347.67	19878.16
92MX2230322	187	97-18-103-06	10/4/16	72777	78983	2564	2100	31.06%	6893.81	7347.40	237.67	14278.88
92MX2230323	188	97-18-103-07	10/4/16	43617	68953	2043	2100	31.06%	4011.76	8342.09	187.81	10541.76
92MX2230329	189	97-18-103-08	10/4/16	33968	214074	7185	2100	31.06%	3124.09	19889.89	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
92MX223027	180	97-18-103-09	10/5/16	7807	32611	1278	2100	1181.31	3741.99	31.84%	-2.46%	PASS

Sources 1 through 8 activity re-verification

Source Serial#	PA ID	Sequential #	Combined Observed dpm	Combined Certified dpm*	Percent Difference %	Within 5% of Certified value?
92MX2230326	182	97-18-103-01	8792.54	8849.86	-0.65%	Yes
92MX2230328	183	97-18-103-02	15387.15	15982.35	-3.91%	Yes
92MX2230324	184	97-18-103-03	12928.75	13503.77	-4.26%	Yes
92MX2230321	185	97-18-103-04	7814.18	8161.24	-4.25%	Yes
92MX2230325	186	97-18-103-05	19878.16	20979.95	-5.25%	No
92MX2230322	187	97-18-103-06	14278.88	15285.63	-6.56%	No
92MX2230323	188	97-18-103-07	10541.76	10723.95	-1.70%	Yes
92MX2230329	189	97-18-103-08	23475.75	23583.84	-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	7449.00	2.43	145.74	21.43	1285.80
5/1/2003	236.30	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	0.83	55.54	72.26	4335.80
5/1/2003	334.80	20088.00	6.55	393.18	53.02	3181.20

OK JP
 10/5/16
 Expires
 10/4/2017

Analyst: ORTEC

Detector: 129

9:14:40AM 10/5/2016

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

Calibration

Analysis Date: 10/4/2016 12:09:56PM
Calibration Type: Energy And EfficiencyCertificate ID: A9 RSO#190
Prepared by: Isotope Product Laboratories
Description:

Source Info

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

Acquisition

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

Energy Calibration Equation:

Gain = 9.9003 keV / Ch

Live Time: 35.00 min.

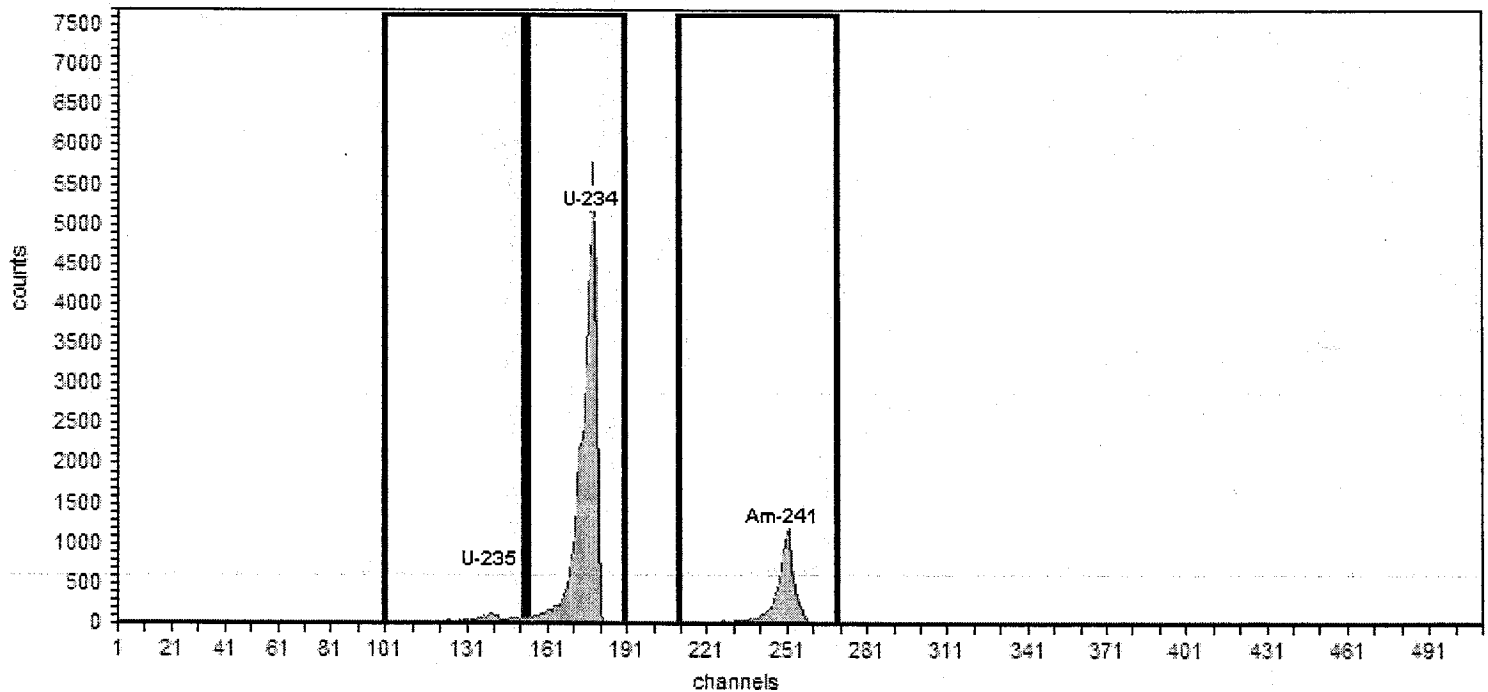
Offset = 3,021.28 keV

Real Time: 35.01 min.

Quadratic = 0.0000 keV / Ch²

Efficiency Calibration Name: SOURCE190_10.04.16 (#9)

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



General Analysis

Method: Manual (ROI)

Initial Calibration: Yes

Algorithm: Linear

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

Analyst: ORTEC

Detector: 129

12:49:08PM 10/4/2016

Energy Calibration: SOURCE182_10.04.16 (#1)

Description:

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

Certificate ID: A1 RSO#182

Prepared by: Isotope Product Laboratories

Description:

Source Info

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.

Energy Calibration Equation:

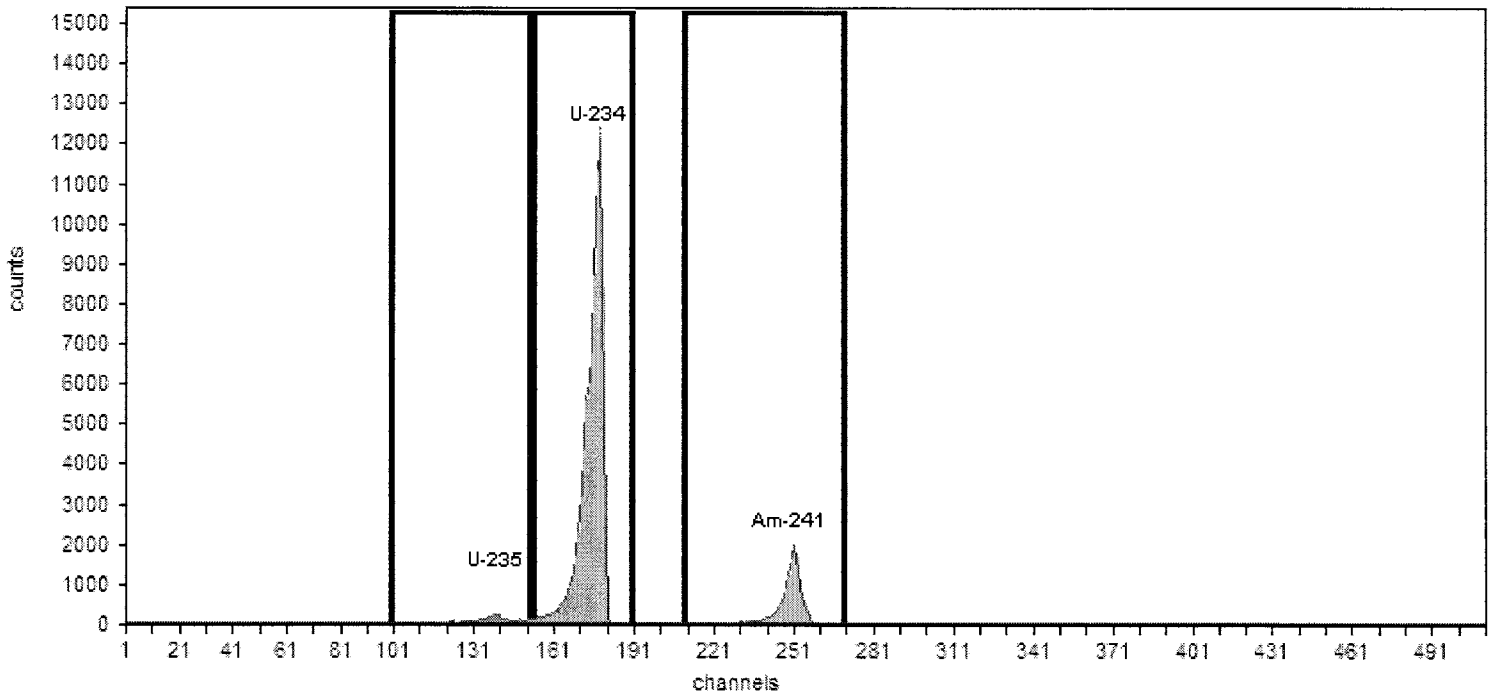
Gain = 9.9003 keV / Ch

Offset = 3,021.28 keV

Quadratic = 0.0000 keV / Ch²

Efficiency Calibration Name: SOURCE182_10.04.16 (#1)

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

JP 10/4/16

Analyst: ORTEC

Detector: 129

1:25:35PM 10/4/2016

Energy Calibration: SOURCE183_10.04.16 (#2)

Description:

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

Certificate ID: A2 RSO#183

Prepared by: Isotope Product Laboratories

Description:

Source Info

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.

Energy Calibration Equation:

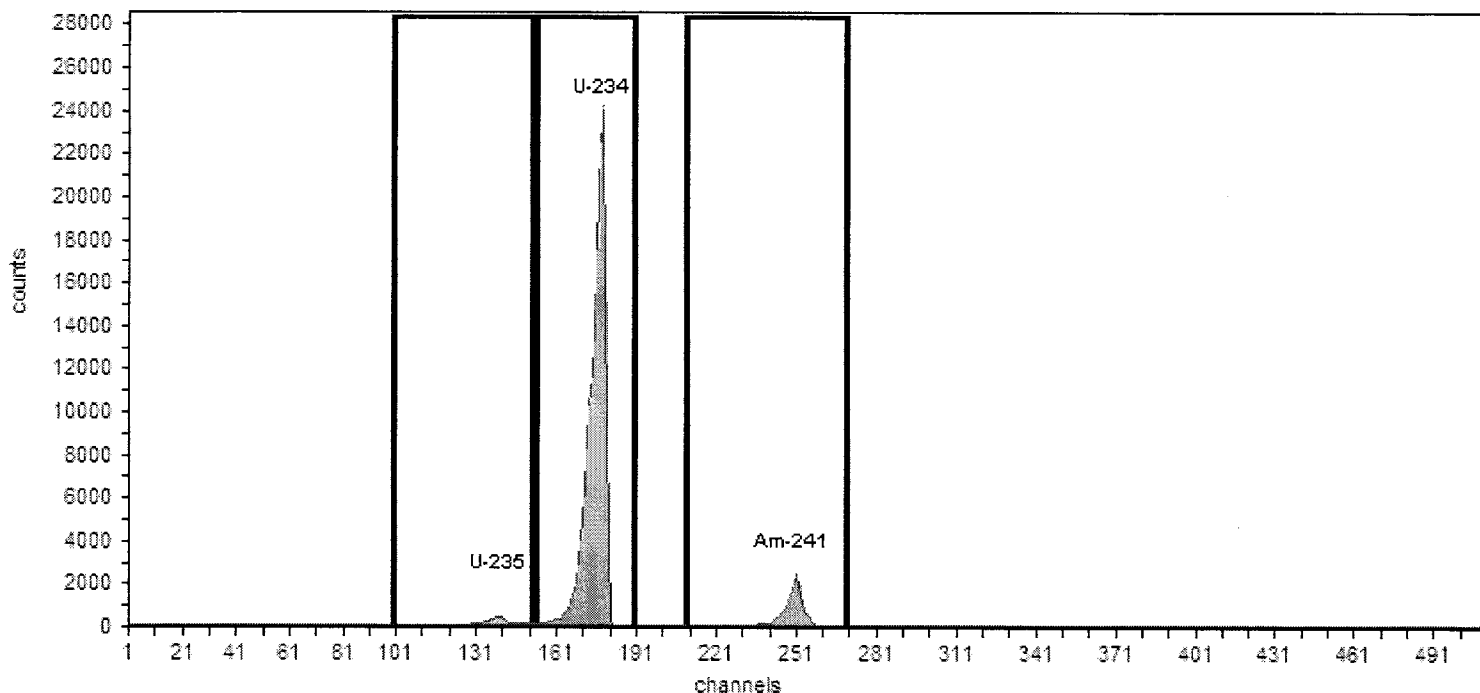
Gain = 9.9003 keV / Ch

Offset = 3,021.28 keV

Quadratic = 0.0000 keV / Ch²

Efficiency Calibration Name: SOURCE183_10.04.16 (#2)

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

Analyst: ORTEC

Detector: 129

2:17:25PM 10/4/2016

Energy Calibration: SOURCE184_10.04.16 (#3)

Description:

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

Certificate ID: A3 RSO#184

Prepared by: Isotope Product Laboratories

Description:

Source Info

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.

Energy Calibration Equation:

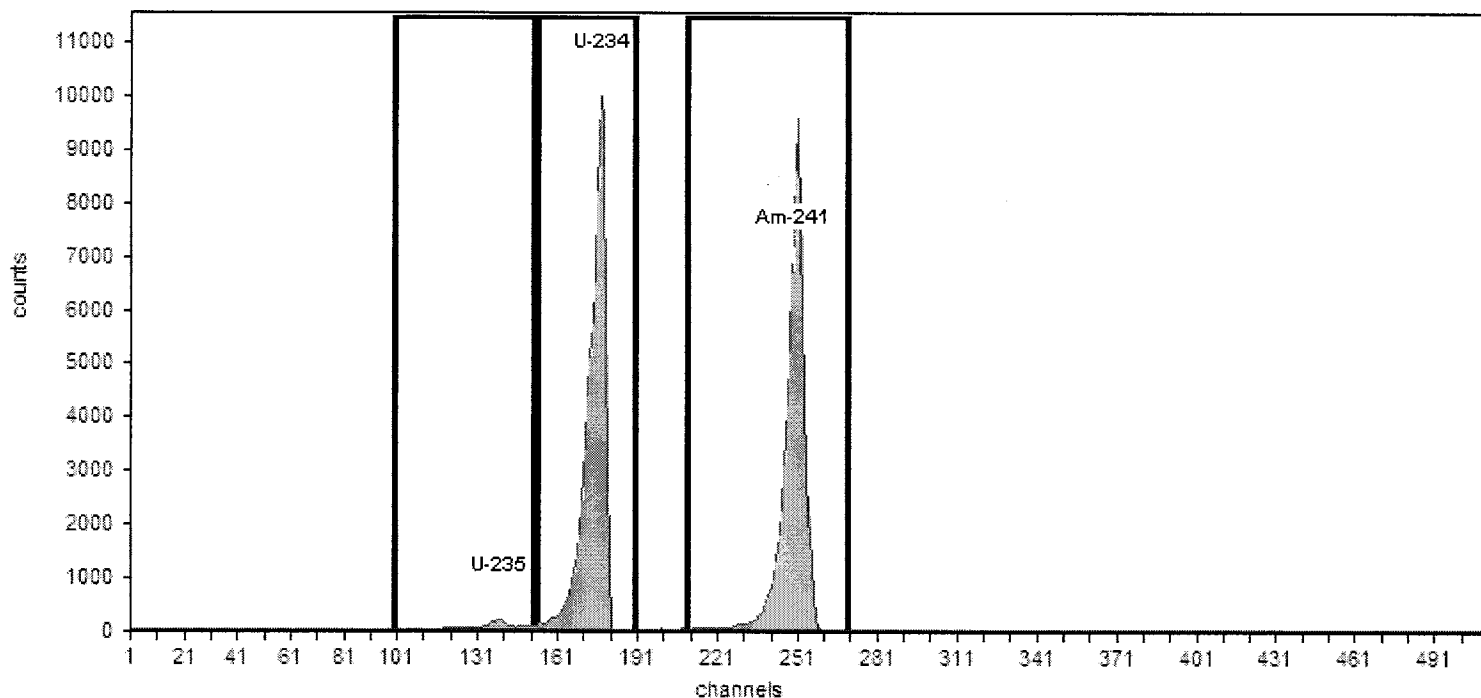
Gain = 9.9003 keV / Ch

Offset = 3,021.28 keV

Quadratic = 0.0000 keV / Ch²

Efficiency Calibration Name: SOURCE184_10.04.16 (#3)

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

Analyst: ORTEC

Detector: 129

9:00:58AM 10/5/2016

Energy Calibration: SOURCE185_10.04.16 (#4)

Description:

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

Certificate ID: A4 RSO#185

Prepared by: Isotope Product Laboratories

Description:

Source Info

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.

Energy Calibration Equation:

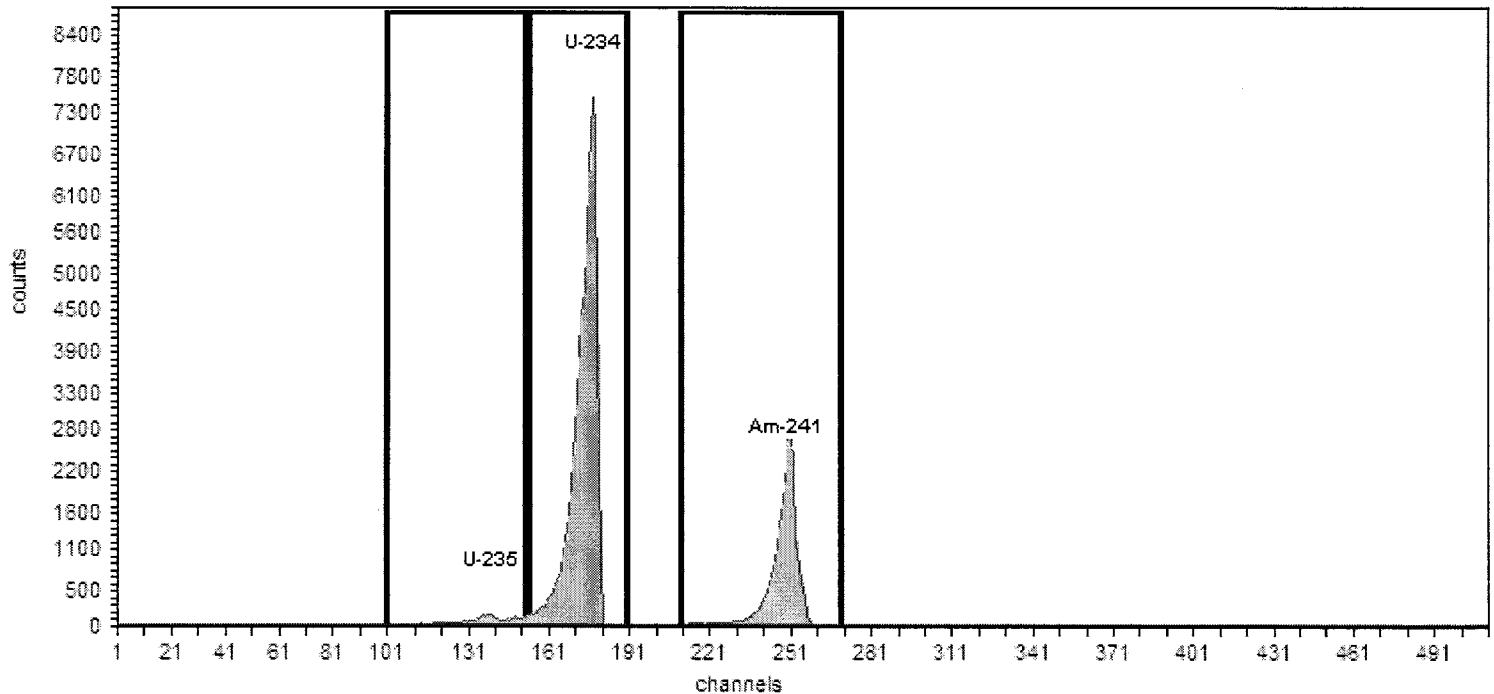
Gain = 9.9003 keV / Ch

Offset = 3,021.28 keV

Quadratic = 0.0000 keV / Ch²

Efficiency Calibration Name: SOURCE185_10.04.16 (#4)

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

Handwritten signature: Jp 10/4/16

Analyst: ORTEC

Detector: 129

7:04:12AM 10/5/2016

Energy Calibration: SOURCE188_10.04.16 (#7)

Description:

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

Certificate ID: A7 RSO#188

Prepared by: Isotope Product Laboratories

Description:

Source Info

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.

Energy Calibration Equation:

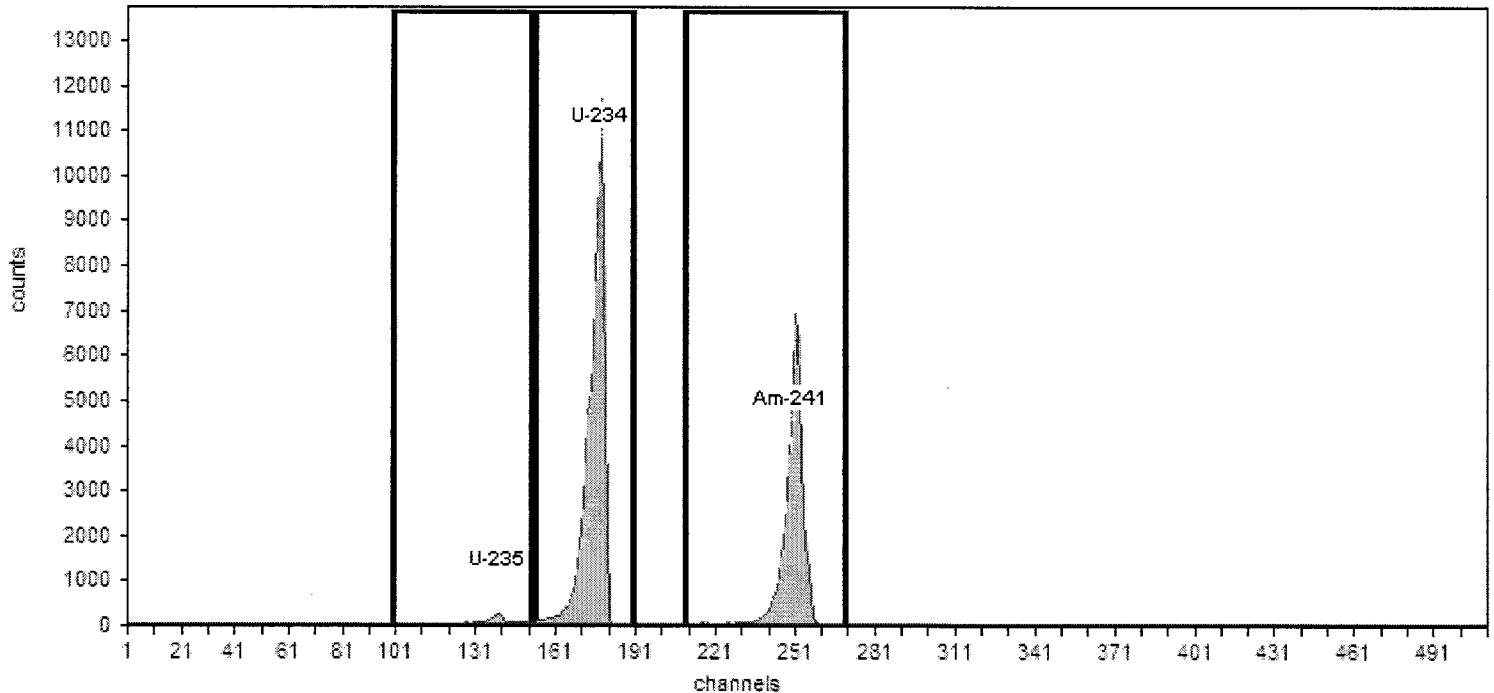
Gain = 9.9003 keV / Ch

Offset = 3,021.28 keV

Quadratic = 0.0000 keV / Ch²

Efficiency Calibration Name: SOURCE188_10.04.16 (#7)

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

Analyst: ORTEC

Detector: 129

7:44:05AM

10/5/2016

Energy Calibration: SOURCE189_10.04.16 (#8)

Description:

Calibration

Analysis Date: 10/5/2016 7:43:56AM

Calibration Type: Energy And Efficiency

Certificate ID: A8 RSO#189

Prepared by: Isotope Product Laboratories

Description:

Source Info

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.

Energy Calibration Equation:

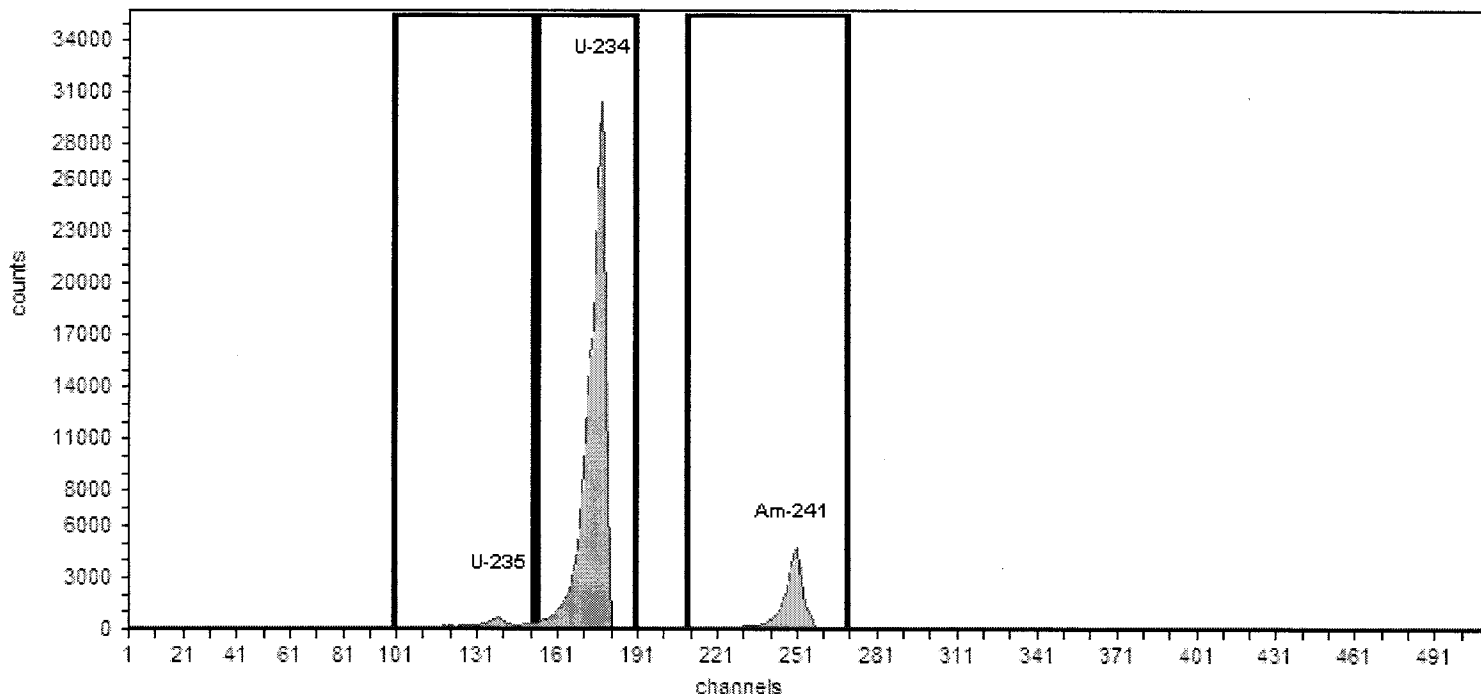
Gain = 9.9003 keV / Ch

Offset = 3,021.28 keV

Quadratic = 0.0000 keV / Ch²

Efficiency Calibration Name: SOURCE189_10.04.16 (#8)

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

Analyst: ORTEC

Detector: 129

8:36:03AM 10/5/2016

Energy Calibration: SOURCE190A_10.04.16 (#9)

Description:

Calibration

Analysis Date: 10/5/2016 8:35:09AM

Calibration Type: Energy And Efficiency

Certificate ID: A9 RSO#190

Prepared by: Isotope Product Laboratories

Description:

Source Info

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.

Energy Calibration Equation:

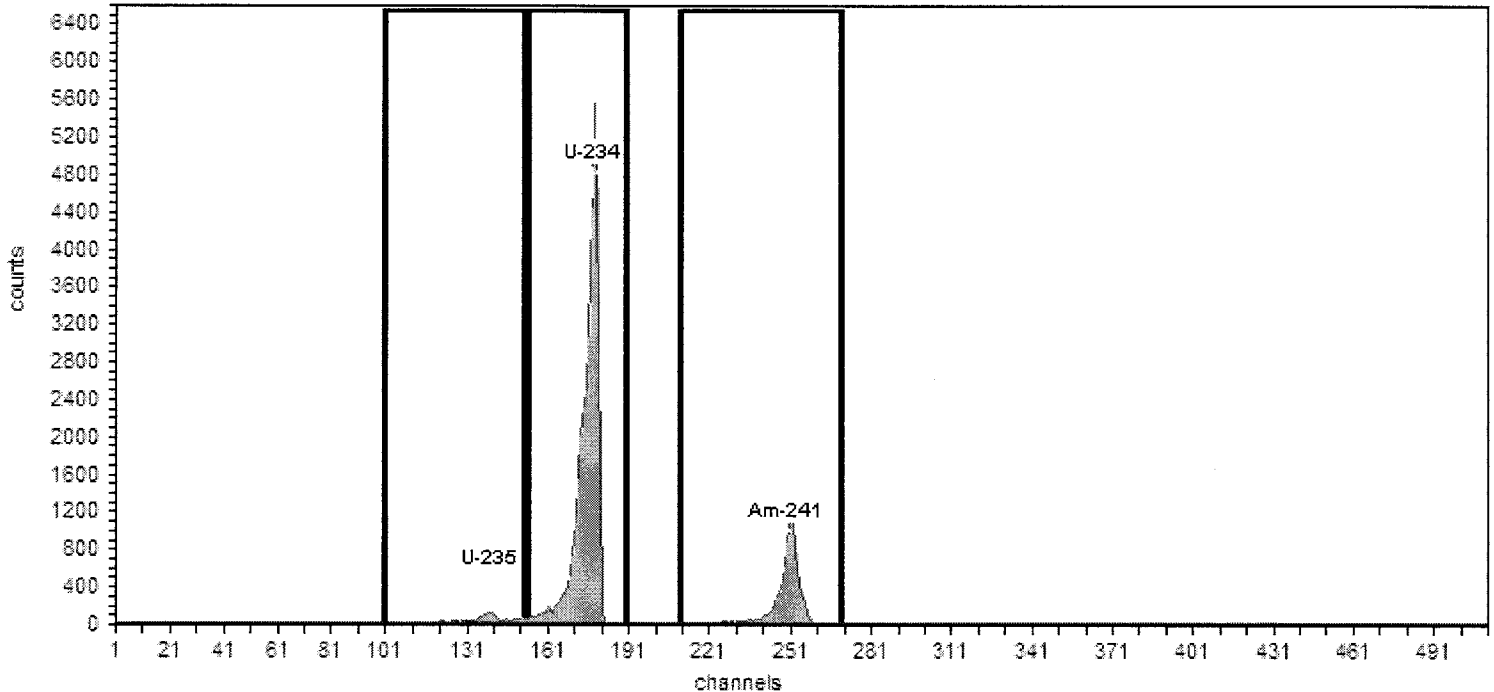
Gain = 9.9003 keV / Ch

Offset = 3,021.28 keV

Quadratic = 0.0000 keV / Ch²

Efficiency Calibration Name: SOURCE190A_10.04.16 (#9)

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



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.


Quality Control

2-OCT-13
Date

IPL Ref. No.: 987-28

ISO 9001 CERTIFIED

Medical Imaging Laboratory

24937 Avenue Tibbitts Valencia, California 91355

Industrial Gauging Laboratory

1800 North Keystone Street Burbank, California 91504

48 of 54



**Isotope Products
Laboratories**

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Re Calibrated 10/4/16

New Exp Date 10/4/2017

PAI 1875
recalibrated 4-15-03

10/15/16

CERTIFICATE OF CALIBRATION MIXED ALPHA STANDARD SOURCE

Radionuclide A: U-234
Radionuclide B: U-235
Radionuclide C: Am-241
Half Life (U-234): $(2.454 \pm 0.006)E+05$ years
Half Life (U-235): $(7.037 \pm 0.011)E+08$ 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.: 92MIX2203026

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

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 2 π on 11 Apr 03.

Daniel James Van Dalsem
Quality Control

15-Apr-03
Date Signed

IPL Ref. No.: 987-7

ISO 9001 CERTIFIED

Medical Imaging Laboratory
24937 Avenue Tibbitts Valencia, California 91355

Industrial Gauging Laboratory
1800 North Keystone Street Burbank, California 91504



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24937 Avenue Tibbitts
Valencia, California 91355

Tel 661-309-1010
Fax 661-257-8303

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

PAI 183
Recalibrated 4-15-03

CERTIFICATE OF CALIBRATION MIXED ALPHA STANDARD SOURCE

Radionuclide A: U-234
Radionuclide B: U-235
Radionuclide C: Am-241
Half Life (U-234): $(2.454 \pm 0.006)E+05$ years
Half Life (U-235): $(7.037 \pm 0.011)E+08$ 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.: 92MIX2203028

Contained Radioactivity:

U-234: 6.467 nCi (239.3 Bq)
U-235: 0.1135 nCi (4.200 Bq)

Am-241: 0.6366 nCi (23.55 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

Radiopurities:

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

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

ISO 9001 CERTIFIED

Medical Imaging Laboratory
24937 Avenue Tibbitts Valencia, California 91355

Industrial Gauging Laboratory
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**Isotope Products
Laboratories**

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Re-Calibrated 10/4/16
New Exp Date 10/4/2017
PAT I.D. 184
recalibrated 4-15-03

CERTIFICATE OF CALIBRATION MIXED ALPHA STANDARD SOURCE

Radionuclide A: U-234
Radionuclide B: U-235
Radionuclide C: Am-241
Half Life (U-234): $(2.454 \pm 0.006)E+05$ years
Half Life (U-235): $(7.037 \pm 0.011)E+08$ 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.: 92MIX2203024

Contained Radioactivity:

U-234: 3.227 nCi (119.4 Bq)
U-235: 0.05205 nCi (1.926 Bq)

Am-241: 2.866 nCi (106.0 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: $\pm 0.6\%$
B. Type B (systematic) uncertainty: $\pm 3.0\%$
C. Uncertainty in aliquot weighing: $\pm 0.0\%$
D. Total uncertainty at the 99% confidence level: $\pm 3.1\%$

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

ISO 9001 CERTIFIED

Medical Imaging Laboratory
24937 Avenue Tibbitts Valencia, California 91355

Industrial Gauging Laboratory
1800 North Keystone Street Burbank, California 91504



**Isotope Products
Laboratories**

An Eckert & Ziegler Company

24937 Avenue Tibbitts
Valencia, California 91355

Tel 661-309-1010
Fax 661-257-8303

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

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

CERTIFICATE OF CALIBRATION ALPHA STANDARD SOURCE

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

Customer: PARAGON ANALYTICS, INC.
P.O. No.: EW030603/R2155
Catalog No.: MISC-STD
Reference Date: 1-Apr-03 12:00 PST
Source No.: 92MIX2203021

Contained Radioactivity:

U-234: 2.731 nCi (101.0 Bq)
U-235: 0.03416 nCi (1.264 Bq)

Am-241: 0.9325 nCi (34.50 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: $\pm 0.8\%$
B. Type B (systematic) uncertainty: $\pm 3.1\%$
C. Uncertainty in aliquot weighing: $\pm 0.0\%$
D. Total uncertainty at the 99% confidence level: $\pm 3.2\%$

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 2 π on 18 Mar 03.

Daniel James Van Dalsem
Quality Control

19-Mar-03
Date Signed

IPL Ref. No.: 987-2

Medical Imaging Laboratory
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Re Calibrated 10/4/16
New Exp Date 10/4/2017
JP10516
PAID 188
Rec'd for recalibration
3-28-03

CERTIFICATE OF CALIBRATION ALPHA STANDARD SOURCE

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

Customer: PARAGON ANALYTICS, INC.
P.O. No.: EW030603/R2155
Catalog No.: MISC-STD
Reference Date: 1-Apr-03 12:00 PST
Source No.: 92MIX2203023

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

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

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Fax 661-257-8303

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

PAI ID 189
rec'd 4-21-03
recalibrated 4-15-03

CERTIFICATE OF CALIBRATION MIXED ALPHA STANDARD SOURCE

Radionuclide A: U-234
Radionuclide B: U-235
Radionuclide C: Am-241
Half Life (U-234): $(2.454 \pm 0.006)E+05$ years
Half Life (U-235): $(7.037 \pm 0.011)E+08$ 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)
U-235: 0.1771 nCi (6.553 Bq)

Am-241: 1.433 nCi (53.02 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:	$\pm 0.5\%$
B. Type B (systematic) uncertainty:	$\pm 3.0\%$
C. Uncertainty in aliquot weighing:	$\pm 0.0\%$
D. Total uncertainty at the 99% confidence level:	$\pm 3.0\%$

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 $11950 \alpha/\text{min}$ in 2π on 11 Apr 03.

Daniel James Van Dalsem
Quality Control

15-Apr-03
Date Signed

IPL Ref. No.: 987-7

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