



facility 439136
project 10243

Isotopic Uranium Case Narrative

COGCC

PW NORM 2017 – 10048

Work Order Number: 1706420

1. This report consists of analytical results and supporting documentation for one water sample received by ALS on 05/09/2017.
2. This sample was prepared according to the current revisions of SOP 776 and SOP 778.
3. The sample was analyzed for the presence of isotopic uranium according to the current revision of SOP 714. The analysis was completed on 06/29/2017.
4. The analysis results for this sample are reported in units of pCi/L. The water sample was filtered prior to analysis.
5. This analytical method quantifies U-235 alpha activity in a specific region of interest corresponding to emission energies between those of U-234 and U-238. A potential limitation of this method is that measurable amounts of U-234 in the sample may cause a small amount of characteristic activity in the U-235 region of interest due to poorly resolved alpha activity at the boundary between the two regions. To minimize the potential for a high bias in the U-235 analytical results, the U-235 region of interest has been narrowed and limited to a lower energy region. An 85.1% abundance correction has been made to the final U-235 results.
6. No anomalous situations were encountered during the preparation or analysis of this sample. All 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
Jean Anderson
Radiochemistry Primary Data Reviewer

7/5/17
Date

Shirley Lewis
Radiochemistry Final Data Reviewer

7/26/17
Date

Section 1

CHAIN OF CUSTODY

ALS -- Fort Collins

Sample Number(s) Cross-Reference Table

OrderNum: 1706420

Client Name: COGCC

Client Project Name: PW NORM 2017

Client Project Number: 10048

Client PO Number: CT 2017-3066

Client Sample Number	Lab Sample Number	COC Number	Matrix	Date Collected	Time Collected
439136	1706420-1		WATER	09-May-17	12:50



Chain-of-Custody

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

[illegible]



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 #	
17052-02	
PROJECT NAME	17052-02
PROJECT No.	
COMPANY NAME	
SEND REPORT TO	
ADDRESS	
CITY / STATE / ZIP	
PHONE	
FAX	
E-MAIL	
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	

Form 2029	
RELINQUISHED BY	SIGNATURE
RECEIVED BY	PRINTED NAME
RELINQUISHED BY	DATE
RECEIVED BY	TIME
RELINQUISHED BY	
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REPORT LEVEL / QC REQUIRED	Summary (Standard CC)
LEVEL II (Standard CC)	
LEVEL III (Std CC + forms)	
LEVEL IV (Std CC + forms + raw)	
PRESERVATION KEY	1-HCl 2-HNO3 3-H2SO4 4-HNO3 5-NaOH 6-NaOH 7-4°C 8-Other



ALS Environmental - Fort Collins
CONDITION OF SAMPLE UPON RECEIPT FORM

Client: COGCC

Workorder No: 1205202

Project Manager: SS

Initials: CAT Date: 5-10-17

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

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

All RAD samples in the Amb cooler.

Added 3.5ml HNO₃ to EA. RAD and Total metals bottle. Final pH < 2. HNO₃ lot no. 152495.

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

Project Manager Signature / Date: [Signature]

Section 2



SAMPLE RESULTS SUMMARY

Isotopic Uranium 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: 1706420

Page: 1 of 1
Reported on: Wednesday, July 05, 2017
11:42:47 AM

Lab Sample ID	Client Sample ID	Sample Type	Nuclide	Result +/- 2 s TPU	MDC	DL	Units	Matrix	Prep Batch	Date Analyzed	Flags
1706420-1	439136	Sample	U-234	4.6E-01 +/- 1.7E-01	7E-02	NA	pCi/l	WATER	AS170626-1	6/29/2017	
1706420-1	439136	Sample	U-235	9E-03 +/- 5.2E-02	7.7E-02	NA	pCi/l	WATER	AS170626-1	6/29/2017	U
1706420-1	439136	Sample	U-238	3.8E-01 +/- 1.5E-01	7E-02	NA	pCi/l	WATER	AS170626-1	6/29/2017	

Comments:

Data Package ID: UR1706420-1

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

3

Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 13

Method Blank Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1706420

Client Name: COGCC

ClientProject ID: PW NORM 2017 10048

Lab ID: AS170626-1MB

Sample Matrix: WATER

Prep SOP: PAI 777 Rev 12

Date Collected: 26-Jun-17

Date Prepared: 26-Jun-17

Date Analyzed: 29-Jun-17

Prep Batch: AS170626-1

QCBatchID: AS170626-1-2

Run ID: AS170626-1U

Count Time: 360 minutes

Final Aliquot: 1000 ml

Result Units: pCi/l

File Name: Spectrum #1

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13966-29-5	U-234	8E-03 +/- 1.9E-02	2.8E-02	2E-01	NA	U
15117-96-1	U-235	4E-03 +/- 2.2E-02	3.3E-02	2E-01	NA	U
7440-61-1	U-238	-4E-03 +/- 1.9E-02	3.3E-02	2E-01	NA	U

Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.700E+00	3.68E+00	pCi/l	78.4	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: UR1706420-1

Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 13

Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1706420

Client Name: COGCC

ClientProject ID: PW NORM 2017 10048

Lab ID: AS170626-1LCS

Sample Matrix: WATER

Prep SOP: PAI 777 Rev 12

Date Collected: 26-Jun-17

Date Prepared: 26-Jun-17

Date Analyzed: 29-Jun-17

Prep Batch: AS170626-1

QCBatchID: AS170626-1-2

Run ID: AS170626-1U

Count Time: 360 minutes

Final Aliquot: 1000 ml

Result Units: pCi/l

File Name: Spectrum #1

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
13966-29-5	U-234	4.32E+00 +/- 7.5E-01	3E-02	4.220E+00	102	82 - 122	P
7440-61-1	U-238	4.19E+00 +/- 7.3E-01	4E-02	4.380E+00	95.6	78 - 126	P

Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	4.700E+00	4.01E+00	pCi/l	85.5	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: UR1706420-1

Section 4

INDIVIDUAL SAMPLE RESULTS



Isotopic Uranium by Alpha Spectroscopy

PAI 714 Rev 13

Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1706420

Client Name: COGCC

ClientProject ID: PW NORM 2017 10048

Field ID: 439136

Lab ID: 1706420-1

Sample Matrix: WATER

Prep SOP: PAI 777 Rev 12

Date Collected: 09-May-17

Date Prepared: 26-Jun-17

Date Analyzed: 29-Jun-17

Prep Batch: AS170626-1

QCBatchID: AS170626-1-2

Run ID: AS170626-1U

Count Time: 360 minutes

Report Basis: Filtered

Final Aliquot: 500 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
13966-29-5	U-234	4.6E-01 +/- 1.7E-01	7E-02	2E-01	NA	
15117-96-1	U-235	9E-03 +/- 5.2E-02	7.7E-02	2E-01	NA	U
7440-61-1	U-238	3.8E-01 +/- 1.5E-01	7E-02	2E-01	NA	

Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
U-232	9.390E+00	5.74E+00	pCi/l	61.2	30 - 110 %	

Comments: This sample was filtered prior to analysis.

Qualifiers/Flags:

U - Result is less than the sample specific MDC.

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

Y2 - Chemical Yield outside default limits.

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

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

M - The requested MDC was not met.

Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: UR1706420-1

Date Printed: Wednesday, July 05, 2017

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LIMS Version: 6.843

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Section 5

RAW DATA

5

Isotopic Uranium by Alpha Spectroscopy Raw Data Report

Laboratory Name: ALS -- Fort Collins

Prep SOP: PAI 777

Reported on: Monday, July 03, 2017

PAI Work Order: 1706420

Analytical SOP: PAI 714

1:06:13 PM

Sample ID QC Type	Nuclide Type	Sample Date/Time	Prep Batch QC BatchID	Ingrowth Date /Time	Decay Date/Time	Matrix %Moist.	Samp Aliq Analy Aliq	Inst ID Det ID	AnRunID File Name	Count Date/Time	Net Cnts Bkg Cnts	BaseEff Bkg(min)	CndDur(min)	Activity +/- 2 s TPU	MDC DeclEv	ReportUnits ReportBasis	DER RPD	%Spk. Recov Flags
1706420-1	U-232 Tracer	5/9/2017 12:50:00 PM	AS170626-1 AS170626-1-2	NA NA	NA NA	WATER NA	500 ml 500 ml	AlphaSpec2 126	AS170626-1U Spectrum #1	6/29/2017 2:25 PM	788.880 17.000	34.37% 1000	360 61.2%	5.74E+00 9.5E-01	1E-01	pCi/l Filtered	NA NA	
1706420-1	U-234 Trg. Analyte	5/9/2017 12:50:00 PM	AS170626-1 AS170626-1-2	NA NA	NA NA	WATER NA	500 ml 500 ml	AlphaSpec2 126	AS170626-1U Spectrum #1	6/29/2017 2:25 PM	38.640 1.000	34.37% 1000	360 61.2%	4.6E-01 1.7E-01	7E-02	pCi/l Filtered	NA NA	
1706420-1	U-235 Trg. Analyte	5/9/2017 12:50:00 PM	AS170626-1 AS170626-1-2	NA NA	NA NA	WATER NA	500 ml 500 ml	AlphaSpec2 126	AS170626-1U Spectrum #1	6/29/2017 2:25 PM	0.640 1.000	34.37% 1000	360 61.2%	9E-03 5.2E-02	7.7E-02	pCi/l Filtered	NA NA	U
1706420-1	U-238 Trg. Analyte	5/9/2017 12:50:00 PM	AS170626-1 AS170626-1-2	NA NA	NA NA	WATER NA	500 ml 500 ml	AlphaSpec2 126	AS170626-1U Spectrum #1	6/29/2017 2:25 PM	31.640 1.000	34.37% 1000	360 61.2%	3.8E-01 1.5E-01	7E-02	pCi/l Filtered	NA NA	
AS170626-1	U-232 Tracer	6/26/2017 8:34:37 AM	AS170626-1 AS170626-1-2	NA NA	NA NA	WATER NA	1000 ml 1000 ml	AlphaSpec2 128	AS170626-1U Spectrum #1	6/29/2017 2:25 PM	934.760 9.000	31.77% 1000	360 78.4%	3.68E+00 6E-01	4E-02	pCi/l Unfiltered	NA NA	
AS170626-1	U-234 Trg. Analyte	6/26/2017 8:34:37 AM	AS170626-1 AS170626-1-2	NA NA	NA NA	WATER NA	1000 ml 1000 ml	AlphaSpec2 128	AS170626-1U Spectrum #1	6/29/2017 2:25 PM	1.640 1.000	31.77% 1000	360 78.4%	8E-03 1.9E-02	2.8E-02	pCi/l Unfiltered	NA NA	U
AS170626-1	U-235 Trg. Analyte	6/26/2017 8:34:37 AM	AS170626-1 AS170626-1-2	NA NA	NA NA	WATER NA	1000 ml 1000 ml	AlphaSpec2 128	AS170626-1U Spectrum #1	6/29/2017 2:25 PM	0.640 1.000	31.77% 1000	360 78.4%	4E-03 2.2E-02	3.3E-02	pCi/l Unfiltered	NA NA	U
AS170626-1	U-238 Trg. Analyte	6/26/2017 8:34:37 AM	AS170626-1 AS170626-1-2	NA NA	NA NA	WATER NA	1000 ml 1000 ml	AlphaSpec2 128	AS170626-1U Spectrum #1	6/29/2017 2:25 PM	-0.720 2.000	31.77% 1000	360 78.4%	-4E-03 1.9E-02	3.3E-02	pCi/l Unfiltered	NA NA	U
AS170626-1	U-232 Tracer	6/26/2017 8:34:37 AM	AS170626-1 AS170626-1-2	NA NA	NA NA	WATER NA	1000 ml 1000 ml	AlphaSpec2 129	AS170626-1U Spectrum #1	6/29/2017 2:25 PM	996.960 14.000	31.07% 1000	360 85.5%	4.01E+00 6.5E-01	5E-02	pCi/l Unfiltered	NA NA	
AS170626-1	U-234 Trg. Analyte	6/26/2017 8:34:37 AM	AS170626-1 AS170626-1-2	NA NA	NA NA	WATER NA	1000 ml 1000 ml	AlphaSpec2 129	AS170626-1U Spectrum #1	6/29/2017 2:25 PM	916.280 2.000	31.07% 1000	360 85.5%	4.32E+00 7.5E-01	3E-02	pCi/l Unfiltered	NA NA	102 P
AS170626-1	U-238 Trg. Analyte	6/26/2017 8:34:37 AM	AS170626-1 AS170626-1-2	NA NA	NA NA	WATER NA	1000 ml 1000 ml	AlphaSpec2 129	AS170626-1U Spectrum #1	6/29/2017 2:25 PM	888.920 3.000	31.07% 1000	360 85.5%	4.19E+00 7.3E-01	4E-02	pCi/l Unfiltered	NA NA	95.6 P

Comments:

Data Package ID: UR1706420-1

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

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LIMS Version: 6.843

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Sample: 1706420-1
Spectrum #1 Analysis #1
:
Sample Collection Date:
Comment:

Type: Sample

Sample

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

Batch Name: UAS170626-1_B

Batch

Client Name: Undefined
Client Contact:

Description:

Tracer

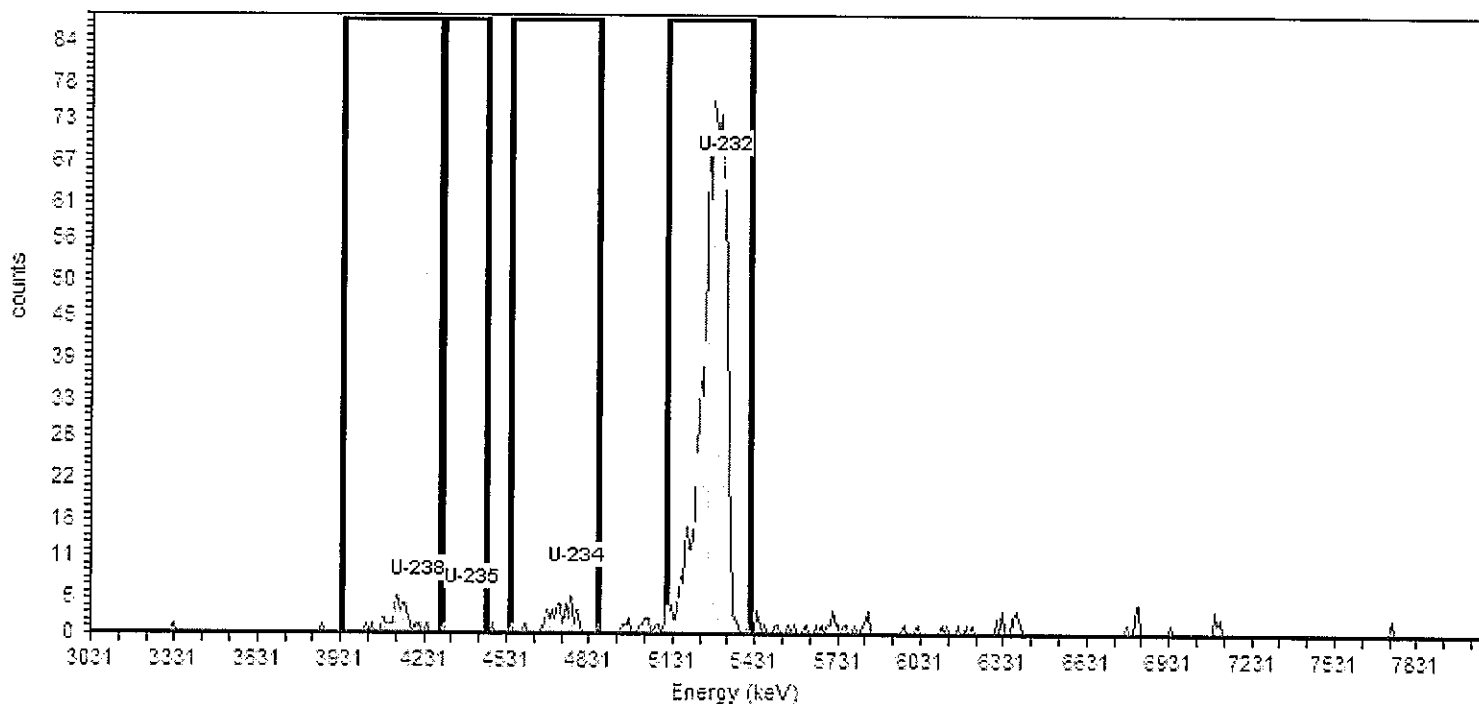
Tracer Name: 946.4243.02_U-232
Tracer Activity: 22.16 DPM / mL x (Vol.) 0.50 mL = 11.08 DPM
Tracer Ref. Date: 6/10/2011 10:00:00AM

Tracer Nuclide: U-232
Tracer Recovery: 60.96%

Acquisition

Detector: 126, SN: 5505427, ID: 126
Acquisition Start Date: 6/29/2017 2:25:07PM
Live Time: 360.00 min.
Real Time: 360.00 min.
Background Date: 6/20/2017 12:45:40PM
Bkgd Info: Sample: B170620126; Det: 126; Spectrum #1; 6/20/2017
12:45:40 PM; Live Time: 1000.000(min.); ID: 126

Energy Calibration: C170620126
Efficiency Calibration: C170620126
Calibration Date: 6/20/2017 11:45:11AM
Energy Cal: Gain = 9.9003 keV / Ch
Offset = 3,021.28 keV
Quadratic = 0.0000 keV / Ch²
Efficiency: 34.37% +/- 2.12% TPU(2 sigma)

**General Analysis**

Analysis Method: ROI Analysis, Set Name = Uranium Default
Decay Correction: 6/29/2017 2:23:43PM
MDA Constants: $K\alpha = 1.64$, $K\beta = 1.64$

Nuclide Library: Uranium
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
U-238	4209.315	3932.107	4288.517	70.0	100.2	32.00	0.3600	31.64	3.771E-001	7.330E-002	1.372E-002	5.969E-002
U-235	4407.320	4298.417	4456.822	0.0	80.9	1.00	0.3600	0.64	9.451E-003	1.571E-002	1.700E-002	7.395E-002
U-234	4783.531	4545.924	4862.733	114.6	100.0	39.00	0.3600	38.64	4.614E-001	8.241E-002	1.375E-002	5.981E-002
U-232	5318.145	5110.239	5417.148	91.4	100.1	795.00	6.1200	788.88	6.085E+000	2.876E-001	6.005E-002	1.543E-001

JP

Sample: AS170626-1MB Type: Sample
Spectrum #1 Analysis #1
Sample Collection Date: *For 1706420 1706445*
Comment:

Sample Volume : 1.00 Sample Units: L
First Stage Dilution: N/A
Aliquot: N/A Aliquot Fraction: N/A
Dilution 2: N/A
Lab Preparation:

Batch Name: UAS170626-1_B

Batch

Client Name: Undefined
Client Contact:

Description:

Tracer

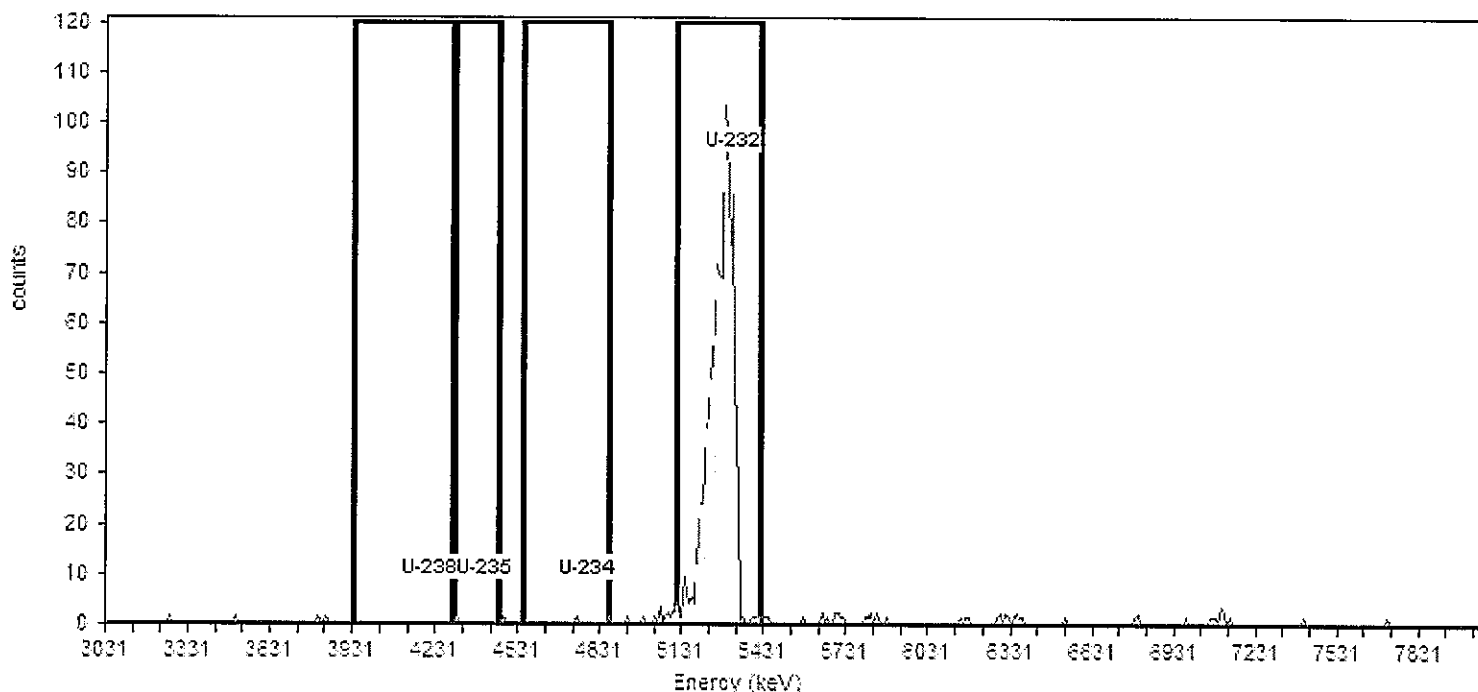
Tracer Name: 946.4243.02_U-232
Tracer Activity: 22.16 DPM / mL x (Vol.) 0.50 mL = 11.08 DPM
Tracer Ref. Date: 6/10/2011 10:00:00AM

Tracer Nuclide: U-232
Tracer Recovery: 78.13%

Acquisition

Detector: 128, SN: 5505429, ID: 128
Acquisition Start Date: 6/29/2017 2:25:07PM
Live Time: 360.00 min.
Real Time: 360.00 min.
Background Date: 6/20/2017 12:45:40PM
Bkgd Info: Sample: B170620128; Det: 128; Spectrum #1; 6/20/2017 12:45:40 PM; Live Time: 1000.000(min.); ID: 128

Energy Calibration: C170620128
Efficiency Calibration: C170620128
Calibration Date: 6/20/2017 11:45:15AM
Energy Cal: Gain = 9.9003 keV / Ch
Offset = 3,021.28 keV
Quadratic = 0.0000 keV / Ch²
Efficiency: 31.77% +/- 1.27% TPU(2 sigma)

**General Analysis**

Analysis Method: ROI Analysis, Set Name = Uranium Default
Decay Correction: 6/29/2017 2:23:43PM
MDA Constants: $K\alpha = 1.64$, $K\beta = 1.64$

Nuclide Library: Uranium
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
U-238	4209.315	3932.107	4288.517	0.0	100.2	0.00	0.7200	-0.72	-3.621E-003	5.649E-003	8.187E-003	2.998E-002
U-235	4407.320	4298.417	4456.822	16.9	80.9	1.00	0.3600	0.64	3.988E-003	6.628E-003	7.172E-003	3.121E-002
U-234	4783.531	4545.924	4862.733	0.0	100.0	2.00	0.3600	1.64	8.264E-003	7.374E-003	5.800E-003	2.524E-002
U-232	5318.145	5110.239	5417.148	90.6	100.1	938.00	3.2400	934.76	3.899E+000	1.496E-001	1.844E-002	5.132E-002

JM

Sample: AS170626-1LCS Type: Sample
Spectrum #1 Analysis #1
Sample Collection Date: *FC 1706420*
Comment: *1706445*

Sample Volume : 1.00 Sample Units: L
First Stage Dilution: N/A
Aliquot: N/A Aliquot Fraction: N/A
Dilution 2: N/A
Lab Preparation:

Batch Name: UAS170626-1_B

Client Name: Undefined
Client Contact:

Description:

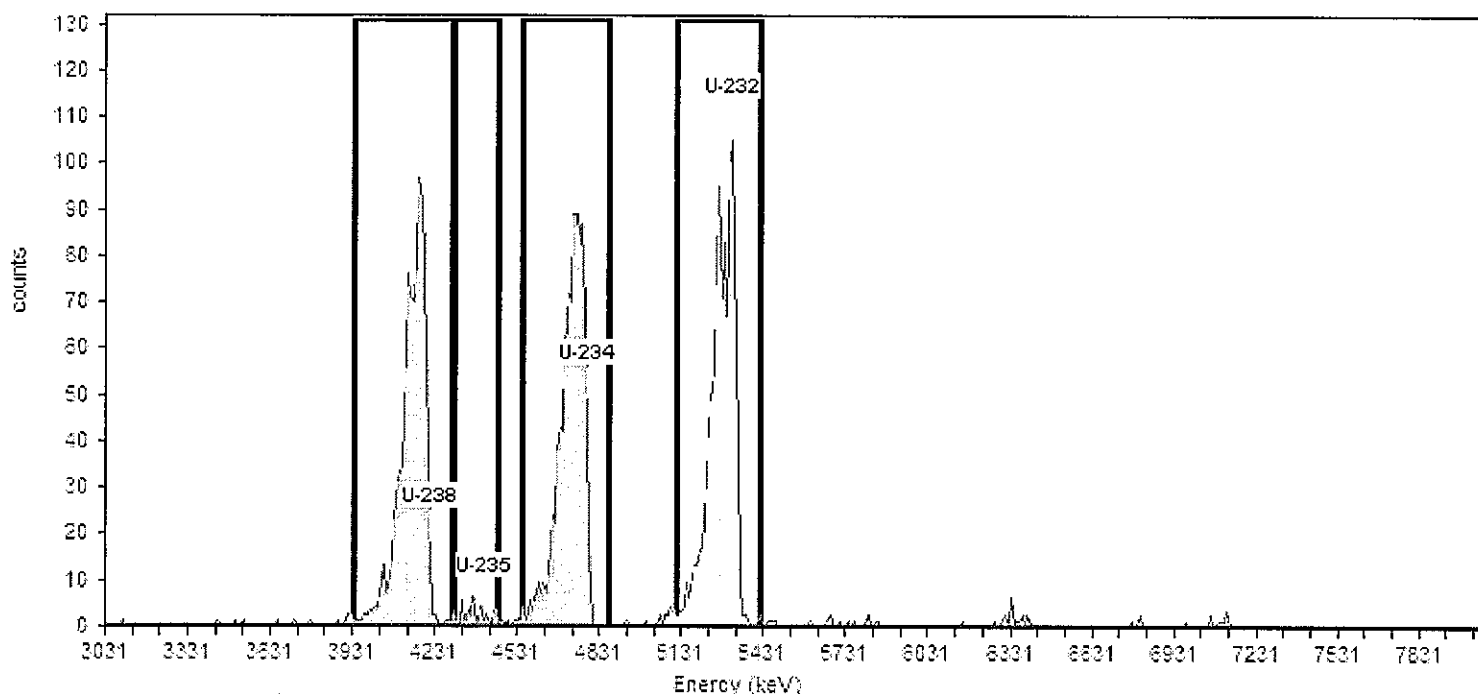
Tracer Name: 946.4243.02_U-232
Tracer Activity: 22.16 DPM / mL x (Vol.) 0.50 mL = 11.08 DPM
Tracer Ref. Date: 6/10/2011 10:00:00AM

Tracer Nuclide: U-232
Tracer Recovery: 85.19%

Detector: 129, SN: 5505430, ID: 129
Acquisition Start Date: 6/29/2017 2:25:08PM
Live Time: 360.00 min.
Real Time: 360.00 min.
Background Date: 6/20/2017 12:45:41PM
Bkgd Info: Sample: B170620129; Det: 129; Spectrum #1; 6/20/2017
12:45:41 PM; Live Time: 1000.000(min.); ID: 129

Acquisition

Energy Calibration: C170620129
Efficiency Calibration: C170620129
Calibration Date: 6/20/2017 11:45:18AM
Energy Cal: Gain = 9.9003 keV / Ch
Offset = 3,021.28 keV
Quadratic = 0.0000 keV / Ch²
Efficiency: 31.07% +/- 1.28% TPU(2 sigma)



General Analysis

Analysis Method: ROI Analysis, Set Name = Uranium Default
Decay Correction: 6/29/2017 2:23:43PM
MDA Constants: $K\alpha = 1.64$, $K\beta = 1.64$

Nuclide Library: Uranium
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
U-238	4209.315	3932.107	4288.517	94.1	100.2	890.00	1.0800	888.92	4.192E+000	3.104E-001	9.401E-003	3.156E-002
U-235	4407.320	4298.417	4456.822	0.0	80.9	33.00	0.0000	33.00	1.928E-001	3.596E-002	0.000E+000	1.581E-002
U-234	4783.531	4545.924	4862.733	94.0	100.0	917.00	0.7200	916.28	4.329E+000	3.196E-001	7.691E-003	2.817E-002
U-232	5318.145	5110.239	5417.148	89.4	100.1	1,002.00	5.0400	996.96	4.252E+000	1.610E-001	2.156E-002	5.667E-002

Handwritten signature or mark.

Alpha Spectrometer Instrument Run Log

Date: 6/29/17

Detector	Batch ID	Sample ID	Iso/Matrix	Duration	Initial
120	RAS170628-1-A	1706599-5-D	RajW	1000	JA
121		1706600-1			
122		↓ -3			
123		1706600-1			
124		↓ -2			
125		↓ -3			
126	UAS170626-1-B	1706420-1	UrW	3600	JA
127		1706445-1			
128		AS170626-1MB			
129		↓ -1CS			
81	RAS170616-1-B	RAS170616-1MB	MB	300	JP
82		↓ (C)			
83	TR	1706374-1			
84	↓	-1D			
85		-2			
86		-7			
87		↓ -8			
88		1706329-1			
89	↓	1706341-3			

[illegible]

Notes:

Reviewed by: *YB*
Date: *6/30/17*

Section 6

QUALITY ASSURANCE SUMMARY REPORTS

6

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

Section 7

LABORATORY BENCH SHEETS



Radiochemistry Instrument Worksheet

ALS -- Fort Collins

Prep Batch: AS170626-1

Prep Procedure: UIISO

420,445 → V-Defaul
Res → U-234+235

360 M₇

Analytical QASS / NCR? Y *NA*

Prep Num	LabID	QC Type	Init Aliq	Fin Aliq	Units	Report Units	Cnt 1 File	Cnt 1 Pos	Cnt 2 File	Cnt 2 Ins/Det	Cnt 2 Chk By	Cnt 3 File	Cnt 3 Ins/Det	Cnt 3 Chk By	Notes
1	1706317-3	SMP	200	200	ml	PC/L	63173	94 JP	63173			63173			A
1	1706360-1	SMP	200	200	ml	pC/L	63601	95	63601			63601			
1	1706360-2	SMP	200	200	ml	pC/L	63602	117	63602			63602			
1	1706360-3	SMP	200	200	ml	pC/L	63603	116	63603			63603			
1	1706360-4	SMP	200	200	ml	pC/L	63604	119	63604			63604			
1	1706360-4	DUP	200	200	ml	pC/L	63604D	120	63604D			63604D			
1	1706360-5	SMP	200	200	ml	pC/L	63605	121	63605			63605			
1	1706360-6	SMP	200	200	ml	pC/L	63606	122	63606			63606			
1	1706360-7	SMP	200	200	ml	pC/L	63607	123	63607			63607			
1	1706360-8	SMP	200	200	ml	pC/L	63608	124	63608			63608			
1	1706360-11	SMP	200	200	ml	pC/L	636011	125	636011			636011			
1	1706383-9	SMP	200	200	ml	pC/L	63839	126	63839			63839			
1	1706383-12	SMP	200	200	ml	pC/L	638312	127	638312			638312			
1	1706383-12	DUP	200	200	ml	pC/L	638312D	128	638312D			638312D			
1	1706420-1	SMP	500	500	ml	pC/L	64201	126 JP	64201			64201			B
1	1706431-4	SMP	200	200	ml	PC/L	64314	129 JP	64314			64314			A
1	1706431-9	SMP	200	200	ml	PC/L	64319	130	64319			64319			
1	1706431-13	SMP	200	200	ml	PC/L	643113	131	643113			643113			
1	1706431-17	SMP	200	200	ml	PC/L	643117	132	643117			643117			
1	1706431-21	SMP	200	200	ml	PC/L	643121	91	643121			643121			
1	1706445-1	SMP	500	500	ml	BQ/L	64451	127 JP	64451			64451			B
1	1706469-4	SMP	200	200	ml	pC/L	64694	92 JP	64694			64694			A
1	AS170626-1	MB	1000	1000	ml	BQ/L	6261B	128 JP	6261B			6261B			B
1	AS170626-1	MB	1000	1000	ml	pC/L	6261B	1	6261B			6261B			
1	AS170626-1	LCS	1000	1000	ml	pC/L	6261L	129	6261L			6261L			
1	AS170626-1	LCS	1000	1000	ml	BQ/L	6261L	1	6261L			6261L			

Radiochemistry Instrument Worksheet

ALS -- Fort Collins

Prep Batch: AS170626-1

Prep Procedure: UIISO

Analytical QASS / NCR? Y

Notes

Prep Num	LabID	QC Type	Init Aliq	Fin Aliq	Units	Report Units	Cnt 1 File	Cnt 1 Inst/Det	Cnt 1 Pos Chk By	Cnt 2 File	Cnt 2 Inst/Det	Cnt 2 Pos Chk By	Cnt 3 File	Cnt 3 Inst/Det	Cnt 3 Pos Chk By	Notes
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Tracer/Carrier Solution Information

Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
T1	U-232	946.4243.02		20.849	DPM/ml	06/26/17	0.5	ml	AW-013

Spike Solution Information

Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
S1	U-234	843.4095.43		18.739	DPM/ml	06/26/17	0.5	ml	AW-013
S1	U-235	843.4095.43		0.896	DPM/ml	06/26/17	0.5	ml	AW-013
S1	U-238	843.4095.43		19.455	DPM/ml	06/26/17	0.5	ml	AW-013

Sample Barcodes

1706317-3 AS170626-1PS1		1706360-1 AS170626-1PS2		1706360-2 AS170626-1PS3	
1706360-3 AS170626-1PS4		1706360-4 AS170626-1PS5		1706380-4DUP AS170626-1PS6	
1706360-5 AS170626-1PS7		1706360-6 AS170626-1PS8		1706360-7 AS170626-1PS9	
1706360-8 AS170626-1PS10		1706360-11 AS170626-1PS11		1706383-9 AS170626-1PS12	
1706383-12 AS170626-1PS13		1706383-12DUP AS170626-1PS14		1706420-1 AS170626-1PS15	
1706431-4 AS170626-1PS16		1706431-9 AS170626-1PS17		1706431-13 AS170626-1PS18	
1706431-17 AS170626-1PS19		1706431-21 AS170626-1PS20		1706445-1 AS170626-1PS21	
1706469-4 AS170626-1PS22		AS170626-1MB AS170626-1PS23		AS170626-1LCS AS170626-1PS24	

Radiochemistry Instrument Worksheet

ALS -- Fort Collins

Prep Batch: AS170626-1

Reporting Units

LabID	IsGrpName	RptUnits
1706445-1	IsoU	BO/L
1706360-1	IsoU(233/4, 235/6)BJC_1	pCi/l
1706420-1	IsoU	pCi/l
1706360-2	IsoU(233/4, 235/6)BJC_1	pCi/l
1706360-3	IsoU(233/4, 235/6)BJC_1	pCi/l
1706317-3	IsoU(233/4, 235/6)BJC_1	PCI/L
1706431-4	IsoU(233/4, 235/6)BJC_1	PCI/L
1706360-4	IsoU(233/4, 235/6)BJC_1	pCi/l
1706469-4	IsoU(233/4, 235/6)BJC_1	pCi/l
1706360-5	IsoU(233/4, 235/6)BJC_1	pCi/l
1706360-6	IsoU(233/4, 235/6)BJC_1	pCi/l
1706360-7	IsoU(233/4, 235/6)BJC_1	pCi/l
1706360-8	IsoU(233/4, 235/6)BJC_1	pCi/l
1706383-9	IsoU(233/4, 235/6)BJC_1	pCi/l
1706431-9	IsoU(233/4, 235/6)BJC_1	PCI/L
1706360-11	IsoU(233/4, 235/6)BJC_1	pCi/l
1706383-12	IsoU(233/4, 235/6)BJC_1	pCi/l
1706431-13	IsoU(233/4, 235/6)BJC_1	PCI/L
1706431-17	IsoU(233/4, 235/6)BJC_1	PCI/L
1706431-21	IsoU(233/4, 235/6)BJC_1	PCI/L

Radiochemistry Prep Worksheet

ALS -- Fort Collins

Prep Batch: AS170626-1

Prep Procedure: UIISO

Reviewed By: *rim*

Review Date: 6/28/2017

Non-Routine Pre-Treatment? Y / N Batch: NA

Prep QASS / NCR? Y / N NA

Prep SOP: PAI 777 Rev: 12

Prep SOP: NONE

Matrix Class: liquid

Prep Analyst: Rebecca L. Merola

Prep Date: 6/26/2017

Prep Dept: AP

Balance: NA

Balance: NA

Sample Num	Prep Num	LabID	QC Type	Dish No.	Init Alq ml	Fin Alq ml	Prep Basis	Micro Init	Micro Date	Standards	Prep Notes
1	1	1706317-3	SMP		200	200	Unfiltered			T1	
2	1	1706360-1	SMP		200	200	Unfiltered			T1	
3	1	1706360-2	SMP		200	200	Unfiltered			T1	
4	1	1706360-3	SMP		200	200	Unfiltered			T1	
5	1	1706360-4	SMP		200	200	Unfiltered			T1	
6	1	1706360-4	DUP		200	200	Unfiltered			T1	
7	1	1706360-5	SMP		200	200	Unfiltered			T1	
8	1	1706360-6	SMP		200	200	Unfiltered			T1	
9	1	1706360-7	SMP		200	200	Unfiltered			T1	
10	1	1706360-8	SMP		200	200	Unfiltered			T1	
11	1	1706360-11	SMP		200	200	Unfiltered			T1	
12	1	1706383-9	SMP		200	200	Unfiltered			T1	
13	1	1706383-12	SMP		200	200	Unfiltered			T1	
14	1	1706383-12	DUP		200	200	Unfiltered			T1	
15	1	1706420-1	SMP		500	500	Filtered			T1	
16	1	1706431-4	SMP		200	200	Unfiltered			T1	
17	1	1706431-9	SMP		200	200	Unfiltered			T1	
18	1	1706431-13	SMP		200	200	Unfiltered			T1	
19	1	1706431-17	SMP		200	200	Unfiltered			T1	
20	1	1706431-21	SMP		200	200	Unfiltered			T1	
21	1	1706445-1	SMP		500	500	Unfiltered			T1	
22	1	1706469-4	SMP		200	200	Unfiltered			T1	
23	1	AS170626-1	MB		1000	1000	Unfiltered			T1	
24	1	AS170626-1	LCS		1000	1000	Unfiltered			S1,T1	

Radiochemistry Prep Worksheet

ALS -- Fort Collins

Prep Batch: AS170626-1

Prep Procedure: UIISO

Reviewed By: rlm

Review Date: 6/28/2017

Non-Routine Pre-Treatment? Y / ☒ Batch: 174 Re-Prep? Y / ☒ Batch: NA Prep QASS / NCR? Y / ☒ NA

Prep SOP: PAI 777 Rev: 12

Prep SOP: NONE

Matrix Class: liquid

Prep Analyst: Rebecca L. Merola

Prep Date: 6/26/2017

Prep Dept: AP

Balance: NA

Balance: NA

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Alq ml	Fin Alq ml	Prep Basis	Micro Init	Micro Date	Standards	Prep Notes

Comments

Reduced aliquots taken due to possible matrix interference.

Spiked By: Rebecca L. Merola Date: 6/26/2017

Witnessed By: Macey S. Hall Date: 6/26/2017

Tracer/Carrier Solution Information

Soln #	Nuclide	SolnID	Exo Date	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
T1	U-232	946.4243.02		20.849	DFM/ml	06/26/17	0.5	ml	AW-013

Spike Solution Information

Soln #	Nuclide	SolnID	Exo Date	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
S1	U-234	843.4095.43		18.739	DFM/ml	06/26/17	0.5	ml	AW-013
S1	U-235	843.4095.43		0.896	DFM/ml	06/26/17	0.5	ml	AW-013
S1	U-238	843.4095.43		19.455	DFM/ml	06/26/17	0.5	ml	AW-013

Radiochemistry Prep Worksheet

ALS -- Fort Collins

Prep Batch: AS170626-1

Prep Procedure: UIISO

Prep Batch Not Validated!!!

Reviewed By:

Review Date:

Non-Routine Pre-Treatment? Y / N Batch:

Prep QASS / NCR? Y / N

Prep SOP: PAI 777 Rev: 12

Prep SOP: NONE

Matrix Class: liquid

Prep Analyst: Rebecca L. Merola

Balance: NA

Prep Date: 6/26/2017

Balance: NA

Prep Dept: AP

Sample Num	Prep Num	LabID	QC Type	Dish No.	Init Alq ml	Fin Alq ml	Prep Basis	Micro Init	Micro Date	Standards	Prep Notes
1	1	1706317-3	SMP		200	200	Unfiltered			T1	
2	1	1706360-1	SMP		200	200	Unfiltered			T1	
3	1	1706360-2	SMP		200	200	Unfiltered			T1	
4	1	1706360-3	SMP		200	200	Unfiltered			T1	
5	1	1706360-4	SMP		200	200	Unfiltered			T1	
6	1	1706360-4	DUP		200	200	Unfiltered			T1	
7	1	1706360-5	SMP		200	200	Unfiltered			T1	
8	1	1706360-6	SMP		200	200	Unfiltered			T1	
9	1	1706360-7	SMP		200	200	Unfiltered			T1	
10	1	1706360-8	SMP		200	200	Unfiltered			T1	
11	1	1706360-11	SMP		200	200	Unfiltered			T1	
12	1	1706383-9	SMP		200	200	Unfiltered			T1	
13	1	1706383-12	SMP		200	200	Unfiltered			T1	
14	1	1706383-12	DUP		200	200	Unfiltered			T1	
15	1	1706420-1	SMP		200	200	Unfiltered			T1	
16	1	1706431-4	SMP		200	200	Unfiltered			T1	
17	1	1706431-9	SMP		200	200	Unfiltered			T1	
18	1	1706431-13	SMP		200	200	Unfiltered			T1	
19	1	1706431-17	SMP		200	200	Unfiltered			T1	
20	1	1706431-21	SMP		200	200	Unfiltered			T1	
21	1	1706445-1	SMP		500	500	Unfiltered			T1	
22	1	1706469-4	SMP		200	200	Unfiltered			T1	
23	1	AS170626-1	MB		1000	1000	Unfiltered			T1	
24	1	AS170626-1	LCS		1000	1000	Unfiltered			S1,T1	

Radiochemistry Prep Worksheet

ALS -- Fort Collins

Prep Batch: AS170626-1

Prep Procedure: UIISO

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 777 Rev: 12

Prep Analyst: Rebecca L. Merola Balance: NA

Prep SOP: NONE

Balance: NA

Matrix Class: liquid

Prep Date: 6/26/2017

Prep Dept: AP

Samp Num Prep Num LabID QC Type Dish No. Init Alq ml Fin Alq ml Prep Basis Micro Init Micro Date Standards Prep Notes

Comments

Reduced aliquots taken due to possible matrix interference.

Spiked By: DA Date: 6/26/17

Witnessed By: MSH Date: 6/26/17

Tracer/Carrier Solution Information

Soln #	Nuclide	SolnID	Exp Date	Prep Date	Prep Conc	Units	Aliquot	Units	Pipet ID
T1	U-232	946.4243.02	9/7/17	06/26/17	20.849	DPM/ml	0.5	ml	AW-013

Spike Solution Information

Soln #	Nuclide	SolnID	Exp Date	Prep Date	Prep Conc	Units	Aliquot	Units	Pipet ID
S1	U-234	843.4095.43	9/7/17	06/26/17	18.739	DPM/ml	0.5	ml	AW-013
S1	U-235	843.4095.43		06/26/17	0.896	DPM/ml	0.5	ml	AW-013
S1	U-238	843.4095.43		06/26/17	19.455	DPM/ml	0.5	ml	AW-013

Sample Condition Form (Liquid)

Analyst: *RM*

Analysis Date: *6/26/17*

Method: *Prep*

Sample Condition (Visual Appearance of Analysis Aliquot at Time of Prep)

Work Order	Sample ID	pH	Color	Remarks
<i>1706317</i>	<i>3</i>	<i>22.0</i>	<i>colorless</i>	<i>MA</i>
<i>1706360</i>	<i>1</i>	<i>↓</i>	<i>↓</i>	<i>↓</i>
<i>↓</i>	<i>2</i>	<i>↓</i>	<i>tan</i>	<i>light sediment</i>
<i>↓</i>	<i>3</i>	<i>↓</i>	<i>colorless</i>	<i>MA</i>
<i>↓</i>	<i>4</i>	<i>↓</i>	<i>↓</i>	<i>↓</i>
<i>↓</i>	<i>5</i>	<i>↓</i>	<i>light tan</i>	<i>light sediment</i>
<i>↓</i>	<i>6</i>	<i>↓</i>	<i>colorless</i>	<i>MA</i>
<i>↓</i>	<i>7</i>	<i>↓</i>	<i>tan</i>	<i>light sediment</i>
<i>↓</i>	<i>8</i>	<i>↓</i>	<i>tan</i>	<i>light sediment</i>
<i>↓</i>	<i>11</i>	<i>↓</i>	<i>colorless</i>	<i>MA</i>
<i>1706383</i>	<i>9</i>	<i>↓</i>	<i>↓</i>	<i>↓</i>
<i>↓</i>	<i>12</i>	<i>↓</i>	<i>↓</i>	<i>↓</i>
<i>1706420</i>	<i>1</i>	<i>↓</i>	<i>light yellow</i>	<i>filtered</i>
<i>1706431</i>	<i>4</i>	<i>↓</i>	<i>colorless</i>	<i>↓</i>
<i>↓</i>	<i>9</i>	<i>↓</i>	<i>↓</i>	<i>↓</i>
<i>↓</i>	<i>13</i>	<i>↓</i>	<i>↓</i>	<i>↓</i>
<i>↓</i>	<i>17</i>	<i>↓</i>	<i>↓</i>	<i>↓</i>
<i>↓</i>	<i>21</i>	<i>↓</i>	<i>↓</i>	<i>↓</i>
<i>1706445</i>	<i>1</i>	<i>↓</i>	<i>↓</i>	<i>↓</i>
<i>1706445-06/26/17</i>	<i>1</i>	<i>↓</i>	<i>↓</i>	<i>↓</i>
<i>1706469</i>	<i>4</i>	<i>↓</i>	<i>↓</i>	<i>↓</i>

Batch: AS170626-1

U Solid

Reagent	Lot #
Conc. Hydrochloric Acid	L09031
Conc. Nitric Acid	2012051832
Conc. Hydrofluoric Acid	52126
Boric Acid	J23624
Iron Carrier	96344
Ammonium Hydroxide	51335
9N Hydrochloric Acid	L09031
Polyethylene Glycol	BCBG6515V
Sodium Nitrite	A0248649
Methanol	DG501, DG078
1x8 Anion Exchange Resin	50912A8C
Ammonium Iodide	G06X011
0.5N Hydrochloric Acid	L09031
Ascorbic Acid	K09637, K37647
Lanthanum Carrier	L09031, B03681
Safranine	1106296
Titanium Chloride	57396AP
3N Hydrofluoric Acid	52126

U Liquid

Reagent	Lot #
Conc. Hydrochloric Acid	L09031
Iron Carrier	96344
Ammonium Hydroxide	51335
9N Hydrochloric Acid	L09031
Polyethylene Glycol	BCBG6515V
Sodium Nitrite	A0248649
Methanol	DG501, DG078
1x8 Anion Exchange Resin	50912A8C
Ammonium Iodide	G06X011
0.5N Hydrochloric Acid	L09031
Conc. Nitric Acid	2012051832
Ascorbic Acid	K09637, K37647
Lanthanum Carrier	L09031, B03681
Safranine	1106296
Titanium Chloride	57396AP
3N Hydrofluoric Acid	52126

Section 8

STANDARDS TRACEABILITY DOCUMENTS



Prepare a working dilution of 843.3610.56

1. Density of 1M HNO₃, lot # 0000035808

Mass of 100mL vol. flask: 68.5639g

Balance # 12

Mass of flask & 100mL acid: 171.6240g

Balance # 12

Net Mass: 103.0601g

Density: 1.0306g/mL

2. Mass of 843.3610.56 transferred:

Mass of open empty nalgene: 74.8967g

Balance # 12

Mass of nalgene & standard: 82.6110g

Balance # 12

Net mass of standard transferred: 7.7143g

Balance # NA

3. Dilute to final volume:

Mass of nalgene, standard, & diluent: 1046.4g

Balance # 26

Mass of empty nalgene (from above): 74.8967g

Balance # 12

Net mass of new dilution: 971.5033g

Balance # NA

4. Final activity calculation:

$$(U-238): 2377.34 \text{ dpm/g} \left(\frac{7.7143g}{971.5033g} \right) (1.0306g/mL) = 19.46 \text{ dpm/mL}$$

$$(U-235): 109.44 \text{ dpm/g} \left(\frac{7.7143g}{971.5033g} \right) (1.0306g/mL) = 0.896 \text{ dpm/mL}$$

$$(U-234): 2,289.91 \text{ dpm/g} \left(\frac{7.7143g}{971.5033g} \right) (1.0306g/mL) = 18.74 \text{ dpm/mL}$$

Std ID: 843.4095.43

Description: U-238

Expiration: 5/28/2016

Activity: 19.46 dpm/mL

2s Uncertainty: 0.12 dpm/mL

Ref. Date: 8/1/1997

Ref Time: N/A

Prep Date: 4/29/2013 Prep by: TE

Matrix/Comp. 1.0 M HNO₃

Half Life (y): 4.47E+09

Reverification Log		
Analysis Date	Initials	Expiration Date
09/07/16	JP	09/07/2017

Continued on Page

Signed

Date

Read and Understood By

Signed

Date

Prepare an intermediate Dilution of BSC # 843

Diluent is (M HNO₃ lot # H3104)
from Pg. 54 this logbook (3610)
 $\rho = 1.0283 \frac{g}{ml}$

bu *

Mass of Parent Transferred

Mass of Open, full Ampule + beaker

38.1504g

12

Mass of Empty Ampule + beaker

32.9991g

1

Net Mass transferred

5.1513g

Dilute to Final Volume

Mass of Open Empty, 40 ml VDA

21.6331g

12

Mass of Open full Vial

53.0961g

1

Net mass of New Dilution

31.4624g

Final Activity (U-238)

$$\left(\frac{247.0 \text{ Bq}}{g} \right) \left(\frac{60 \text{ dpm}}{1 \text{ Bq}} \right) \left(\frac{5.1513 \text{ g}}{31.4624 \text{ g}} \right) = \frac{2382.5 \text{ dpm}}{2377.34 \text{ g}}$$

Final activity (U-235):

(RSO: 843) = 11.14 Bq/g

109.44 dpm/g

Final activity (U-234):

(RSO: 843) = 233.1 Bq/g

2289.91 dpm/g

Continued on Page

Read and Understood By

Signed

4/23/10

Date

Signed

5/11/10

Date



National Institute of Standards & Technology Certificate

Standard Reference Material 4321C Natural Uranium Radioactivity Standard

RSO #
843
rec 7-20-07

This Standard Reference Material (SRM) consists of a solution of a standardized and certified quantity of radioactive uranium-238, uranium-235, and uranium-234 in a suitably stable and homogeneous matrix. It is intended primarily for the calibration of instruments that are used to measure radioactivity and for the monitoring of radiochemical procedures. The solution, whose composition is specified in Table 1, is contained in a flame-sealed, 5 mL, NIST, borosilicate-glass ampoule (see Note 1)*.

The certified massic activities for the uranium isotopes at a Reference Time of 1200 EST, 1 August 1997, are:

Uranium-238: $(242.0 \pm 1.5) \text{ Bq} \cdot \text{g}^{-1}$

Uranium-235: $(11.14 \pm 0.07) \text{ Bq} \cdot \text{g}^{-1}$

Uranium-234: $(233.1 \pm 2.2) \text{ Bq} \cdot \text{g}^{-1}$

Additional physical, chemical, and radiological properties for the SRM, as well as details on the standardization method, are given in Table 1. Uncertainty intervals for certified quantities are expanded ($k=2$) uncertainties calculated according to the ISO and NIST Guidelines (see Note 2). Table 2 contains a specification of the components that comprise the uncertainty analyses.

The certification of this SRM, within the measurement uncertainties specified, is valid for at least five (5) years after receipt. The solution matrix, in an unopened ampoule, is believed to be indefinitely homogeneous and stable, within its half-life-dependent, useful lifetime. NIST will monitor this material and will report any substantive changes in certification to the purchaser. Should any of the certified values change, purchasers of this SRM will be notified of the change by NIST.

This SRM may represent a radiological hazard and a chemical hazard. Consult the Material Safety Data Sheet (MSDS), enclosed with the SRM shipment, for details (see Note 1).

This Standard Reference Material was prepared in the Physics Laboratory, Ionizing Radiation Division, Radioactivity Group, Dr. M.P. Unterwieser, Acting Group Leader. The overall technical direction and physical measurements leading to certification were provided by Dr. L.L. Lucas of the Radioactivity Group. The support aspects involved in the preparation, certification, and issuance of this SRM were coordinated through the Standard Reference Materials Program.

Gaithersburg, Maryland 20899

November 1997

Text revised and expiration date extended February 2007

Lisa R. Karam, Deputy Chief
Ionizing Radiation Division

Robert L. Watters, Jr., Chief
Measurement Services Division

Table 1. Properties of SRM 4321C

Certified values	
Radionuclides	Natural Uranium (Mixture of ^{238}U , ^{235}U , and ^{234}U)
Reference time	1200 EST, 1 August 1997
Massic activities of the solution	^{238}U : $242.0 \text{ Bq}\cdot\text{g}^{-1}$ ^{235}U : $11.14 \text{ Bq}\cdot\text{g}^{-1}$ ^{234}U : $233.1 \text{ Bq}\cdot\text{g}^{-1}$
Relative expanded uncertainties ($k = 2$)	^{238}U : 0.60% (see Note 2)* ^{235}U : 0.60% (see Note 2) ^{234}U : 0.96% (see Note 2)

Uncertified information	
Source description	Liquid in flame-sealed, 5 mL NIST borosilicate ampoule (see Note 1)
Solution composition	$1.0 \text{ mol}\cdot\text{L}^{-1}$ HCl with 30 mg $\text{UO}_2(\text{NO}_3)_2$ per gram of solution
Solution density	$(1.053 \pm 0.001) \text{ g}\cdot\text{mL}^{-1}$ at 21.4°C (see Note 3)
Solution mass	$(5.258 \pm 0.002) \text{ g}$ (see Note 3)
Mass fraction of uranium	$(0.01960 \pm 0.00010) \text{ g}\cdot\text{g}^{-1}$ (see Note 3)
Photon-emitting impurities	None detected (see Note 4)
Half-lives used [1]	^{238}U : $(4.468 \pm 0.003) \times 10^9 \text{ a}^\ddagger$ ^{235}U : $(7.038 \pm 0.005) \times 10^8 \text{ a}^\ddagger$ ^{234}U : $(2.455 \pm 0.006) \times 10^5 \text{ a}^\ddagger$
Calibration method (and instruments)	The certified massic activity for natural uranium was obtained by mass spectrometer, silicon surface-barrier detector, and $4\pi\alpha\beta$ liquid scintillation (LS) counting systems.

[‡] See Note 5

Table 2. Uncertainty evaluation for the massic activity for SRM 4321C

Uncertainty component		Assessment Type [†]	Relative standard uncertainty contribution on massic activity of Natural Uranium (%)
1	Isotopic uranium atom fraction in SRM 960; standard deviation of the mean for replicate mass-spectrometric measurements for ²³⁸ U	A	0.001
2	Isotopic uranium atom fraction in SRM 960; standard deviation of the mean for replicate mass-spectrometric measurements for ²³⁵ U	A	0.07
3	Isotopic uranium atom fraction in SRM 960; standard deviation of the mean for replicate mass-spectrometric measurements for ²³⁴ U	A	0.3
4	Half life of ²³⁸ U; standard uncertainty of the half-life	A	0.07
5	Half life of ²³⁵ U; standard uncertainty of the half-life	A	0.07
6	Half life of ²³⁴ U; standard uncertainty of the half-life	A	0.24
7	Uranium mass fraction in SRM 960; from SRM960 certificate	B	0.003
8	Quantitative dissolution	B	0.25
9	Gravimetric (mass) measurements	B	0.10
10	Limit for photon-emitting impurities	B	0.10
Relative combined standard uncertainty		²³⁸ U	0.30
		²³⁵ U	0.30
		²³⁴ U	0.48
Relative expanded uncertainty (<i>k</i> = 2)		²³⁸ U	0.60
		²³⁵ U	0.60
		²³⁴ U	0.96

[†] = (A) denotes evaluation by statistical methods; (B) denotes evaluation by other methods.

NOTES

Note 1. Refer to <http://physics.nist.gov/Divisions/Div846/srm.html> for the standardized ampoule dimensions and for assistance and instructions on how to properly open an ampoule. Information on additional storage and handling requirements is also included in the website.

Note 2. The uncertainties on certified values are expanded uncertainties, $U = ku_c$. The quantity u_c is the combined standard uncertainty calculated according to the ISO and NIST Guides (see references [2] and [3]). The combined standard uncertainty is multiplied by a coverage factor of $k = 2$ and was chosen to obtain an approximate 95 % level of confidence.

Note 3. The stated uncertainty is two times the standard uncertainty. See reference [3].

Note 4. The estimated lower limits of detection for photon-emitting impurities, expressed as massic photon emission rates are:

- 1.4 $\text{s}^{-1}\cdot\text{g}^{-1}$ for 8 keV < E < 59 keV
- 1.1 $\text{s}^{-1}\cdot\text{g}^{-1}$ for 67 keV < E < 88 keV
- 0.5 $\text{s}^{-1}\cdot\text{g}^{-1}$ for 102 keV < E < 197 keV
- 0.3 $\text{s}^{-1}\cdot\text{g}^{-1}$ for 205 keV < E < 762 keV
- 0.2 $\text{s}^{-1}\cdot\text{g}^{-1}$ for 770 keV < E < 996 keV, and
- 0.1 $\text{s}^{-1}\cdot\text{g}^{-1}$ for 1006 keV < E < 1900 keV

provided that the photons are separated in energy by 4 keV or more from photons emitted in the decay of ^{238}U , ^{235}U , ^{234}U , or their progeny

Note 5. The stated uncertainty is the standard uncertainty. See reference [3].

REFERENCES

- [1] Evaluated Nuclear Structure Data File (ENSDF), online database, National Nuclear Data Center, Brookhaven Laboratory (Upton, NY), August 2007. Refer to <http://www.nndc.bnl.gov/ensdf/>
- [2] International Organization for Standardization (ISO), *Guide to the Expression of Uncertainty in Measurement*, 1993 (corrected and reprinted, 1995). Available from Global Engineering Documents, 12 Inverness Way East, Englewood, CO 80112, U.S.A. Telephone 1-800-854-7179.
- [3] B. N. Taylor and C. E. Kuyatt, *Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results*, NIST Technical Note 1297, 1994. Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20407, U.S.A.

Project

Continued from Page

U232 working std 946.4243.02

Prepare a working dilution of 946.4095.98

1. Density of 1M HNO₃, lot # 0006118134

Mass of 100mL vol. flask:

Mass of flask & 100mL acid:

Net Mass:

Density:

68.5624g

171.2481g

102.6857g

1.0269g/mL

Balance # 12

Balance # 12

2. Mass of 946.4095.98 transferred:

Mass of open empty nalgene:

Mass of nalgene & standard:

Net mass of standard transferred:

73.6095g

76.6130g

3.0035g

Balance # 12

Balance # 12

3. Dilute to final volume:

Mass of nalgene, standard, & diluent:

Mass of empty nalgene (from above):

Net mass of new dilution:

1005.4g

73.6095g

931.7905g

Balance # 26

Balance # 12

4. Final activity calculation:

$$6693.55 \text{ dpm/g} (1.0269 \text{ g/mL}) \left(\frac{3.0035 \text{ g}}{931.7905 \text{ g}} \right) = 22.16 \text{ dpm/mL}$$

Std ID: 946.4243.02

Description: U-232

Expiration: 9/7/2017

Activity: 22.16 dpm/ml

2s Uncertainty: 1.09 dpm/ml

Ref. Date: 6/10/2011

Ref Time: N/A

Prep Date: 12/31/2015 Prep by: TE

Matrix/Comp. 1.0 M HNO₃

Half Life (y): 6.89E+01

Reverification Log

Analysis Date Initials Expiration Date

Continued on Page

Signed

Date

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Signed

Date

40 of 61

U232 intermediate std 946.4095.98

intermediate 12/31/15
 Prepare a working dilution of RSO# 946

1. Density of 1M HNO₃, lot # 0000118134

Mass of 100mL vol. flask:

Mass of flask & 100mL acid:

Net Mass:

Density:

68.5624g
 171.2481g
 102.6857g
 1.0269g/mL

Balance # 12

Balance # 12

2. Mass of RSO# 946 transferred:

Mass of empty vial:

Mass of vial & standard:

Net mass of standard transferred:

25.9001g
 31.0703g
 5.1702g

Balance # 12

Balance # 12

3. Dilute to final volume:

Mass of vial, standard, & diluent:

Mass of empty vial:

Net mass of new dilution:

42.4037g
 25.9001g
 16.5036g

Balance # 12

Balance # 12

4. Final activity calculation:

$$1869 \text{ Bq} \left(\frac{60 \text{ dpm}}{1 \text{ Bq}} \right) \left(\frac{5.1702 \text{ g}}{5.24847 \text{ g}} \right) \left(\frac{1}{16.5036 \text{ g}} \right) = 6693.55 \text{ dpm/g}$$

Continued on Page

Signed

Date

Read and Understood By

Signed

Date



Eckert & Ziegler

Analytics

Rec'd
6-14-11

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

CERTIFICATE OF CALIBRATION

Standard Radionuclide Source

84896-307

5 mL Liquid in Flame Sealed Vial

Customer: ALS Laboratory/Fort Collins, CO
P.O. No.: 73625, Item 1

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

Isotope	Half-Life, Days	Activity (Bq)	Uncertainty* , %			Reference Date (12:00 PM EST)
			Type	u _A	u _B	
U-232	2.517E+04	1.869E+03	0.5	2.4	4.9	06/10/2011

***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: γ -impurities (other than decay products) < 0.1 %. 5.24847 grams 1M HNO₃ solution.

Source Prepared by:

M. I. Taskaeva
M. I. Taskaeva, Radiochemist

QA Approved:

J. D. McCorvey
J. D. McCorvey, QA Manager Alternate

Date:

6/10/11



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: 1706420

Prep SOP: PAI 777
Analytical SOP: PAI 714

Reported on: Monday, July 03, 2017
1:06:13 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
1706420-1 Spectrum #1 6/29/2017	SMP	AS170626-1 AS170626-1U	UI50	126	C170620126 B170620126 C170620126	6/20/2017 6/20/2017 6/20/2017	34.37 0.1650 5555.8	Warning Pass Pass	31.18 0.0000 5506.0	31.73 0.0500 5516.0	33.90 0.5000 5596.0	34.46 0.7500 5606.0
AS170626-1 Spectrum #1 6/29/2017	MB	AS170626-1 AS170626-1U	UI50	128	C170620128 B170620128 C170620128	6/20/2017 6/20/2017 6/20/2017	31.77 0.1390 5555.8	Warning Pass Pass	31.28 0.0000 5506.0	31.84 0.0500 5516.0	34.01 0.5000 5596.0	34.57 0.7500 5606.0
AS170626-1 Spectrum #1 6/29/2017	LCS	AS170626-1 AS170626-1U	UI50	129	C170620129 B170620129 C170620129	6/20/2017 6/20/2017 6/20/2017	31.07 0.1370 5555.8	Warning Pass Pass	30.83 0.0000 5506.0	31.38 0.0500 5516.0	33.52 0.5000 5596.0	34.07 0.7500 5606.0

Data Package ID: UR1706420-1

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

Date Printed: Wednesday, July 05, 2017

ALS -- Fort Collins

LIMS Version: 6.843

Page 1 of 1

Alpha Spec Calibration Source Re-Certification

Recalibration performed by Isotope Products Laboratories

Primary Certified Source

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

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

Nuclide	Act (Bq)	Act (dpm)	Half-life (yrs)	Decay Corrected
U-234:	40.54	2972.4	2.48E+05	2972.38 dpm
U-235:	1.09	65.58	7.04E+08	65.58 dpm
Am-241:	11.79	707.4	432.17	704.04 dpm
TOTAL				3741.99 dpm

Efficiency Determination for Detector:

129

Source Serial#	PA ID	Sequential #	Count Date	Am-241 net cts	U-234 net cts	U-235 net cts	count dur (s)	Total cpm	Known dpm	Detector efficiency
92MX223027	180	97-18-103-09	10/4/16	7502	32112	1070	2100	1162.40	3741.99	31.06%

Sources 1 through 8 activity determination

Source Serial#	PA ID	Sequential #	Count Date	Am-241 net cts	U-234 net cts	U-235 net cts	count dur (s)	Detector Efficiency	Am-241 dpm	U-234 dpm	U-235 dpm	Combined dpm
92MX2203026	182	97-18-103-01	10/4/16	12981	79837	2777	2100	31.06%	1193.95	7343.17	255.42	8792.54
92MX2203028	183	97-18-103-02	10/4/16	15085	148128	3863	2100	31.06%	1387.47	13824.37	355.31	15367.15
92MX2203024	184	97-18-103-03	10/4/16	67474	70483	2608	2100	31.06%	6206.06	6482.82	239.88	12928.75
92MX2203021	185	97-18-103-04	10/4/16	21961	60440	2557	2100	31.06%	2019.91	5559.09	235.19	7814.18
92MX2203025	186	97-18-103-05	10/4/16	97983	114458	3780	2100	31.06%	9002.99	10527.51	347.67	19878.16
92MX2203022	187	97-18-103-06	10/4/16	72777	78983	2564	2100	31.06%	6893.81	7347.40	237.67	14278.88
92MX2203023	188	97-18-103-07	10/4/16	43617	68953	2043	2100	31.06%	4011.76	8342.09	187.81	10541.76
92MX2203029	189	97-18-103-08	10/4/16	33968	214074	7185	2100	31.06%	3124.09	19889.89	661.77	23475.75

Efficiency Verification

Source Serial#	PA ID	Sequential #	Count Date	Am-241 net cts	U-234 net cts	U-235 net cts	Count dur (s)	Total cpm	Known dpm	Detector efficiency	RPD	FLAG
92MX223027	180	97-18-103-09	10/5/16	7807	32611	1278	2100	1181.31	3741.99	31.84%	-2.46%	PASS

Sources 1 through 8 activity re-verification

Source Serial#	PA ID	Sequential #	Combined Observed dpm	Combined Certified dpm*	Percent Difference %	Within 5% of Certified value?
92MX2203026	182	97-18-103-01	8792.54	8849.86	-0.65%	Yes
92MX2203028	183	97-18-103-02	15387.15	15982.35	-3.91%	Yes
92MX2203024	184	97-18-103-03	12928.75	13503.77	-4.26%	Yes
92MX2203021	185	97-18-103-04	7814.18	8161.24	-4.25%	Yes
92MX2203025	186	97-18-103-05	19878.16	20979.95	-5.25%	No
92MX2203022	187	97-18-103-06	14278.88	15285.63	-6.56%	No
92MX2203023	188	97-18-103-07	10541.76	10723.95	-1.70%	Yes
92MX2203029	189	97-18-103-08	23475.75	23583.84	-0.50%	Yes

* Certificate values decay corrected to the count date

Data from certificates

Reference Date	U-234 (Bq)	U-234 (dpm)	U-235 (Bq)	U-235 (dpm)	Am-241 (Bq)	Am-241 (dpm)
5/1/2003	124.10	7449.00	2.43	145.74	21.43	1285.80
5/1/2003	236.30	14358.00	4.20	252.00	23.55	1413.00
5/1/2003	119.40	7164.00	1.93	115.56	106.00	6360.00
4/1/2003	101.00	6060.00	1.26	75.84	34.50	2070.00
4/1/2003	203.00	12180.00	3.41	204.72	146.40	8784.00
4/1/2003	132.90	7974.00	3.17	189.96	121.30	7278.00
4/1/2003	107.10	6426.00	0.93	55.54	72.26	4335.80
5/1/2003	334.80	20088.00	6.55	393.18	53.02	3181.20

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

Analyst: ORTEC

Detector: 129

9:14:40AM 10/5/2016

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

Calibration

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

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

Source Info

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

Acquisition

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

Energy Calibration Equation:

Gain = 9.9003 keV / Ch

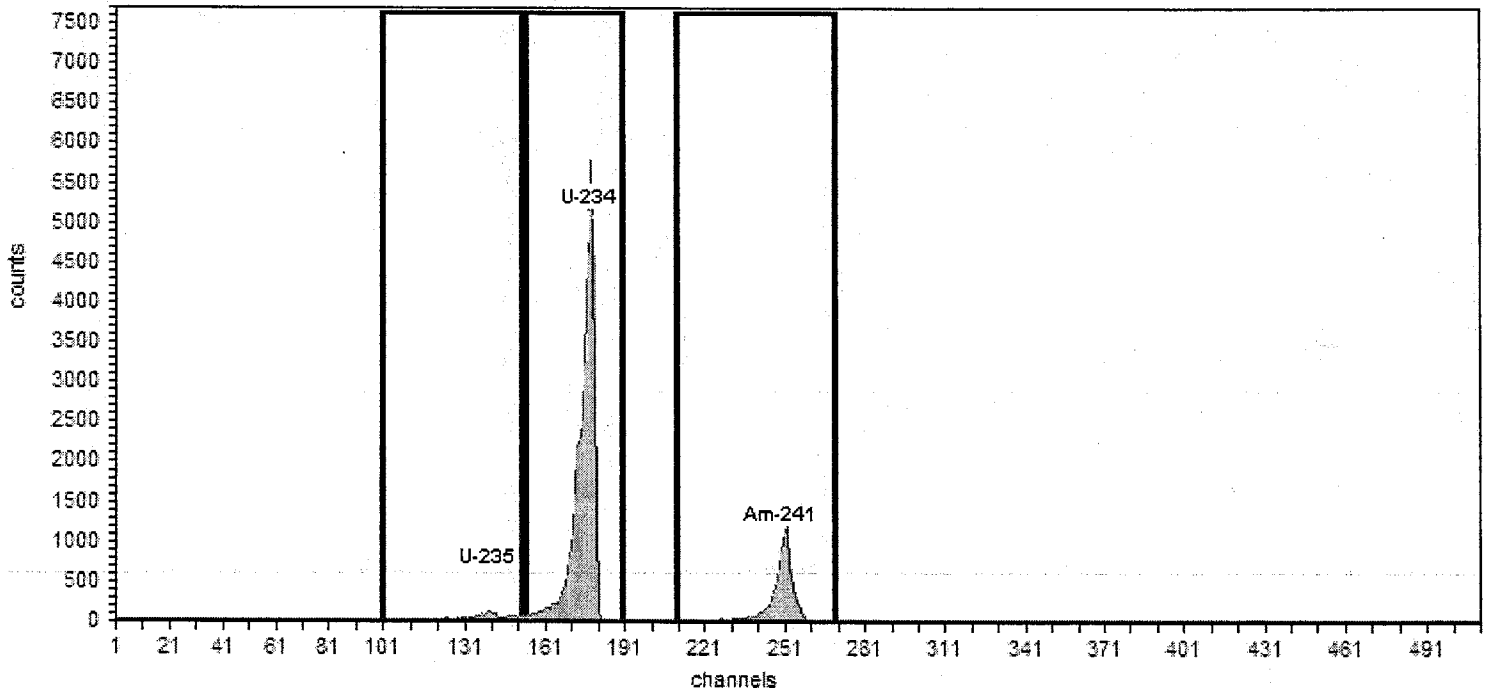
Offset = 3,021.28 keV

Quadratic = 0.0000 keV / Ch²

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

Efficiency Calibration Name: SOURCE190_10.04.16 (#9)

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

**General Analysis**

Method: Manual (ROI)

Initial Calibration: Yes

Algorithm: Linear

Shelf: 0

Nuclide Activity Summary

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

JP 10/4/16

Analyst: ORTEC

Detector: 129

12:49:08PM 10/4/2016

Energy Calibration: SOURCE182_10.04.16 (#1)

Description:

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

Certificate ID: A1 RSO#182

Prepared by: Isotope Product Laboratories

Description:

Source Info

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

Acquisition

Detector: 129, SN:5505430, ID: 129

Acquisition Start Date: 10/4/2016 12:11:42PM

Live Time: 35.00 min.

Real Time: 35.02 min.

Energy Calibration Equation:

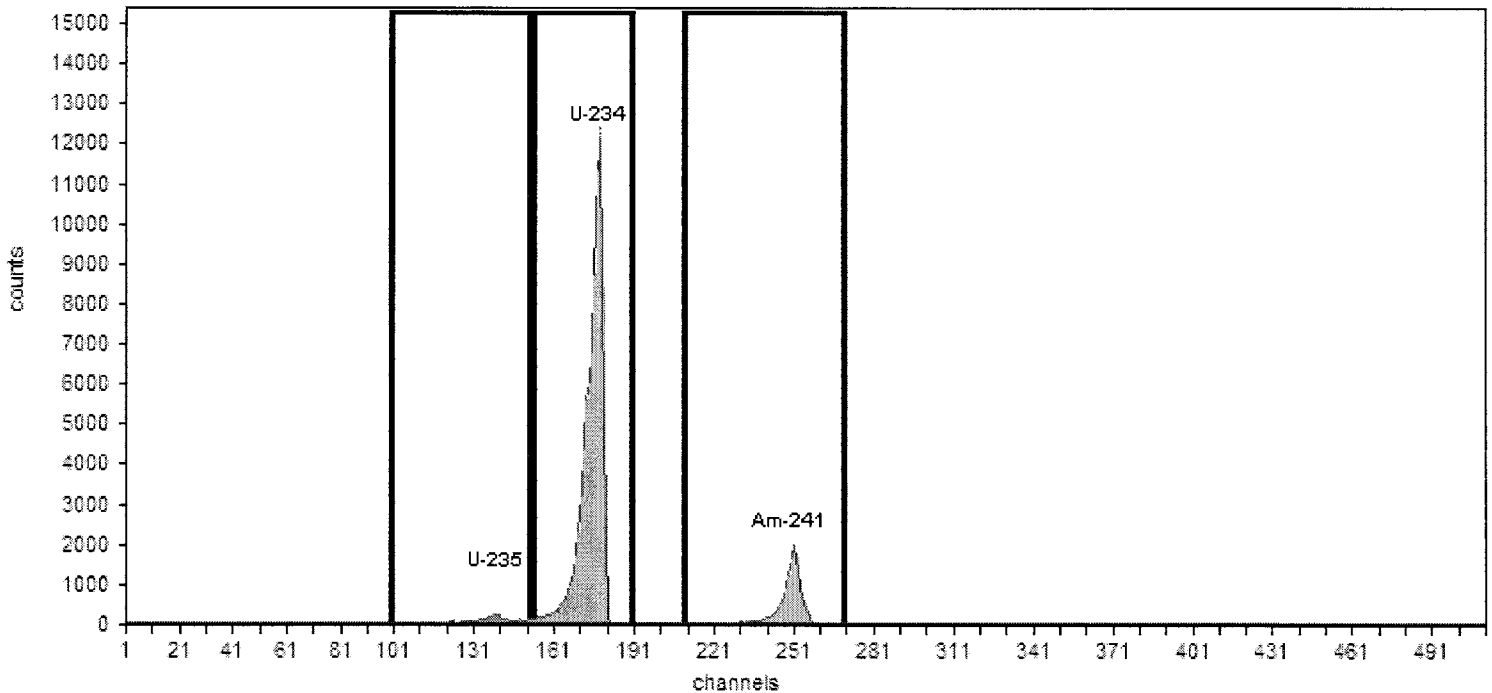
Gain = 9.9003 keV / Ch

Offset = 3,021.28 keV

Quadratic = 0.0000 keV / Ch²

Efficiency Calibration Name: SOURCE182_10.04.16 (#1)

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

**General Analysis**

Method: Manual (ROI)

Algorithm: Linear

Initial Calibration: Yes

Shelf: 0

Nuclide Activity Summary

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

JP 10/4/16

Analyst: ORTEC

Detector: 129

1:25:35PM 10/4/2016

Energy Calibration: SOURCE183_10.04.16 (#2)

Description:

Calibration

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

Certificate ID: A2 RSO#183

Prepared by: Isotope Product Laboratories

Description:

Source Info

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

Acquisition

Detector: 129, SN:5505430, ID: 129

Acquisition Start Date: 10/4/2016 12:49:04PM

Live Time: 35.00 min.

Real Time: 35.03 min.

Energy Calibration Equation:

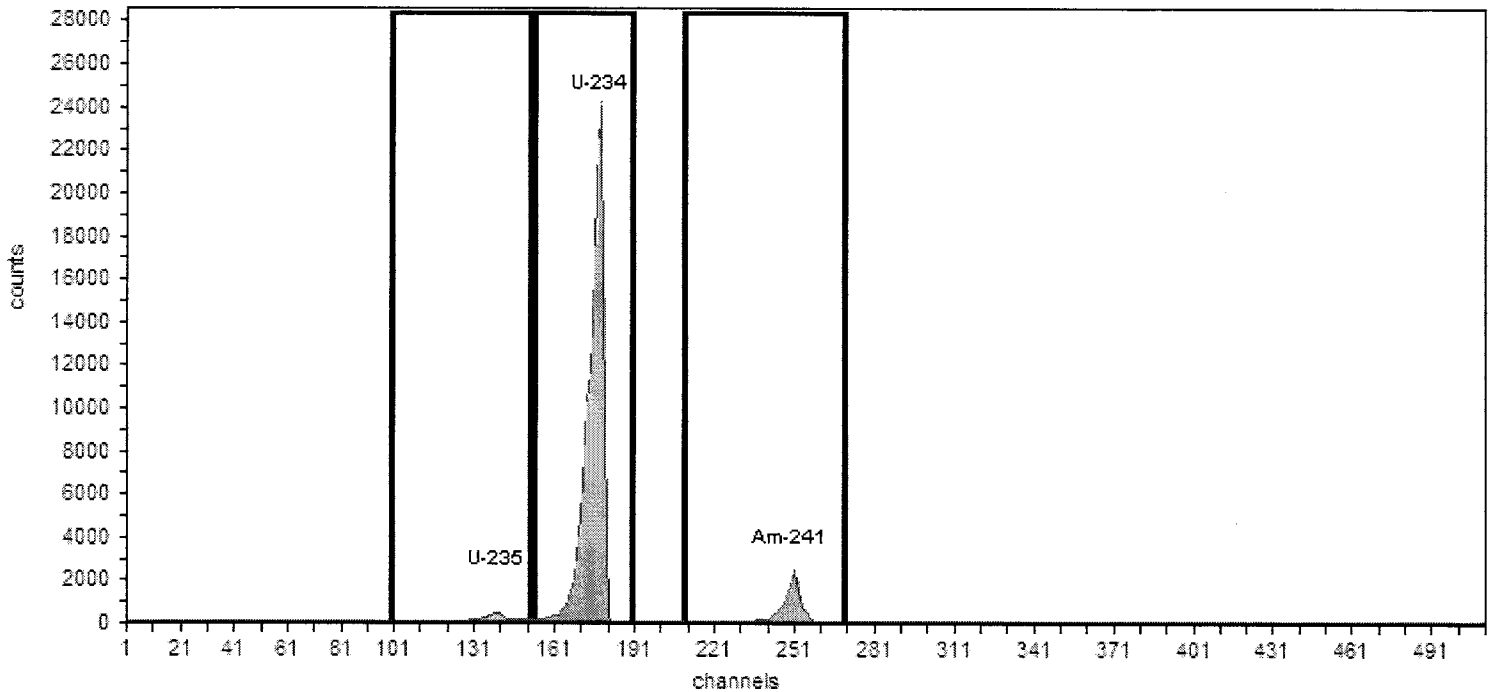
Gain = 9.9003 keV / Ch

Offset = 3,021.28 keV

Quadratic = 0.0000 keV / Ch²

Efficiency Calibration Name: SOURCE183_10.04.16 (#2)

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



General Analysis

Method: Manual (ROI)

Algorithm: Linear

Initial Calibration: Yes

Shelf: 0

Nuclide Activity Summary

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

JP 10/4/16

Analyst: ORTEC

Detector: 129

2:17:25PM 10/4/2016

Energy Calibration: SOURCE184_10.04.16 (#3)

Description:

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

Certificate ID: A3 RSO#184

Prepared by: Isotope Product Laboratories

Description:

Source Info

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

Acquisition

Detector: 129, SN:5505430, ID: 129

Acquisition Start Date: 10/4/2016 1:26:53PM

Live Time: 35.00 min.

Real Time: 35.03 min.

Energy Calibration Equation:

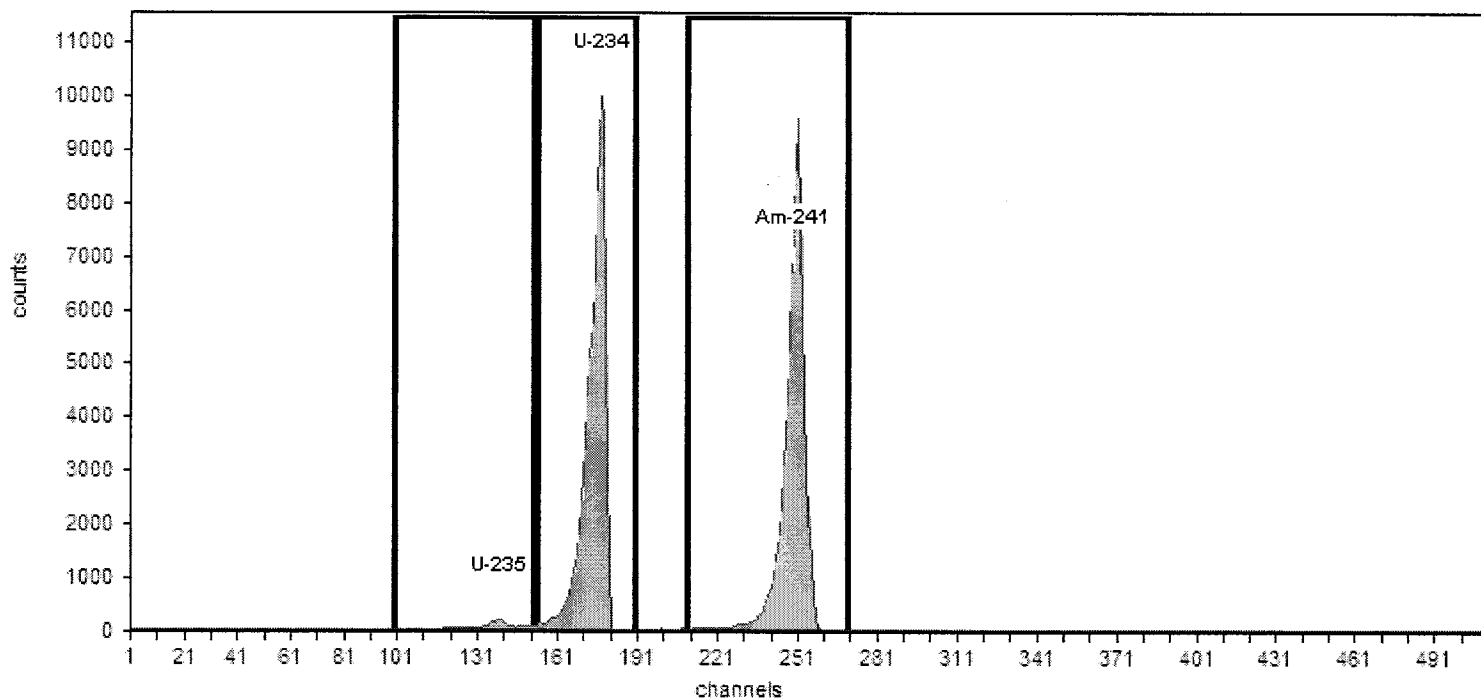
Gain = 9.9003 keV / Ch

Offset = 3,021.28 keV

Quadratic = 0.0000 keV / Ch²

Efficiency Calibration Name: SOURCE184_10.04.16 (#3)

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

**General Analysis**

Method: Manual (ROI)

Algorithm: Linear

Initial Calibration: Yes

Shelf: 0

Nuclide Activity Summary

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

JP 10/4/16

Analyst: ORTEC

Detector: 129

9:00:58AM 10/5/2016

Energy Calibration: SOURCE185_10.04.16 (#4)

Description:

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

Certificate ID: A4 RSO#185

Prepared by: Isotope Product Laboratories

Description:

Source Info

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

Acquisition

Detector: 129, SN:5505430, ID: 129

Acquisition Start Date: 10/4/2016 2:18:14PM

Live Time: 35.00 min.

Real Time: 35.02 min.

Energy Calibration Equation:

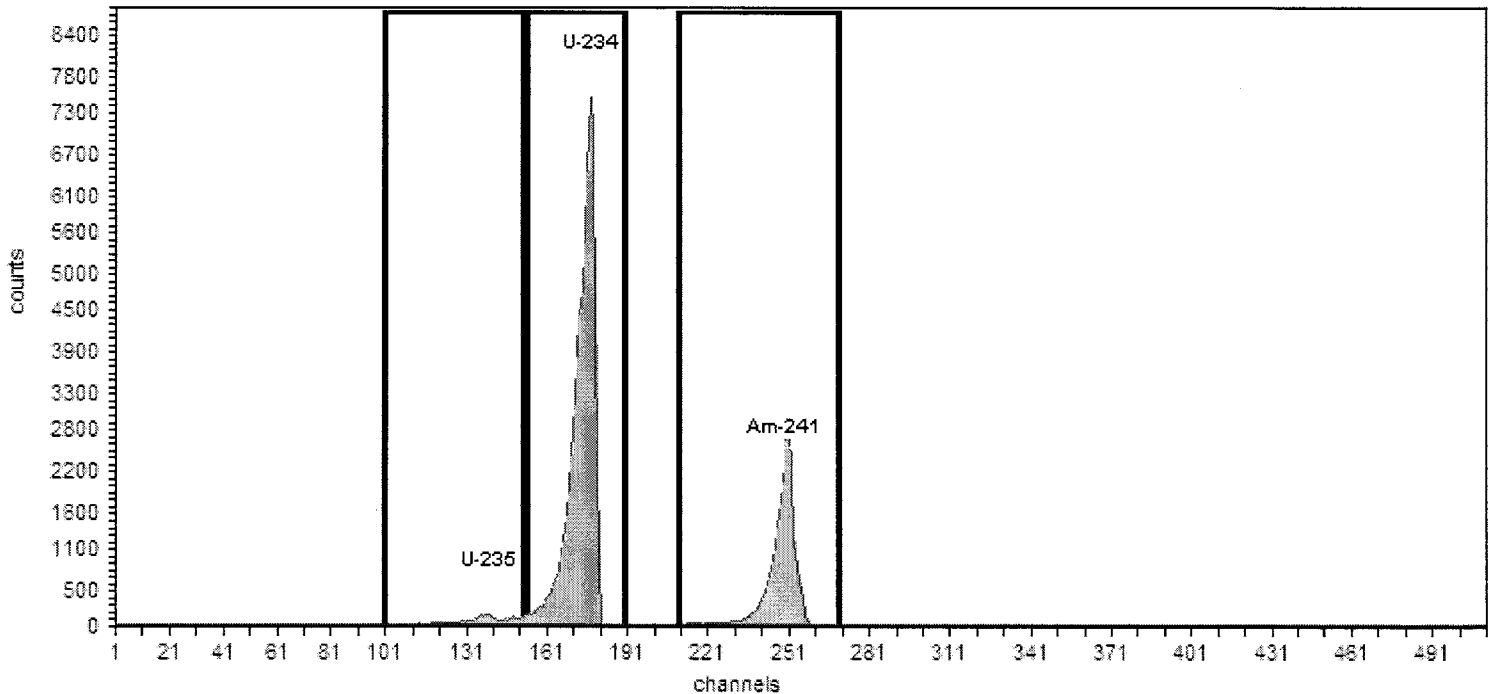
Gain = 9.9003 keV / Ch

Offset = 3,021.28 keV

Quadratic = 0.0000 keV / Ch²

Efficiency Calibration Name: SOURCE185_10.04.16 (#4)

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

**General Analysis**

Method: Manual (ROI)

Algorithm: Linear

Initial Calibration: Yes

Shelf: 0

Nuclide Activity Summary

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

JP 10/4/16

Analyst: ORTEC

Detector: 129

7:04:12AM 10/5/2016

Energy Calibration: SOURCE188_10.04.16 (#7)

Description:

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

Certificate ID: A7 RSO#188

Prepared by: Isotope Product Laboratories

Description:

Source Info

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

Acquisition

Detector: 129, SN:5505430, ID: 129

Acquisition Start Date: 10/5/2016 6:13:44AM

Live Time: 35.00 min.

Real Time: 35.02 min.

Energy Calibration Equation:

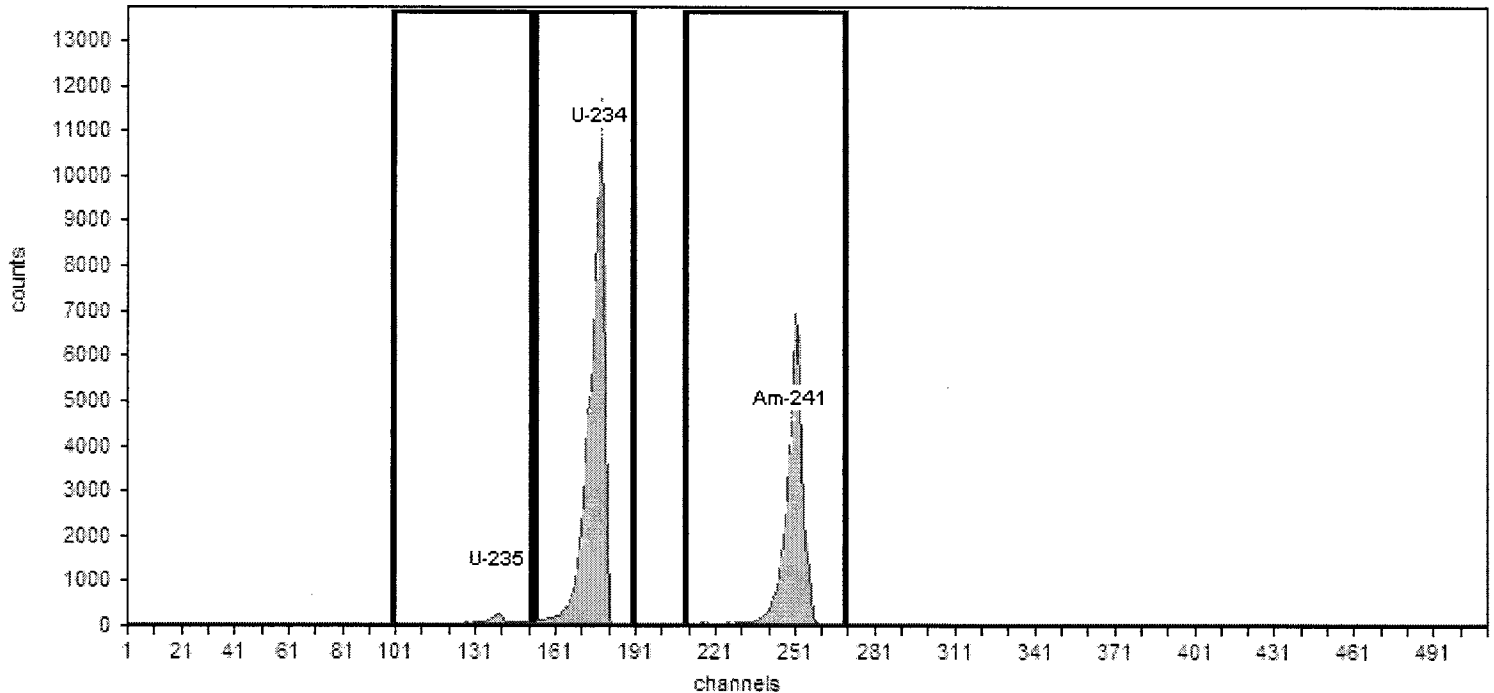
Gain = 9.9003 keV / Ch

Offset = 3,021.28 keV

Quadratic = 0.0000 keV / Ch²

Efficiency Calibration Name: SOURCE188_10.04.16 (#7)

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

**General Analysis**

Method: Manual (ROI)

Algorithm: Linear

Initial Calibration: Yes

Shelf: 0

Nuclide Activity Summary

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

Analyst: ORTEC

Detector: 129

7:44:05AM 10/5/2016

Energy Calibration: SOURCE189_10.04.16 (#8)

Description:

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

Certificate ID: A8 RSO#189

Prepared by: Isotope Product Laboratories

Description:

Source Info

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

Acquisition

Detector: 129, SN:5505430, ID: 129

Acquisition Start Date: 10/5/2016 7:04:08AM

Live Time: 35.00 min.

Real Time: 35.05 min.

Energy Calibration Equation:

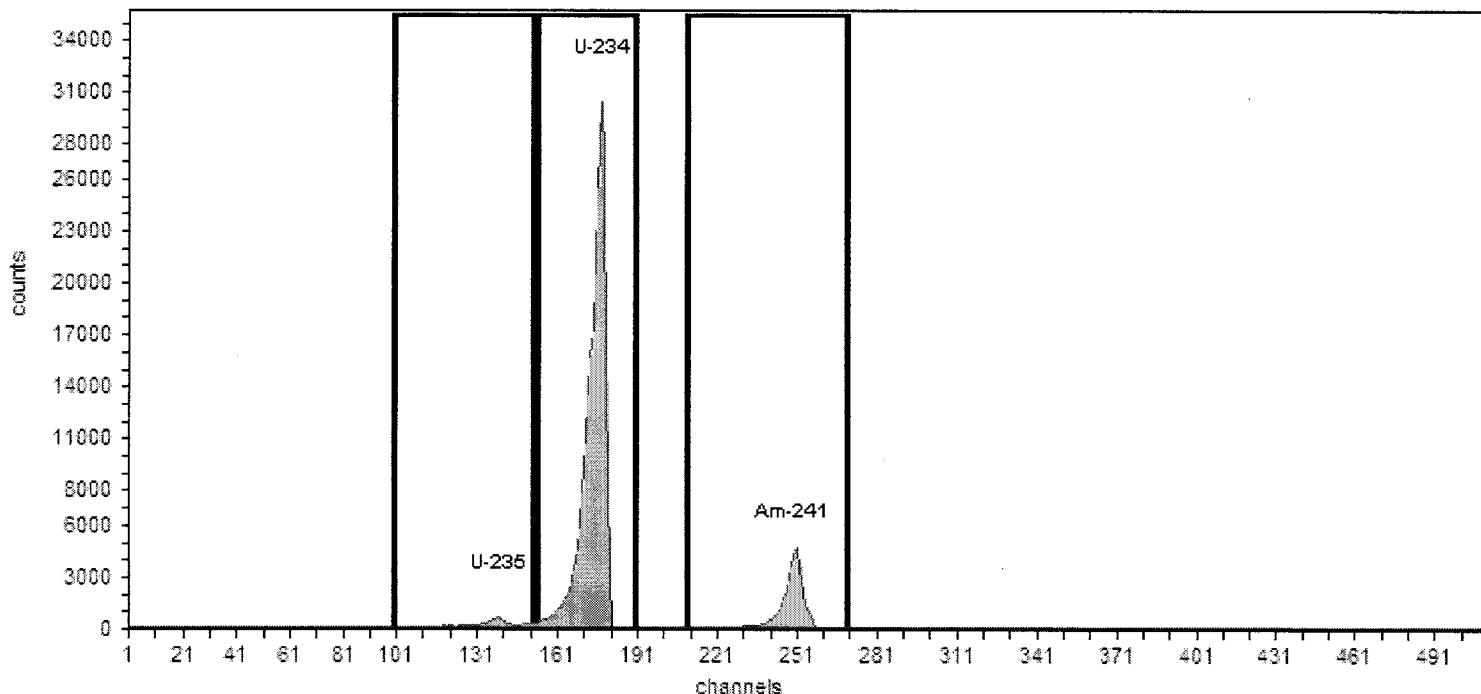
Gain = 9.9003 keV / Ch

Offset = 3,021.28 keV

Quadratic = 0.0000 keV / Ch²

Efficiency Calibration Name: SOURCE189_10.04.16 (#8)

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

**General Analysis**

Method: Manual (ROI)

Algorithm: Linear

Initial Calibration: Yes

Shelf: 0

Nuclide Activity Summary

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

Analyst: ORTEC

Detector: 129

8:36:03AM 10/5/2016

Energy Calibration: SOURCE190A_10.04.16 (#9)

Description:

Calibration

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

Calibration Type: Energy And Efficiency

Certificate ID: A9 RSO#190

Prepared by: Isotope Product Laboratories

Description:

Source Info

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

Acquisition

Detector: 129, SN:5505430, ID: 129

Acquisition Start Date: 10/5/2016 7:45:09AM

Live Time: 35.00 min.

Real Time: 35.01 min.

Energy Calibration Equation:

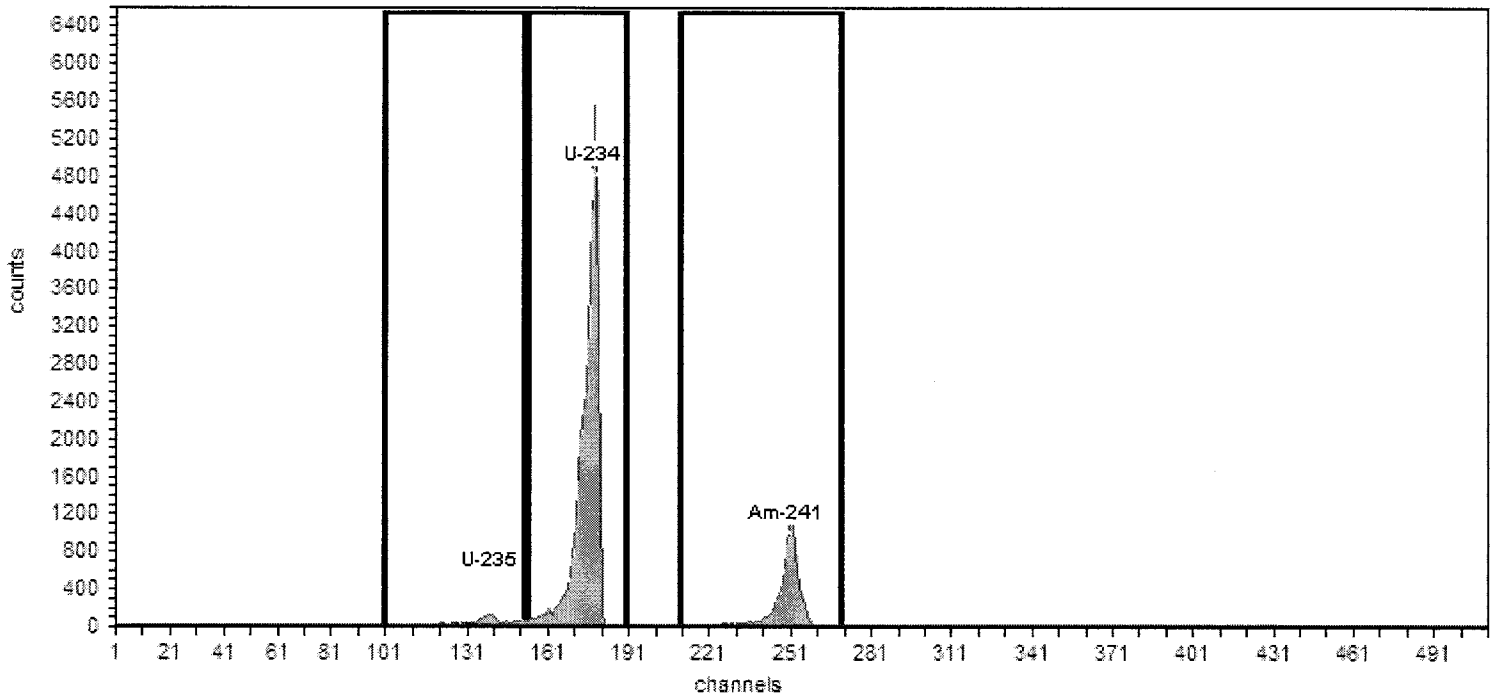
Gain = 9.9003 keV / Ch

Offset = 3,021.28 keV

Quadratic = 0.0000 keV / Ch²

Efficiency Calibration Name: SOURCE190A_10.04.16 (#9)

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

**General Analysis**

Method: Manual (ROI)

Algorithm: Linear

Initial Calibration: Yes

Shelf: 0

Nuclide Activity Summary

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



Eckert & Ziegler

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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.


Quality Control

2-OCT-13
Date

IPL Ref. No.: 987-28

ISO 9001 CERTIFIED

Medical Imaging Laboratory

24937 Avenue Tibbitts Valencia, California 91355

Industrial Gauging Laboratory

1800 North Keystone Street Burbank, California 91504



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Re Calibrated 10/4/16

New Exp Date 10/4/2017

PAI 1875
recalibrated 4-15-03

10/15/16

CERTIFICATE OF CALIBRATION MIXED ALPHA STANDARD SOURCE

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

Customer: PARAGON ANALYTICS, INC.
P.O. No.: EW040203/R2193
Catalog No.: MISC-STD
Reference Date: 1-May-03 12:00 PST
Source No.: 92MIX2203026

Contained Radioactivity:

U-234: 3.354 nCi (124.1 Bq)
U-235: 0.06566 nCi (2.429 Bq)

Am-241: 0.5793 nCi (21.43 Bq)
Total Activity: 3.999 nCi (148.0 Bq)

Physical description:

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

Radioimpurities:

Not determined

Method of Calibration:

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

Uncertainty of Measurement:

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

Notes:

- See reverse side for leak test(s) performed on this source.
- IPL participates in a NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials (As in NRC Regulatory Guide 4.15).
- Nuclear data was taken from "Table of Radioactive Isotopes", edited by Virginia Shirley, 1986.
- This source has a working life of 2 years.
- This source had a total alpha surface emission rate of 4483 α /min in 2 π on 11 Apr 03.

Daniel James Van Dalsem
Quality Control

15-Apr-03
Date Signed

IPL Ref. No.: 987-7

ISO 9001 CERTIFIED

Medical Imaging Laboratory
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Industrial Gauging Laboratory
1800 North Keystone Street Burbank, California 91504



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

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

PAI 183
Recalibrated 4-15-03

CERTIFICATE OF CALIBRATION MIXED ALPHA STANDARD SOURCE

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

Customer: PARAGON ANALYTICS, INC.
P.O. No.: EW040203/R2193
Catalog No.: MISC-STD
Reference Date: 1-May-03 12:00 PST
Source No.: 92MIX2203028

Contained Radioactivity:

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

Am-241: 0.6366 nCi (23.55 Bq)
Total Activity: 7.217 nCi (267.1 Bq)

Physical description:

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

Radiopurities:

Not determined

Method of Calibration:

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

Uncertainty of Measurement:

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

Notes:

- See reverse side for leak test(s) performed on this source.
- IPL participates in a NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials (As in NRC Regulatory Guide 4.15).
- Nuclear data was taken from "Table of Radioactive Isotopes", edited by Virginia Shirley, 1986.
- This source has a working life of 2 years.
- This source had a total alpha surface emission rate of 8091 α /min in 2π on 11 Apr 03.

Daniel James Van Dalsen
Quality Control

15-Apr-03
Date Signed

IPL Ref. No.: 987-7

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

CERTIFICATE OF CALIBRATION MIXED ALPHA STANDARD SOURCE

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

Customer: PARAGON ANALYTICS, INC.
P.O. No.: EW040203/R2193
Catalog No.: MISC-STD
Reference Date: 1-May-03 12:00 PST
Source No.: 92MIX2203024

Contained Radioactivity:

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

Am-241: 2.866 nCi (106.0 Bq)
Total Activity: 6.145 nCi (227.3 Bq)

Physical description:

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

Radioimpurities:

Not determined

Method of Calibration:

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

Uncertainty of Measurement:

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

Notes:

- See reverse side for leak test(s) performed on this source.
- IPL participates in a NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials (As in NRC Regulatory Guide 4.15).
- Nuclear data was taken from "Table of Radioactive Isotopes", edited by Virginia Shirley, 1986.
- This source has a working life of 2 years.
- This source had a total alpha surface emission rate of 6889 α/min in 2π on 11 Apr 03.

Daniel James Van Dalsem
Quality Control

15-Apr-03
Date Signed

IPL Ref. No.: 987-7

ISO 9001 CERTIFIED

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

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

CERTIFICATE OF CALIBRATION ALPHA STANDARD SOURCE

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

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

Contained Radioactivity:

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

Am-241: 0.9325 nCi (34.50 Bq)
Total Activity: 3.698 nCi (136.8 Bq)

Physical description:

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

Radioimpurities:

Not determined

Method of Calibration:

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

Uncertainty of Measurement:

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

Notes:

- See reverse side for leak test(s) performed on this source.
- IPL participates in a NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials (As in NRC Regulatory Guide 4.15).
- Nuclear data was taken from "Table of Radioactive Isotopes", edited by Virginia Shirley, 1986.
- This source has a working life of 2 years.
- This source had a total alpha surface emission rate of 4145 α /min in 2 π on 18 Mar 03.

Daniel James Van Dalsem
Quality Control

19-Mar-03
Date Signed

IPL Ref. No.: 987-2

ISO 9001 CERTIFIED

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Isotope Products
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Fax 661•257•8303

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

CERTIFICATE OF CALIBRATION ALPHA STANDARD SOURCE

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

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

Contained Radioactivity:

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

Physical description:

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

Radioimpurities:

Not determined

Method of Calibration:

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

Uncertainty of Measurement:

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

Notes:

- See reverse side for leak test(s) performed on this source.
- IPL participates in a NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials (As in NRC Regulatory Guide 4.15).
- Nuclear data was taken from "Table of Radioactive Isotopes", edited by Virginia Shirley, 1986.
- This source has a working life of 2 years.
- This source had a total alpha surface emission rate of 5463 α /min in 2π on 18 Mar 03.

Daniel James Van Dalsem
Quality Control

19-Mar-03
Date Signed

IPL Ref. No.: 987-2

ISO 9001 CERTIFIED

Medical Imaging Laboratory
24937 Avenue Tibbitts Valencia, California 91355

Industrial Gauging Laboratory
1800 North Keystone Street Burbank, California 91504



**Isotope Products
Laboratories**

An Eckert & Ziegler Company

24937 Avenue Tibbitts
Valencia, California 91355

Tel 661-309-1010

Fax 661-257-8303

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

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

CERTIFICATE OF CALIBRATION MIXED ALPHA STANDARD SOURCE

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

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

Contained Radioactivity:

U-234: 9.048 nCi (334.8 Bq)
U-235: 0.1771 nCi (6.553 Bq)

Am-241: 1.433 nCi (53.02 Bq)
Total Activity: 10.66 nCi (394.4 Bq)

Physical description:

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

Radioimpurities:

Not determined

Method of Calibration:

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

Uncertainty of Measurement:

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

Notes:

- See reverse side for leak test(s) performed on this source.
- IPL participates in a NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials (As in NRC Regulatory Guide 4.15).
- Nuclear data was taken from "Table of Radioactive Isotopes", edited by Virginia Shirley, 1986.
- This source has a working life of 2 years.
- This source had a total alpha surface emission rate of $11950 \alpha/\text{min}$ in 2π on 11 Apr 03.

Daniel James Van Dalsem
Quality Control

15-Apr-03
Date Signed

IPL Ref. No.: 987-7

Medical Imaging Laboratory
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