facility 755652
facility 755653
project 10243

Isotopic Polonium

Case Narrative

COGCC

PW NORM 2017 – 10048

Work Order Number: 1706286

1. This report consists of analytical results and supporting documentation for two water samples received by ALS on 06/13/2017.

2. These samples were prepared according to the current revisions SOP 776 and SOP 711.

3. The samples were analyzed for the presence of Polonium-210 according to the current revision of SOP 714. The analyses were completed on 06/25/2017.

4. The analysis results for these samples are reported in units of pCi/L. The samples were 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. The requested MDC was not met for samples 1706286-1 and -3. These samples were prepared at a reduced aliquot due to suspected matrix interference. These samples were counted for a maximum count time of 1000 minutes and results are reported without further qualification. The results are identified with an “M” qualifier on the final reports.

7. Sample 1706286-3 was initially prepared in batch PL170616-1 on 06/16/2017, at a 50mL aliquot. The sample had a 3% yield after the initial analysis. The sample was re-prepared in batch PL170623-1 at an even further reduced aliquot of 10mL and has a 5.12% yield. All quality control criteria were achieved for the re-preparation. The results of this sample will be reported from batch PL170623-1 at the decision of the client. This sample is identified with an “Y2” flag on the final reports.

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 these samples. 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.

Jean Anderson — 7/24/17
Radiochemistry Primary Data Reviewer — Date

Radiochemistry Final Data Reviewer — 7/26/17
Date

Section 1

CHAIN OF CUSTODY

ALS -- Fort Collins

Sample Number(s) Cross-Reference Table

OrderNum: 1706286
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
755652 Coalview	1706286-1		WATER	13-Jun-17	10:16
755652 Coalview	1706286-2		WATER	13-Jun-17	10:16
755653 Oscar Y	1706286-3		WATER	13-Jun-17	11:36
755653 Oscar Y	1706286-4		WATER	13-Jun-17	11:36

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 # 1706286

TURNAROUND TIME	45 days	SAMPLER	RC/PAG	PAGE	2 of 3
SITE ID				DISPOSAL	BY LAB or

PROJECT NAME	PW NORM 2017	EDD FORMAT	COGCC
PROJECT No.	10048	PURCHASE ORDER	CT 2017-3066
COMPANY NAME	Colorado Oil & Gas Conservation Commission	BILL TO COMPANY	
SEND REPORT TO	Peter Gintautas	INVOICE ATTN TO	
ADDRESS	1120 Lincoln St., Suite 801	ADDRESS	
CITY / STATE / ZIP	Denver, CO 80203	CITY / STATE / ZIP	
PHONE	719-679-1326	PHONE	
FAX		FAX	
E-MAIL	peter.gintautas@state.co.us	E-MAIL	

PARAMETER/METHOD REQUEST FOR ANALYSIS

A	total metals SW6010/6020
B	dissolved metals SW6010
C	SW9040A pH
D	SM2510B specific conductance
E	SM2320C total, bicarbonate and carbonate alkalinity
F	SM2540C dissolved solids
G	SM2540D suspended solids
H	SW9056 anions (Br, Cl, F, SO4)
I	SAR calculation
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	755652 Coalview	W	6/13/17	10:16	1	2		X										
	755652 Coalview	W	6/13/17	10:16	2	7			X	X	X	X	X	X	X	X		
2	755653 Oscar Y	W	6/13/17	11:36	1	2		X										
	755653 Oscar Y	W	6/13/17	11:36	2	7			X	X	X	X	X	X	X	X		

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

NOTES

6010 total = B, Be, Ca, Cr, Fe, K, Li, Mg, Na, Ni, P, S, Si, V

6020 total = Al, Ag, As, Ba, Cd, Co, Cu, Mo, Mn, Na, Pb, Se, Sr, Th, Tl, U, Zn

diss. 6010 = Ba, Ca, Fe, K, Mg, Na, Si, Sr

Dissolved = filter and preserve upon receipt at lab

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

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		Peter Gintautas	6/13/2017	14:20
RECEIVED BY	C Trimble	C Trimble	6-13-17	1420
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 #
1706786

TURNAROUND TIME	45 days	SAMPLER	RC/PAG	PAGE	1 of 3
				DISPOSAL	BY LAB or

PROJECT NAME	PW NORM 2017	SITE ID			
PROJECT No.	10048	EDD FORMAT	COGCC	PARAMETER/METHOD REQUEST FOR ANALYSIS	
		PURCHASE ORDER	CT 2017-3066	A	gross alpha/gross beta
COMPANY NAME	Colorado Oil & Gas Conservation Commission	BILL TO COMPANY		B	210Pb
SEND REPORT TO	Peter Gintautas	INVOICE ATTN TO		C	210Po
ADDRESS	1120 Lincoln St., Suite 801	ADDRESS		D	222Rn
CITY / STATE / ZIP	Denver, CO 80203	CITY / STATE / ZIP		E	224Ra & 226Ra
PHONE	719-679-1326	PHONE		F	228Ra
FAX		FAX		G	gamma emitters
E-MAIL	peter.gintautas@state.co.us	E-MAIL		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
1	755652 Coalview	W	6/13/17	10:16	3	2		X	X	X		X	X	X	*	*		
	755652 Coalview	W	6/13/17	10:16	3	7					X							
2	755653 Oscar Y	W	6/13/17	11:36	2 PAG	2		X	X	X		X	X	X	*	*		
	755653 Oscar Y	W	6/13/17	11:36	3	7					X							
	gamma emitters 40K, 137Cs, 212Pb, 212Bi, 214Pb, 224Bi, 226Ra/235U, 228Ac/228Ra, 234mPa, 234Th																	

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

NOTES	REPORT LEVEL / QC REQUIRED	
GAB prepped (coprecip) and counted within 4 days of sampling		Summary (Standard QC)
224Ra prepped and counted within 4 days of sampling		LEVEL II (Standard QC)
*iso U only if 6020 "total" U >3µg/l		LEVEL III (Std QC + forms)
*iso Th only if 6020 "total" Th >3µg/l		
gamma = 40K, 137Cs, 212Pb, 212Bi, 214Pb, 224Bi, 226Ra/235U	X	LEVEL IV (Std QC + forms + raw data)
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		Peter Gintautas	6/13/2017	14:20
RECEIVED BY	C Trimble	C Trimble	6-13-17	1420
RELINQUISHED BY				
RECEIVED BY				
RELINQUISHED BY				
RECEIVED BY				

ALS Environmental - Fort Collins
CONDITION OF SAMPLE UPON RECEIPT FORM

Client: COGCC Workorder No: 1706286

Project Manager: SS Initials: JNS Date: 6/13/17

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 (X) 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	3	4				
Temperature (°C):	amb	amb	4	3.6				
No. of custody seals on cooler:	0	0	0	0				
DOT Survey/ Acceptance Information — External µR/hr reading:	n.a							
Background µR/hr reading:	10							

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.

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

Project Manager Signature / Date: Shilab Sunny

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

Section 2

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: 1706286

Reported on: Wednesday, July 05, 2017
2:54:09 PM

Lab Sample ID	Client Sample ID	Sample Type	Nuclide	Result +/- 2 s TPU	MDC	DL	Units	Matrix	Prep Batch	Date Analyze	Flags
1706286-1	755652 Coalview	Sample	Po-210	0E+00 +/- 3.5E-01	6.6E-01	NA	pCi/l	WATER	PL170616-1	6/21/2017	U,M
1706286-3	755653 Oscar Y	Sample	Po-210	0E+00 +/- 3E+01	5.6E+01	NA	pCi/l	WATER	PL170623-1	6/25/2017	Y2,U,M

Comments:

Data Package ID: *PL1706286-1*

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: 1706286
Client Name: COGCC
ClientProject ID: PW NORM 2017 10048

Lab ID: PL170616-1MB

Sample Matrix: WATER
Prep SOP: PAI 711 Rev 10
Date Collected: 16-Jun-17
Date Prepared: 16-Jun-17
Date Analyzed: 21-Jun-17

Prep Batch: PL170616-1
QCBatchID: PL170616-1-1
Run ID: PL170616-1A
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	2.1E-02 +/- 2E-02	2.8E-02	5E-01	NA	U

Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Po-209	9.940E+00	9.3E+00	pCi/l	93.3	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: *PL1706286-1*

Polonium-210 by Alpha Spectroscopy

PAI 714 Rev 13

Method Blank Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1706286
Client Name: COGCC
ClientProject ID: PW NORM 2017 10048

Lab ID: PL170623-1MB

Sample Matrix: WATER
Prep SOP: PAI 711 Rev 10
Date Collected: 23-Jun-17
Date Prepared: 23-Jun-17
Date Analyzed: 25-Jun-17

Prep Batch: PL170623-1
QCBatchID: PL170623-1-1
Run ID: PL170623-1A
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	6E-03 +/- 1.8E-02	3.4E-02	5E-01	NA	U

Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Po-209	9.940E+00	9.1E+00	pCi/l	91.7	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.

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: *PL1706286-1*

Polonium-210 by Alpha Spectroscopy

PAI 714 Rev 13

Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins
Work Order Number: 1706286
Client Name: COGCC
ClientProject ID: PW NORM 2017 10048

Lab ID: PL170616-1LCS

Sample Matrix: WATER
Prep SOP: PAI 711 Rev 10
Date Collected: 16-Jun-17
Date Prepared: 16-Jun-17
Date Analyzed: 21-Jun-17

Prep Batch: PL170616-1
QCBatchID: PL170616-1-1
Run ID: PL170616-1A
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	1.12E+01 +/- 1.7E+00	0E+00	1.070E+01	105	83 - 117	P

Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Po-209	9.940E+00	8.7E+00	pCi/l	87.5	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: *PL1706286-1*

Polonium-210 by Alpha Spectroscopy

PAI 714 Rev 13

Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins
Work Order Number: 1706286
Client Name: COGCC
ClientProject ID: PW NORM 2017 10048

Lab ID: PL170623-1LCS

Sample Matrix: WATER
Prep SOP: PAI 711 Rev 10
Date Collected: 23-Jun-17
Date Prepared: 23-Jun-17
Date Analyzed: 25-Jun-17

Prep Batch: PL170623-1
QCBatchID: PL170623-1-1
Run ID: PL170623-1A
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	1.1E+01 +/- 1.7E+00	0E+00	1.070E+01	103	83 - 117	P

Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Po-209	9.940E+00	9.6E+00	pCi/l	96.4	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: *PL1706286-1*

Section 4

INDIVIDUAL SAMPLE RESULTS

Polonium-210 by Alpha Spectroscopy

PAI 714 Rev 13

Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1706286
Client Name: COGCC
ClientProject ID: PW NORM 2017 10048

Field ID: 755652 Coalview
Lab ID: 1706286-1

Sample Matrix: WATER
Prep SOP: PAI 711 Rev 10
Date Collected: 13-Jun-17
Date Prepared: 16-Jun-17
Date Analyzed: 21-Jun-17

Prep Batch: PL170616-1
QCBatchID: PL170616-1-1
Run ID: PL170616-1A
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	0E+00 +/- 3.5E-01	6.6E-01	5E-01	NA	U,M

Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Po-209	1.990E+02	1.67E+02	pCi/l	83.9	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: *PL1706286-1*

Polonium-210 by Alpha Spectroscopy

PAI 714 Rev 13

Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 1706286
Client Name: COGCC
ClientProject ID: PW NORM 2017 10048

Field ID: 755653 Oscar Y
Lab ID: 1706286-3

Sample Matrix: WATER
Prep SOP: PAI 711 Rev 10
Date Collected: 13-Jun-17
Date Prepared: 23-Jun-17
Date Analyzed: 25-Jun-17

Prep Batch: PL170623-1
QCBatchID: PL170623-1-1
Run ID: PL170623-1A
Count Time: 1000 minutes
Report Basis: Unfiltered

Final Aliquot: 5.00 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	0E+00 +/- 3E+01	5.6E+01	5E-01	NA	Y2,U,M

Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
Po-209	9.940E+02	5.1E+01	pCi/l	5.12	30 - 110 %	Y2

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: *PL1706286-1*

Section 5

RAW DATA

Polonium-210 by Alpha Spectroscopy Raw Data Report

Laboratory Name: ALS -- Fort Collins
PAI Work Order: 1706286
Prep SOP: PAI 711
Analytical SOP: PAI 714
Reported on: Monday, July 03, 2017 2:29:56 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
1706286-1	Po-209	6/13/2017	PL170616-1	NA	6/19/2017	WATER	50 ml	AlphaSpec2	PL170616-1A	6/21/2017	2939.000	31.73%	1000	1.67E+02	1E+00	pCi/l	NA	
SMP	Tracer	10:16:00 AM	PL170616-1-1	NA	3:50:00 PM	NA	25 ml	105	Spectrum #1	10:46 AM	4.000	1000	83.9%	2.4E+01		Filtered	NA	
1706286-1	Po-210	6/13/2017	PL170616-1	NA	6/19/2017	WATER	50 ml	AlphaSpec2	PL170616-1A	6/21/2017	0.000	31.73%	1000	0E+00	6.6E-01	pCi/l	NA	
SMP	Trg. Analyte	10:16:00 AM	PL170616-1-1	NA	3:50:00 PM	NA	25 ml	105	Spectrum #1	10:46 AM	2.000	1000	83.9%	3.5E-01		Filtered	NA	U,M
1706286-3	Po-209	6/13/2017	PL170623-1	NA	6/24/2017	WATER	10 ml	AlphaSpec2	PL170623-1A	6/25/2017	174.000	30.78%	1000	5.1E+01	3E+00	pCi/l	NA	
SMP	Tracer	11:36:00 AM	PL170623-1-1	NA	4:08:00 PM	NA	5 ml	103	Spectrum #1	10:42 AM	3.000	1000	5.12%	1.1E+01		Unfiltered	NA	Y2
1706286-3	Po-210	6/13/2017	PL170623-1	NA	6/24/2017	WATER	10 ml	AlphaSpec2	PL170623-1A	6/25/2017	0.000	30.78%	1000	0E+00	5.6E+01	pCi/l	NA	
SMP	Trg. Analyte	11:36:00 AM	PL170623-1-1	NA	4:08:00 PM	NA	5 ml	103	Spectrum #1	10:42 AM	2.000	1000	5.12%	3E+01		Unfiltered	NA	Y2,U,M
PL170616-1	Po-209	6/16/2017	PL170616-1	NA	6/19/2017	WATER	1000 ml	AlphaSpec2	PL170616-1A	6/21/2017	3352.000	32.54%	1000	9.3E+00	0E+00	pCi/l	NA	
MB	Tracer	2:50:26 PM	PL170616-1-1	NA	3:50:00 PM	NA	500 ml	113	Spectrum #1	10:46 AM	3.000	1000	93.3%	1.3E+00		Unfiltered	NA	
PL170616-1	Po-210	6/16/2017	PL170616-1	NA	6/19/2017	WATER	1000 ml	AlphaSpec2	PL170616-1A	6/21/2017	7.000	32.54%	1000	2.1E-02	2.8E-02	pCi/l	NA	
MB	Trg. Analyte	2:50:26 PM	PL170616-1-1	NA	3:50:00 PM	NA	500 ml	113	Spectrum #1	10:46 AM	2.000	1000	93.3%	2E-02		Unfiltered	NA	U
PL170616-1	Po-209	6/16/2017	PL170616-1	NA	6/19/2017	WATER	1000 ml	AlphaSpec2	PL170616-1A	6/21/2017	1548.520	33.42%	480	8.7E+00	0E+00	pCi/l	NA	
LCS	Tracer	2:50:26 PM	PL170616-1-1	NA	3:50:00 PM	NA	500 ml	114	Spectrum #1	10:47 AM	1.000	1000	87.5%	1.3E+00		Unfiltered	NA	
PL170616-1	Po-210	6/16/2017	PL170616-1	NA	6/19/2017	WATER	1000 ml	AlphaSpec2	PL170616-1A	6/21/2017	1741.520	33.42%	480	1.12E+01	0E+00	pCi/l	NA	105
LCS	Trg. Analyte	2:50:26 PM	PL170616-1-1	NA	3:50:00 PM	NA	500 ml	114	Spectrum #1	10:47 AM	1.000	1000	87.5%	1.7E+00		Unfiltered	NA	P
PL170623-1	Po-209	6/23/2017	PL170623-1	NA	6/24/2017	WATER	1000 ml	AlphaSpec2	PL170623-1A	6/25/2017	3227.000	31.90%	1000	9.1E+00	0E+00	pCi/l	NA	
MB	Tracer	11:13:20 AM	PL170623-1-1	NA	4:08:00 PM	NA	500 ml	112	Spectrum #1	10:42 AM	3.000	1000	91.7%	1.3E+00		Unfiltered	NA	
PL170623-1	Po-210	6/23/2017	PL170623-1	NA	6/24/2017	WATER	1000 ml	AlphaSpec2	PL170623-1A	6/25/2017	2.000	31.90%	1000	6E-03	3.4E-02	pCi/l	NA	
MB	Trg. Analyte	11:13:20 AM	PL170623-1-1	NA	4:08:00 PM	NA	500 ml	112	Spectrum #1	10:42 AM	3.000	1000	91.7%	1.8E-02		Unfiltered	NA	U
PL170623-1	Po-209	6/23/2017	PL170623-1	NA	6/24/2017	WATER	1000 ml	AlphaSpec2	PL170623-1A	6/25/2017	1661.560	32.54%	480	9.6E+00	0E+00	pCi/l	NA	
LCS	Tracer	11:13:20 AM	PL170623-1-1	NA	4:08:00 PM	NA	500 ml	113	Spectrum #1	10:43 AM	3.000	1000	96.4%	1.4E+00		Unfiltered	NA	

Comments:

Data Package ID: *PL1706286-1*

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

Polonium-210 by Alpha Spectroscopy Raw Data Report

Laboratory Name: ALS -- Fort Collins
PAI Work Order: 1706286
Prep SOP: PAI 711
Analytical SOP: PAI 714
Reported on: Monday, July 03, 2017 2:41:14 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
PL170623-1	Po-210	6/23/2017	PL170623-1	NA	6/24/2017	WATER	1000 ml	AlphaSpec2	PL170623-1A	6/25/2017	1839.040	32.54%	480	1.1E+01	0E+00	pCi/l	NA	103
LCS	Trg. Analyte	11:13:20 AM	PL170623-1-1	NA	4:08:00 PM	NA	500 ml	113	Spectrum #1	10:43 AM	2.000	1000	96.4%	1.7E+00		Unfiltered	NA	P

Comments:

Data Package ID: *PL1706286-1*

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'

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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

Analyst: ORTEC 10:43:24AM 6/23/2017

Sample

Sample: 1706286-1 Type: Sample
Spectrum #1 Analysis #1
:
Sample Collection Date:
Comment:

Sample Volume : 0.03 Sample Units: L
First Stage Dilution: N/A
Aliquot: N/A Aliquot Fraction: N/A
Dilution 2: N/A
Lab Preparation:

Batch

Batch Name: PL170616-1_B
:
Description:

Client Name: Undefined
Client Contact:

Tracer

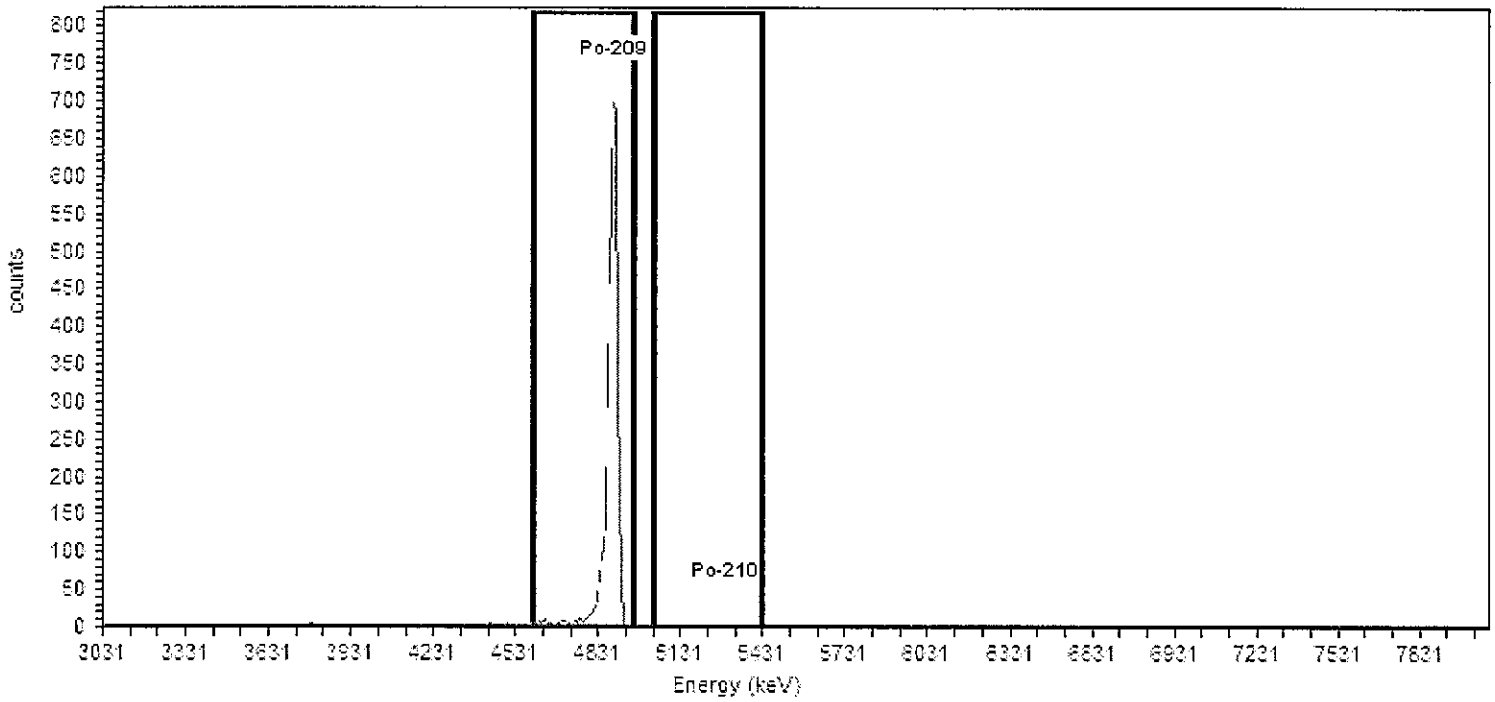
Tracer Name: 1045.4243.07 Po-209
Tracer Activity: 22.23 DPM / mL x (Vol.) 0.50 mL = 11.11 DPM
Tracer Ref. Date: 6/8/2016 10:00:00AM

Tracer Nuclide: Po-209
Tracer Recovery: 84.14%

Acquisition

Detector: 105, SN: 5505338, ID: 105
Acquisition Start Date: 6/21/2017 10:46:42AM
Live Time: 1,000.00 min.
Real Time: 1,000.00 min.
Background Date: 6/20/2017 12:43:21PM
Bkgd Info: Sample: B170620105; Det: 105; Spectrum #1; 6/20/2017 12:43:21 PM; Live Time: 1000.000(min.); ID: 105

Energy Calibration: C170620105A
Efficiency Calibration:C170620105A
Calibration Date: 6/20/2017 11:38:25AM
Energy Cal: Gain = 9.9003 keV / Ch
Offset = 3,021.28 keV
Quadratic = 0.0000 keV / Ch^2
Efficiency: 31.73% +/- 1.31% TPU(2 sigma)



General Analysis

Analysis Method: ROI Analysis, Set Name = Po-210
Decay Correction:6/21/2017 10:45:40AM
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	62.7	99.7	2,943.00	4.0000	2939.00	1.685E+002	4.670E+000	3.171E-001	8.185E-001
Po-210	5298.345	5031.037	5427.048	59.0	100.0	2.00	2.0000	0.00	0.000E+000	5.399E+000	2.220E-001	6.267E-001

Analyst: user 8:42:30AM 6/26/2017

Sample

Sample: 1706286-3 Type: Sample
Spectrum #1 Analysis #1
:
Sample Collection Date:
Comment:

Sample Volume : 0.00 Sample Units: L
First Stage Dilution: N/A
Aliquot: N/A Aliquot Fraction: N/A
Dilution 2: N/A
Lab Preparation:

Batch

Batch Name: PL170623-1_A
:
Description:

Client Name: Undefined
Client Contact:

Tracer

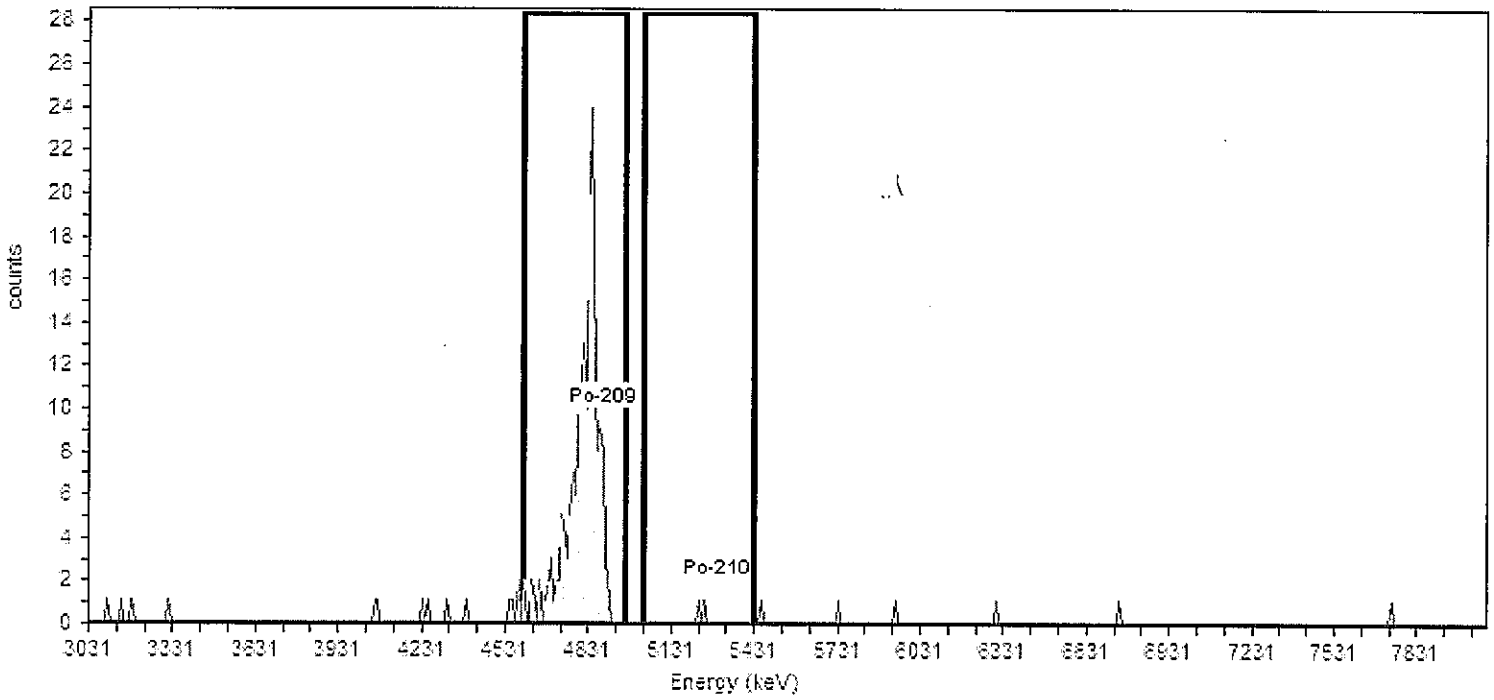
Tracer Name: 1045.4243.07 Po-209
Tracer Activity: 22.23 DPM / mL x (Vol.) 0.50 mL = 11.11 DPM
Tracer Ref. Date: 6/8/2016 10:00:00AM

Tracer Nuclide: Po-209
Tracer Recovery: 5.14%

Acquisition

Detector: 103, SN: 5505336, ID: 103
Acquisition Start Date: 6/25/2017 10:42:14AM
Live Time: 1,000.00 min.
Real Time: 1,000.00 min.
Background Date: 6/20/2017 12:43:21PM
Bkgd Info: Sample: B170620103; Det: 103; Spectrum #1; 6/20/2017 12:43:21 PM; Live Time: 1000.000(min.); ID: 103

Energy Calibration: C170620103
Efficiency Calibration:C170620103
Calibration Date: 6/20/2017 11:38:19AM
Energy Cal: Gain = 9.9003 keV / Ch
Offset = 3,021.28 keV
Quadratic = 0.0000 keV / Ch^2
Efficiency: 30.78% +/- 1.22% TPU(2 sigma)



General Analysis

Analysis Method: ROI Analysis, Set Name = Po-210
Decay Correction:6/25/2017 10:41:12AM
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	85.6	99.7	177.00	3.0000	174.00	5.143E+001	4.095E+000	2.319E+001	6.195E+001
Po-210	5298.345	5031.037	5427.048	57.6	100.0	2.00	2.0000	0.00	0.000E+000	2.280E+003	1.875E+001	5.293E+001

Analyst: ORTEC 10:44:14AM 6/23/2017

Sample

Sample: PL170616-1MB Type: Sample
Spectrum #1 Analysis #1
:
Sample Collection Date:
Comment:

Sample Volume : 0.03 Sample Units: L
First Stage Dilution: N/A
Aliquot: N/A Aliquot Fraction: N/A
Dilution 2: N/A
Lab Preparation:

Batch

Batch Name: PL170616-1_B
:
Description:

Client Name: Undefined
Client Contact:

Tracer

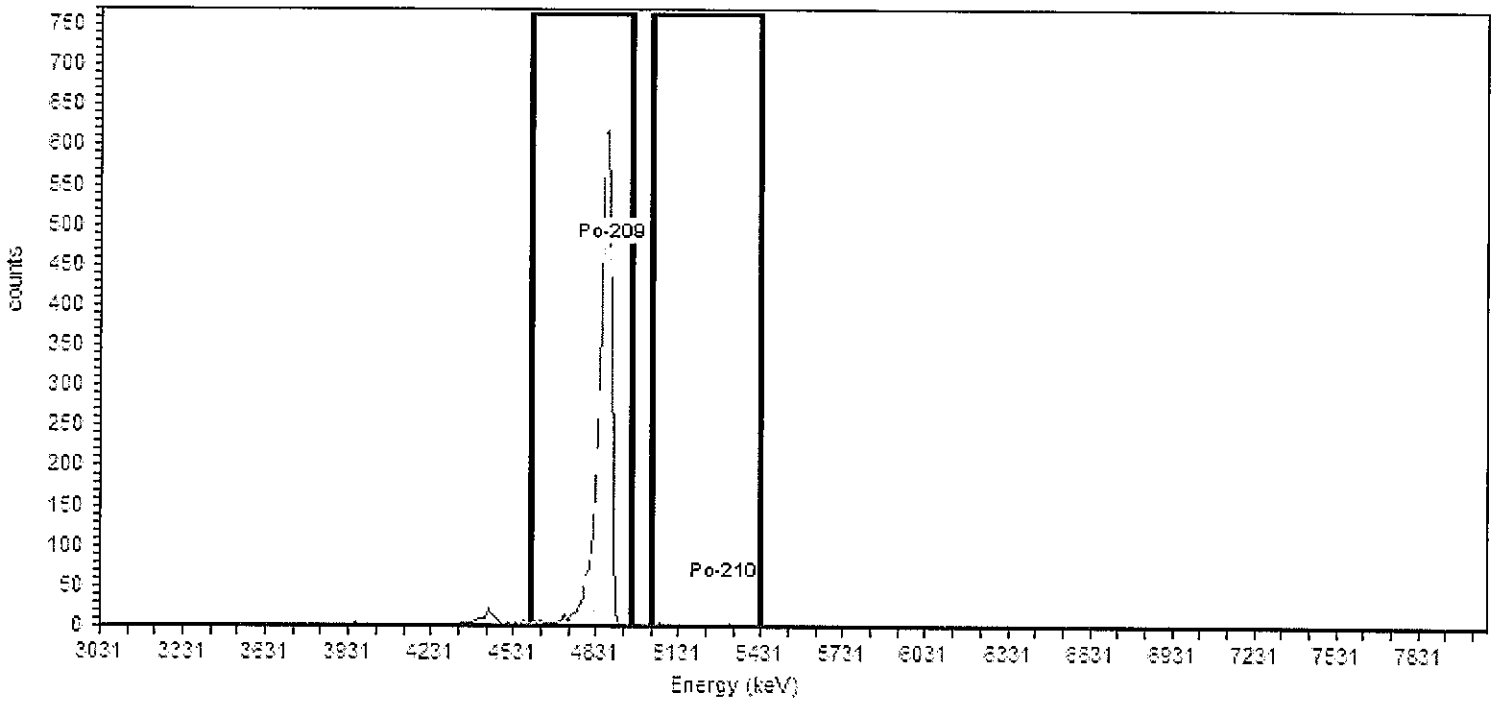
Tracer Name: 1045.4243.07 Po-209
Tracer Activity: 22.23 DPM / mL x (Vol.) 0.50 mL = 11.11 DPM
Tracer Ref. Date: 6/8/2016 10:00:00AM

Tracer Nuclide: Po-209
Tracer Recovery: 93.56%

Acquisition

Detector: 113, SN: 5505346, ID: 113
Acquisition Start Date: 6/21/2017 10:46:43AM
Live Time: 1,000.00 min.
Real Time: 1,000.06 min.
Background Date: 6/20/2017 12:44:10PM
Bkgd Info: Sample: B170620113; Det: 113; Spectrum #1; 6/20/2017 12:44:10 PM; Live Time: 1000.000(min.); ID: 113

Energy Calibration: C170620113
Efficiency Calibration:C170620113
Calibration Date: 6/20/2017 11:38:44AM
Energy Cal: Gain = 9.9003 keV / Ch
Offset = 3,021.28 keV
Quadratic = 0.0000 keV / Ch^2
Efficiency: 32.54% +/- 1.24% TPU(2 sigma)



General Analysis

Analysis Method: ROI Analysis, Set Name = Po-210
Decay Correction:6/21/2017 10:45:40AM
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	62.6	99.7	3,355.00	3.0000	3352.00	1.874E+002	4.831E+000	2.407E-001	6.432E-001
Po-210	5298.345	5031.037	5427.048	37.4	100.0	9.00	2.0000	7.00	4.142E-001	1.978E-001	1.947E-001	5.495E-001

Analyst: ORTEC 10:44:20AM 6/23/2017

Sample

Sample: PL170616-1LCS 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: PL170616-1_C
:
Description:

Client Name: Undefined
Client Contact:

Tracer

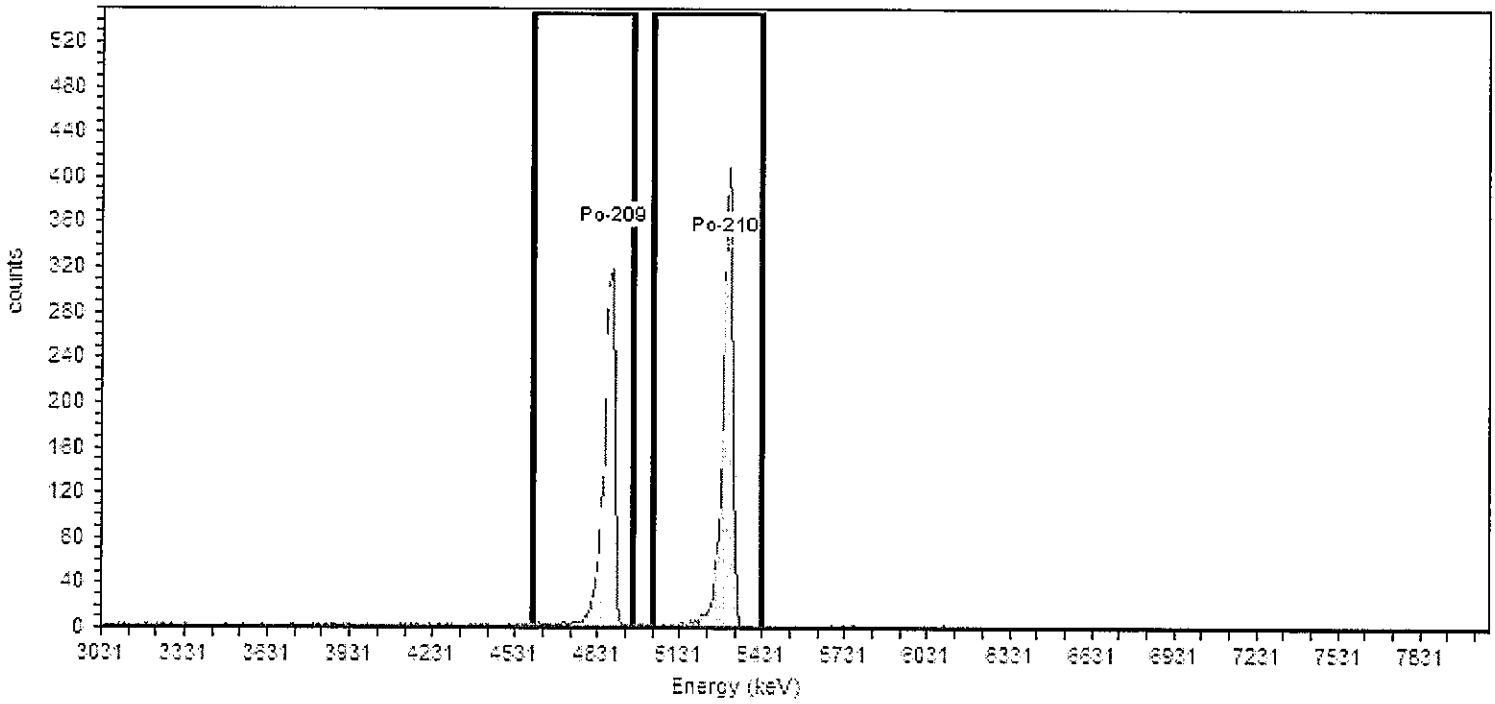
Tracer Name: 1045.4243.07 Po-209
Tracer Activity: 22.23 DPM / mL x (Vol.) 0.50 mL = 11.11 DPM
Tracer Ref. Date: 6/8/2016 10:00:00AM

Tracer Nuclide: Po-209
Tracer Recovery: 87.69%

Acquisition

Detector: 114, SN: 5505347, ID: 114
Acquisition Start Date: 6/21/2017 10:47:20AM
Live Time: 480.00 min.
Real Time: 480.00 min.
Background Date: 6/20/2017 12:44:10PM
Bkgd Info: Sample: B170620114; Det: 114; Spectrum #1; 6/20/2017 12:44:10 PM; Live Time: 1000.000(min.); ID: 114

Energy Calibration: C170620114
Efficiency Calibration:C170620114
Calibration Date: 6/20/2017 11:38:46AM
Energy Cal: Gain = 9.9003 keV / Ch
Offset = 3,021.28 keV
Quadratic = 0.0000 keV / Ch^2
Efficiency: 33.42% +/- 2.06% TPU(2 sigma)



General Analysis

Analysis Method: ROI Analysis, Set Name = Po-210
Decay Correction:6/21/2017 10:46:58AM
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	61.4	99.7	1,549.00	0.4800	1548.52	8.781E+000	3.505E-001	8.966E-003	3.543E-002
Po-210	5298.345	5031.037	5427.048	60.5	100.0	1,742.00	0.4800	1741.52	1.115E+001	8.358E-001	8.880E-003	3.509E-002

Analyst: user 8:43:11AM 6/26/2017

Sample

Sample: PL170623-1MB 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: PL170623-1_A
:
Description:

Client Name: Undefined
Client Contact:

Tracer

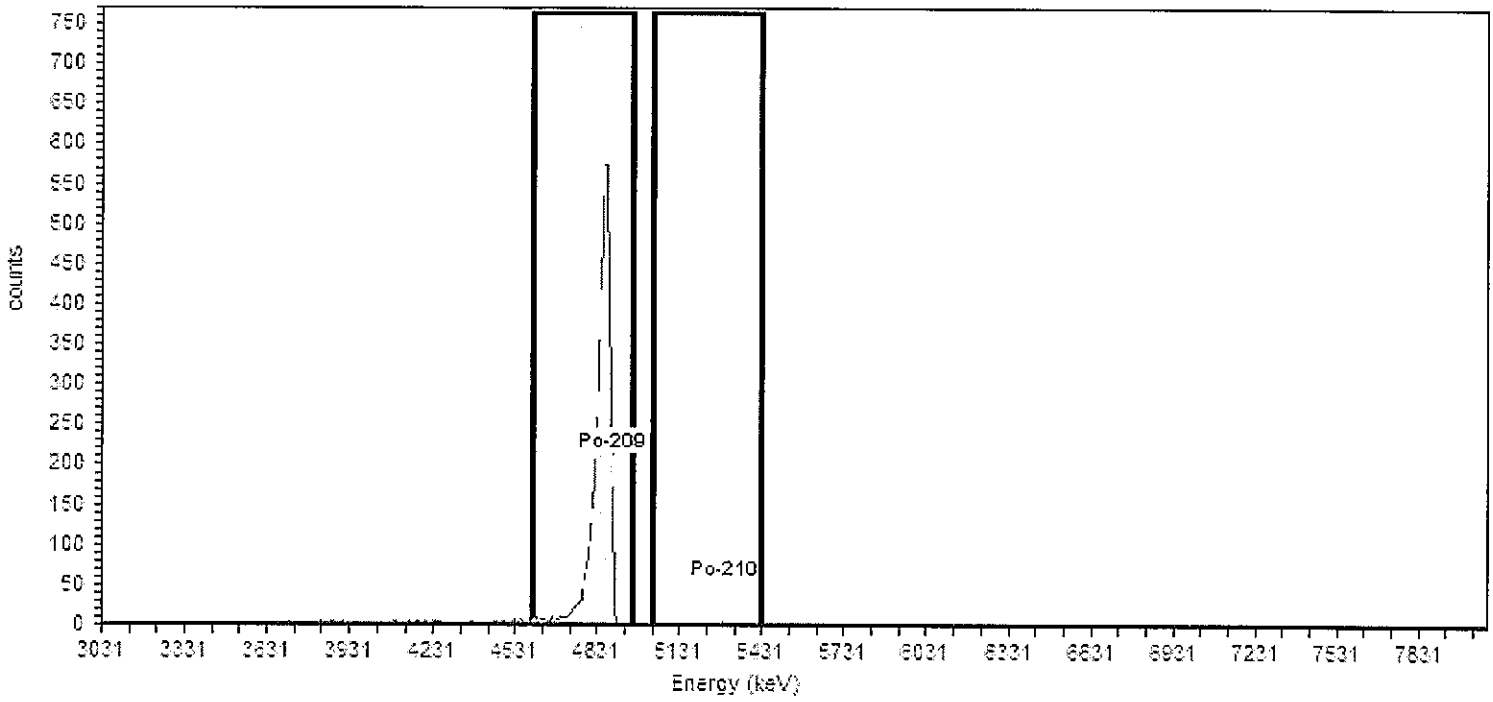
Tracer Name: 1045.4243.07 Po-209
Tracer Activity: 22.23 DPM / mL x (Vol.) 0.50 mL = 11.11 DPM
Tracer Ref. Date: 6/8/2016 10:00:00AM

Tracer Nuclide: Po-209
Tracer Recovery: 91.91%

Acquisition

Detector: 112, SN: 5505345, ID: 112
Acquisition Start Date: 6/25/2017 10:42:15AM
Live Time: 1,000.00 min.
Real Time: 1,000.00 min.
Background Date: 6/20/2017 12:44:10PM
Bkgd Info: Sample: B170620112; Det: 112; Spectrum #1; 6/20/2017 12:44:10 PM; Live Time: 1000.000(min.); ID: 112

Energy Calibration: C170620112
Efficiency Calibration:C170620112
Calibration Date: 6/20/2017 11:38:41AM
Energy Cal: Gain = 9.9003 keV / Ch
Offset = 3,021.28 keV
Quadratic = 0.0000 keV / Ch^2
Efficiency: 31.90% +/- 1.32% TPU(2 sigma)



General Analysis

Analysis Method: ROI Analysis, Set Name = Po-210
Decay Correction:6/25/2017 10:41:12AM
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	64.1	99.7	3,230.00	3.0000	3227.00	9.203E+000	2.497E-001	1.250E-002	3.340E-002
Po-210	5298.345	5031.037	5427.048	58.2	100.0	5.00	3.0000	2.00	6.146E-003	8.700E-003	1.238E-002	3.308E-002

Analyst: user 8:43:33AM 6/26/2017

Sample

Sample: PL170623-1LCS 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: PL170623-1_B
:
Description:

Client Name: Undefined
Client Contact:

Tracer

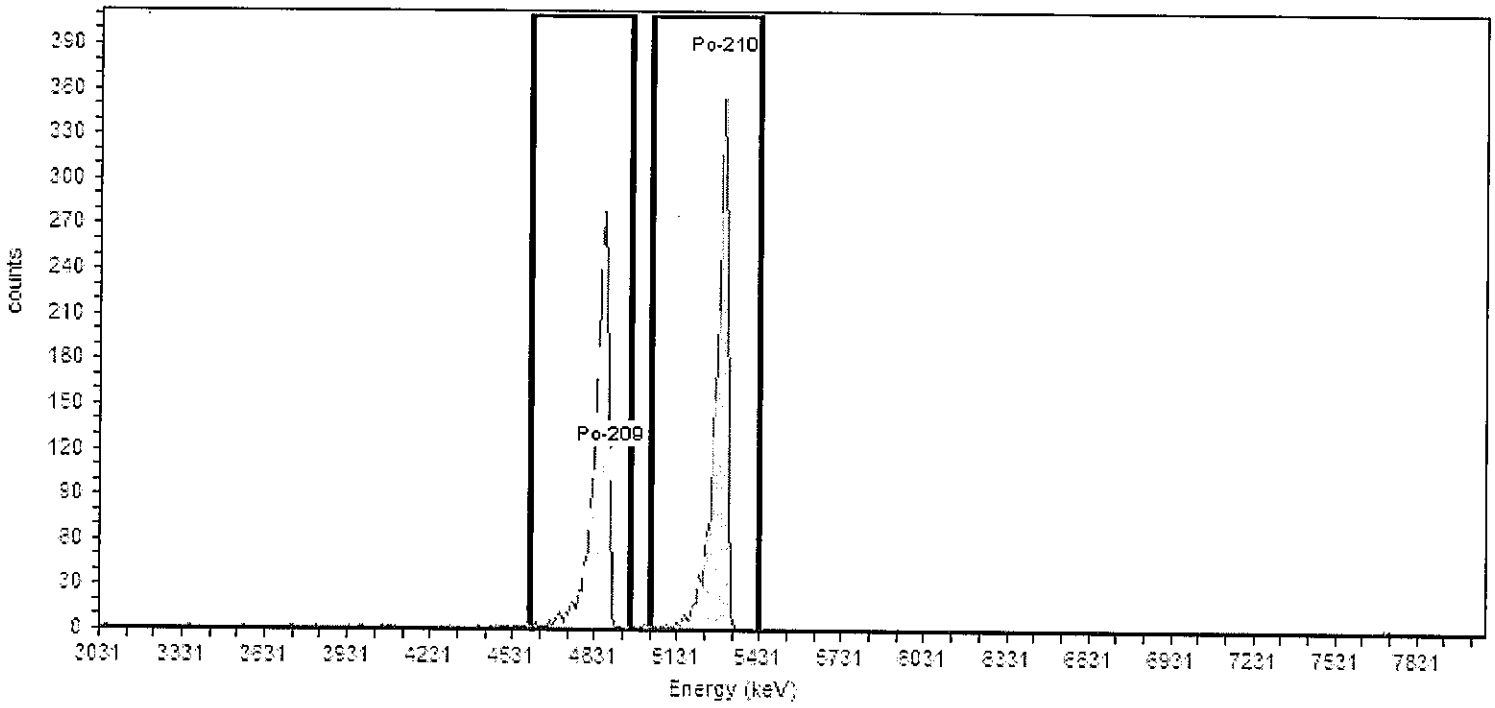
Tracer Name: 1045.4243.07 Po-209
Tracer Activity: 22.23 DPM / mL x (Vol.) 0.50 mL = 11.11 DPM
Tracer Ref. Date: 6/8/2016 10:00:00AM

Tracer Nuclide: Po-209
Tracer Recovery: 96.63%

Acquisition

Detector: 113, SN: 5505346, ID: 113
Acquisition Start Date: 6/25/2017 10:43:00AM
Live Time: 480.00 min.
Real Time: 480.00 min.
Background Date: 6/20/2017 12:44:10PM
Bkgd Info: Sample: B170620113; Det: 113; Spectrum #1; 6/20/2017 12:44:10 PM; Live Time: 1000.000(min.); ID: 113

Energy Calibration: C170620113
Efficiency Calibration:C170620113
Calibration Date: 6/20/2017 11:38:44AM
Energy Cal: Gain = 9.9003 keV / Ch
Offset = 3,021.28 keV
Quadratic = 0.0000 keV / Ch²
Efficiency: 32.54% +/- 1.24% TPU(2 sigma)



General Analysis

Analysis Method: ROI Analysis, Set Name = Po-210
Decay Correction:6/25/2017 10:42:31AM
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	64.7	99.7	1,663.00	1.4400	1661.56	9.676E+000	3.011E-001	1.447E-002	4.525E-002
Po-210	5298.345	5031.037	5427.048	64.2	100.0	1,840.00	0.9600	1839.04	1.098E+001	7.263E-001	1.170E-002	3.956E-002

ALS

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

Alpha Spectrometer Instrument Run Log

6/23/17 6/22/17

Date: 6/21/17

Detector	Batch ID	Sample ID	Iso/Matrix	Duration	Initial
103	PL170616-1-B	1706271-1	Po W	1000	JP
104		-2			
105		1706286-1			
107		-3			
108		1706299-1			
109		-2			
110		1706329-1			
111		-2			
112	C	1706374-2		480	
113	B	PL170616-1MB		1000	
114	C	LCS		480	
81	RAS170621-1-A	RAS170621-1MB	Ra W	1000	JP
82		LCS			
83		1706421-1			
84		-2			
85		-2D			
86		1706453-1			
~~87~~ 87	JP 6/22/17	-2			
88		1706423-1			
89		1706426-1			
90		-3			
91		-3D			

Detector	Batch ID	Sample ID	Iso/Matrix	Duration	Initial
81	RAS170622-1A	RAS170622-MB	Ra W	1000	JP
82		LCS			
83		1706487-1			
84		-1D			
85		-4			
86		-5			
65	PL170616-1-D	1706286-3	Po W	1000	JP
67	PL170616-16A	1718018-1		360	JP
69		-2			
70		-3			
72		-4			
74		-5			
75		PL170616-16AMB			
77		BMB			
78		CMB			
87	TAS170620-1A	1706228-1	Th S	1000	JP
88		-2			
69		1706234-1			
90		-4			
91		-5			
92		-7			
93		-9			
94		-10			
95		-12			

6/23/17

Notes:

Reviewed by: JP

Date: 6/23/17

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

ALS

Alpha Spectrometer Instrument Run Log

Date: 6/26/17 (6/26/17)

Detector	Batch ID	Sample ID	Iso/Matrix		Duration	Initial
81	TAS170620-3 B	1706326-6	Th	W	1000	JP
82		-7				
83		1706343-2				
84		-3				
85		-4				
86		-5				
87		-6				
88		-7				
89		-8				
90		-9				
91		1706380-2				
93		-3				
94		-4				
95		-5				
117		AS170620-3MB				
118		LCS				
103	PL170623-1-A	1706286-3	Po	W	1000	JP
104		1706341-1				
105		-3				
107	B	1706421-1			480	
108		-10				
109	A	1706473-1			1000	
110		1706426-1				
111		-3				

Detector	Batch ID	Sample ID	Iso/Matrix		Duration	Initial
112	PL170623-1-A	PL170623-1MB	Po	W	1000	JP
113	B	LCS			480	
81	RAS170614-1-B	RAS170614-1MB	Ra	W	300	JP
82		LCS				
83		1706271-1				
84		-2				
85		1706278-2				
86		-3				
87		-4				
88		-5				
89		-5D				
90		-6				
91		1706286-1				
93		-1D				
94		-3				
95		1706299-1				
117		-2				
118		1706306-1				
119		-2				
120		-3				
121		-9				
122		-10				
123		-11				
124		-12				
125		1706329-1				
126		-2				

6/26/17

6/26/17

Notes:

Reviewed by: JP
Date: 6/26/17

471177

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

Prep Batch: PL170616-1

Prep Procedure: Po210 USGS,LCS→ 480Mn COGCC,MB→ 1000Mn

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
7/10 1	1706271-1	SMP	50	25	ml	pCi/l	_62711	103	JP	_62711			_62711		B	
1	1706271-2	SMP	50	25	ml	pCi/l	_62712	104	↓	_62712			_62712		↓	
1	1706278-2	SMP	187.879	93.939	ml	pCi/l	_62782	65	JP	_62782			_62782		A	
1	1706278-5	SMP	188	94	ml	pCi/l	_62785	67		_62785			_62785			JP 7/3/17
1	1706278-6	SMP	187.817	93.909	ml	pCi/l	_62786	69	↓	_62786			_62786	JP 7/3/17	↓	
1	1706286-1	SMP	50	25	ml	pCi/l	_62861	105	JP°	_62861			_62861		B	
1	1706286-3	SMP	50	25	ml	pCi/l	_62863 JP 6/21/17	~~106~~ 107	JP	_62863	65	JP	_62863			° Recount to confirm low yield (Reprep → 40% yield)
1	1706299-1	SMP	50	25	ml	pCi/l	_62991	108		_62991			_62991			
1	1706299-2	SMP	50	25	ml	pCi/l	_62992	109	↓	_62992			_62992		↓	
1	1706306-1	SMP	187.879	93.939	ml	pCi/l	_63061	70	JP	_63061			_63061		A	
1	1706306-11	SMP	187.94	93.97	ml	pCi/l	_630611	72		_630611			_630611			
1	1706306-12	SMP	188	94	ml	pCi/l	_630612	74	↓	_630612			_630612		↓	
1	1706329-1	SMP	50	25	ml	pCi/l	_63291	110	JP	_63291			_63291		B	
1	1706329-2	SMP	50	25	ml	pCi/l	_63292	111		_63292			_63292			
1	1706342-3	SMP	188	94	ml	pCi/l	_63423	75	JP	_63423			_63423		A	
1	1706342-3	DUP	188	94	ml	pCi/l	_63423D	77		_63423D			_63423D			
1	1706342-7	SMP	186.957	93.478	ml	pCi/l	_63427 JP 6/20/17	~~75~~ 78		_63427			_63427			
1	1706342-8	SMP	187.5	93.75	ml	pCi/l	_63428	79		_63428			_63428			
1	1706374-1	SMP	188	94	ml	pCi/l	_63741	80	↓	_63741			_63741		↓	
1	1706374-2	SMP	187.817	93.909	ml	pCi/l	_63742	112	JP	_63742			_63742		C	JP 7/3/17
1	PL170616-1	MB	1000	500	ml	pCi/l	_170611B	113		_170611B			_170611B	JP 7/3/17	B	
1	PL170616-1	LCS	1000	500	ml	pCi/l	_170611L	114	↓	_170611L			_170611L		C	

Tracer/Carrier Solution Information

Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
T1	Po-209	1045.4243.07		22.074	DPM/ml	06/16/17	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		94.877	DPM/ml	06/16/17	0.25	ml	AW016
S1	Po-210	899.4095.66		94.877	DPM/ml	06/16/17	0.25	ml	AW016

Sample Barcodes

Radiochemistry Instrument Worksheet

ALS -- Fort Collins

Prep Batch: PL170616-1

Prep Procedure: Po210

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
1706271-1 PL170616-1PS1																
1706271-2 PL170616-1PS2																
1706278-2 PL170616-1PS3																
1706278-5 PL170616-1PS4																
1706278-6 PL170616-1PS5																
1706286-1 PL170616-1PS6																
1706286-3 PL170616-1PS7																
1706299-1 PL170616-1PS8																
1706299-2 PL170616-1PS9																
1706306-1 PL170616-1PS10																
1706306-11 PL170616-1PS11																
1706306-12 PL170616-1PS12																
1706329-1 PL170616-1PS13																
1706329-2 PL170616-1PS14																
1706342-3 PL170616-1PS15																
1706342-3DUP PL170616-1PS16																
1706342-7 PL170616-1PS17																
1706342-8 PL170616-1PS18																
1706374-1 PL170616-1PS19																
1706374-2 PL170616-1PS20																
PL170616-1MB PL170616-1PS21																
PL170616-1LCS PL170616-1PS22																

Reporting Units

LabID:	TstGrpName:	RptUnits:
1706306-1	Po210_USGS	pCi/l
1706374-1	Po210_USGS	pCi/l
1706286-1	Po210	pCi/l
1706299-1	Po210	pCi/l
1706329-1	Po210	pCi/l
1706271-1	Po210	pCi/l
1706271-2	Po210	pCi/l
1706278-2	Po210_USGS	pCi/l
1706299-2	Po210	pCi/l
1706374-2	Po210_USGS	pCi/l
1706329-2	Po210	pCi/l
1706286-3	Po210	pCi/l
1706342-3	Po210_USGS	pCi/l
1706278-5	Po210_USGS	pCi/l
1706278-6	Po210_USGS	pCi/l
1706342-7	Po210_USGS	pCi/l
1706342-8	Po210_USGS	pCi/l
1706306-11	Po210_USGS	pCi/l
1706306-12	Po210_USGS	pCi/l

Radiochemistry Prep Worksheet

ALS -- Fort Collins

Prep Batch: PL170616-1

Prep Procedure: Po210

Reviewed By: rlm 6/20/17 **Review Date:** 6/20/2017

Non-Routine Pre-Treatment? (Y) / N Batch: MA see QASS Re-Prep? Y / (N) Batch: MA Prep QASS / NCR? (Y) / N .421993

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

Prep Analyst: Tambrae Elhart
Prep Date: 6/16/2017
Prep Dept: AP

Balance: na
Balance: na

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	1706271-1	SMP		50	25	Filtered	0	0	06/19/17 15:50	T1	
2	1	1706271-2	SMP		50	25	Filtered	0	0	06/19/17 15:50	T1	
3	1	1706278-2	SMP		187.8788	93.93939	As Received	990	200	06/19/17 15:50	T1	
4	1	1706278-5	SMP		188	94	As Received	1000	200	06/19/17 15:50	T1	
5	1	1706278-6	SMP		187.8173	93.90863	As Received	985	200	06/19/17 15:50	T1	
6	1	1706286-1	SMP		50	25	Filtered	0	0	06/19/17 15:50	T1	
7	1	1706286-3	SMP		50	25	Filtered	0	0	06/19/17 15:50	T1	
8	1	1706299-1	SMP		50	25	Unfiltered	0	0	06/19/17 15:50	T1	
9	1	1706299-2	SMP		50	25	Unfiltered	0	0	06/19/17 15:50	T1	
10	1	1706306-1	SMP		187.8788	93.93939	As Received	990	200	06/19/17 15:50	T1	
11	1	1706306-11	SMP		187.9397	93.96985	As Received	995	200	06/19/17 15:50	T1	
12	1	1706306-12	SMP		188	94	As Received	1000	200	06/19/17 15:50	T1	
13	1	1706329-1	SMP		50	25	Unfiltered	0	0	06/19/17 15:50	T1	
14	1	1706329-2	SMP		50	25	Unfiltered	0	0	06/19/17 15:50	T1	
15	1	1706342-3	SMP		188	94	As Received	1000	200	06/19/17 15:50	T1	
16	1	1706342-3	DUP		188	94	As Received	1000	200	06/19/17 15:50	T1	
17	1	1706342-7	SMP		186.9565	93.47826	As Received	920	200	06/19/17 15:50	T1	
18	1	1706342-8	SMP		187.5	93.75	As Received	960	200	06/19/17 15:50	T1	
19	1	1706374-1	SMP		188	94	As Received	1000	200	06/19/17 15:50	T1	
20	1	1706374-2	SMP		187.8173	93.90863	As Received	985	200	06/19/17 15:50	T1	
21	1	PL170616-1	MB		1000	500	Unfiltered	0	0	06/19/17 15:50	T1	
22	1	PL170616-1	LCS		1000	500	Unfiltered	0	0	06/19/17 15:50	T1,S1	

6/20/17

Radiochemistry Prep Worksheet

ALS -- Fort Collins

Prep Batch: PL170616-1

Prep Procedure: Po210

Reviewed By: rlm **Review Date:** 6/20/2017

Non-Routine Pre-Treatment? (Y) / N **Batch:** See QASS **Re-Prep?** Y / (N) **Batch:** NA **Prep QASS / NCR?** (Y) / N 431993

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

Prep Analyst: Tambrae Elhart
Prep Date: 6/16/2017
Prep Dept: AP

Balance: na
Balance: na

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

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

Spiked By: Jeremy S. Jones **Date:** 6/16/2017

Witnessed By: Lucas A. Daut **Date:** 6/16/2017

Tracer/Carrier Solution Information

Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
T1	Po-209	1045.4243.07		22.074	DPM/ml	06/16/17	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		94.877	DPM/ml	06/16/17	0.25	ml	AW016
S1	Po-210	899.4095.66		94.877	DPM/ml	06/16/17	0.25	ml	AW016

ALS -- Fort Collins

Radiochemistry Prep Worksheet

Prep Batch: PL170616-1

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: Tambrae Elhart
Prep Date: 6/16/2017
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	1706271-1	SMP		50	50	Unfiltered	0	0	6/19/17	T1	
2	1	1706271-2	SMP		50	50	Unfiltered	0	0	1550	T1	
3	1	1706278-2	SMP		930	187.8788	As Received	990	200		T1	
4	1	1706278-5	SMP		940	188	As Received	1000	200		T1	
5	1	1706278-6	SMP		925	187.8173	As Received	985	200		T1	
6	1	1706286-1	SMP		50	50	Unfiltered	0	0		T1	
7	1	1706286-3	SMP		50	50	Unfiltered	0	0		T1	
8	1	1706299-1	SMP		50	50	Unfiltered	0	0		T1	
9	1	1706299-2	SMP		50	50	Unfiltered	0	0		T1	
10	1	1706306-1	SMP		930	187.8788	As Received	990	200		T1	
11	1	1706306-11	SMP		935	187.9397	As Received	995	200		T1	
12	1	1706306-12	SMP		940	188	As Received	1000	200		T1	
13	1	1706329-1	SMP		50	50	Unfiltered	0	0		T1	
14	1	1706329-2	SMP		50	50	Unfiltered	0	0		T1	
15	1	1706342-3	SMP		940	188	As Received	1000	200		T1	
16	1	1706342-3	DUP		940	188	As Received	1000	200		T1	
17	1	1706342-7	SMP		860	186.9565	As Received	920	200		T1	
18	1	1706342-8	SMP		900	187.5	As Received	960	200		T1	
19	1	1706374-1	SMP		940	188	As Received	1000	200		T1	
20	1	1706374-2	SMP		925	187.8173	As Received	985	200		T1	
21	1	PL170616-1	MB		1000	1000	Unfiltered	0	0		T1	
22	1	PL170616-1	LCS		1000	1000	Unfiltered	0	0		T1,S1	

Radiochemistry Prep Worksheet

ALS -- Fort Collins

Prep Batch: PL170616-1

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: Tambrae Elhart
Prep Date: 6/16/2017
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

Comments

Due to potential matrix interferences, reduced aliquots were taken.

Spiked By: JSS **Date:** 6/16/17

Witnessed By: [signature] **Date:** 6/16/17

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	22.074	DPM/ml	06/16/17	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	10/21/17	94.877	DPM/ml	06/16/17	0.25	ml	AW016
S1	Po-210	899.4095.66	↓	94.877	DPM/ml	06/16/17	0.25	ml	AW016

Sample Condition Form (Liquid)

Analyst: JSS

Analysis Date: 6/16/17 Method: Prep

Work Order	Sample ID	Sample Condition (Visual Appearance of Analysis Aliquot at Time of Prep) pH	Color	Remarks
1706271	1	<2	Tan	Sedimented (Eluted Filtered)
↓	2	≈7	↓	↓ + (Acidified)
1706278	2	<2	Clear	None
↓	5	↓	↓	↓
↓	6	↓	↓	↓
1706286	1	↓	Tan	Sedimented (Eluted Filtered)
↓	3	↓	Yellow	↓
1706299	1	↓	Clear	Dusting of sediment
↓	2	↓	↓	↓
1706306	1	↓	↓	None
↓	11	↓	↓	↓
↓	12	↓	↓	↓
1706329	1	≈7	↓	Dusting of sediment (Acidified)
↓	2	≈3	↓	↓
1706342	3	<2	↓	None
↓	7	↓	↓	↓
↓	8	↓	↓	↓
1706374	1	↓	↓	↓
↓	2	↓	↓	↓

Batch: PL170616-1

Po Solid

Reagent	Lot #
1N Hydrochloric Acid	0000132881
Ascorbic Acid	0000120890
Amyl Acetate	K46604
Flexible Colloidian	0000087213

Po Liquid

Reagent	Lot #
Conc. Hydrochloric Acid	0000132881
1N Hydrochloric Acid	0000132881
Ascorbic Acid	0000120890
Amyl Acetate	K46604
Flexible Colloidian	0000087213

Radiochemistry Instrument Worksheet

ALS -- Fort Collins

Prep Batch: PL170623-1

Prep Procedure: Po210

Analytical QASS / NCR? Y (N) NM

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
1	1706286-3	SMP	10	5	ml	pCi/l	_62863	103	JP	_62863			_62863			
1	1706341-1	SMP	50	25	ml	pCi/l	_63411	104		_63411			_63411			
1	1706341-3	SMP	50	25	ml	pCi/l	_63413	105		_63413			_63413			
1	1706421-1	SMP	187.879	93.939	ml	pCi/l	_64211	107		_64211			_64211			
1	1706421-1	DUP	187.879	93.939	ml	pCi/l	_64211D	106		_64211D			_64211D			
1	1706423-1	SMP	50	25	ml	pCi/l	_64231	109		_64231			_64231			
1	1706426-1	SMP	50	25	ml	pCi/l	_64261	116		_64261			_64261			
1	1706426-3	SMP	50	25	ml	pCi/l	_64263	111		_64263			_64263			
1	PL170623-1	MB	1000	500	ml	pCi/l	_170621B	112		_170621B			_170621B			
1	PL170623-1	LCS	1000	500	ml	pCi/l	_170621L	113		_170621L			_170621L			

JP 7/3/17

JP 7/3/17

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	22.072	DPM/ml	06/23/17	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	10/21/17	94.822	DPM/ml	06/23/17	0.25	ml	AW016
S1	Po-210	899.4095.66	↓	94.822	DPM/ml	06/23/17	0.25	ml	AW016

Sample Barcodes

1706286-3 PL170623-1PS1	1706341-1 PL170623-1PS2	1706341-3 PL170623-1PS3
1706421-1 PL170623-1PS4	1706421-1DUP PL170623-1PS5	1706423-1 PL170623-1PS6
1706426-1 PL170623-1PS7	1706426-3 PL170623-1PS8	PL170623-1MB PL170623-1PS9
PL170623-1LCS PL170623-1PS10		

Reporting Units

LabID:	TstGrpName:	RptUnits:
1706426-1	Po210	pCi/l
1706423-1	Po210	pCi/l
1706421-1	Po210_USGS	pCi/l
1706341-1	Po210	pCi/l
1706426-3	Po210	pCi/l
1706341-3	Po210	pCi/l
1706286-3	Po210	pCi/l

Radiochemistry Prep Worksheet

ALS -- Fort Collins

Prep Batch: PL170623-1

Prep Procedure: Po210

Reviewed By: lad LAD **Review Date:** 6/25/2017

Non-Routine Pre-Treatment? Y / (N) **Batch:** NA **Re-Prep?** Y / (N) **Batch:** NA **Prep QASS / NCR?** Y / (N) NA 421993 JP 6/25/17

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

Prep Analyst: Lucas A. Daut LAD
Prep Date: 6/23/2017
Prep Dept: AP

Balance: N/A
Balance: N/A

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	1706286-3	SMP		10	5	Unfiltered	0	0	06/24/17 16:08	T1	
2	1	1706341-1	SMP		50	25	Unfiltered	0	0	06/24/17 16:08	T1	
3	1	1706341-3	SMP		50	25	Unfiltered	0	0	06/24/17 16:08	T1	
4	1	1706421-1	SMP		187.8788	93.9394	As Received	990	200	06/24/17 16:08	T1	
5	1	1706421-1	DUP		187.8788	93.9394	As Received	990	200	06/24/17 16:08	T1	
6	1	1706423-1	SMP		50	25	Unfiltered	0	0	06/24/17 16:08	T1	
7	1	1706426-1	SMP		50	25	Unfiltered	0	0	06/24/17 16:08	T1	
8	1	1706426-3	SMP		50	25	Unfiltered	0	0	06/24/17 16:08	T1	
9	1	PL170623-1	MB		1000	500	Unfiltered	0	0	06/24/17 16:08	T1	
10	1	PL170623-1	LCS		1000	500	Unfiltered	0	0	06/24/17 16:08	T1,S1	

Comments

Due to potential matrix interference reduced aliquots were taken; MDCs were met.

Spiked By: Lucas A. Daut **Date:** 6/23/2017

Witnessed By: Tambrae Elhart **Date:** 6/23/2017

Tracer/Carrier Solution Information

Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
T1	Po-209	1045.4243.07	8/3/17	22.072	DPM/ml	06/23/17	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	10/2/17	94.822	DPM/ml	06/23/17	0.25	ml	AW016
S1	Po-210	899.4095.66		94.822	DPM/ml	06/23/17	0.25	ml	AW016

ALS -- Fort Collins

Radiochemistry Prep Worksheet

Prep Batch: PL170623-1

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: Lucas A. Daut
Prep Date: 6/23/2017
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	1706286-3	SMP	10	200	1000	unfiltered	0	0	4:08 PM 6/24	T1	Matrix Interfere
2	1	1706341-1	SMP	50	200	1000	↓	0	0	↓	T1	↓
3	1	1706341-3	SMP	↓	200	1000	↓	0	0	↓	T1	MDCs are Met
4	1	1706421-1	SMP		930	187.8788	As rec'd	990	200	↓	T1	↓
5	1	1706421-1	DUP		930	187.8788	As Received	990	200	↓	T1	Matrix Interfere
6	1	1706423-1	SMP	50	200	1000	unfiltered	0	0	↓	T1	↓
7	1	1706426-1	SMP	↓	200	1000	↓	0	0	↓	T1	↓
8	1	1706426-3	SMP	↓	200	1000	↓	0	0	↓	T1	↓
9	1	PL170623-1	MB		1000	1000	↓	0	0	↓	T1	↓
10	1	PL170623-1	LCS		1000	1000	↓	0	0	↓	T1,S1	↓

Comments

Spiked By: _____ **Date:** 6/23/17

Witnessed By: _____ **Date:** 6/23/17

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	22.072	DPM/ml	06/23/17	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	10/21/17	94.822	DPM/ml	06/23/17	0.25	ml	AW016
S1	Po-210	899.4095.66	↓	94.822	DPM/ml	06/23/17	0.25	ml	AW016

Sample Condition Form (Liquid)

Analyst: Lucas Daut

Analysis Date: 6/23/17 Method: Prep

		Sample Condition (Visual Appearance of Analysis Aliquot at Time of Prep)		
Work Order	Sample ID	pH	Color	Remarks
1706286	3	<2	Yellow	Oily; Orange Sediment
1706341	1		Cloudy	None
↓	3		↓	↓
1706421	1		Clear	None
1706423	1		Cloudy	
1706426	1		↓	
↓	3	↓		

LAD 6/23/17

PL170623-1 LAD 6/25

Batch: ~~PL170616-1~~

Po Solid

Reagent	Lot #
1N Hydrochloric Acid	0000132881
Ascorbic Acid	0000120890
Amyl Acetate	K46604
Flexible Colloidian	0000087213

Po Liquid

Reagent	Lot #
Conc. Hydrochloric Acid	0000132881
1N Hydrochloric Acid	0000132881
Ascorbic Acid	0000120890
Amyl Acetate	K46604
Flexible Colloidian	0000087213

Section 8

STANDARDS TRACEABILITY DOCUMENTS

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

TE 12/8/14
Signed Date

Read and Understood By
Signed Date 11/3/15

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. Mont
D. M. Montgomery, QA Manager

Date: 8-13-09

ACCREDITED SOURCE CALIBRATION LABORATORY
HEALTH PHYSICS SOCIETY
FOUNDED 1956

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:

$$400.3\,Bq\,\frac{(1.03309\,g/mL)}{(1096.3768\,g)}\,\frac{(5.0598\,g)}{(5.15159\,g)}\,\frac{(60\,dpm/1\,Bq)}{} = 22.23\,dpm/mL$$

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

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: 1706286

Prep SOP: PAI 711
Analytical SOP: PAI 714

Reported on: Monday, July 03, 2017
2:29:56 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
1706286-1	SMP	PL170616-1	Po210	105	C170620105A	6/20/2017	31.73	Pass	31.09	31.65	33.81	34.37
Spectrum #1		PL170616-1A			B170620105	6/20/2017	0.0260	Pass	0.0000	0.0100	0.1000	0.1500
6/21/2017					C170620105A	6/20/2017	5555.8	Pass	5506.0	5516.0	5596.0	5606.0
1706286-3	SMP	PL170623-1	Po210	103	C170620103	6/20/2017	30.78	Pass	30.23	30.77	32.87	33.42
Spectrum #1		PL170623-1A			B170620103	6/20/2017	0.0180	Pass	0.0000	0.0100	0.1000	0.1500
6/25/2017					C170620103	6/20/2017	5555.8	Pass	5506.0	5516.0	5596.0	5606.0
PL170616-1	MB	PL170616-1	Po210	113	C170620113	6/20/2017	32.54	Warning	32.00	32.58	34.80	35.37
Spectrum #1		PL170616-1A			B170620113	6/20/2017	0.0180	Pass	0.0000	0.0100	0.1000	0.1500
6/21/2017					C170620113	6/20/2017	5555.8	Pass	5506.0	5516.0	5596.0	5606.0
PL170616-1	LCS	PL170616-1	Po210	114	C170620114	6/20/2017	33.42	Pass	31.25	32.80	33.89	34.74
Spectrum #1		PL170616-1A			B170620114	6/20/2017	0.0110	Pass	0.0000	0.0100	0.1000	0.1500
6/21/2017					C170620114	6/20/2017	5555.8	Pass	5506.0	5516.0	5596.0	5606.0
PL170623-1	MB	PL170623-1	Po210	112	C170620112	6/20/2017	31.90	Warning	31.79	32.36	34.57	35.14
Spectrum #1		PL170623-1A			B170620112	6/20/2017	0.0140	Pass	0.0000	0.0100	0.1000	0.1500
6/25/2017					C170620112	6/20/2017	5555.8	Pass	5506.0	5516.0	5596.0	5606.0
PL170623-1	LCS	PL170623-1	Po210	113	C170620113	6/20/2017	32.54	Warning	32.00	32.58	34.80	35.37
Spectrum #1		PL170623-1A			B170620113	6/20/2017	0.0180	Pass	0.0000	0.0100	0.1000	0.1500
6/25/2017					C170620113	6/20/2017	5555.8	Pass	5506.0	5516.0	5596.0	5606.0

Data Package ID: *PL1706286-1*

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.

SOP 711

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

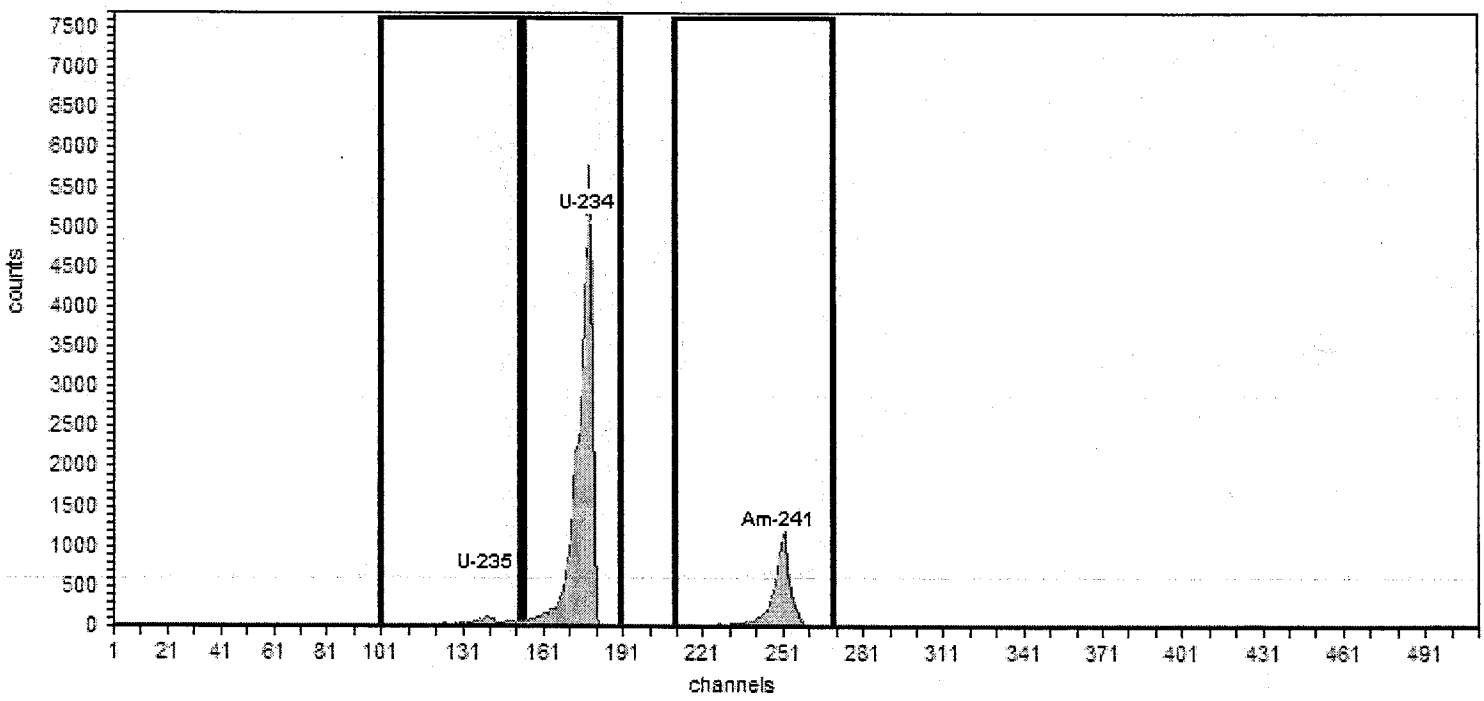
Detector: 129, SN:5505430, ID: 129
Acquisition Start Date: 10/4/2016 11:26:06AM

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

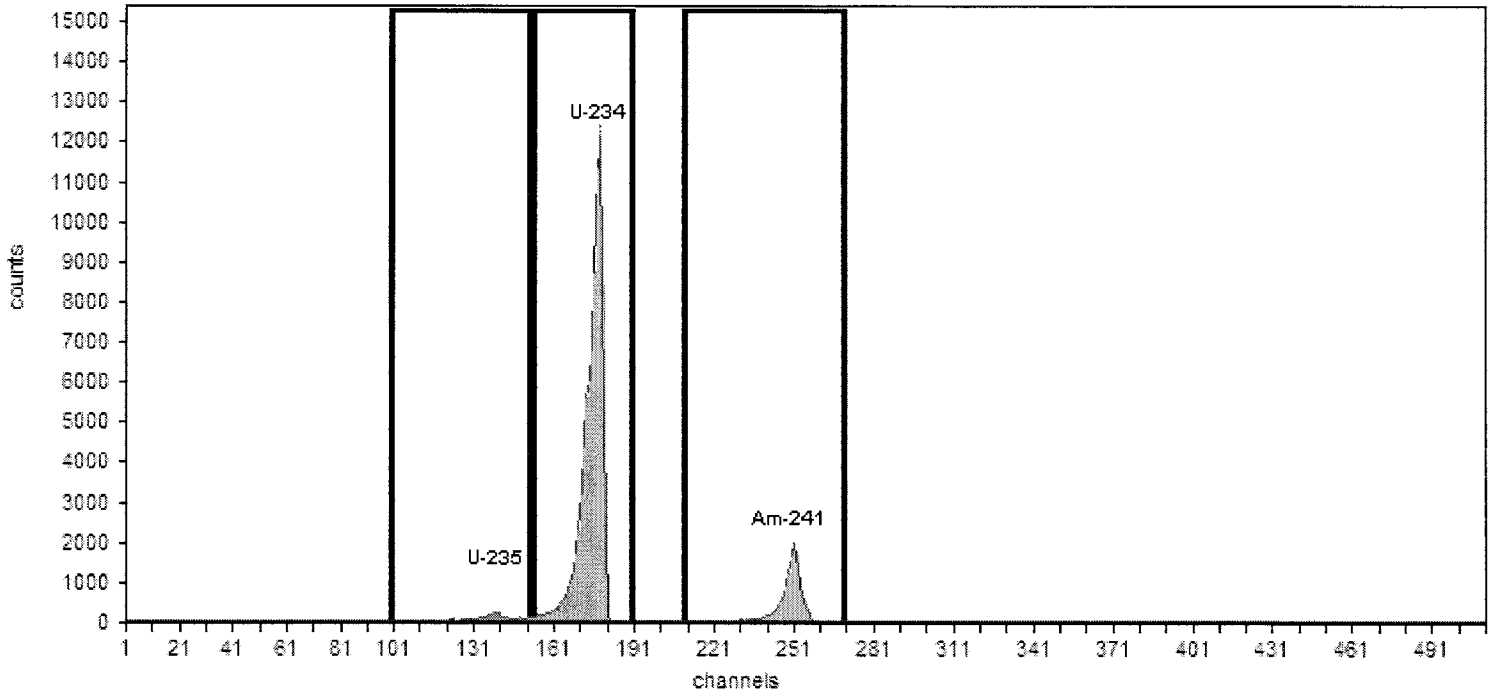
Detector: 129, SN:5505430, ID: 129
Acquisition Start Date: 10/4/2016 12:11:42PM

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

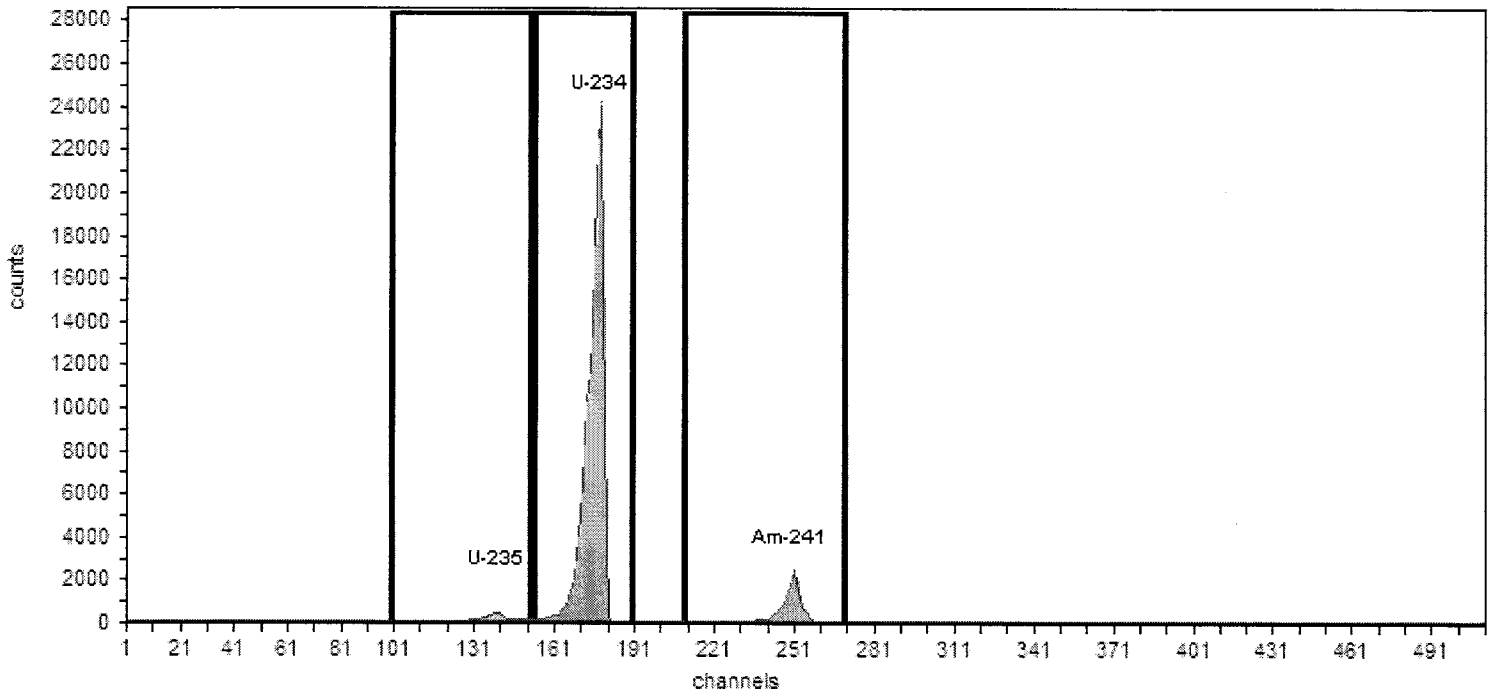
Detector: 129, SN:5505430, ID: 129
Acquisition Start Date: 10/4/2016 12:49:04PM

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

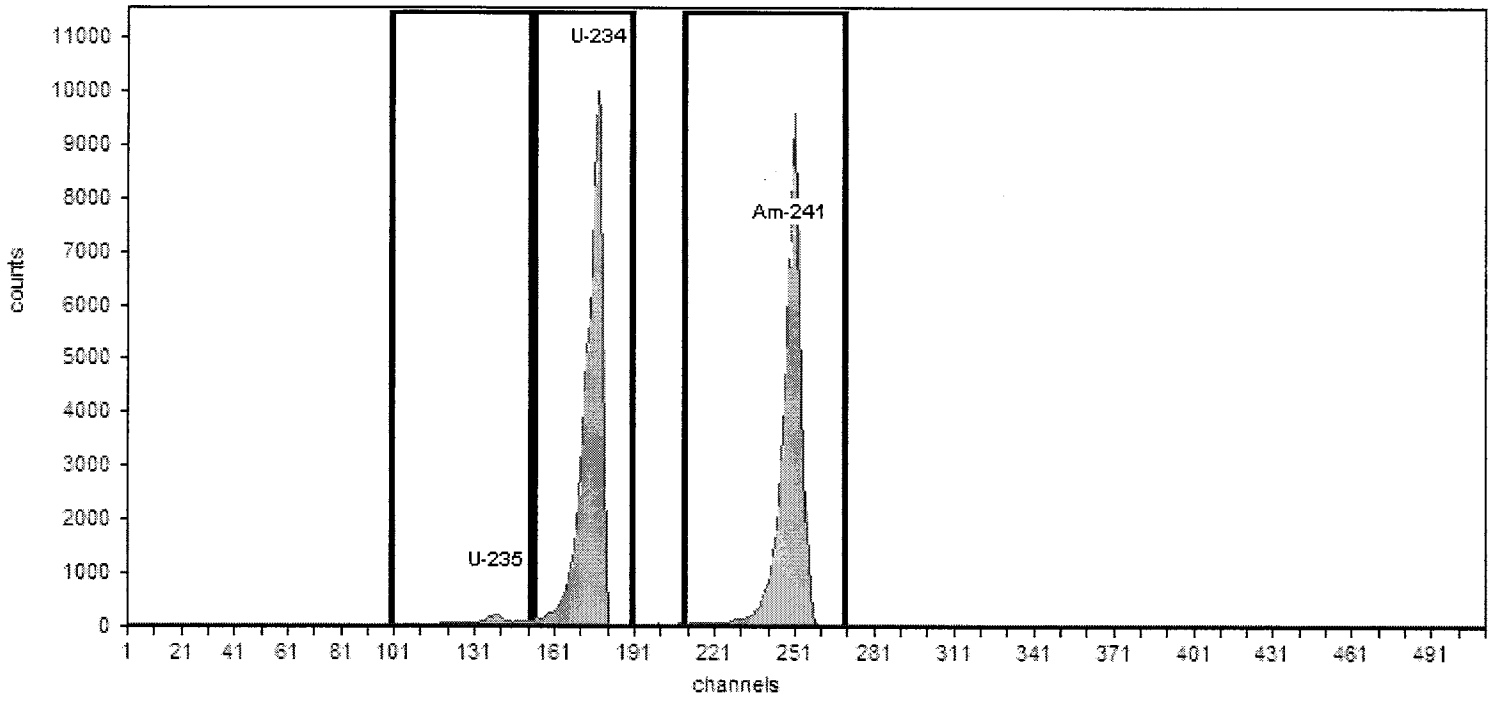
Detector: 129, SN:5505430, ID: 129
Acquisition Start Date: 10/4/2016 1:26:53PM

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

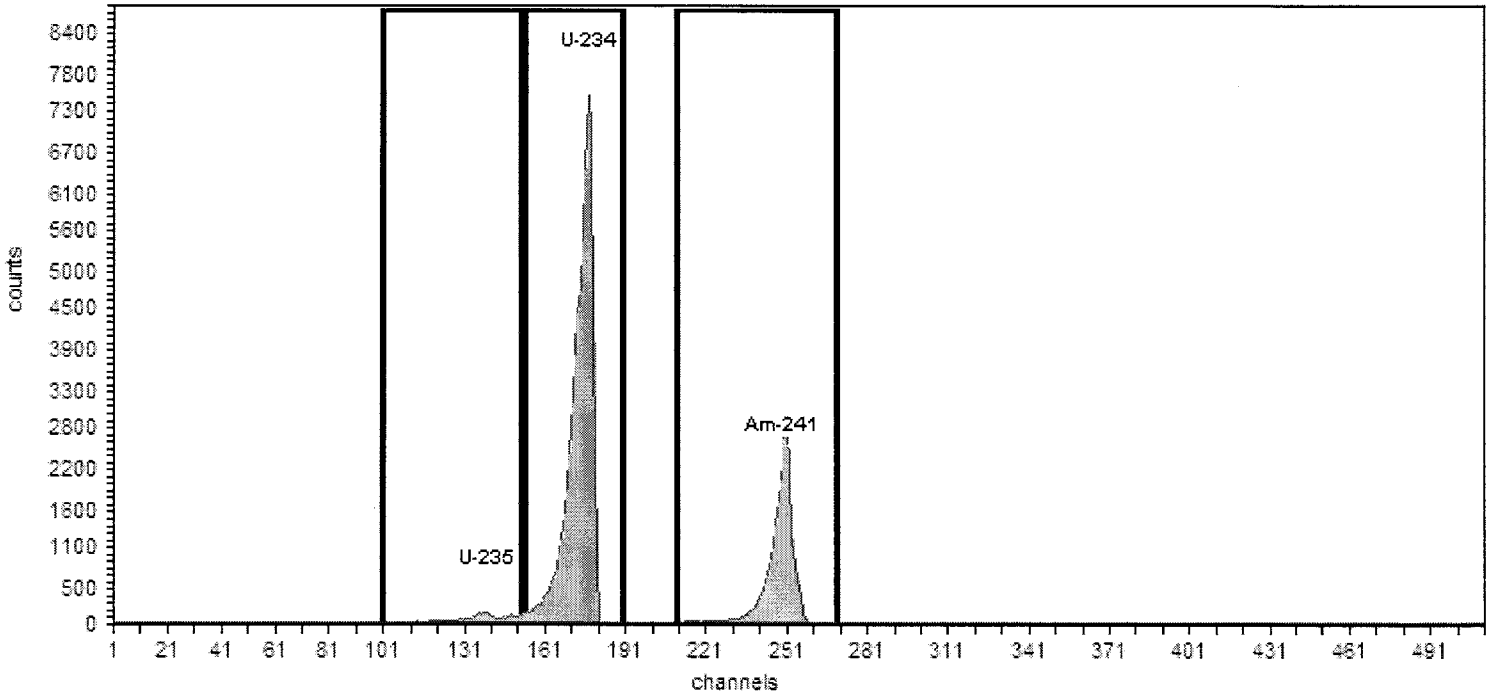
Detector: 129, SN:5505430, ID: 129
Acquisition Start Date: 10/4/2016 2:18:14PM

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

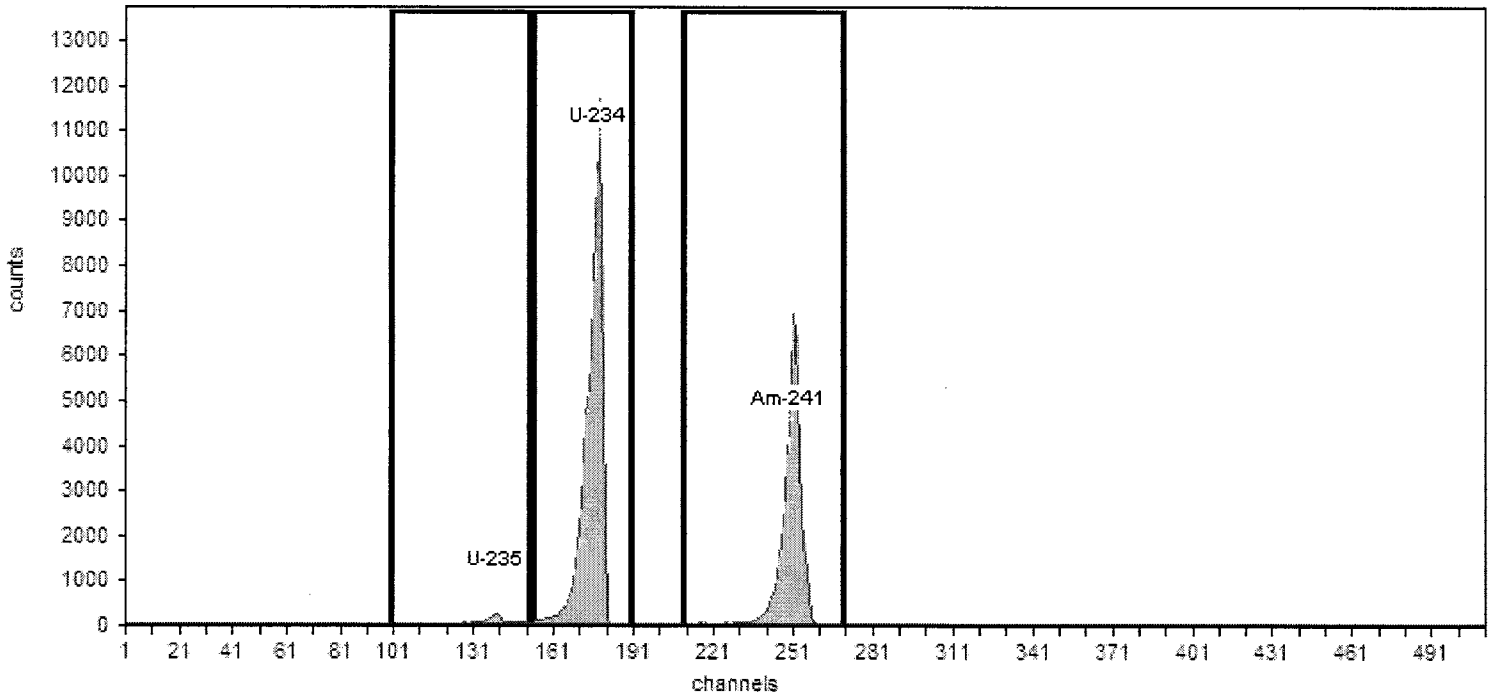
Detector: 129, SN:5505430, ID: 129
Acquisition Start Date: 10/5/2016 6:13:44AM

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

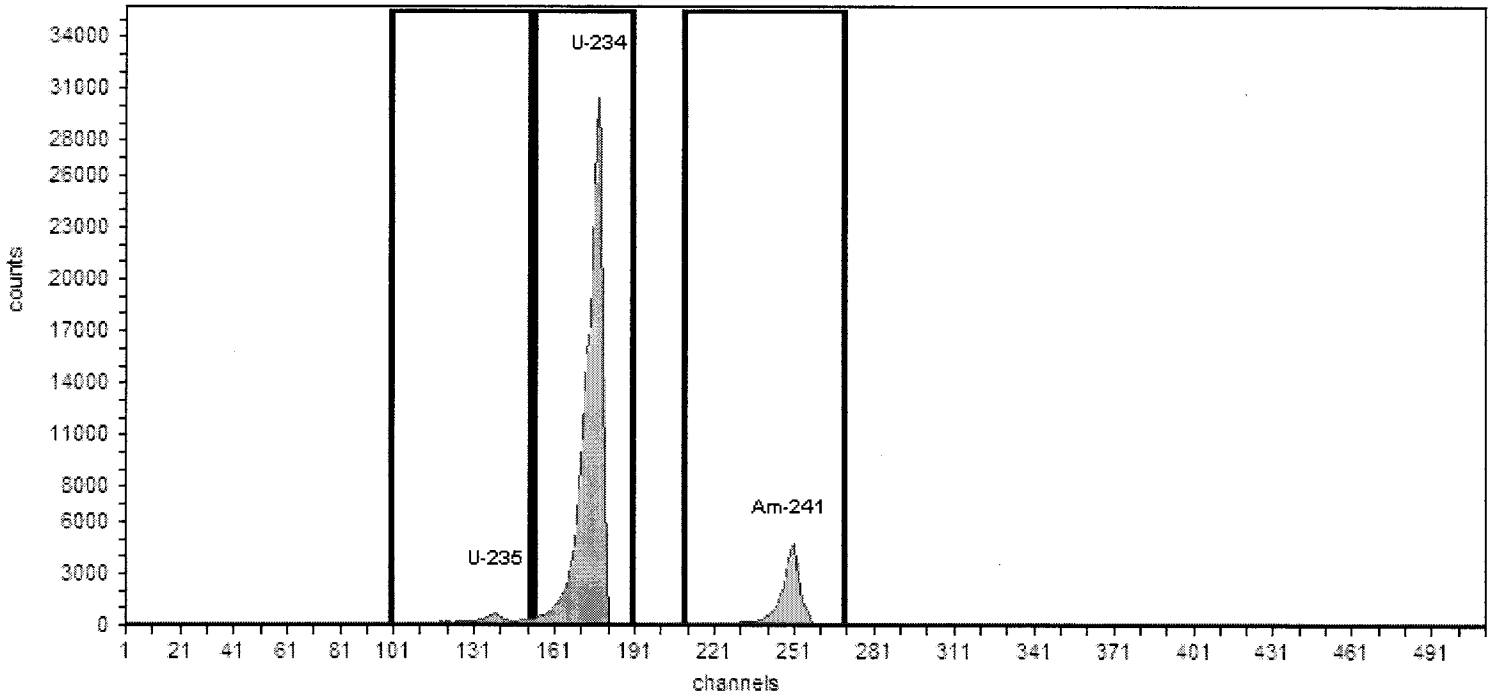
Detector: 129, SN:5505430, ID: 129
Acquisition Start Date: 10/5/2016 7:04:08AM

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

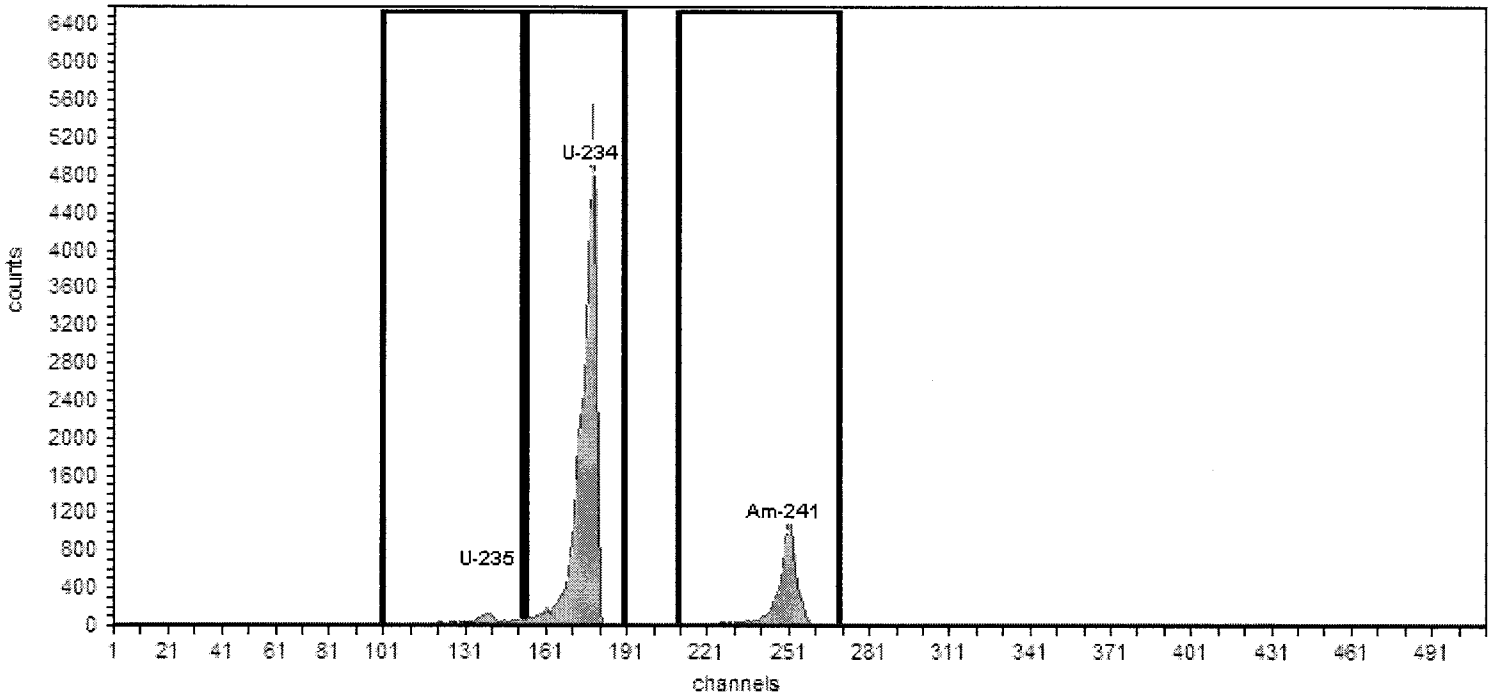
Detector: 129, SN:5505430, ID: 129
Acquisition Start Date: 10/5/2016 7:45:09AM

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
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#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
recalibrated 4-1503

TM 10/5/16

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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

Isotope Products Laboratories
An Eckert & Ziegler Company

24937 Avenue Tibbitts
Valencia, California 91355

Tel 661•309•1010
Fax 661•257•8303

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