



facility 439136
project 10243

Lead-210 Case Narrative

COGCC

PW NORM 2017 – 10048

Work Order Number: 1705202

1. This report consists of the analytical results and supporting documentation for one water sample received by ALS on 05/09/2017.
2. This sample was prepared according to the current revision of SOP 726.
3. This sample was analyzed for the presence of ^{210}Pb according to the current revision of SOP 704. The analysis was completed on 05/17/2017.
4. Sample volume was insufficient to allow preparation of a duplicate. A laboratory control sample duplicate (LCSD) was prepared in lieu of a client sample duplicate.
5. The analysis results for this sample are reported in units of pCi/L. The sample was filtered prior to analysis.
6. The ICP-AES measurement of lead concentrations prior to chemical separation for sample 1705202-1 and method blank PB170510-1MB showed concentrations less than the amount known to have been added to the sample in the form of lead carrier. To avoid and minimize the potential low bias in the final analytical results for these samples, the known concentration of the carrier was used in the chemical yield calculations in lieu of the pre-separation measurement. The samples have a low bias of 15% or less in the pre-separation measurement and are identified with an 'LB' flag. The low bias in the pre-separation ICP measurement for the samples may be attributable to matrix interference. The reported TPU values for the affected samples may not reflect the additional uncertainty imparted in the pre-separation ICP measurement due to matrix effects. A low bias in this measurement for the batch method blank is attributed to the uncertainty associated with the determination of the carrier concentration in the initial ICP measurements. These qualifications can be found on the Radiochemistry ICP Worksheet, located in Section 5, "Raw Data" of this report.

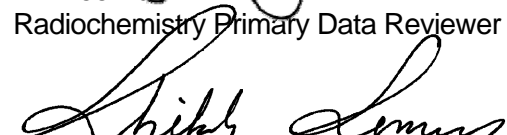


7. No further anomalous situations were encountered during the preparation and analysis of this sample. All remaining quality control criteria were met.

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


Pik Yee Yuen
Radiochemistry Primary Data Reviewer

5/25/17
Date


Radiochemistry Final Data Reviewer

5/25/17
Date

Section 1

CHAIN OF CUSTODY

ALS -- Fort Collins

Sample Number(s) Cross-Reference Table

OrderNum: 1705202

Client Name: COGCC

Client Project Name: PW NORM 2017

Client Project Number: 10048

Client PO Number: CT 2017-3066

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



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

Chain-of-Custody

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

ALS WORKORDER #

1705202

[illegible]



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

ALS WORKORDER #

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

TURNAROUND TIME		45 day		SAMPLER		Robert Yonney		PAGE		of	
SITE ID		C06CC		PURCHASE ORDER		CT 2017-3066		PARAMETER/METHOD REQUEST FOR ANALYSIS		DISPOSAL	
EDD FORMAT		C06CC		BILL TO COMPANY		INVOICE ATTN TO		ADDRESS		CITY / STATE / ZIP	
PHONE		719 679 1326		FAX		E-MAIL		CITY / STATE / ZIP		PHONE	
COMPANY NAME		C06CC		SEND REPORT TO		ADDRESS		CITY / STATE / ZIP		PHONE	
PROJECT NAME		PW N0RM 2017		PROJECT No.		10048		COMPANY NAME		C06CC	
LAB ID		439136		FIELD ID		439136		MATRIX		W	
SAMPLE DATE		5/9/17		SAMPLE TIME		1250		# OF BOTTLES		3	
PRESERVATIVE		2		QC		X		A		X	
B		X		C		X		D		X	
E		X		F		X		G		X	
H		X		I		X		J		X	
K		X		L		X		M		X	
N		X		O		X		P		X	
Q		X		R		X		S		X	
T		X		U		X		V		X	
W		X		X		X		X		X	
X		X		X		X		X		X	
Y		X		X		X		X		X	
Z		X		X		X		X		X	
AA		X		X		X		X		X	
AB		X		X		X		X		X	
AC		X		X		X		X		X	
AD		X		X		X		X		X	
AE		X		X		X		X		X	
AF		X		X		X		X		X	
AG		X		X		X		X		X	
AH		X		X		X		X		X	
AI		X		X		X		X		X	
AJ		X		X		X		X		X	
AK		X		X		X		X		X	
AL		X		X		X		X		X	
AM		X		X		X		X		X	
AN		X		X		X		X		X	
AO		X		X		X		X		X	
AP		X		X		X		X		X	
AQ		X		X		X		X		X	
AR		X		X		X		X		X	
AS		X		X		X		X		X	
AT		X		X		X		X		X	
AU		X		X		X		X		X	
AV		X		X		X		X		X	
AW		X		X		X		X		X	
AX		X		X		X		X		X	
AY		X		X		X		X		X	
AZ		X		X		X		X		X	
BA		X		X		X		X		X	
BB		X		X		X		X		X	
BC		X		X		X		X		X	
BD		X		X		X		X		X	
BE		X		X		X		X		X	
BF		X		X		X		X		X	
BG		X		X		X		X		X	
BH		X		X		X		X		X	
BI		X		X		X		X		X	
BJ		X		X		X		X		X	
BK		X		X		X		X		X	
BL		X		X		X		X		X	
BM		X		X		X					



ALS Environmental - Fort Collins
CONDITION OF SAMPLE UPON RECEIPT FORM

Client: COGCC
Project Manager: SS

Workorder No: 1705202
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		<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 µR/hr reading: <u>NA</u> <u>NA</u>			
Background µR/hr reading: <u>NA</u>			
Were external µR/hr readings ≤ two times background and within DOT acceptance criteria? YES / NO / <u>NA</u> (If no, see Form 008.)			

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

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

Lead-210 by Liquid Scintillation Sample Results Summary

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

Page: 1 of 1
Reported on: Tuesday, May 23, 2017
10:20:09 AM

Lab Sample ID	Client Sample ID	Sample Type	Nuclide	Result +/- 2 s TPU	MDC	DL	Units	Matrix	Prep Batch	Date Analyze	Flags
1705202-1	439136	Sample	Pb-210	-4E-02 +/- 5.1E-01	8.7E-01	NA	pCi/l	WATER	PB170510-1	5/16/2017	U

Comments:

Data Package ID: PB1705202-1

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



Lead-210 by Liquid Scintillation

PAI 704 Rev 11

Method Blank Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1705202

Client Name: COGCC

ClientProject ID: PW NORM 2017 10048

Lab ID: PB170510-1MB

Sample Matrix: WATER

Prep SOP: PAI 726 Rev 9

Date Collected: 10-May-17

Date Prepared: 10-May-17

Date Analyzed: 16-May-17

Prep Batch: PB170510-1

QCBatchID: PB170510-1-2

Run ID: PB170510-1A

Count Time: 117.966 minutes

Final Aliquot: 833 ml

Result Units: pCi/l

File Name: Q191901N.001

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14255-04-0	Pb-210	-1.4E-01 +/- 3.6E-01	6.1E-01	1E+00	NA	U

Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
LEAD	8.360E+02	8.060E+02	ug	96.4	40 - 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: PB1705202-1

Lead-210 by Liquid Scintillation

PAI 704 Rev 11

Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1705202

Client Name: COGCC

ClientProject ID: PW NORM 2017 10048

Lab ID: PB170510-1LCS

Sample Matrix: WATER

Prep SOP: PAI 726 Rev 9

Date Collected: 10-May-17

Date Prepared: 10-May-17

Date Analyzed: 16-May-17

Prep Batch: PB170510-1

QCBatchID: PB170510-1-2

Run ID: PB170510-1A

Count Time: 29.1128 minutes

Final Aliquot: 833 ml

Result Units: pCi/l

File Name: Q202001N.001

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
14255-04-0	Pb-210	4.1E+01 +/- 1E+01	1E+00	4.290E+01	95.8	75 - 125	P,M3

Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
LEAD	8.780E+02	8.350E+02	ug	95.1	40 - 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: PB1705202-1

Lead-210 by Liquid Scintillation

PAI 704 Rev 11

Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1705202

Client Name: COGCC

ClientProject ID: PW NORM 2017 10048

Lab ID: PB170510-1LCSD

Sample Matrix: WATER

Prep SOP: PAI 726 Rev 9

Date Collected: 10-May-17

Date Prepared: 10-May-17

Date Analyzed: 17-May-17

Prep Batch: PB170510-1

QCBatchID: PB170510-1-2

Run ID: PB170510-1A

Count Time: 29.1128 minutes

Final Aliquot: 833 ml

Result Units: pCi/l

File Name: Q214101N.001

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
14255-04-0	Pb-210	4.2E+01 +/- 1E+01	1E+00	4.290E+01	97.4	75 - 125	P,M3

Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
LEAD	8.450E+02	7.660E+02	ug	90.7	40 - 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: PB1705202-1

Lead-210 by Liquid Scintillation

PAI 704 Rev 11

Duplicate Sample Results (DER)

Lab Name: ALS -- Fort Collins

Work Order Number: 1705202

Client Name: COGCC

ClientProject ID: PW NORM 2017 10048

Field ID:
Lab ID: PB170510-1LCSD

Sample Matrix: WATER

Prep SOP: PAI 726 Rev 9

Date Collected: 10-May-17

Date Prepared: 10-May-17

Date Analyzed: 17-May-17

Prep Batch: PB170510-1

QCBatchID: PB170510-1-2

Run ID: PB170510-1A

Count Time: 29.1128 minutes

Final Aliquot: 833 ml

Prep Basis: Unfiltered

Moisture(%): NA

Result Units: pCi/l

File Name: Q214101N.001

CASNO	Analyte	Sample				Duplicate				DER	DER Lim
		Result +/-	2 s TPU	MDC	Flags	Result +/-	2 s TPU	MDC	Flags		
14255-04-0	Pb-210	4.1E+01 +/-	1E+01	1E+00	P,M3	4.2E+01 +/-	1E+01	1E+00	P,M3	0.0489	2.13

Comments:

Duplicate 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

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

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

Abbreviations:

TPU - Total Propagated Uncertainty

DER - Duplicate Error Ratio

BDL - Below Detection Limit

NR - Not Reported

Data Package ID: PB1705202-1

Date Printed: Tuesday, May 23, 2017

ALS -- Fort Collins

LIMS Version: 6.842

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Section 4

INDIVIDUAL SAMPLE RESULTS



Lead-210 by Liquid Scintillation

PAI 704 Rev 11

Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1705202

Client Name: COGCC

ClientProject ID: PW NORM 2017 10048

Field ID: 439136

Lab ID: 1705202-1

Sample Matrix: WATER

Prep SOP: PAI 726 Rev 9

Date Collected: 09-May-17

Date Prepared: 10-May-17

Date Analyzed: 16-May-17

Prep Batch: PB170510-1

QCBatchID: PB170510-1-2

Run ID: PB170510-1A

Count Time: 117.964 minutes

Report Basis: Filtered

Final Aliquot: 833 ml

Prep Basis: Filtered

Moisture(%): NA

Result Units: pCi/l

File Name: Q171701N.001

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14255-04-0	Pb-210	-4E-02 +/- 5.1E-01	8.7E-01	1E+00	NA	U

Chemical Yield Summary

Carrier/Tracer	Amount Added	Result	Units	Yield	Control Limits	Flag
LEAD	8.360E+02	5.700E+02	ug	68.2	40 - 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: PB1705202-1

Section 5

RAW DATA

5

Lead-210 by Liquid Scintillation Raw Data Report

Laboratory Name: ALS -- Fort Collins

Prep SOP: PAI 726

Reported on: Friday, May 19, 2017

PAI Work Order: 1705202

Analytical SOP: PAI 704

10:26:24 AM

Sample ID QC Type	Nuclide Type	Sample Date/Time	Prep Batch QC Batch ID	Ingrowth Date /Time	Quench Factor %Lum	Matrix %Moist.	Samp Aliq Analy Aliq	Inst ID Det ID	AnRunID File Name	Count Date/Time	GrossCPM BkgCPM	BaseEff ProgEff	CntDur(min) Yield	Activity +/- 2 s TPU	MDC DeclEv	ReportUnits ReportBasis	DER RPD	%Spk. Recov Flags
1705202-1	Pb-210 Trg. Analyte	5/9/2017 12:50:00 PM	PB170510-1 PB170510-1-2	5/12/2017 10:40:00 AM	782.08 0	WATER NA	1000 ml 833 ml	Q1220 1-17	PB170510-1A Q171701N001	5/16/2017 5:33 PM	3.550 3.587	76.44% NA	117.964 68.2%	-4E-02 5.1E-01	8.7E-01	pCi/l Filtered	NA NA	U
PB170510-1	Pb-210 Trg. Analyte	5/10/2017 2:23:03 PM	PB170510-1 PB170510-1-2	5/12/2017 10:40:00 AM	788.13 0	WATER NA	1000 ml 833 ml	Q1220 1-19	PB170510-1A Q191901N001	5/16/2017 9:36 PM	3.400 3.587	76.44% NA	117.966 96.4%	-1.4E-01 3.6E-01	6.1E-01	pCi/l Unfiltered	NA NA	U
PB170510-1	Pb-210 Trg. Analyte	5/10/2017 2:23:03 PM	PB170510-1 PB170510-1-2	5/12/2017 10:40:00 AM	773.54 0.0510638	WATER NA	1000 ml 833 ml	Q1220 1-20	PB170510-1A Q202001N001	5/16/2017 11:37 PM	58.720 3.587	76.44% NA	29.1128 95.1%	4.1E+01 1E+01	1E+00	pCi/l Unfiltered	NA NA	95.8 P,M3
PB170510-1	Pb-210 Trg. Analyte	5/10/2017 2:23:03 PM	PB170510-1 PB170510-1-2	5/12/2017 10:40:00 AM	774.99 0	WATER NA	1000 ml 833 ml	Q1220 1-41	PB170510-1A Q214101N001	5/17/2017 12:10 AM	57.070 3.587	76.44% NA	29.1128 90.7%	4.2E+01 1E+01	1E+00	pCi/l Unfiltered	0.05 NA	97.4 P,M3

Comments:

Data Package ID: PB1705202-1

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

Date Printed: Tuesday, May 23, 2017

ALS -- Fort Collins

LIMS Version: 6.842

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LabID:	WIN 1 (190 - 325)					WIN 2 (800 - 1024)						
	Count Rate Spectrum 11	Count Rate Spectrum 12	Lumex Corrected	Lumex (%)	Lumex Check	Count Rate Spectrum 11	Count Rate Spectrum 12	Lumex Corrected	Lumex (%)	Lower Control Limit	Upper Control Limit	Win 2 Check
PB170510-1CB1	.00	3.88	3.88	0.00	OK	.00	.70	0.7	0.00	NA	NA	NA
PB170510-1CB2	.00	3.66	3.66	0.00	OK	.00	.69	0.69	0.00	NA	NA	NA
PB170510-1CB3	.00	3.22	3.22	0.00	OK	.00	.74	0.74	0.00	NA	NA	NA
1704378-1	.00	4.32	4.32	0.00	OK	.00	.76	0.76	0.00	0.477750	0.942250	OK
1704412-1	.00	3.57	3.57	0.00	OK	.00	.63	0.63	0.00	0.477750	0.942250	OK
1704412-3	.00	3.48	3.48	0.00	OK	.00	.64	0.64	0.00	0.477749	0.942251	OK
1704412-6	.05	3.32	3.27	1.51	OK	.00	.66	0.66	0.00	0.477750	0.942250	OK
1704417-1	.00	3.64	3.64	0.00	OK	.00	.82	0.82	0.00	0.477752	0.942248	OK
1704449-3	.00	3.46	3.46	0.00	OK	.00	.82	0.82	0.00	0.477752	0.942248	OK
1704449-4	.00	3.58	3.58	0.00	OK	.00	.69	0.69	0.00	0.477752	0.942248	OK
1705055-1	.00	3.60	3.6	0.00	OK	.00	.71	0.71	0.00	0.477752	0.942248	OK
1705055-4	.00	3.56	3.56	0.00	OK	.00	.75	0.75	0.00	0.477752	0.942248	OK
1705086-1	.00	3.51	3.51	0.00	OK	.00	.64	0.64	0.00	0.477751	0.942249	OK
1705086-4	.00	3.32	3.32	0.00	OK	.00	.66	0.66	0.00	0.477750	0.942250	OK
1705095-1	.00	7.39	7.39	0.00	OK	.00	.80	0.8	0.00	0.477750	0.942250	OK
1705177-2	.00	3.42	3.42	0.00	OK	.00	.83	0.83	0.00	0.477749	0.942251	OK
1705177-3	.00	3.73	3.73	0.00	OK	.00	.79	0.79	0.00	0.477258	0.942742	OK
1705202-1	.00	3.55	3.55	0.00	OK	.00	.84	0.84	0.00	0.477258	0.942742	OK
1705203-1	.00	5.24	5.24	0.00	OK	.00	.70	0.7	0.00	0.477259	0.942741	OK
PB170510-1MB	.00	3.40	3.4	0.00	OK	.00	.81	0.81	0.00	0.477259	0.942741	OK
PB170510-1LCS	.03	58.75	58.72	0.05	OK	.00	.91	0.91	0.00	0.241502	1.17850	OK
PB170510-1LCSD	.00	57.07	57.07	0.00	OK	.00	.67	0.67	0.00	0.241501	1.17850	OK

Lumex LCL = 0.00
Lumex UCL = 10.00

The gross count rates and count times used for the final activity calculations and the lumex correction sheet are different than the values shown on the raw data output. These values come from two software programs which round the sample counts differently. The difference between these two values is believed to be insignificant. Window 2 control limits are established using the average count rate from the three reagent blanks +/- 3X the estimated Poisson uncertainty.

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Spectrum report

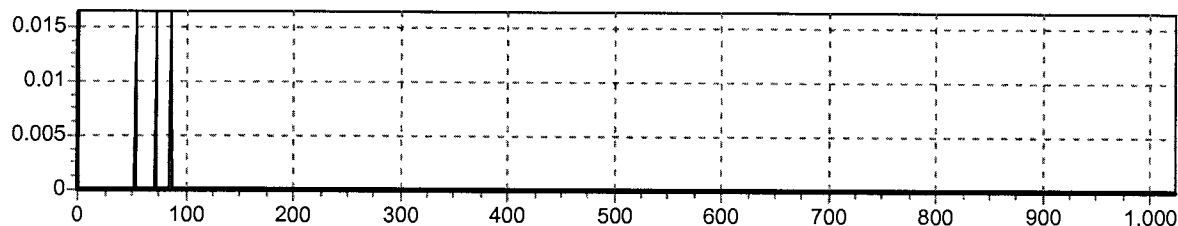
5/17/17 6:56:31 AM

Setup information
C:\Program Files\wallac\easy view\PB-210.wss

Window 1 = 190..325 190..325, MCA 11 mode CPM
volume 10 ml
Window 2 = 800..1024 800..1024, MCA 11 mode CPM
volume 10 ml
Window 3 = 190..325 190..325, MCA 12 mode CPM
volume 10 ml
Window 4 = 800..1024 800..1024, MCA 12 mode CPM
volume 10 ml

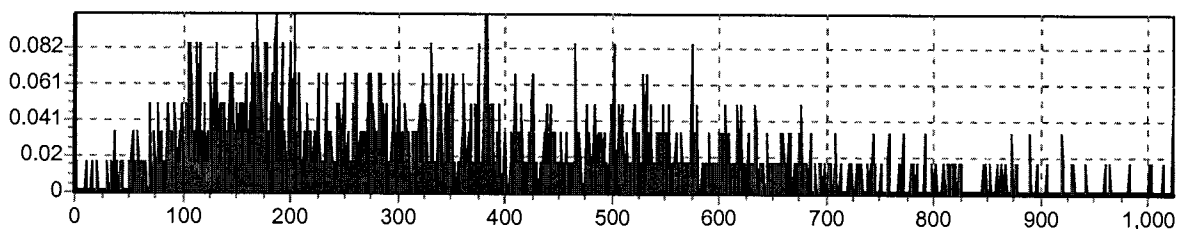
file :C:\Pb-210\ PB-0516\
Q010101N.001
spectrum :11
counting time :3555.80 s
SQP(E) :780.24 ✓
counting :5/15/17 11:54:00 AM
sampling :5/15/17 11:54:00 AM
ID: PB170510-1CB1

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325	0.000	0.000				0.000		
800..1024	0.000	0.000				0.000		
190..325								
800..1024								



file :C:\Pb-210\ PB-0516\
Q010101N.001
spectrum :12
counting time :3555.80 s
SQP(E) :780.24 ✓
counting :5/15/17 11:54:00 AM
sampling :5/15/17 11:54:00 AM
ID: PB170510-1CB1

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325								
800..1024								
190..325	3.881	0.256				0.000		
800..1024	0.709	0.109				0.000		



file :C:\Pb-210\ PB-0516\
Q020201N.001
spectrum :11
counting time :7109.86 s
SQP(E) :778.28 ✓
counting :5/15/17 1:56:00 PM
sampling :5/15/17 1:56:00 PM
ID: 1704378-1

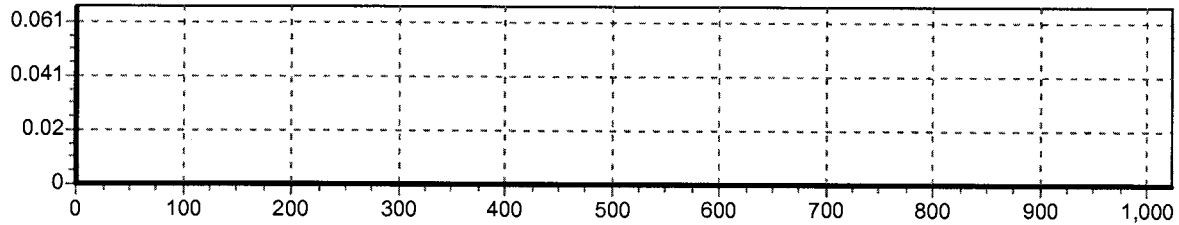
	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325	0.000	0.000				0.000		
800..1024	0.000	0.000				0.000		
190..325								
800..1024								

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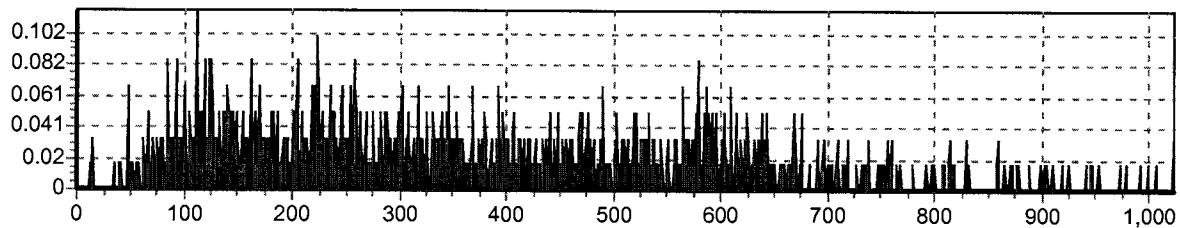
file :C:\Pb-210\ PB-0516\
 Q111101N.001
 spectrum :11
 counting time :3555.83 s
 SQP(E) :779.06✓
 counting :5/16/17 7:20:00 AM
 sampling :5/16/17 7:20:00 AM
 ID: PB170510-1CB2

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325	0.000	0.000				0.000		
800..1024	0.000	0.000				0.000		
190..325								
800..1024								



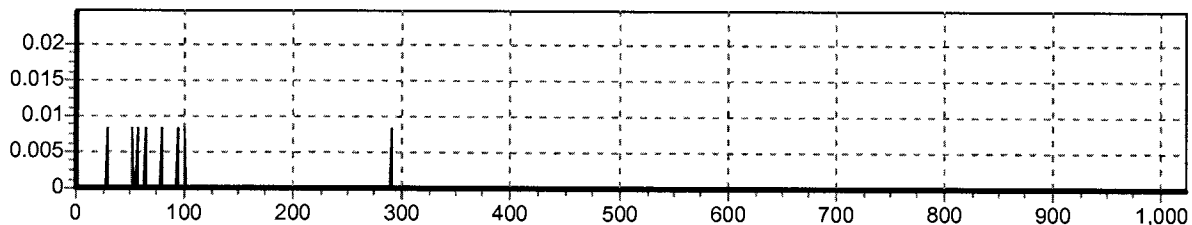
file :C:\Pb-210\ PB-0516\
 Q111101N.001
 spectrum :12
 counting time :3555.83 s
 SQP(E) :779.06✓
 counting :5/16/17 7:20:00 AM
 sampling :5/16/17 7:20:00 AM
 ID: PB170510-1CB2

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325								
800..1024								
190..325	3.662	0.249				0.000		
800..1024	0.692	0.108				0.000		



file :C:\Pb-210\ PB-0516\
 Q121201N.001
 spectrum :11
 counting time :7109.94 s
 SQP(E) :781.46 ✓
 counting :5/16/17 9:22:00 AM
 sampling :5/16/17 9:22:00 AM
 ID: 1705086-1

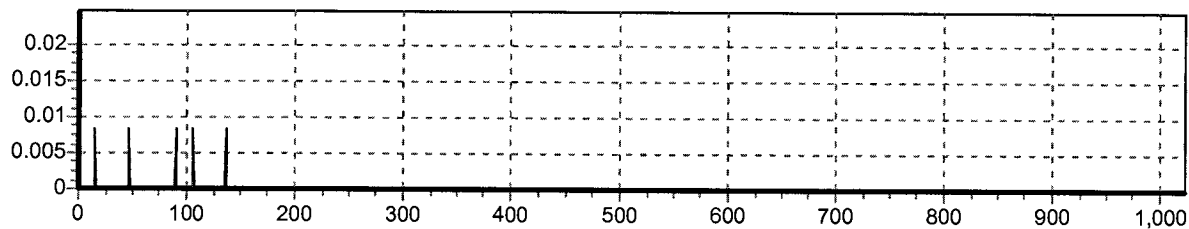
	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325	0.008	0.008				0.000		
800..1024	0.000	0.000				0.000		
190..325								
800..1024								



file :C:\Pb-210\ PB-0516\
 Q121201N.001
 spectrum :12
 counting time :7109.94 s
 SQP(E) :781.46 ✓
 counting :5/16/17 9:22:00 AM
 sampling :5/16/17 9:22:00 AM
 ID: 1705086-1

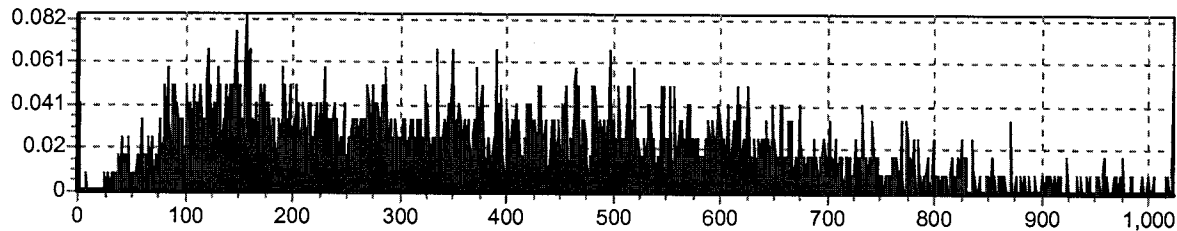
	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325								
800..1024								
190..325	3.519	0.172				0.000		
800..1024	0.641	0.074				0.000		

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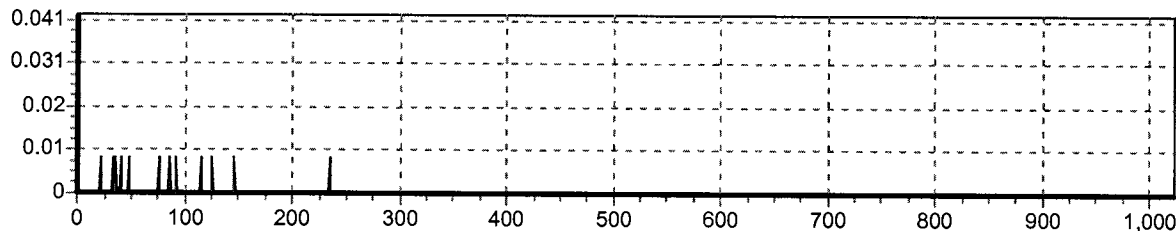
file :C:\Pb-210\ PB-0516\
Q161601N.001
spectrum :12
counting time :7109.85 s
SQP(E) :779.20 ✓
counting :5/16/17 5:32:00 PM
sampling :5/16/17 5:32:00 PM
ID: 1705177-3

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325								
800..1024								
190..325	3.730	0.177				0.000		
800..1024	0.793	0.082				0.000		



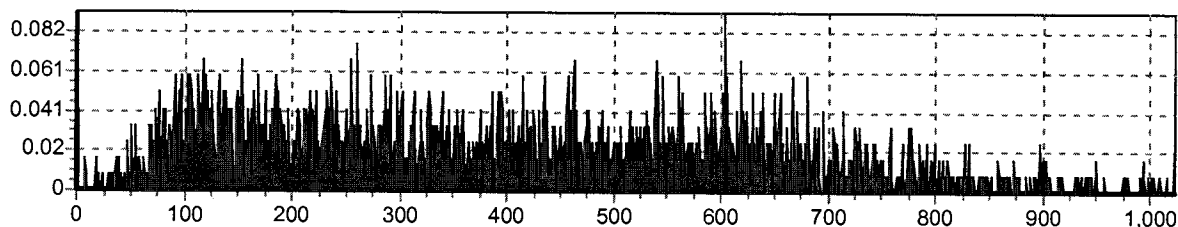
file :C:\Pb-210\ PB-0516\
Q171701N.001
spectrum :11
counting time :7109.87 s
SQP(E) :782.08 ✓
counting :5/16/17 7:34:00 PM
sampling :5/16/17 7:34:00 PM
ID: 1705202-1

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325	0.008	0.008				0.000		
800..1024	0.000	0.000				0.000		
190..325								
800..1024								



file :C:\Pb-210\ PB-0516\
Q171701N.001
spectrum :12
counting time :7109.87 s
SQP(E) :782.08 ✓
counting :5/16/17 7:34:00 PM
sampling :5/16/17 7:34:00 PM
ID: 1705202-1

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325								
800..1024								
190..325	3.553	0.173				0.000		
800..1024	0.844	0.084				0.000		

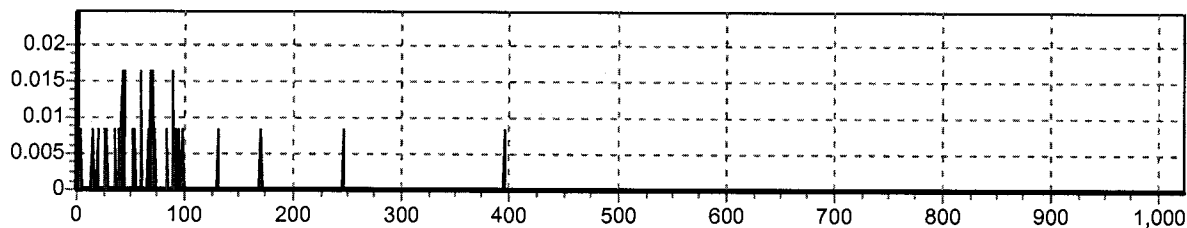


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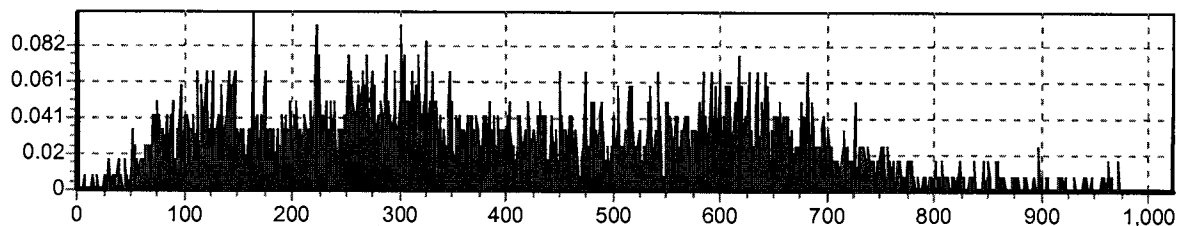
file :C:\Pb-210\ PB-0516\
 Q181801N.001
 spectrum :11
 counting time :7109.92 s
 SQP(E) :784.50✓
 counting :5/16/17 9:35:00 PM
 sampling :5/16/17 9:35:00 PM
 ID: 1705203-1

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325	0.008	0.008				0.000		
800..1024	0.000	0.000				0.000		
190..325								
800..1024								



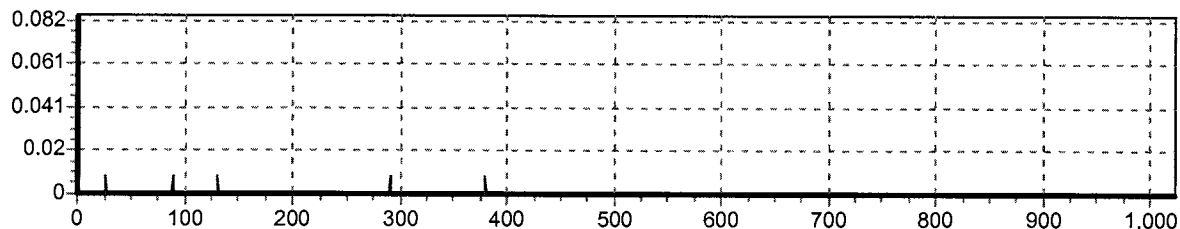
file :C:\Pb-210\ PB-0516\
 Q181801N.001
 spectrum :12
 counting time :7109.92 s
 SQP(E) :784.50✓
 counting :5/16/17 9:35:00 PM
 sampling :5/16/17 9:35:00 PM
 ID: 1705203-1

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325								
800..1024								
190..325	5.249	0.210				0.000		
800..1024	0.709	0.077				0.000		



file :C:\Pb-210\ PB-0516\
 Q191901N.001
 spectrum :11
 counting time :7109.95 s
 SQP(E) :788.13✓
 counting :5/16/17 11:37:00 PM
 sampling :5/16/17 11:37:00 PM
 ID: PB170510-1MB

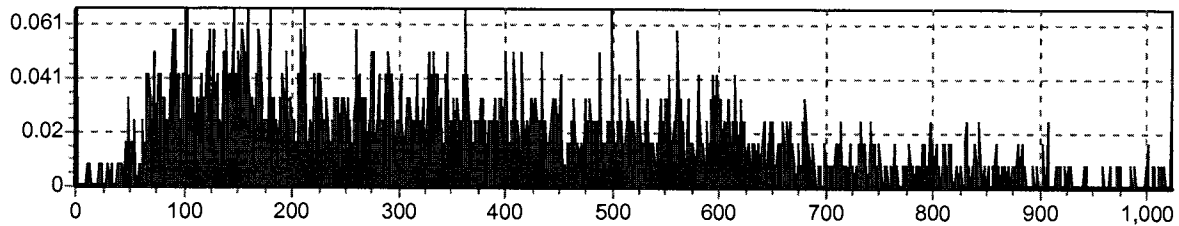
	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325	0.008	0.008				0.000		
800..1024	0.000	0.000				0.000		
190..325								
800..1024								



file :C:\Pb-210\ PB-0516\
 Q191901N.001
 spectrum :12
 counting time :7109.95 s
 SQP(E) :788.13✓
 counting :5/16/17 11:37:00 PM
 sampling :5/16/17 11:37:00 PM
 ID: PB170510-1MB

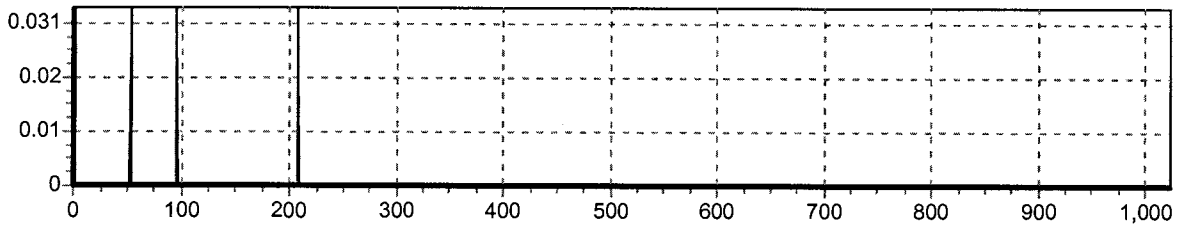
	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325								
800..1024								
190..325	3.401	0.169				0.000		
800..1024	0.819	0.083				0.000		

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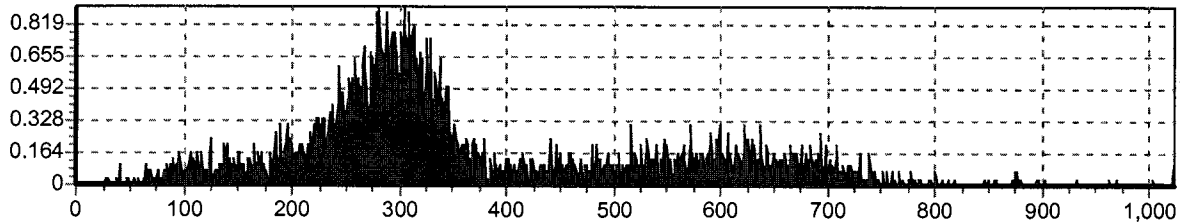
file :C:\Pb-210\ PB-0516\
 Q202001N.001
 spectrum :11
 counting time :1778.77 s
 SQP(E) :773.54 ✓
 counting :5/17/17 12:08:00 AM
 sampling :5/17/17 12:08:00 AM
 ID: PB170510-1LCS

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325	0.034	0.034				0.000		
800..1024	0.000	0.000				0.000		
190..325								
800..1024								



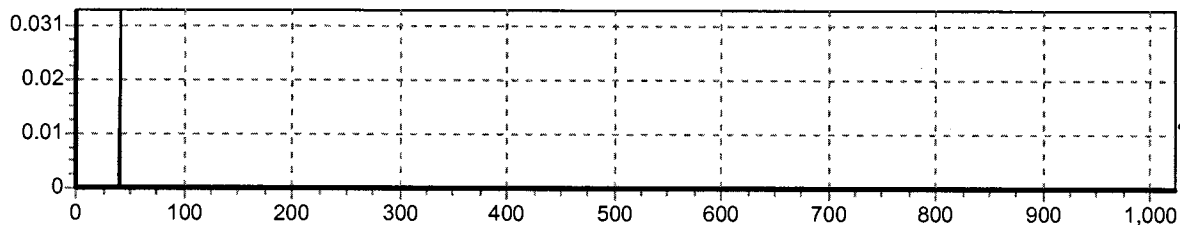
file :C:\Pb-210\ PB-0516\
 Q202001N.001
 spectrum :12
 counting time :1778.77 s
 SQP(E) :773.54 ✓
 counting :5/17/17 12:08:00 AM
 sampling :5/17/17 12:08:00 AM
 ID: PB170510-1LCS

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325								
800..1024								
190..325	58.760	1.408				0.000		
800..1024	0.911	0.175				0.000		



file :C:\Pb-210\ PB-0516\
 Q214101N.001
 spectrum :11
 counting time :1778.77 s
 SQP(E) :774.99 ✓
 counting :5/17/17 12:41:00 AM
 sampling :5/17/17 12:41:00 AM
 ID: PB170510-1LCSD

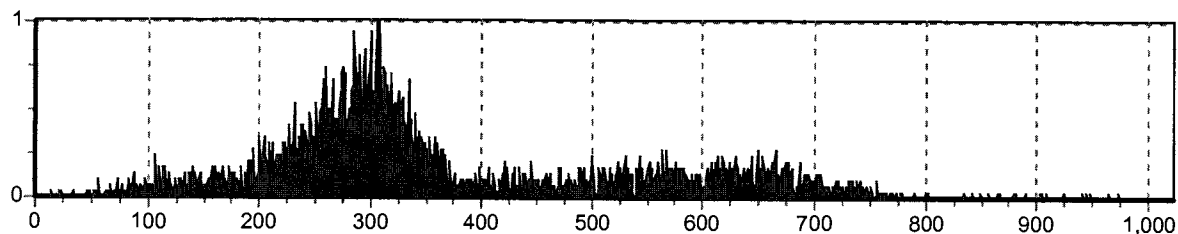
	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325	0.000	0.000				0.000		
800..1024	0.000	0.000				0.000		
190..325								
800..1024								



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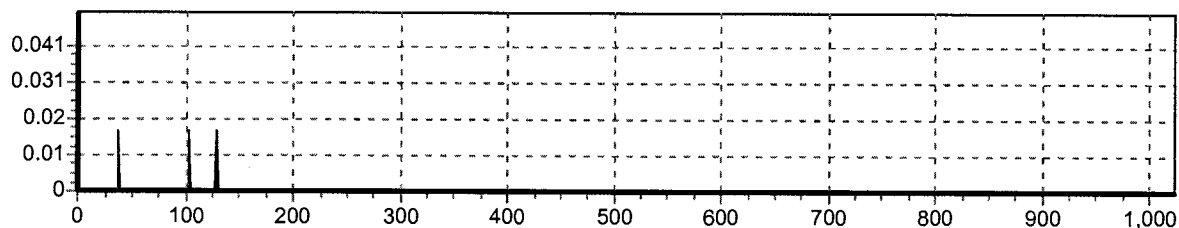
file :C:\Pb-210\ PB-0516\
 Q214101N.001
 spectrum :12
 counting time :1778.77 s
 SQP(E) :774.99✓
 counting :5/17/17 12:41:00 AM
 sampling :5/17/17 12:41:00 AM
 ID: PB170510-1LCSD

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325								
800..1024								
190..325	57.073	1.387				0.000		
800..1024	0.675	0.151				0.000		



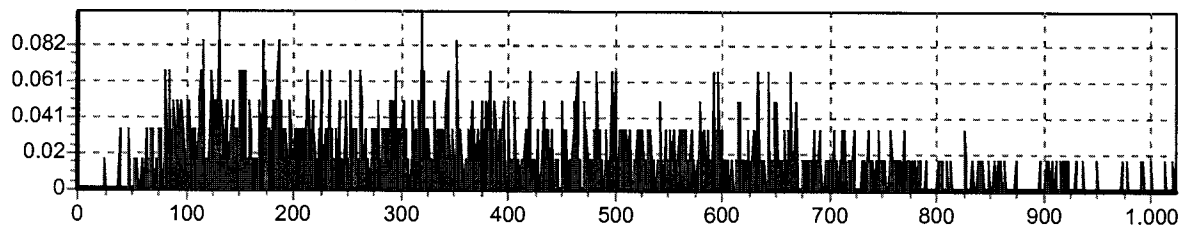
file :C:\Pb-210\ PB-0516\
 Q224201N.001
 spectrum :11
 counting time :3555.91 s
 SQP(E) :781.43✓
 counting :5/17/17 1:43:00 AM
 sampling :5/17/17 1:43:00 AM
 ID: PB170510-1CB3

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325	0.000	0.000				0.000		
800..1024	0.000	0.000				0.000		
190..325								
800..1024								



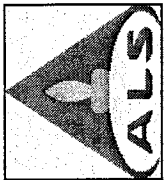
file :C:\Pb-210\ PB-0516\
 Q224201N.001
 spectrum :12
 counting time :3555.91 s
 SQP(E) :781.43✓
 counting :5/17/17 1:43:00 AM
 sampling :5/17/17 1:43:00 AM
 ID: PB170510-1CB3

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325								
800..1024								
190..325	3.223	0.233				0.000		
800..1024	0.742	0.112				0.000		



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ALS Global

LSC Run Log

* Temp. 13 C Therm. ID 80241569

Instrument ID: Quantulus 1220

Load Date *	Sample ID	CountTime (min.)	Position	Protocol	File Name	Batch ID	Position Check	Initials	Comments
5/11/17	NI170321-9/B1	59.3	21	NI-63	NI-0511	NI170321-8	42	42	NA
	1715010-1	177.7	22						
	-2		23						
	-3		24						
	NI170321-8C/B2	59.3	25						
	-8AMB	177.7	26						
	-8YMB		27						
	-8ZMB		28						
	-8CB3	59.3	29						
5/11/17	Daily QC	10	51-54		QC-0511Z		42	42	
5/11/17	Daily QC	10	51-54		QC-0516		42	42	
5/15/17	PB170310-1C/B1	59.3	1	PB-210	PB-0516	PB170310-1	42	42	
	1704378-1	118.5	2						
	412-1		3						
	-3		4						
	-6		5						
	417-1		6						
	449-3		7						
	-4		8						
	1705055-1		9						
	-4		10						
	PB170510-1C/B2	59.3	11						
	1705086-1	118.5	12						
	-4		13						
	095-1		14						
	177-2		15						
	-3		16						
	202-1		17						
	203-1		18						
	PB170510-1MB		19						

Reviewed by / Date

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FORM 700_Quantulus3.xls (9/22/09)

471009



LSC Run Log

* Temp. 17 C Therm. ID 80241569

Instrument ID: Quantulus 1220

[illegible]

27 Reviewed by / Date

25/11/17

FORM 700_Quantulusr3.xls (9/22/09)

Prep Procedure: Pb210_LiqS

Reviewed By: rlm

Review Date: 5/16/2017

LEAD Recovery Results

Reference Carrier

LabID	QC Type	Car Vol	Ref Carr Dil Vol	Ref Carr ICP Alq	Ref Carr ICP Run	Ref Carr ICP Conc
PB170510-1	CAR	1	50	1	5	IR170515-2A1 3.93676

Samples

Prep Num	LabID	QC Type	Init Samp Alq (ml)	Car Vol (ml)	Samp Dil Vol (ml)	Init ICP Alq (ml)	Pre-Con Vol (ml)	Post-Con Vol (ml)	Pre-Sep Vol (ml)	Post-Sep Vol (ml)	Fin ICP Alq (ml)	Fin ICP Dil Vol (ml)	Initial ICP Run	Final ICP Run	Init ICP Conc (ug/ml)	Fin ICP Conc (ug/ml)	Init Samp Mass (ug)	Ref Mass (ug)	Flag	Fin Samp Mass (ug)	% Yield	Final Sample Alq	
1	1704378-1	SMP	1000	1	1001	1	5	1000	6	5.1	5.1	0.1	10	IR170515-2A1	IR170515-2A1	0.19787	1.559618	840.9417	835.7259		795.4053	94.59%	832.5
1	1704412-1	SMP	1000	1	1001	1	5	1000	6	5.1	5.1	0.1	10	IR170515-2A1	IR170515-2A1	0.19703	1.454917	837.38	835.7259		742.0075	88.61%	832.5
1	1704412-3	SMP	1000	1	1001	1	5	1000	6	5.1	5.1	0.1	10	IR170515-2A1	IR170515-2A1	0.20445	1.614043	868.9008	835.7259		823.1619	94.74%	832.5
1	1704412-6	SMP	1000	1	1001	1	5	1000	6	5.1	5.1	0.1	10	IR170515-2A1	IR170515-2A1	0.23289	1.772005	989.7983	835.7259		903.7228	91.30%	832.5
1	1704417-1	SMP	1000	1	1001	1	5	1000	6	5.1	5.1	0.1	10	IR170515-2A1	IR170515-2A1	0.19681	1.578737	836.4402	835.7259		805.1556	96.26%	832.5
1	1704449-3	SMP	1000	1	1001	1	5	1000	6	5.1	5.1	0.1	10	IR170515-2A1	IR170515-2A1	0.19433	1.573076	825.9208	835.7259	LB	802.2686	96.00%	832.5
1	1704449-4	SMP	1000	1	1001	1	5	1000	6	5.1	5.1	0.1	10	IR170515-2A1	IR170515-2A1	0.19746	1.579502	839.2083	835.7259		805.5461	95.99%	832.5
1	1705055-1	SMP	1000	1	1001	1	5	1000	6	5.1	5.1	0.1	10	IR170515-2A1	IR170515-2A1	0.19848	1.634122	843.5457	835.7259		833.4025	98.80%	832.5
1	1705055-4	SMP	1000	1	1001	1	5	1000	6	5.1	5.1	0.1	10	IR170515-2A1	IR170515-2A1	0.19507	1.630418	829.0485	835.7259	LB	831.5133	99.50%	832.5
1	1705086-1	SMP	1000	1	1001	1	5	1000	6	5.1	5.1	0.1	10	IR170515-2A1	IR170515-2A1	0.19864	1.614542	844.2399	835.7259		823.4167	97.53%	832.5
1	1705086-4	SMP	1000	1	1001	1	5	1000	6	5.1	5.1	0.1	10	IR170515-2A1	IR170515-2A1	0.19362	1.564048	822.8709	835.7259	LB	797.6643	95.45%	832.5
1	1705095-1	SMP	100	1	1001	1	5	1000	6	5.1	5.1	0.1	10	IR170515-2A1	IR170515-2A1	0.18924	1.272491	804.2623	835.7259	LB	648.9705	77.65%	83.25
1	1705177-2	SMP	1000	1	1001	1	5	1000	6	5.1	5.1	0.1	10	IR170515-2A1	IR170515-2A1	0.17672	1.49825	751.0773	835.7259	LB	764.1074	91.43%	832.5
1	1705177-3	SMP	1000	1	1001	1	5	1000	6	5.1	5.1	0.1	10	IR170515-2A1	IR170515-2A1	0.18829	1.511383	800.2451	835.7259	LB	770.8055	92.23%	832.5
1	1705202-1	SMP	1000	1	1001	1	5	1000	6	5.1	5.1	0.1	10	IR170515-2A1	IR170515-2A1	0.18591	1.118378	790.1219	835.7259	LB	570.3727	68.25%	832.5
1	1705203-1	SMP	1000	1	1001	1	5	1000	6	5.1	5.1	0.1	10	IR170515-2A1	IR170515-2A1	0.19413	1.390924	825.0679	835.7259	LB	709.3714	84.88%	832.5
1	PB170510-1	MB	1000	1	1001	1	5	1000	6	5.1	5.1	0.1	10	IR170515-2A1	IR170515-2A1	0.19507	1.580006	829.0652	835.7259	LB	805.8028	96.42%	832.5
1	PB170510-1	LCS	1000	1	1002	1	5	1001	6	5.1	5.1	0.1	10	IR170515-2A1	IR170515-2A1	0.20643	1.637139	878.2218	835.7267		834.9409	95.07%	832.5
1	PB170510-1	LCSD	1000	1	1002	1	5	1001	6	5.1	5.1	0.1	10	IR170515-2A1	IR170515-2A1	0.1987	1.502823	845.316	835.7267		766.4398	90.67%	832.5

12/5/2015 15:22:11

Sample Id1	Ca	Fe	K	Mg	Na	Sr	Mn	S	Al	Ba	Pb	Ni
CCV	49.6209	19.9069	50.0807	49.8734	49.9879	0.4987	0.9973	4.9959	49.9331	1.0005	0.9934	0.9956
CCB	0.0218	0.0092	0.0116	0.0224	0.0281	0.0002	0.0016	0.0041	0.0284	0.0003	0.0018	-0.0015
I 1704378-1	1.1561	0.0100	0.0520	0.2778	0.7969	0.0040	-0.0006	0.1925	-0.0457	-0.0017	0.1979	-0.0009
I 1704412-1	26.9220	3.5998	3.9554	2.8729	237.1948	3.7913	0.0561	0.2539	0.0068	1.7412	0.1970	-0.0006
I 1704412-3	26.8663	3.8748	3.9304	2.8450	231.9464	3.7844	0.0569	0.2703	0.1267	1.7442	0.2044	-0.0010
I 1704412-6	35.0863	5.0390	17.7685	4.8249	281.7155	4.3411	0.0819	1.4947	-0.0259	0.7862	0.2329	0.0012
I 1704417-1	6.0570	0.1024	0.2819	1.0885	6.0361	0.0307	0.0015	0.5446	-0.0469	0.0949	0.1968	-0.0024
I 1704449-3	18.6688	-0.0136	0.1809	3.2135	1.9829	0.1028	-0.0012	1.7690	-0.0513	0.0065	0.1943	0.0001
I 1704449-4	14.9156	0.0911	1.8908	3.8975	51.7737	0.1188	0.0083	1.2326	-0.0395	0.0689	0.1975	-0.0018
I 1705055-1	9.1897	0.0067	0.0844	1.3172	3.7538	0.0466	-0.0004	1.1343	-0.0494	0.0223	0.1985	-0.0018
I 1705055-4	1.6584	0.0300	0.0636	0.2718	1.4218	0.0107	0.0003	0.2826	-0.0475	-0.0022	0.1951	-0.0001
I 1705086-1	4.4866	0.0226	0.2682	0.9045	11.7970	0.0185	0.0378	0.9378	-0.0476	0.0323	0.1986	-0.0021
I 1705086-4	19.9824	-0.0191	0.1730	3.3598	2.2771	0.1076	-0.0015	1.8591	-0.0476	0.0061	0.1936	-0.0030
I 1705095-1	321.3888	1.0883	36.1536	42.3361	263.6923	10.7925	0.0420	2.4734	-0.0395	0.1381	0.1892	-0.0026
I 1705177-2	139.7058	0.2089	54.4448	46.8940	266.6643	3.7813	0.0287	364.3448	0.2237	0.0044	0.1767	0.0195
I 1705177-3	159.9923	1.5597	37.5325	26.5393	263.0319	4.5530	0.0339	111.8468	-0.0321	0.0169	0.1883	0.0041
I 1705202-1	19.8831	11.3441	10.8374	4.7741	270.1837	1.8556	0.1694	1.0852	0.0082	2.9612	0.1859	0.0811
I 1705203-1	1.7647	4.0601	23.7207	1.9766	264.5660	0.8745	0.0711	0.7412	-0.0302	1.2306	0.1941	-0.0005
I PB170510-1MB	0.0182	0.0268	-0.0457	-0.0584	0.8817	0.0041	-0.0012	0.0942	-0.0296	-0.0022	0.1951	-0.0015
I PB170510-1LCS	-0.0256	-0.0085	-0.0553	-0.0688	0.3249	0.0029	-0.0015	0.0860	-0.0438	-0.0018	0.2064	-0.0019
I PB170510-1LCSD	-0.0237	-0.0107	-0.0557	-0.0748	0.1201	0.0024	-0.0015	0.0573	-0.0444	-0.0030	0.1987	-0.0029
PB170510-1RC	-0.0259	0.0548	-0.0312	-0.0704	0.0143	0.0022	-0.0010	0.0532	-0.0333	-0.0029	3.9368	-0.0023
CCV	49.4711	19.7890	49.9476	49.6725	49.2344	0.4969	0.9869	5.0205	49.8930	0.9985	0.9873	0.9991
CCB	0.0192	0.0085	0.0237	0.0147	0.0498	0.0002	0.0014	0.0205	0.0358	0.0003	0.0028	0.0011
F 1704378-1	46.0106	-0.0116	-0.0482	-0.0328	8.5926	0.0211	0.0541	-0.0041	-0.0364	-0.0012	1.5596	-0.0020
F 1704412-1	45.1522	0.0368	-0.0578	-0.0398	20.6534	0.2149	0.1728	0.0491	-0.0309	0.0800	1.4549	-0.0014
F 1704412-3	45.9565	0.0977	-0.0628	-0.0502	5.6665	0.1299	0.0301	0.0041	-0.0401	0.0360	1.6140	-0.0025
F 1704412-6	46.0083	0.0148	-0.0516	-0.0377	16.3544	0.2468	0.1436	0.0082	-0.0352	0.0548	1.7720	-0.0027
F 1704417-1	45.4913	-0.0140	-0.0595	-0.0366	2.8797	0.0270	0.2317	0.0000	-0.0321	0.0045	1.5787	-0.0008
F 1704449-3	45.0402	0.0025	-0.0686	-0.0404	7.1519	0.0291	0.0219	0.1392	-0.0235	0.0073	1.5731	-0.0012
F 1704449-4	45.6261	-0.0136	-0.0678	-0.0333	1.9350	0.0438	0.3971	0.0000	-0.0290	0.0063	1.5795	-0.0025
F 1705055-1	46.0672	-0.0077	-0.0570	-0.0475	0.6210	0.0284	0.2389	-0.0205	-0.0364	0.0003	1.6341	-0.0013
F 1705055-4	45.9004	-0.0038	-0.0807	-0.0453	5.8412	0.0230	0.0587	-0.0041	-0.0340	-0.0010	1.6304	-0.0026
F 1705086-1	46.4060	0.0956	-0.1089	-0.0464	0.9616	0.0267	0.6267	-0.0164	-0.0278	0.0036	1.6145	-0.0019
F 1705086-4	45.5073	-0.0147	-0.0890	-0.0426	0.6104	0.0352	0.2270	-0.0041	-0.0302	-0.0007	1.5640	-0.0017
F 1705095-1	47.5063	0.0114	-0.0749	0.1725	0.6632	0.1259	0.4049	0.0041	-0.0228	0.0039	1.2725	-0.0032
F 1705177-2	46.0935	-0.0821	-0.0715	0.1971	0.6848	0.0605	0.3006	0.0041	-0.0204	-0.0007	1.4983	-0.0008
F 1705177-3	46.0231	-0.0146	-0.0437	-0.0104	0.5993	0.0784	0.0915	-0.0041	-0.0321	-0.0005	1.5114	-0.0005
F 1705202-1	45.2793	0.1651	-0.0807	-0.0317	0.8088	0.2318	0.3763	-0.0205	-0.0259	0.2076	1.1184	-0.0017
F 1705203-1	44.8987	0.1166	-0.0786	-0.0224	0.8258	0.5795	1.2524	-0.0123	-0.0278	0.2696	1.3909	-0.0025
F PB170510-1MB	45.1029	0.0078	-0.0516	-0.0546	0.6938	0.0209	0.5391	-0.0164	-0.0284	-0.0002	1.5800	-0.0010
F PB170510-1LCS	45.9107	0.0058	-0.0749	-0.0480	3.8549	0.0215	0.0212	-0.0041	-0.0278	-0.0008	1.6371	-0.0021
F PB170510-1LCSD	45.6174	-0.0031	-0.0686	-0.0480	0.7399	0.0212	0.0166	-0.0164	-0.0197	-0.0009	1.5028	-0.0024
CCV	49.1939	19.5476	49.4365	49.1053	49.5234	0.4895	0.9742	4.8935	49.1327	0.9834	0.9759	0.9995
CCB	0.0285	0.0100	0.0000	0.0098	0.0460	0.0002	0.0013	0.0041	0.0531	0.0003	0.0076	-0.0009

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: PB170510-1

Prep Procedure: Pb210_LiqSsp 120

Analytical QASS / NCR? Y *(N)* *na*

Prep Num	LabID	QC Type	Init Aliq	Fin Aliq	Report Units	Cnt 1 File/Inst	Cnt 1 Rack-Pos	Cnt 1 Pos Chk By	Cnt 2 File/Inst	Cnt 2 Rack-Pos	Cnt 2 Pos Chk By	Cnt 3 File/Inst	Cnt 3 Rack-Pos	Cnt 3 Pos Chk By	Notes
1	1704378-1	SMP	1000	832.50	ml	pCi/l	0516	<i>na</i>	PB-0512	2	<i>na</i>				
1	1704412-1	SMP	1000	832.50	ml	pCi/l	3								
1	1704412-3	SMP	1000	832.50	ml	pCi/l	4								
1	1704412-6	SMP	1000	832.50	ml	pCi/l	5								
1	1704417-1	SMP	1000	832.50	ml	pCi/l	6								
1	1704449-3	SMP	1000	832.50	ml	pCi/l	7								
1	1704449-4	SMP	1000	832.50	ml	pCi/l	8								
1	1705055-1	SMP	1000	832.50	ml	pCi/l	9								
1	1705055-4	SMP	1000	832.50	ml	pCi/l	10								
1	1705086-1	SMP	1000	832.50	ml	pCi/l	12								
1	1705086-4	SMP	1000	832.50	ml	pCi/l	13								
1	1705095-1	SMP	100	83.250	ml	pCi/l	14								
1	1705177-1	SMP	1000	832.50	ml	pCi/l	15								
1	1705177-2	SMP	1000	832.50	ml	pCi/l	16								
1	1705177-3	SMP	1000	832.50	ml	pCi/l	17								
1	1705202-1	SMP	1000	832.50	ml	pCi/l	18								
1	1705203-1	SMP	1000	832.50	ml	pCi/l	1								
1	170510510-1CB	MB	1000	832.50	ml	pCi/l	11								
1	170510510-1CB	MB	1000	832.50	ml	pCi/l	42								
1	170510510-1CB	MB	1000	832.50	ml	pCi/l	19								
1	PB170510-1	MB	1000	832.50	ml	pCi/l	20								
1	PB170510-1	LCS	1000	832.50	ml	pCi/l	41								
1	PB170510-1	LCSD	1000	832.50	ml	pCi/l									

Tracer/Carrier Solution Information

Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
T1	LEAD	418231		1,001.811	pCi/ml	NA	1	ml	RS-037

Spike Solution Information

Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
S1	Pb-210	899.4095.66		95.177	DPM/ml	05/10/17	1	ml	RS-037
S1	Pb-210	899.4095.66		95.177	DPM/ml	05/10/17	1	ml	RS-037

Radiochemistry Instrument Worksheet

ALS -- Fort Collins

Prep Batch: PB170510-1

Prep Procedure: Pb210_LiqS

Analytical QASS / NCR? Y *NA*

Prep Num	LabID	QC Type	Init Aliq	Fin Aliq	Units	Report Units	Cnt 1 File/Inst	Cnt 1 Rack-Pos	Cnt 1 Pos Chk By	Cnt 2 File/Inst	Cnt 2 Rack-Pos	Cnt 2 Pos Chk By	Cnt 3 File/Inst	Cnt 3 Rack-Pos	Cnt 3 Pos Chk By	Notes
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Sample Barcodes

1704378-1 PB170510-1PS1							1704412-1 PB170510-1PS2							1704412-3 PB170510-1PS3		
1704412-6 PB170510-1PS4							1704417-1 PB170510-1PS5							1704449-3 PB170510-1PS6		
1704449-4 PB170510-1PS7							1705055-1 PB170510-1PS8							1705055-4 PB170510-1PS9		
1705086-1 PB170510-1PS10							1705086-4 PB170510-1PS11							1705095-1 PB170510-1PS19		
1705177-3 PB170510-1PS20							1705177-1 PB170510-1PS21							1705177-2 PB170510-1PS22		
1705177-3 PB170510-1PS23							1705202-1 PB170510-1PS24							1705203-1 PB170510-1PS25		
PB170510-1CB1MB PB170510-1PS12							PB170510-1CB2MB PB170510-1PS13							PB170510-1CB3MB PB170510-1PS14		
PB170510-1MB PB170510-1PS15							PB170510-1LCS PB170510-1PS16							PB170510-1LCS PB170510-1PS17		
PB170510-1CAR PB170510-1PS18																

Radiochemistry Instrument Worksheet

ALS -- Fort Collins

Prep Batch: PB170510-1

Reporting Units

LabID:	IsGrpName:	RptUnits:
1705086-1	Pb210_USGS	pCi/l
1704412-1	Pb210L	pCi/l
1704417-1	Pb210_USGS	pCi/l
1704378-1	Pb210_USGS	pCi/l
1705055-1	Pb210_USGS	pCi/l
1705203-1	Pb210L	pCi/l
1705095-1	Pb210L	pCi/l
1705158-1	Pb210L	pCi/l
1705177-1	Pb210L	pCi/l
1705202-1	Pb210L	pCi/l
1705177-2	Pb210L	pCi/l
1704449-3	Pb210_USGS	pCi/l
1705177-3	Pb210L	pCi/l
1704412-3	Pb210L	pCi/l
1705086-4	Pb210_USGS	pCi/l
1704449-4	Pb210_USGS	pCi/l
1705055-4	Pb210_USGS	pCi/l
1704412-6	Pb210L	pCi/l

Radiochemistry Prep Worksheet

ALS -- Fort Collins

Prep Batch: PB170510-1

Prep Procedure: Pb210_LiqS

Reviewed By: rlm

Review Date: 5/16/2017

Non-Routine Pre-Treatment? Y / N Batch: 174 Re-Prep? Y / N Batch: MT Prep QASS / NCR? Y / N MA

Prep SOP: PAI 726 Rev: 9

Prep SOP: NONE

Matrix Class: liquid

Prep Analyst: Rebecca L. Merola

Prep Date: 5/10/2017

Prep Dept: RS

Balance: na

Balance: na

Cocktail: UGLLT

Cocktail Pipet: T-004

Aliquot Pipet: RS-032

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Alq ml	Fin Alq ml	Prep Basis	Ingrowth Date/Time	Standards	Prep Notes
1	1	1704378-1	SMP	<u>VB</u>	1000	832.5009	As Received	05/12/17 10:40	T1	
2	1	1704412-1	SMP		1000	832.5009	Filtered	05/12/17 10:40	T1	
3	1	1704412-3	SMP		1000	832.5009	Filtered	05/12/17 10:40	T1	
4	1	1704412-6	SMP		1000	832.5009	Filtered	05/12/17 10:40	T1	
5	1	1704417-1	SMP		1000	832.5009	As Received	05/12/17 10:40	T1	
6	1	1704449-3	SMP		1000	832.5009	As Received	05/12/17 10:40	T1	
7	1	1704449-4	SMP		1000	832.5009	As Received	05/12/17 10:40	T1	
8	1	1705055-1	SMP		1000	832.5009	As Received	05/12/17 10:40	T1	
9	1	1705055-4	SMP		1000	832.5009	As Received	05/12/17 10:40	T1	
10	1	1705086-1	SMP		1000	832.5009	As Received	05/12/17 10:40	T1	
11	1	1705086-4	SMP		1000	832.5009	As Received	05/12/17 10:40	T1	
12	1	1705095-1	SMP		100	83.25009	Filtered	05/12/17 10:40	T1	
13	1	1705177-2	SMP		1000	832.5009	Filtered	05/12/17 10:40	T1	
14	1	1705177-3	SMP		1000	832.5009	Filtered	05/12/17 10:40	T1	
15	1	1705202-1	SMP		1000	832.5009	Filtered	05/12/17 10:40	T1	
16	1	1705203-1	SMP		1000	832.5009	Filtered	05/12/17 10:40	T1	
17	1	PB170510-1CB1	MB		1000	832.5009	As Received	05/12/17 10:40		
18	1	PB170510-1CB1	MB		1000	832.5009	Unfiltered	05/12/17 10:40		
19	1	PB170510-1CB2	MB		1000	832.5009	Unfiltered	05/12/17 10:40		
20	1	PB170510-1CB2	MB		1000	832.5009	As Received	05/12/17 10:40		
21	1	PB170510-1CB3	MB		1000	832.5009	Unfiltered	05/12/17 10:40		
22	1	PB170510-1CB3	MB		1000	832.5009	As Received	05/12/17 10:40		
23	1	PB170510-1	MB		1000	832.5009	As Received	05/12/17 10:40	T1	
24	1	PB170510-1	MB		1000	832.5009	Unfiltered	05/12/17 10:40	T1	
25	1	PB170510-1	LCS		1000	832.5017	Unfiltered	05/12/17 10:40	T1,S1	
26	1	PB170510-1	LCS		1000	832.5017	As Received	05/12/17 10:40	T1,S1	
27	1	PB170510-1	LCS		1000	832.5017	As Received	05/12/17 10:40	T1,S1	
28	1	PB170510-1	LCS		1000	832.5017	Unfiltered	05/12/17 10:40	T1,S1	

Radiochemistry Prep Worksheet

ALS -- Fort Collins

Prep Batch: PB170510-1

Prep Procedure: Pb210_LiqS

Reviewed By: rlm Review Date: 5/16/2017

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

Prep SOP: PAI 726 Rev: 9
Prep SOP: NONE
Matrix Class: liquid

Prep Analyst: Rebecca L. Merola
Prep Date: 5/10/2017
Prep Dept: RS

Cocktail: UGLLT
Cocktail Pipet: T-004
Aliquot Pipet: RS-032

Balance: na
Balance: na

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Alq ml	Fin Alq ml	Prep Basis	Ingrwth Date/Time	Standards	Prep Notes
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Comments

LCSD was used due to limited sample volume. Reduced aliquot taken for sample 1705095-1 due to high calicum in native sample. Samples 1705158-1 and 1705177-1 were removed from batch due to a sample switch on columns and will be reprep in batch PB170516-1.

Spiked By: Rebecca L. Merola Date: 5/11/2017

Witnessed By: Hunter C. Jordan Date: 5/11/2017

Tracer/Carrier Solution Information

Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
T1	LEAD	418231	8/27/17	1,001.811	pCi/ml	NA	1	ml	RS-037

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	95.177	DPM/ml	05/10/17	1	ml	RS-037
S1	Pb-210	899.4095.66	↓	95.177	DPM/ml	05/10/17	1	ml	RS-037

Radiochemistry Prep Worksheet

ALS -- Fort Collins

Prep Batch: PB170510-1

Prep Procedure: Pb210_LiqS

Prep Batch Not Validated!!!

Reviewed By:

Review Date:

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

Prep QASS / NCR? Y / N

Prep SOP: PAI 726 Rev: 9

Prep Analyst: Rebecca L. Merola

Prep Date: 5/10/2017

Prep Dept: RS

Balance: na

Balance: na

Cocktail: UGLLT

Cocktail Pipet: T-004

Aliquot Pipet: RS-032

Matrix Class: liquid

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Alq ml	Fin Alq ml	Prep Basis	Ingrowth Date/Time	Standards	Prep Notes
1	1	1704378-1	SMP		1000	832.5009	As Received	5/12/17	T1	
2	1	1704412-1	SMP		1000	832.5009	Unfiltered	1040	T1	
3	1	1704412-3	SMP		1000	832.5009	Unfiltered		T1	
4	1	1704412-6	SMP		1000	832.5009	Unfiltered		T1	
5	1	1704417-1	SMP		1000	832.5009	As Received		T1	
6	1	1704449-3	SMP		1000	832.5009	As Received		T1	
7	1	1704449-4	SMP		1000	832.5009	As Received		T1	
8	1	1705055-1	SMP		1000	832.5009	As Received		T1	
9	1	1705055-4	SMP		1000	832.5009	As Received		T1	
10	1	1705086-1	SMP		1000	832.5009	As Received		T1	
11	1	1705086-4	SMP		1000	832.5009	As Received		T1	
12	1	1705095-1	SMP		100	83.25009	Unfiltered		T1	
13	1	1705169-1 SMP			1000	832.5009	Unfiltered		T1	
14	1	1705177-1 SMP			1000	832.5009	Unfiltered		T1	
15	1	1705177-2	SMP		1000	832.5009	Unfiltered		T1	
16	1	1705177-3	SMP		1000	832.5009	Unfiltered		T1	
17	1	1705202-1	SMP		1000	832.5009	Unfiltered		T1	
18	1	1705203-1	SMP		1000	832.5009	Unfiltered		T1	
19	1	PB170510-1CB1 MB			1000	832.5009	As Received		T1	
20	1	PB170510-1CB1 MB			1000	832.5009	Unfiltered		T1	
21	1	PB170510-1CB2 MB			1000	832.5009	As Received		T1	
22	1	PB170510-1CB2 MB			1000	832.5009	Unfiltered		T1	
23	1	PB170510-1CB3 MB			1000	832.5009	As Received		T1	
24	1	PB170510-1CB3 MB			1000	832.5009	Unfiltered		T1	
25	1	PB170510-1 MB			1000	832.5009	As Received		T1	
26	1	PB170510-1 MB			1000	832.5009	Unfiltered		T1	
27	1	PB170510-1 LCS			1000	832.5017	As Received		T1,S1	
28	1	PB170510-1 LCS			1000	832.5017	Unfiltered		T1,S1	
29	1	PB170510-1 LCSD			1000	832.5017	As Received		T1,S1	
30	1	PB170510-1 LCSD			1000	832.5017	Unfiltered		T1,S1	

Radiochemistry Prep Worksheet

ALS -- Fort Collins

Prep Batch: PB170510-1

Prep Procedure: Pb210_LiqS

Prep Batch Not Validated!!!

Reviewed By:

Review Date:

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

Prep SOP: PAI 726 Rev: 9

Prep SOP: NONE

Matrix Class: liquid

Prep Analyst: Rebecca L. Merola

Prep Date: 5/10/2017

Prep Dept: RS

Balance: na

Balance: na

Cocktail: UGLLT

Cocktail Pipet: T-004

Aliquot Pipet: RS-032

Prep Notes

Standards

Ingrowth Date/Time

Prep Basis

Fin Alq ml

Init Alq ml

Dish No.

QC Type

Samp Num

Comments

LCSD was used due to limited sample volume. Reduced aliquot taken for sample 1705095-1 due to high calcium in native sample.

Spiked By: RL Date: 5/11/17

Witnessed By: UCS Date: 5-11-17

Tracer/Carrier Solution Information

Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
T1	LEAD	418231	8-27-17	1,001.811	pCi/ml	NA	1	ml	RS-037

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	95.177	DPM/ml	05/10/17	1	ml	RS-037
S1	Pb-210	899.4095.66		95.177	DPM/ml	05/10/17	1	ml	RS-037

Sample Condition Form (Liquid)					
Analyst: <i>R</i>					
Analysis Date: <i>5/11/17</i>			Method: <i>Prep</i>		
		Sample Condition (Visual Appearance of Analysis Aliquot at Time of Prep)			
Work Order	Sample ID	pH	Color	Remarks	
1704378	1	62.0	colorless	<i>MA</i>	
1704412	1	↓	yellow	filtered	
↓	3		↓		
↓	6		cloudy	↓	
1704417	1		colorless		
1704449	3				
↓	4				
1705055	1				
↓	4				
1705086	1				
↓	4				
1705095	1				filtered
1705158	1				filtered
1705177	1				↓
↓	2		cloudy		
↓	3		colorless		
1705202	1		opaque		
1705203	1	↓	colorless	↓	
		<i>5/16/17 m 5/16/17</i> <i>m 5/12/17</i>			

Section 8

STANDARDS TRACEABILITY DOCUMENTS



Radiochemistry Solution Report

Solution Id: 418231	Name: Pb carrier	Lot:	Vendor Name:	Type: IS
---------------------	------------------	------	--------------	----------

Final Vol: 4000	Dept: RD	Prep By	CAS	on	8/27/2015	Reviewed By	td	on	8/27/2015
Units: mL	Location: SR/RA	Opened By		on		Verified By	TDE	on	8/27/2015
Matrix: LIQUID	ExpireDate: 8/26/2017	Received By		on		Deactivated By		on	

Comment:

Component Name	Component ID	Volume Added	Units
Lead nitrate<4>	J45597	6.4054	g

Calibrated Primary Calibration Reference

CompName	Act/Conc	Date	1/2 Life (Yrs)	Final Act/Conc	Summed Conc	Units
LEAD	625604	10/2/2016		1001.811		pCi/ml

Associated Parent IDs

Abbreviations: NC = Not Calculated for reagents when the volume added is not entered. (Pmt) = Secular equilibrium; parent half life used to calculate concentration.
NE = Not Entered

Date Printed: Sunday, October 02, 2016

ALS Environmental -- FC

Standards DB Version: 1.111

Page 1 of 1

Pb-210 899.4095.66 working standard

Prepare a working dilution of 899.3610.42

1. Density of 1M HNO₃, lot # 0000084176
 Mass of 100mL vol. flask: 56.4468g Balance # 12
 Mass of flask & 100mL acid: 159.4521g Balance # 12
 Net Mass: 103.0053g
 Density: 1.0301 g/mL

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

3. Dilute to final volume:
 Mass of nalgene, standard, & diluent: 1147.7g Balance # 26
 Mass of empty nalgene (from above): 74.5139g Balance # 12
 Net mass of new dilution: 1073.1861g Balance # NA

4. Final activity calculation:

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

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

Std ID: 899.4095.66

Description: Pb-210

Expiration: 10/26/2016

Activity: 121.10 dpm/mL

2s Uncertainty: 3.39 dpm/mL

Ref. Date: 8/10/2009

Ref Time: N/A

Prep Date: 12/8/2014 Prep by: TE

Matrix/Comp. 1 M HNO₃

Half Life (y): 2.22E+01

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

Continued on Page

Signed

Date

Read and Understood By

Signed

Date 43 of 93



Eckert & Ziegler

Analytics

R508
899
rec
8-14-09

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

CERTIFICATE OF CALIBRATION

Standard Radionuclide Source

80328-307

Pb-210 5 mL Liquid in Flame Sealed Vial

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

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

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

*Uncertainty: U - Relative expanded uncertainty, $k = 2$. See NIST Technical Note 1297, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results."

Comments:

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

Source Prepared by:

N. E. Kasate
N. E. Kasate, Radiochemist

QA Approved:

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

Date: 8-13-09



Corporate Office

24937 Avenue Tibbitts Valencia, California 91355

Laboratory

1380 Seaboard Industrial Blvd. Atlanta, Georgia, 30314 of 93

Section 9

ADDITIONAL SUPPORTING DOCUMENTATION

Liquid Scintillation Counter

Instrumentation Calibration

Initial Efficiency Calibration Standards Traceability

Q1220 Pb-210 Background Determination

Interim control limits are established from the initial calibration for the analysis and geometry of interest **OR** from the initial batch calibration blank data set acquired after the instrument re-calibration. Limits are +/- 3 standard deviations (counting unc.) from the initial calibration blank data. Once enough historical data is acquired, new historical limits are set as follows: Control limits for reagent blanks are established from 30 individual historical data points (10 batches). Limits are +/- 3 standard deviations from 30 individual historical data points. Individual reagent blanks and the average of reagent blanks from each batch are in control if the Count Rate (CPM) is within the established control limits.

CURRENTLY UNDER HISTORICAL LIMITS

Updated on 05/30/13 NES									
COUNT DATE	#	Sample ID	Count Duration (m)	Count Rate (CPM)	Total Cts.	Mean	Individual Reagent Blanks		
							LCL	UCL	Pass ?
5/15/2017	640	PB170510-1CB1	59.3	3.88	230.084		2.0410	4.2714	PASS
5/16/2017	641	PB170510-1CB2	59.3	3.66	217.038		2.0410	4.2714	PASS
5/17/2017	642	PB170510-1CB3	59.3	3.22	190.946	3.587	2.0410	4.2714	PASS
									PASS

PB-210 Efficiency Calibration Q1220

5 mL sample (8N HNO₃) + 15 mL Ultima Gold LLT

2/23/2017

Q1220

Standard used: 901.3610.50

2633.37 dpm/ml as of 6/15/2006
1/2 life = 2.23E+01 yrs.
current activity = 1888.65 dpm/ml
volume = 1.0000 ml
Spike Activity = 1888.65 dpm
(190-325) (800-1024)

Window 1 CPM adjusted for chemical yield and volume

Sample ID	WIN1 CORR	Yield	Vol Adj.	Adj WIN1 CPM
1714005-1	1030.579	0.8827	0.8274	1411.08
1714005-2	1041.611	0.9266	0.8274	1358.62
1714005-3	1073.692	0.8257	0.8274	1571.60

Sample ID	WIND1 cpm*	WIND2 cpm	%LUMEX	SQP(E) #
1714005-1	1411.083	0.877	0.000	784.13
1714005-2	1358.619	0.843	0.000	779.19
1714005-3	1571.600	0.742	4.380	777.66
PB170221-1AMB	3.499	0.883	0.000	776.17
PB170221-1BMB	3.483	0.765	0.000	780.79
PB170221-1CMB	3.500	0.855	0.000	778.67

average LCS= 1447.10 0.834 0.730 779.44 averages

average bkg= 3.494

net cpm= 1443.61

/known dpm= 1888.65

efficiency= 0.7644

WIND2 cpm	%LUMEX	SQP(E) #	
1.04	10.00	794.44	UCL
0.63	0.00	764.44	LCL
See Tech. Mgr.	See Tech. Mgr.	Std. Addition	Corrective Action

*WIND1 cpm were corrected for chemical yield and volume (Pb-210 spiked into 1000 mL)

Instrument Technician:

Signature & Date

Supervisory Review:

Signature & Date

PB 210 Efficiency Calibration Verification / Method Blank Verification 3/1/2017

Calibration Source Check

Q1220

Analysis Date: 3/1/2017
Nuclide: PB210
Half Life: 2.23E+01

Calibration Check Source:

Spike Standard: 899.4095.66
Reference Date: 8/10/2009
Spiked DPM/mL: 121.10 dpm/mL
Spike Volume: 1.0 mL
Spiked into: 1000.0 mL
Current Spk. Act: 43.14 dpm/L

Control Limits: 70%-130%

Calibration Check Source Count

Sample ID	Position	Prep Date	Cnt. Dur.	Anal. Vol. (L)	GrsCPM	BkgCPM	Efficiency	Activity	Units	Chem. Yield	LCS Recovery:	Pass/Fail
1714006-1	2	2/27/2017	29.6	0.8325	59.330	3.050	0.7644	42.41	pCi/L	93.95%	98.3%	PASS
1714006-2	3	2/27/2017	29.6	0.8325	58.650	3.050	0.7644	41.16	pCi/L	95.63%	95.4%	PASS
1714006-3	4	2/27/2017	29.6	0.8325	62.160	3.050	0.7644	44.57	pCi/L	93.89%	103.3%	PASS

Method Blank Check Count

Sample ID	Position	Prep Date	Cnt. Dur.	Anal. Vol.	GrsCPM	BkgCPM	Efficiency	Chem. Yield	k (denom.)	activity	MDC	Pass/Fail	Units	2s CU	1 σ IU	1 σ PU	2 σ PU	2 σ TPU
PB170227-1AMB	6	2/27/2017	177.72	0.8325	3.050	3.050	0.7644	95.59%	1.350	0.0000	0.46	PASS	pCi/L	0.274	0.00000	0.00000	0.00000	0.274
PB170227-1BMB	7	2/27/2017	177.72	0.8325	3.350	3.050	0.7644	94.75%	1.338	0.2242	0.49	PASS	pCi/L	0.284	0.02511	0.02287	0.02287	0.286
PB170227-1CMB	8	2/27/2017	177.72	0.8325	3.110	3.050	0.7644	96.48%	1.363	0.0440	0.46	PASS	pCi/L	0.273	0.00493	0.00449	0.00449	0.273

OK JP
3/2/17

Luminescence Correction Quantulus 1220
PB170221-1
 2/23/2017

sample ID	WIN 1 (190-325)					WIN 2 (800-1024)					Wind 2 check
	count rate spectrum 11	count rate spectrum 12	lumex corrected	% lumex	% lumex check	count rate spectrum 11	count rate spectrum 12	lumex corrected	% lumex		
1714005-1	0.000	1030.579	1030.579	0.00	OK	0.000	0.877	0.877	0.00		
1714005-2	0.034	1041.645	1041.611	0.00	OK	0.000	0.843	0.843	0.00		
1714005-3	0.000	1073.692	1073.692	0.00	OK	0.034	0.776	0.742	4.38		
PB170221-1AMB	0.006	3.505	3.499	0.17	OK	0.000	0.883	0.883	0.00		
PB170221-1BMB	0.006	3.489	3.483	0.17	OK	0.000	0.765	0.765	0.00		
PB170221-1CMB	0.011	3.511	3.500	0.31	OK	0.000	0.855	0.855	0.00		

0.00
 10.00

5/2/17

LabID:	WIN 1 (190 - 325)					WIN 2 (800 - 1024)					Win 2 Check	
	Count Rate Spectrum 11	Count Rate Spectrum 12	Lumex Corrected	Lumex (%)	Lumex Check	Count Rate Spectrum 11	Count Rate Spectrum 12	Lumex Corrected	Lumex (%)	Lower Control Limit	Upper Control Limit	Win 2 Check
PB170227-1CB1	.08	2.88	2.8	2.78	OK	.00	.57	0.57	0.00	NA	NA	NA
PB170227-1CB2	.00	3.00	3	0.00	OK	.00	.65	0.65	0.00	NA	NA	NA
PB170227-1CB3	.00	3.35	3.35	0.00	OK	.00	.72	0.72	0.00	NA	NA	NA
1714006-1	.00	59.33	59.33	0.00	OK	.00	.87	0.87	0.00	0.203343	1.08999	OK
1714006-2	.00	58.65	58.65	0.00	OK	.00	.91	0.91	0.00	0.203343	1.08999	OK
1714006-3	.00	62.16	62.16	0.00	OK	.00	.33	0.33	0.00	0.203343	1.08999	OK
PB170227-1AMB	.00	3.05	3.05	0.00	OK	.00	.93	0.93	0.00	0.465693	0.827641	HIGH
PB170227-1BMB	.01	3.36	3.35	0.30	OK	.00	.73	0.73	0.00	0.465693	0.827640	OK
PB170227-1CMB	.01	3.12	3.11	0.32	OK	.00	.76	0.76	0.00	0.465693	0.827641	OK

Lumex LCL = 0.00
Lumex UCL = 10.00

The gross count rates and count times used for the final activity calculations and the lumex correction sheet are different than the values shown on the raw data output. These values come from two software programs which round the sample counts differently. The difference between these two values is believed to be insignificant. Window 2 control limits are established using the average count rate from the three reagent blanks +/- 3X the estimated Poisson uncertainty.

Spectrum report

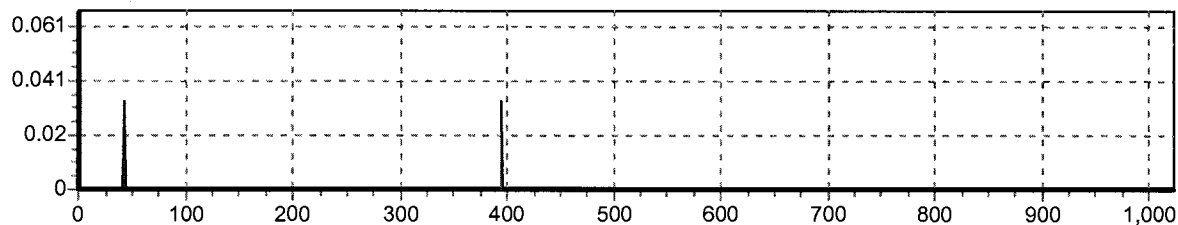
2/24/17 8:54:34 AM

Setup information
C:\Program Files\wallac\easy view\PB-210.wss

Window 1 = 190..325 190..325, MCA 11 mode CPM
volume 10 ml
Window 2 = 800..1024 800..1024, MCA 11 mode CPM
volume 10 ml
Window 3 = 190..325 190..325, MCA 12 mode CPM
volume 10 ml
Window 4 = 800..1024 800..1024, MCA 12 mode CPM
volume 10 ml

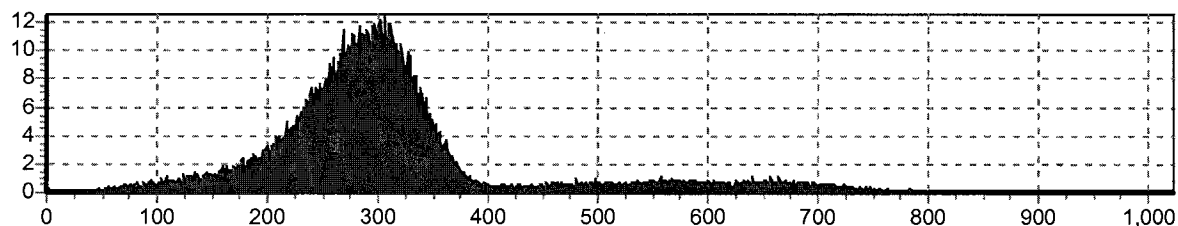
file :C:\Pb-210\ PB-0223\
Q010801N.001
spectrum :11
counting time :1778.38 s
SQP(E) :784.13
counting :2/23/17 2:21:00 PM
sampling :2/23/17 2:21:00 PM
ID: 1714005-1

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325	0.000	0.000				0.000		
800..1024	0.000	0.000				0.000		
190..325								
800..1024								



file :C:\Pb-210\ PB-0223\
Q010801N.001
spectrum :12
counting time :1778.38 s
SQP(E) :784.13
counting :2/23/17 2:21:00 PM
sampling :2/23/17 2:21:00 PM
ID: 1714005-1

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325								
800..1024								
190..325	1030.579	5.897				0.000		
800..1024	0.877	0.172				0.000		

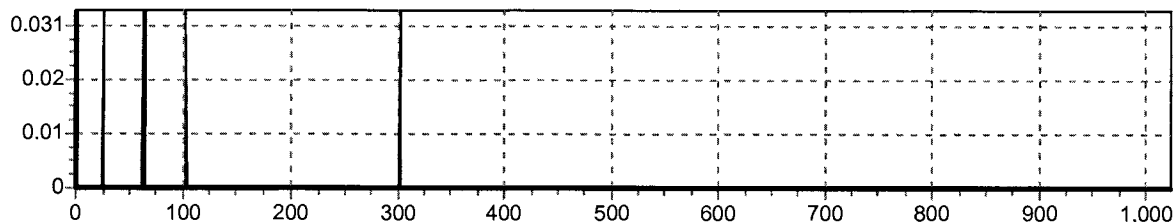


file :C:\Pb-210\ PB-0223\
Q020901N.001
spectrum :11
counting time :1778.38 s
SQP(E) :779.19
counting :2/23/17 2:53:00 PM
sampling :2/23/17 2:53:00 PM
ID: 1714005-2

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325	0.034	0.034				0.000		
800..1024	0.000	0.000				0.000		
190..325								
800..1024								

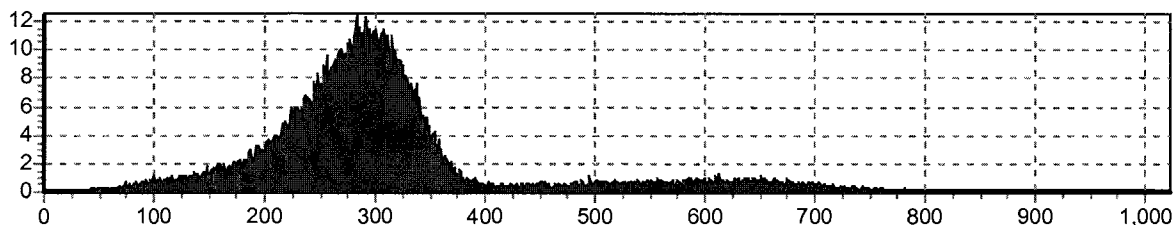
JP 3/2/17

2/28/17



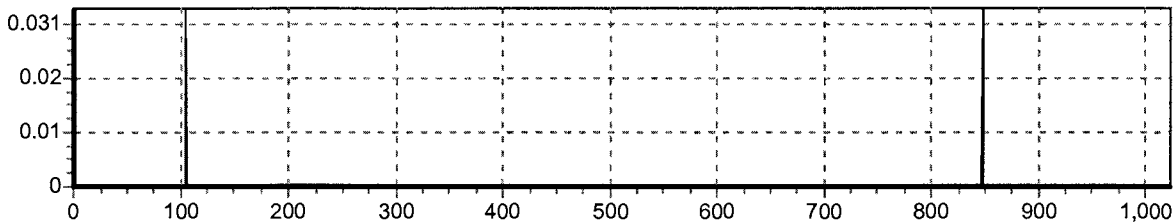
file :C:\Pb-210\ PB-0223\
Q020901N.001
spectrum :12
counting time :1778.38 s
SQP(E) :779.19
counting :2/23/17 2:53:00 PM
sampling :2/23/17 2:53:00 PM
ID: 1714005-2

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325								
800..1024								
190..325	1041.645	5.928				0.000		
800..1024	0.843	0.169				0.000		



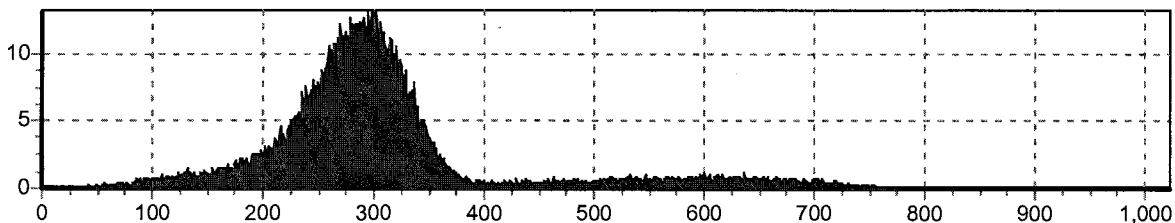
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Q031001N.001
spectrum :11
counting time :1778.39 s
SQP(E) :777.66
counting :2/23/17 3:26:00 PM
sampling :2/23/17 3:26:00 PM
ID: 1714005-3

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325	0.000	0.000				0.000		
800..1024	0.034	0.034				0.000		
190..325								
800..1024								



file :C:\Pb-210\ PB-0223\
Q031001N.001
spectrum :12
counting time :1778.39 s
SQP(E) :777.66
counting :2/23/17 3:26:00 PM
sampling :2/23/17 3:26:00 PM
ID: 1714005-3

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325								
800..1024								
190..325	1073.692	6.019				0.000		
800..1024	0.776	0.162				0.000		

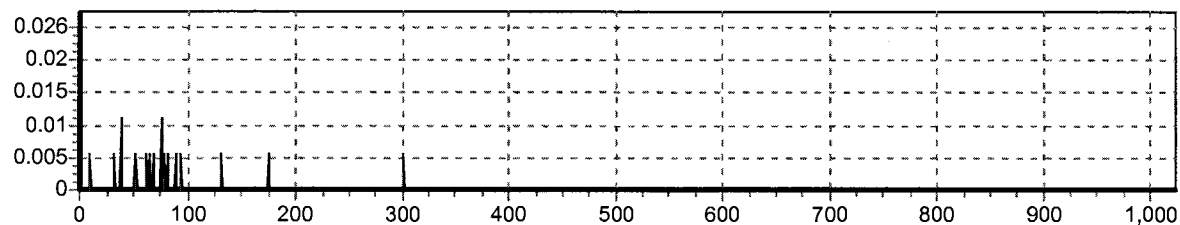


JP 3/2/17

2/23/17 of 93

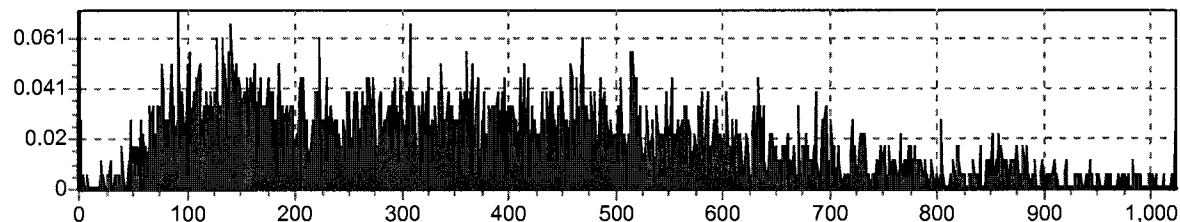
file :C:\ Pb-210\ PB-0223\
 Q041101N.001
 spectrum :11
 counting time :10663.99 s
 SQP(E) :776.17
 counting :2/23/17 6:29:00 PM
 sampling :2/23/17 6:29:00 PM
 ID: PB170221-1AMB

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325	0.006	0.006				0.000		
800..1024	0.000	0.000				0.000		
190..325								
800..1024								



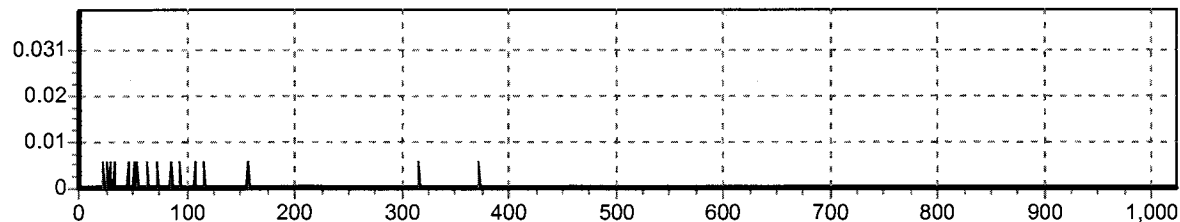
file :C:\ Pb-210\ PB-0223\
 Q041101N.001
 spectrum :12
 counting time :10663.99 s
 SQP(E) :776.17
 counting :2/23/17 6:29:00 PM
 sampling :2/23/17 6:29:00 PM
 ID: PB170221-1AMB

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325								
800..1024								
190..325	3.505	0.140				0.000		
800..1024	0.883	0.070				0.000		



file :C:\ Pb-210\ PB-0223\
 Q051201N.001
 spectrum :11
 counting time :10663.03 s
 SQP(E) :780.79
 counting :2/23/17 9:31:00 PM
 sampling :2/23/17 9:31:00 PM
 ID: PB170221-1BMB

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325	0.006	0.006				0.000		
800..1024	0.000	0.000				0.000		
190..325								
800..1024								

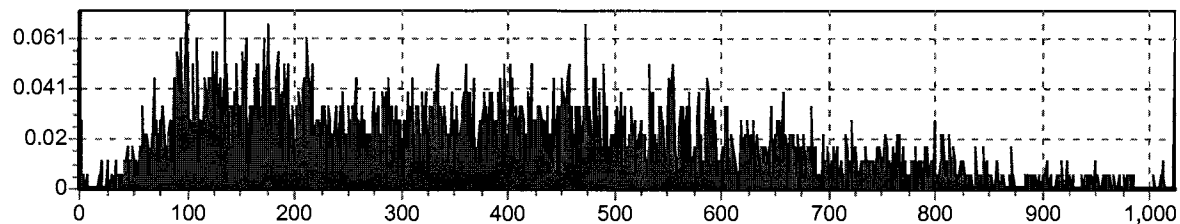


file :C:\ Pb-210\ PB-0223\
 Q051201N.001
 spectrum :12
 counting time :10663.03 s
 SQP(E) :780.79
 counting :2/23/17 9:31:00 PM
 sampling :2/23/17 9:31:00 PM
 ID: PB170221-1BMB

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325								
800..1024								
190..325	3.489	0.140				0.000		
800..1024	0.765	0.066				0.000		

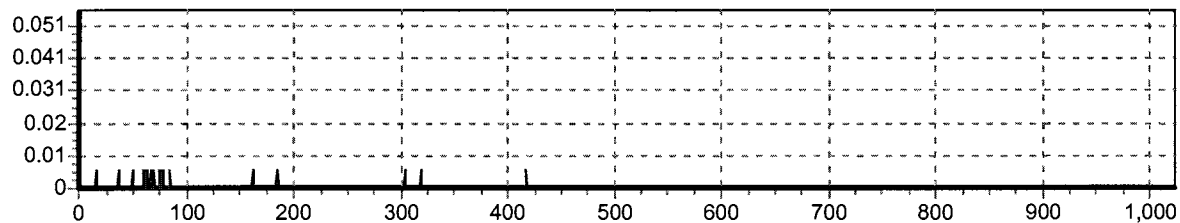
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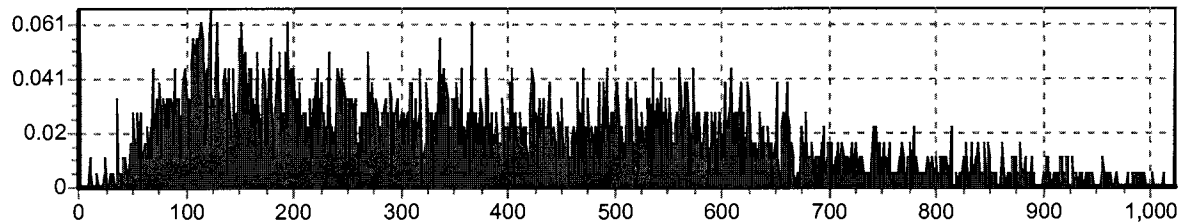
file :C:\Pb-210\ PB-0223\
 Q061301N.001
 spectrum :11
 counting time :10664.02 s
 SQP(E) :778.67
 counting :2/24/17 12:34:00 AM
 sampling :2/24/17 12:34:00 AM
 ID: PB170221-1CMB

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325	0.011	0.008				0.000		
800..1024	0.000	0.000				0.000		
190..325								
800..1024								



file :C:\Pb-210\ PB-0223\
 Q061301N.001
 spectrum :12
 counting time :10664.02 s
 SQP(E) :778.67
 counting :2/24/17 12:34:00 AM
 sampling :2/24/17 12:34:00 AM
 ID: PB170221-1CMB

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325								
800..1024								
190..325	3.511	0.141				0.000		
800..1024	0.855	0.069				0.000		



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Spectrum report

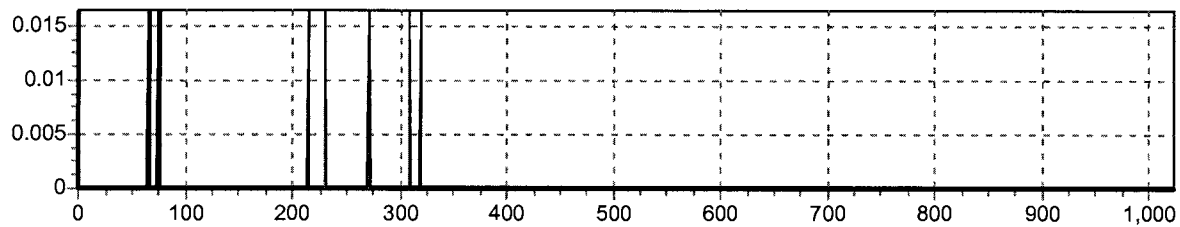
3/2/17 7:57:58 AM

Setup information
C:\Program Files\wallac\easy view\PB-210.wss

Window 1 = 190..325 190..325, MCA 11 mode CPM
volume 10 ml
Window 2 = 800..1024 800..1024, MCA 11 mode CPM
volume 10 ml
Window 3 = 190..325 190..325, MCA 12 mode CPM
volume 10 ml
Window 4 = 800..1024 800..1024, MCA 12 mode CPM
volume 10 ml

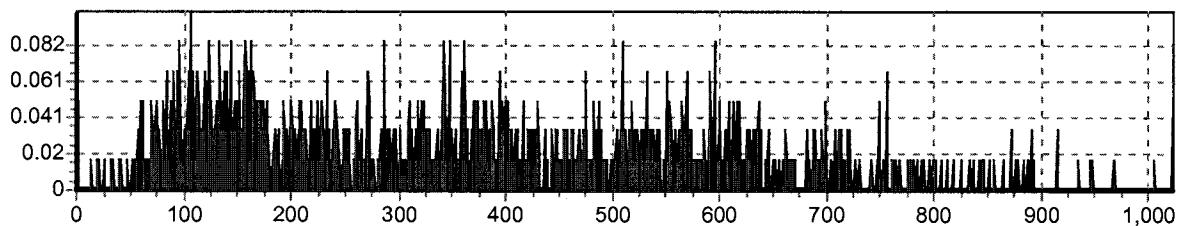
file :C:\Pb-210\ PB-0301\
Q010101N.001
spectrum :11
counting time :3555.84 s
SQP(E) :783.73
counting :3/1/17 1:05:00 PM
sampling :3/1/17 1:05:00 PM
ID: PB170227-1CB1

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325	0.084	0.038				0.000		
800..1024	0.000	0.000				0.000		
190..325								
800..1024								



file :C:\Pb-210\ PB-0301\
Q010101N.001
spectrum :12
counting time :3555.84 s
SQP(E) :783.73
counting :3/1/17 1:05:00 PM
sampling :3/1/17 1:05:00 PM
ID: PB170227-1CB1

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325								
800..1024								
190..325	2.885	0.221				0.000		
800..1024	0.574	0.098				0.000		

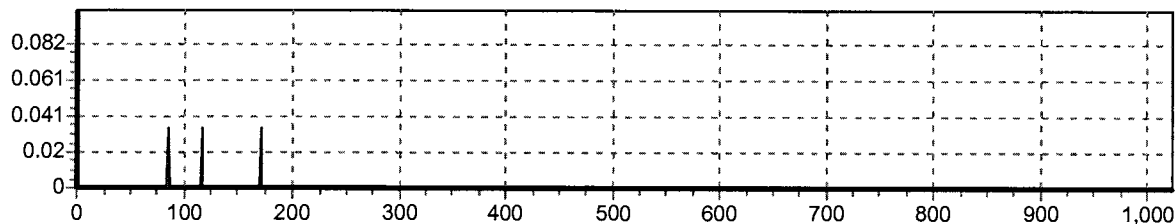


file :C:\Pb-210\ PB-0301\
Q020201N.001
spectrum :11
counting time :1778.78 s
SQP(E) :782.99
counting :3/1/17 1:37:00 PM
sampling :3/1/17 1:37:00 PM
ID: 1714006-1

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325	0.000	0.000				0.000		
800..1024	0.000	0.000				0.000		
190..325								
800..1024								

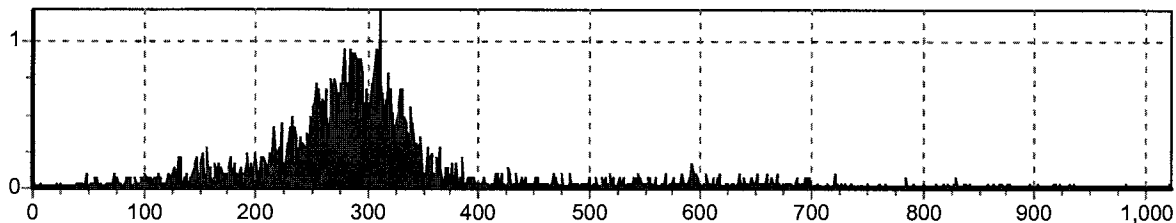
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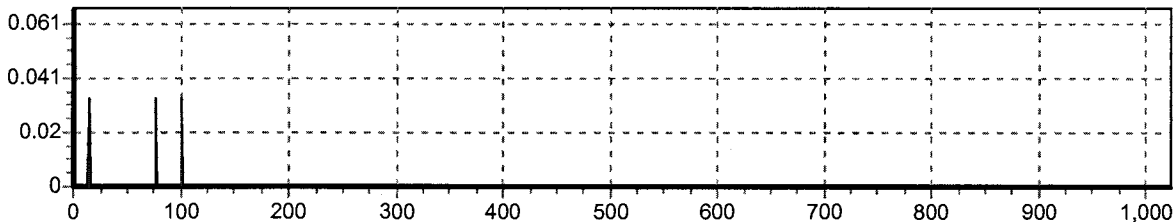
file :C:\Pb-210\ PB-0301\
 Q020201N.001
 spectrum :12
 counting time :1778.78 s
 SQP(E) :782.99
 counting :3/1/17 1:37:00 PM
 sampling :3/1/17 1:37:00 PM
 ID: 1714006-1

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325								
800..1024								
190..325	59.333	1.415				0.000		
800..1024	0.877	0.172				0.000		



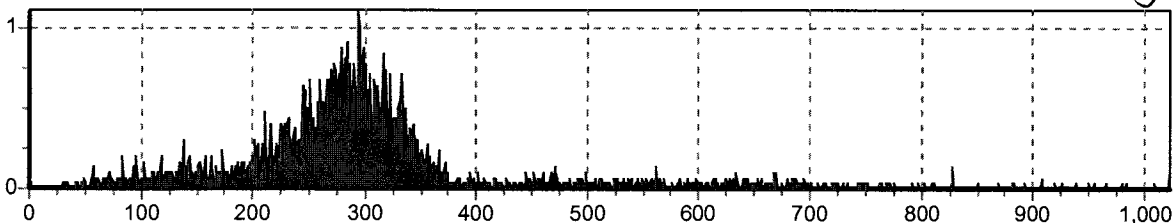
file :C:\Pb-210\ PB-0301\
 Q030301N.001
 spectrum :11
 counting time :1778.77 s
 SQP(E) :780.69
 counting :3/1/17 2:10:00 PM
 sampling :3/1/17 2:10:00 PM
 ID: 1714006-2

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325	0.000	0.000				0.000		
800..1024	0.000	0.000				0.000		
190..325								
800..1024								



file :C:\Pb-210\ PB-0301\
 Q030301N.001
 spectrum :12
 counting time :1778.77 s
 SQP(E) :780.69
 counting :3/1/17 2:10:00 PM
 sampling :3/1/17 2:10:00 PM
 ID: 1714006-2

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325								
800..1024								
190..325	58.658	1.407				0.000		
800..1024	0.911	0.175				0.000		

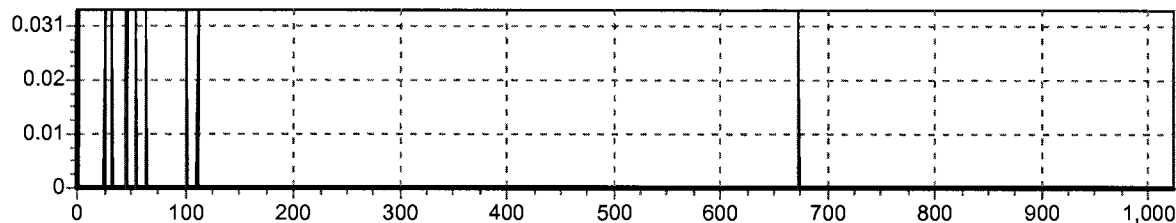


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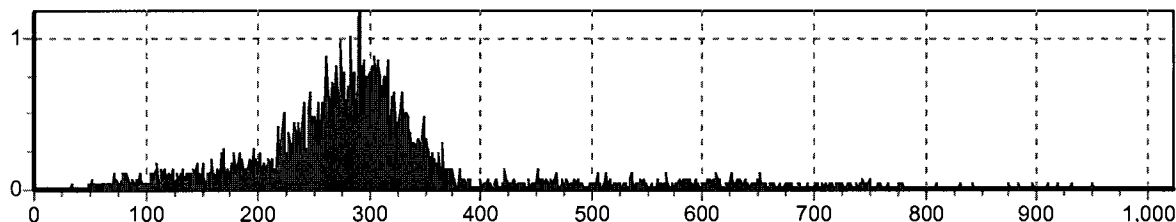
file :C:\ Pb-210\ PB-0301\
 Q040401N.001
 spectrum :11
 counting time :1778.78 s
 SQP(E) :781.85
 counting :3/1/17 2:43:00 PM
 sampling :3/1/17 2:43:00 PM
 ID: 1714006-3

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325	0.000	0.000				0.000		
800..1024	0.000	0.000				0.000		
190..325								
800..1024								



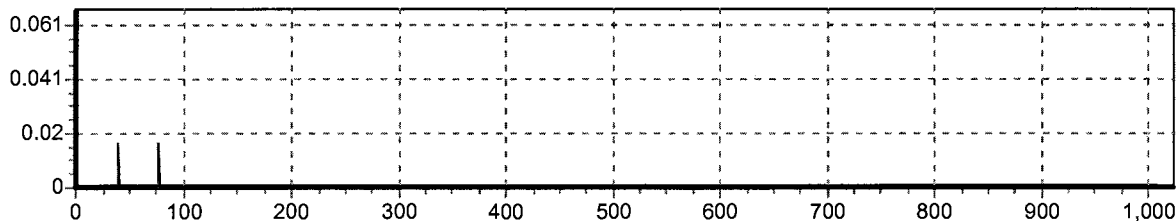
file :C:\ Pb-210\ PB-0301\
 Q040401N.001
 spectrum :12
 counting time :1778.78 s
 SQP(E) :781.85
 counting :3/1/17 2:43:00 PM
 sampling :3/1/17 2:43:00 PM
 ID: 1714006-3

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325								
800..1024								
190..325	62.166	1.448				0.000		
800..1024	0.337	0.107				0.000		



file :C:\ Pb-210\ PB-0301\
 Q050501N.001
 spectrum :11
 counting time :3555.84 s
 SQP(E) :780.24
 counting :3/1/17 3:45:00 PM
 sampling :3/1/17 3:45:00 PM
 ID: PB170227-1CB2

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325	0.000	0.000				0.000		
800..1024	0.000	0.000				0.000		
190..325								
800..1024								

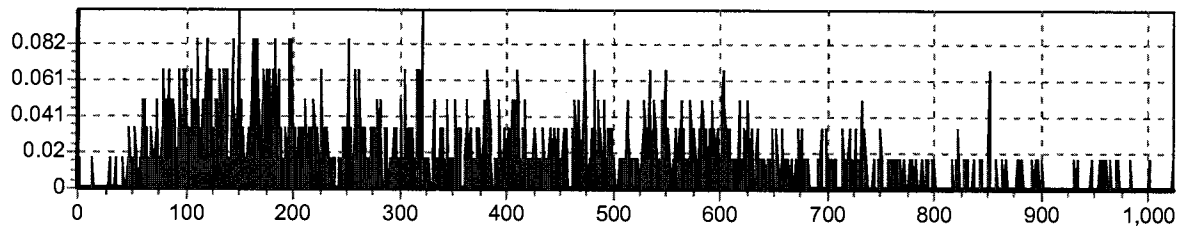


file :C:\ Pb-210\ PB-0301\
 Q050501N.001
 spectrum :12
 counting time :3555.84 s
 SQP(E) :780.24
 counting :3/1/17 3:45:00 PM
 sampling :3/1/17 3:45:00 PM
 ID: PB170227-1CB2

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325								
800..1024								
190..325	3.004	0.225				0.000		
800..1024	0.658	0.105				0.000		

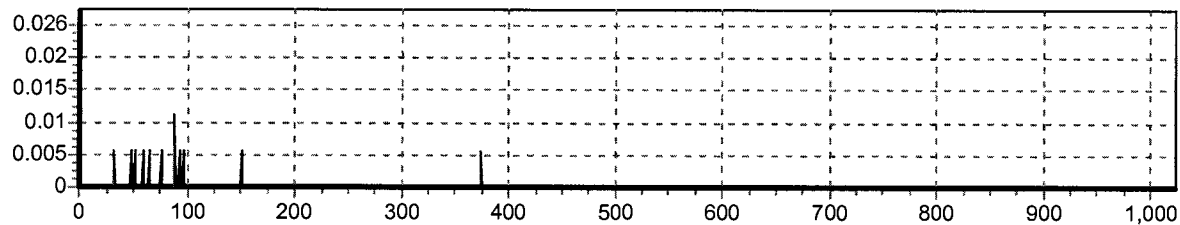
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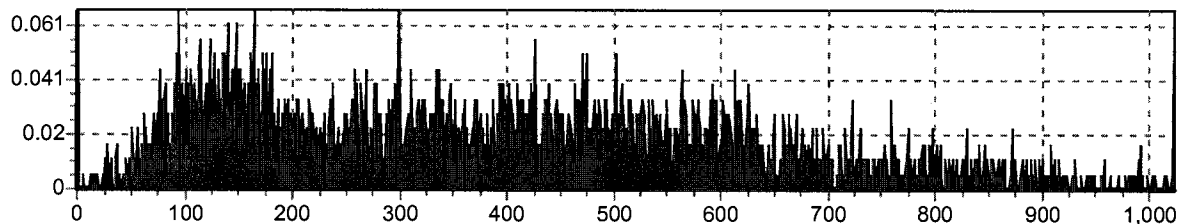
file :C:\Pb-210\ PB-0301\
 Q060601N.001
 spectrum :11
 counting time :10664.06 s
 SQP(E) :783.62
 counting :3/1/17 6:48:00 PM
 sampling :3/1/17 6:48:00 PM
 ID: PB170227-1AMB

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325	0.000	0.000				0.000		
800..1024	0.000	0.000				0.000		
190..325								
800..1024								



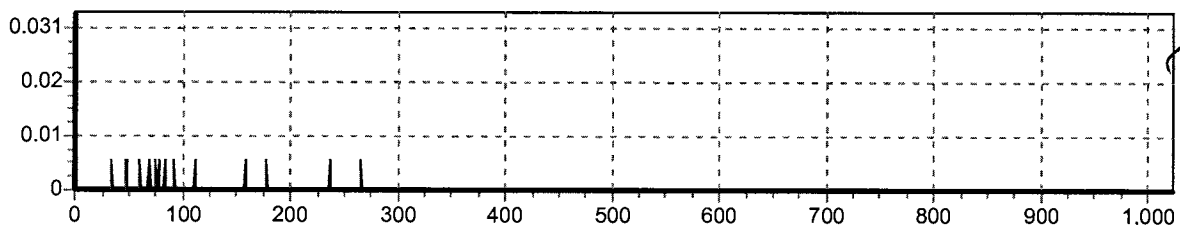
file :C:\Pb-210\ PB-0301\
 Q060601N.001
 spectrum :12
 counting time :10664.06 s
 SQP(E) :783.62
 counting :3/1/17 6:48:00 PM
 sampling :3/1/17 6:48:00 PM
 ID: PB170227-1AMB

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325								
800..1024								
190..325	3.055	0.131				0.000		
800..1024	0.940	0.073				0.000		



file :C:\Pb-210\ PB-0301\
 Q070701N.001
 spectrum :11
 counting time :10664.14 s
 SQP(E) :780.20
 counting :3/1/17 9:50:00 PM
 sampling :3/1/17 9:50:00 PM
 ID: PB170227-1BMB

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325	0.011	0.008				0.000		
800..1024	0.000	0.000				0.000		
190..325								
800..1024								

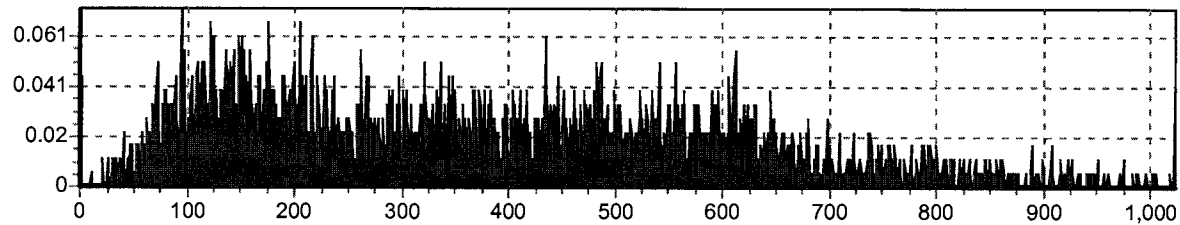


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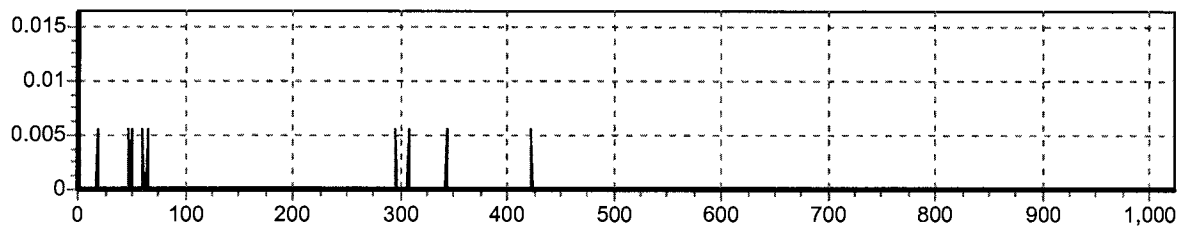
file :C:\ Pb-210\ PB-0301\
 Q070701N.001
 spectrum :12
 counting time :10664.14 s
 SQP(E) :780.20
 counting :3/1/17 9:50:00 PM
 sampling :3/1/17 9:50:00 PM
 ID: PB170227-1BMB

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325								
800..1024								
190..325	3.365	0.138				0.000		
800..1024	0.737	0.064				0.000		



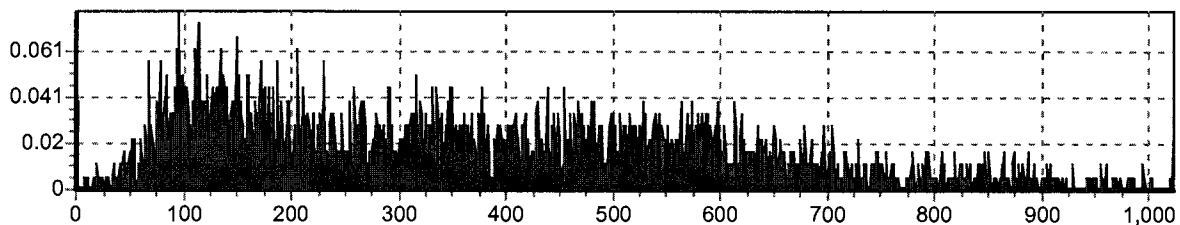
file :C:\ Pb-210\ PB-0301\
 Q080801N.001
 spectrum :11
 counting time :10664.09 s
 SQP(E) :779.28
 counting :3/2/17 12:53:00 AM
 sampling :3/2/17 12:53:00 AM
 ID: PB170227-1CMB

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325	0.011	0.008				0.000		
800..1024	0.000	0.000				0.000		
190..325								
800..1024								



file :C:\ Pb-210\ PB-0301\
 Q080801N.001
 spectrum :12
 counting time :10664.09 s
 SQP(E) :779.28
 counting :3/2/17 12:53:00 AM
 sampling :3/2/17 12:53:00 AM
 ID: PB170227-1CMB

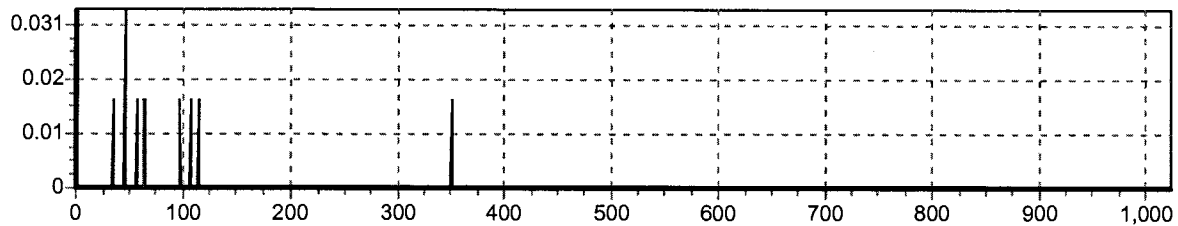
	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325								
800..1024								
190..325	3.128	0.133				0.000		
800..1024	0.765	0.066				0.000		



file :C:\ Pb-210\ PB-0301\
 Q090901N.001
 spectrum :11
 counting time :3555.84 s
 SQP(E) :780.56
 counting :3/2/17 1:56:00 AM
 sampling :3/2/17 1:56:00 AM
 ID: PB170227-1CB3

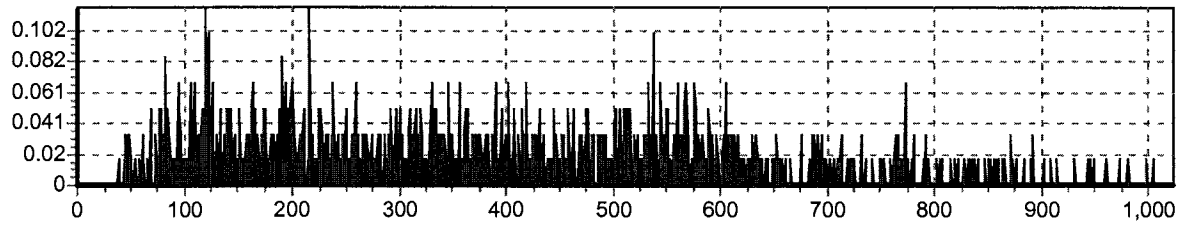
	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325	0.000	0.000				0.000		
800..1024	0.000	0.000				0.000		
190..325								
800..1024								

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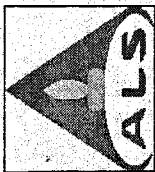


file :C:\Pb-210\ PB-0301\
 Q090901N.001
 spectrum :12
 counting time :3555.84 s
 SQP(E) :780.56
 counting :3/2/17 1:56:00 AM
 sampling :3/2/17 1:56:00 AM
 ID: PB170227-1CB3

	C rate	Error	D rate	D error	Eff	BG	FM	MDA
190..325								
800..1024								
190..325	3.358	0.238				0.000		
800..1024	0.726	0.111				0.000		



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ALS Global

LSC Run Log

* Temp. °C Therm. ID 80241569

Instrument ID: Quantulus 1220

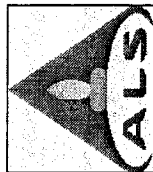
Load Date *	Sample ID	Count Time (min.)	Position	Protocol	File Name	Batch ID	Position Check	Initials	Comments
2/25/17	C170216-16B2	51.3	5	C14	C-0221E0	C170216-1	AC	AC	C14 KCal
	C170216-14MB	177.7	6						
	16MB		7						
	16MB		8						
	16B3	51.3	9						
2/22/17	Daily QC	10	51-54		QC-0222		AC	AC	NA
2/22/17	PB170207-16B1	51.26	1	PB210	PB-0222	PB170207-1	AC	AC	
	1701323-1	177.7	2						
	PB170207-1MB		3						
	16B2	51.26	4						
	16B3	21.6	5						
	16B4		6						
	16B5	51.26	7						
2/23/17	Daily QC	10.08	51-54		QC-0223		AC	AC	NA
2/23/17	1714005-1	8.246	8	PB-210	PB-0223	PB170221-1	AC	AC	PB cal 364
	1714005-1	8.246	9						
	1714005-1	8.246	10						
	1714005-1	8.246	11						
	1714005-1	8.246	12						
	1714005-1	8.246	13						
	1714005-1	8.246	14						
	1714005-1	8.246	15						
	1714005-1	8.246	16						
	1714005-1	8.246	17						
	1714005-1	8.246	18						
	1714005-1	8.246	19						
	1714005-1	8.246	20						
2/24/17	Daily QC	10	51-54		QC-0224		AC	AC	NA
2/24/17	C170217-16B1	61.1	21	C14	C-0224	C170217-1	AC	AC	
	1702007-21		22						
	1702007-21		23						
	1702007-21		24						
	1702007-21		25						
	1702007-21		26						
	1702007-21		27						
	1702007-21		28						
	1702007-21		29						
	1702007-21		30						

Reviewed by / Date

AC 2/25/17

FORM 700_Quantulus3.xls (9/22/09)

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ALS Global

LSC Run Log

* Temp. C Therm. ID 80241569

Instrument ID: Quantulus 1220

Load Date *	Sample ID	CountTime (min.)	Position	Protocol	File Name	Batch ID	Position Check	Initials	Comments
2/24/17	1702058-5	69.1	30	C14	C-0224	C170217-1	AC	AC	NA
	170217-1682		31						
	1702058-5DUP		32						
	-11		33						
	-23		34						
	-29		35						
	-42		36						
	-48		37						
	-54		38						
	C170217-1MB		39						
	-165		40						
	-163		41						
2/25/17	Daily QC	10	51-54		QC-0225		AC	AC	NA
2/25/17	C170217-2681	69.1	1	C14	C-0225	C170217-2	AC	AC	NA
	1702089-5		2						
	-18		3						
	-27		4						
	-42		5						
	1702109-5		6						
	-30		7						
	-36		8						
	-42		9						
	1702133-5		10						
	-11		11						
	C170217-2087-5		12						
	1702160-5-17		13						
	5-KDOP-5		14						
	5-N-5DUP		15						
	5-N-17-11		16						
	5-89-17		17						

Reviewed by / Date

AC 2/27/17

FORM 700_Quantulus3.xls (9/22/09)

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Instrument ID: Quantulus 1220

LSC Run Log

Reviewed by / Date AK 5/2/17

FORM 700 Quantulusr3.xls (9/22/09)

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Radiochemistry ICP Worksheet

ALS -- Fort Collins

Prep Batch: PB170221-1

Prep Procedure: Pb210_Liqs

Reviewed By: rlm *rlm* Review Date: 2/23/2017

LEAD Recovery Results

Reference Carrier

LabID	QC Type	Carr Vol	Ref Carr Dil Vol	Ref Carr ICP Alq	Ref Carr ICP Run	Ref Carr ICP Conc
PB170221-1	CAR	1	201	0.5	10	IR170222-2A1 0.2538763

Samples

Prep Num	LabID	QC Type	Init Samp Alq (ml)	Samp Dil Vol (ml)	Car Vol (ml)	Init ICP Alq (ml)	Pre-Con Vol (ml)	Post-Con Vol (ml)	Pre-Sep Vol (ml)	Post-Sep Vol (ml)	Fin ICP Alq (ml)	Fin ICP Dil Vol (ml)	Initial ICP Run	Final ICP Run	Init ICP Conc (ug/ml)	Fin ICP Conc (ug/ml)	Init Samp Mass (ug)	Ref Mass (ug)	Flag	Fin Samp Mass (ug)	% Yield	Final Sample Alq
1	1714005-1	SMP	1000	1	7	0.05	10.05	6.95	6	5.05	0.05	10.05	IR170222-2A1	IR170222-2A1	0.75593	0.772889	888.8019	852.8549		784.5212	88.27%	827.4
1	1714005-2	SMP	1000	1	7	0.05	10.05	6.95	6	5.05	0.05	10.05	IR170222-2A1	IR170222-2A1	0.76134	0.817126	895.1542	852.8549		829.4234	92.66%	827.4
1	1714005-3	SMP	1000	1	7	0.05	10.05	6.95	6	5.05	0.05	10.05	IR170222-2A1	IR170222-2A1	0.77781	0.743962	914.518	852.8549		755.1581	82.57%	827.4
1	PB170221-1A	MB	1000	1	6	0.05	10.05	5.95	6	5.05	0.05	10.05	IR170222-2A1	IR170222-2A1	0.89859	0.781105	904.5103	851.8323		792.861	87.66%	826.4
1	PB170221-1B	MB	1000	1	6	0.05	10.05	5.95	6	5.05	0.05	10.05	IR170222-2A1	IR170222-2A1	0.99861	0.794982	1005.189	851.8323		806.9464	80.28%	826.4
1	PB170221-1C	MB	1000	1	6	0.05	10.05	5.95	6	5.05	0.05	10.05	IR170222-2A1	IR170222-2A1	0.89364	0.814381	899.5306	851.8323		826.6373	91.90%	826.4

12170222-2A1

Sample Id1	Ca	Fe	K	Mg	Na	Sr	Mn	S	Al	Ba	Pb	Ni
CCV	50.1201	20.0155	50.2305	50.1242	50.1866	0.5029	0.9995	5.0330	50.1499	1.0077	0.9824	1.0133
CCB	0.0262	0.0111	0.0312	0.0366	0.0183	0.0003	0.0007	0.0124	0.0350	0.0007	0.0067	0.0016
I 1714005-1	0.0007	0.0082	-0.0009	-0.0120	-0.0185	-0.0005	-0.0002	0.0000	0.0337	-0.0002	0.7559	0.0044
I 1714005-2	-0.0131	-0.0054	0.0264	-0.0143	-0.0209	-0.0005	-0.0001	0.0124	-0.0039	-0.0001	0.7613	0.0054
I 1714005-3	-0.0138	-0.0056	0.0269	-0.0223	-0.0213	-0.0005	-0.0003	0.0124	-0.0065	-0.0002	0.7778	0.0041
I PBI7221-1AMB	-0.0124	-0.0049	0.0238	-0.0137	-0.0214	-0.0005	-0.0002	0.0083	-0.0097	-0.0001	0.8986	0.0064
I PBI7221-1BMB	-0.0094	-0.0052	0.0199	-0.0183	-0.0199	-0.0005	-0.0003	0.0083	-0.0104	-0.0002	0.9986	0.0055
I PBI7221-1CMB	-0.0148	-0.0055	0.0191	-0.0137	-0.0220	-0.0005	-0.0001	0.0083	-0.0123	0.0000	0.8936	0.0065
PBI7221-1RC	-0.0077	0.0032	0.0594	-0.0080	-0.0214	-0.0004	0.0003	0.0165	-0.0175	0.0001	0.2539	0.0016
F 1714005-1	22.8858	-0.0043	0.0290	0.0023	0.3928	0.0085	-0.0001	0.0165	-0.0156	0.0010	0.7729	0.0005
F 1714005-2	24.3155	-0.0051	0.0256	-0.0046	0.3462	0.0092	-0.0001	0.0000	-0.0136	0.0011	0.8171	0.0019
F 1714005-3	22.9022	-0.0041	0.0195	0.0000	0.3454	0.0088	0.0001	0.0083	-0.0032	0.0012	0.7440	0.0009
F PBI7221-1AMB	23.9385	0.0132	0.0117	0.0006	0.3706	0.0094	0.0003	0.0041	-0.0182	0.0014	0.7811	0.0011
F PBI7221-1BMB	23.6115	-0.0063	0.0338	-0.0023	0.3488	0.0084	-0.0001	0.0206	-0.0110	0.0009	0.7950	0.0012
F PBI7221-1CMB	24.8347	-0.0040	0.0403	0.0086	0.4573	0.0093	0.0002	0.0206	-0.0175	0.0014	0.8144	0.0032
CCV	50.0054	19.9418	50.0576	49.9788	50.1478	0.5014	1.0000	5.0454	50.0955	1.0034	0.9808	1.0029
CCB	0.0312	0.0125	0.0381	0.0361	0.0196	0.0003	0.0006	0.0083	0.0266	0.0007	0.0077	0.0012

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Radiochemistry Instrument Worksheet

ALS -- Fort Collins

Prep Batch: PB170221-1

Prep Procedure: Pb210_LiqS

Analytical QASS / NCR? Y N

Prep Num	LabID	QC Type	Init Alq	Fin Alq	Units	Report Units	Cnt 1 File/Inst	Cnt 1 Rack-Pos	Cnt 1 Pos Chk By	Cnt 2 File/Inst	Cnt 2 Rack-Pos	Cnt 2 Pos Chk By	Cnt 3 File/Inst	Cnt 3 Rack-Pos	Cnt 3 Pos Chk By	Notes
1	1714005-1	SMP	1000	827.38	ml	pCi/l	1714005-1	8	1714005-1	1714005-1	8	1714005-1	1714005-1	8	1714005-1	1714005-1
1	1714005-2	SMP	1000	827.38	ml	pCi/l	1714005-2	9	1714005-2	1714005-2	9	1714005-2	1714005-2	9	1714005-2	1714005-2
1	1714005-3	SMP	1000	827.38	ml	pCi/l	1714005-3	10	1714005-3	1714005-3	10	1714005-3	1714005-3	10	1714005-3	1714005-3
1	PB170221-1A	MB	1000	826.39	ml	pCi/l	PB170221-1A	11	PB170221-1A	PB170221-1A	11	PB170221-1A	PB170221-1A	11	PB170221-1A	PB170221-1A
1	PB170221-1B	MB	1000	826.39	ml	pCi/l	PB170221-1B	12	PB170221-1B	PB170221-1B	12	PB170221-1B	PB170221-1B	12	PB170221-1B	PB170221-1B
1	PB170221-1C	MB	1000	826.39	ml	pCi/l	PB170221-1C	13	PB170221-1C	PB170221-1C	13	PB170221-1C	PB170221-1C	13	PB170221-1C	PB170221-1C

Tracer/Carrier Solution Information

Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
T1	LEAD	418231		1,001.811	pCi/ml	NA	1	ml	RS-033

Spike Solution Information

Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
S1	Pb-210	901.3610.50		1,888.885	DPM/ml	02/21/17	1	ml	RS-033
S1	Pb-210	901.3610.50		1,888.885	DPM/ml	02/21/17	1	ml	RS-033

Sample Barcodes

1714005-1 PB170221-1PS1	1714005-2 PB170221-1PS2	1714005-3 PB170221-1PS3
PB170221-1AMB PB170221-1PS4	PB170221-1BMB PB170221-1PS5	PB170221-1CMB PB170221-1PS6
PB170221-1CAR PB170221-1PS7		

Reporting Units

LabID	InstGrpName	RptUnits
1714005-1	Pb210L	pCi/l
1714005-2	Pb210L	pCi/l
1714005-3	Pb210L	pCi/l

Radiochemistry Prep Worksheet

ALS -- Fort Collins

Prep Batch: PB170221-1

Prep Procedure: Pb210_LiqS

Reviewed By: rlm Review Date: 2/23/2017

Non-Routine Pre-Treatment? Y ☒ Batch: MA Prep QASS / NCR? Y ☒ 114

Prep SOP: PAI 726 Rev: 9

Prep Analyst: Rebecca L. Merola RLM

Matrix Class: liquid

Prep Date: 2/21/2017

Prep Dept: RS

Balance: na

Balance: na

Cocktail: UGLLT

Cocktail Pipet: T-004

Aliquot Pipet: RS-038

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Aliq ml	Fin Aliq ml	Prep Basis	Ingrowth Date/Time	Standards	Prep Notes
1	1	1714005-1	SMP	<u>MA</u>	1000	827.3809	Unfiltered	02/22/17 09:20	T1, S1	
2	1	1714005-2	SMP		1000	827.3809	Unfiltered	02/22/17 09:20	T1, S1	
3	1	1714005-3	SMP		1000	827.3809	Unfiltered	02/22/17 09:20	T1, S1	
4	1	PB170221-1A	MB		1000	826.3889	Unfiltered	02/22/17 09:20	T1	
5	1	PB170221-1B	MB		1000	826.3889	Unfiltered	02/22/17 09:20	T1	
6	1	PB170221-1C	MB		1000	826.3889	Unfiltered	02/22/17 09:20	T1	

Comments

Pb21- single point calibration. Samples spiked (calibration spike) into 5ml 8N HNO3. A 0.05mL initial ICP was taken and samples loaded onto Sr spec column to remove Bi-210.

Spiked By: Rebecca L. Merola Date: 2/22/2017

Witnessed By: Hunter C. Jordan Date: 2/22/2017

Tracer/Carrier Solution Information						
Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Pipet ID
T1	LEAD	418231		1,001.811	pCi/ml	NA
					1	ml
					NA	RS-033

Spike Solution Information						
Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Pipet ID
S1	Pb-210	901.3610.50		1,888.885	DPM/ml	RS-033
					1	ml
S1	Pb-210	901.3610.50		1,888.885	DPM/ml	RS-033
					1	ml

Reagent Solution IDs*

47171749 97-15251 H04156 J26A03 K37027

*Except where otherwise noted, all reagents were applied in accordance with the specifications of the preparation methods associated with this batch.

Radiochemistry Prep Worksheet

ALS -- Fort Collins

Prep Batch: PB170221-1

Prep Procedure: Pb210_LiqS

Prep Batch Not Validated!!!

Reviewed By:

Review Date:

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

Prep SOP: PAI 726 Rev: 9

Prep SOP: NONE

Matrix Class: liquid

Prep Analyst: Rebecca L. Merola

Prep Date: 2/21/2017

Prep Dept: RS

Balance:

Balance:

Cocktail:

Cocktail Pipet:

Aliquot Pipet:

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Alq ml	Fin Alq ml	Prep Basis	Ingrowth Date/Time	Standards	Prep Notes
1	1	1714005-1	SMP		1000	827.3809	Unfiltered	2/22/17	T1,S1	
2	1	1714005-2	SMP		1000	827.3809	Unfiltered	0920	T1,S1	
3	1	1714005-3	SMP		1000	827.3809	Unfiltered		T1,S1	
4	1	PB170221-1A	MB		1000	826.3889	Unfiltered		T1	
5	1	PB170221-1B	MB		1000	826.3889	Unfiltered		T1	
6	1	PB170221-1C	MB		1000	826.3889	Unfiltered		T1	

Comments

Pb21- single point calibration. Samples spiked (calibration spike) into 5ml 8N HNO3. A 0.05mL initial ICP was taken and samples loaded onto Sr spec column to remove Bi-210.

Spiked By: Rebecca L. Merola Date: 2/22/17

Witnessed By: RLC Date: 2/22/17

Tracer/Carrier Solution Information

Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
T1	LEAD	418231	8/22/17	1,001.811	pCi/ml	NA	1	ml	RS-033

Spike Solution Information

Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
S1	Pb-210	901.3610.50	10/21/17	1,888.885	DPM/ml	02/21/17	1	ml	RS-033
S1	Pb-210	901.3610.50	8/22/17	1,888.885	DPM/ml	02/21/17	1	ml	RS-033

Reagent Solution IDs*

47171749	97-15251	H04156	J26A03	K37027
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*Except where otherwise noted, all reagents were applied in accordance with the specifications of the preparation methods associated with this batch.

Sample Condition Form (Liquid)

Analyst: *RM*

Analysis Date: 2/21/17	Method: Prep
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Analysis Date: 2/21/17	Method: Prep
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	Sample Condition (Visual Appearance of Analysis Aliquot at Time of Prep)
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[illegible]

Prep Procedure: Pb210_LiqS

Reviewed By: rim *rim*

Review Date: 3/1/2017

LEAD Recovery Results

Reference Carrier

LabID	QC Type	Car Vol	Ref Carr Dil Vol	Ref Carr ICP Alq	Ref Carr ICP Run	Ref Carr ICP Conc
PB170227-1	CAR	1	50	1	5	IR170301-2A1 3.906219

Samples

Prep Num	LabID	QC Type	Init Samp Alq (ml)	Car Vol (ml)	Samp Dil Vol (ml)	Init ICP Alq (ml)	Init ICP Dil Vol (ml)	Pre-Con Vol (ml)	Post-Con Vol (ml)	Pre-Sep Vol (ml)	Post-Sep Vol (ml)	Fin ICP Alq (ml)	Fin ICP Dil Vol (ml)	Initial ICP Run	Final ICP Run	Init ICP Conc (ug/ml)	Fin ICP Conc (ug/ml)	Init Samp Mass (ug)	Ref Mass (ug)	Flag	Fin Samp Mass (ug)	% Yield	Final Sample Alq
1	1714006-1	SMP	1000	1	1002	1	5	1001	6	5.1	5.1	0.1	0.1	IR170301-2A1	IR170301-2A1	0.19743	1.547313	839.9287	829.243		789.1296	93.95%	832.5
1	1714006-2	SMP	1000	1	1002	1	5	1001	6	5.1	5.1	0.1	0.1	IR170301-2A1	IR170301-2A1	0.19417	1.554877	826.058	829.243	LB	792.9871	95.63%	832.5
1	1714006-3	SMP	1000	1	1002	1	5	1001	6	5.1	5.1	0.1	0.1	IR170301-2A1	IR170301-2A1	0.19969	1.563869	849.5192	829.243		797.5732	93.89%	832.5
1	PB170227-1A	MB	1000	1	1001	1	5	1000	6	5.1	5.1	0.1	0.1	IR170301-2A1	IR170301-2A1	0.18835	1.554279	800.5052	829.2422	LB	792.6823	95.59%	832.5
1	PB170227-1B	MB	1000	1	1001	1	5	1000	6	5.1	5.1	0.1	0.1	IR170301-2A1	IR170301-2A1	0.19338	1.540615	821.8544	829.2422	LB	785.7136	94.75%	832.5
1	PB170227-1C	MB	1000	1	1001	1	5	1000	6	5.1	5.1	0.1	0.1	IR170301-2A1	IR170301-2A1	0.17417	1.568767	740.2247	829.2422	LB	800.0712	96.48%	832.5

12170301-2A1

Sample Id1	Ca	Fe	K	Mg	Na	Sr	Mn	S	Al	Ba	Pb	Ni
CCV	49.8731	19.9369	50.8715	50.2686	50.8990	0.5035	0.9963	4.9701	50.8612	1.0079	0.9901	1.0033
CCB	0.0219	0.0093	0.0606	0.0201	0.0256	0.0005	0.0002	0.0075	0.0244	0.0005	0.0011	0.0006
I 1714006-1	-0.0172	-0.0072	0.0441	-0.0288	-0.0083	-0.0001	-0.0006	0.0000	-0.0144	-0.0002	0.1974	0.0001
I 1714006-2	0.0125	0.0775	0.0504	-0.0359	-0.0046	-0.0001	0.0002	0.0112	-0.0106	-0.0002	0.1942	-0.0008
I 1714006-3	-0.0231	0.0157	0.0259	-0.0375	-0.0102	-0.0002	-0.0004	0.0075	-0.0069	-0.0003	0.1997	-0.0013
I PB170227-1AMB	-0.0209	-0.0119	0.0246	-0.0391	-0.0100	-0.0002	-0.0006	0.0075	-0.0119	-0.0002	0.1884	-0.0006
I PB170227-1BMB	-0.0203	-0.0077	0.0305	-0.0381	-0.0099	-0.0002	-0.0004	0.0224	0.0025	-0.0002	0.1934	-0.0008
I PB170227-1DMB	0.8775	0.0035	0.0407	-0.0272	0.0070	0.0002	0.0002	0.0187	0.0125	0.0003	0.1742	0.0011
PB170227-1RC	-0.0109	0.0658	0.0356	-0.0381	-0.0019	-0.0001	0.0003	0.0149	-0.0069	0.0000	3.9062	0.0007
F 1714006-1	46.5057	-0.0034	0.0059	-0.0125	0.9647	0.0186	0.4110	0.0112	0.0031	0.0025	1.5473	0.0014
F 1714006-2	46.5735	-0.0028	0.0034	-0.0152	0.9764	0.0178	0.1371	0.0187	0.0063	0.0024	1.5549	0.0007
F 1714006-3	46.5851	0.0025	0.0030	-0.0163	0.6196	0.0177	0.2764	0.0000	0.0006	0.0022	1.5639	0.0019
F PB170227-1AMB	46.4473	-0.0038	0.0229	-0.0158	0.6170	0.0180	0.1108	0.0075	-0.0006	0.0024	1.5543	0.0004
F PB170227-1BMB	46.5745	-0.0055	0.0466	-0.0098	0.9798	0.0179	0.0303	-0.0037	-0.0138	0.0022	1.5406	0.0007
F PB170227-1DMB	47.0991	-0.0046	0.0365	-0.0163	2.4618	0.0170	0.0224	0.0037	-0.0019	0.0019	1.5688	0.0017
CCV	49.5181	19.7109	49.9780	49.5711	50.1230	0.4953	0.9843	4.9701	49.7590	0.9916	0.9830	0.9961
CCB	0.0312	0.0125	0.0644	0.0261	0.0336	0.0006	0.0004	0.0187	0.0319	0.0005	0.0032	0.0006

AL

Radiochemistry Instrument Worksheet

ALS -- Fort Collins

Prep Batch: PB170227-1

Prep Procedure: Pb210_LiqS ILV-ICD c.m.

Analytical QASS / NCR? Y *N* *NA*

Prep Num	LabID	QC Type	Init Alq	Fin Alq	Units	Report Units	Cnt 1 File/Inst	Cnt 1 Rack-Pos	Cnt 1 Pos Chk By	Cnt 2 File/Inst	Cnt 2 Rack-Pos	Cnt 2 Pos Chk By	Cnt 3 File/Inst	Cnt 3 Rack-Pos	Cnt 3 Pos Chk By	Notes
1	1714006-1	SMP	1000	832.50	ml	pCi/l	PB-0301	2	<i>NA</i>							
1	1714006-2	SMP	1000	832.50	ml	pCi/l		3								
1	1714006-3	SMP	1000	832.50	ml	pCi/l		4								
1	PB170227-1A	MB	1000	832.50	ml	pCi/l		6								
1	PB170227-1B	MB	1000	832.50	ml	pCi/l		7								
1	PB170227-1CB	MB	1000	1000	ml	pCi/l		1								
1	PB170227-1CB	MB	1000	1000	ml	pCi/l		5								
1	PB170227-1CB	MB	1000	1000	ml	pCi/l		9								
1	PB170227-1D	MB	1000	832.50	ml	pCi/l		8								

NA 3/2/17

Tracer/Carrier Solution Information

Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
T1	LEAD	418231		1,001.811	pCi/ml	NA	1	ml	RS-033

Spike Solution Information

Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
S1	Pb-210	899.4095.66		95.764	DPM/ml	02/27/17	1	ml	RS-033
S1	Po-210	899.4095.66		95.764	DPM/ml	02/27/17	1	ml	RS-033

Sample Barcodes

1714006-1 PB170227-1PS1		1714006-2 PB170227-1PS2		1714006-3 PB170227-1PS3	
PB170227-1AMB PB170227-1PS4		PB170227-1BMB PB170227-1PS5		PB170227-1CB1MB PB170227-1PS6	
PB170227-1CB2MB PB170227-1PS7		PB170227-1CB3MB PB170227-1PS8		PB170227-1DMB PB170227-1PS9	
PB170227-1ICAR PB170227-1PS10					

Reporting Units

LabID	TstGrpName	RptUnits
1714006-1	Pb210L	pCi/l
1714006-2	Pb210L	pCi/l
1714006-3	Pb210L	pCi/l

Prep Procedure: Pb210 LiqS

Reviewed By:  rlm
Review Date: 3/1/2017

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

Prep QASS / NCR? Y / ~~N~~ MA

Prep SOP: PAI 726 Rev: 9

Prep Analyst: Rebecca L. Merola *RLM*
Prep Date: 2/27/2017

Balance: NA

Prep SOP: NONE

Prep Date: 2/27/2017

Cocktail Pipet: T-004

Matrix Class: liquid

Prep Dept: RS

Aliquot Pipet:

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Aliq ml	Fin Aliq ml	Prep Basis	Ingrowth Date/Time	Standards	Prep Notes
1	1	1714006-1	SMP	<i>NA</i>	1000	832.5017	Unfiltered	03/01/17 08:40	T1, S1	
2	1	1714006-2	SMP		1000	832.5017	Unfiltered	03/01/17 08:40	T1, S1	
3	1	1714006-3	SMP		1000	832.5017	Unfiltered	03/01/17 08:40	T1, S1	
4	1	PB170227-1A	MB		1000	832.5009	Unfiltered	03/01/17 08:40	T1	
5	1	PB170227-1B	MB		1000	832.5009	Unfiltered	03/01/17 08:40	T1	
6	1	PB170227-1CB1	MB		1000	1000	Unfiltered	03/01/17 08:40		
7	1	PB170227-1CB2	MB		1000	1000	Unfiltered	03/01/17 08:40		
8	1	PB170227-1CB3	MB		1000	1000	Unfiltered	03/01/17 08:40		
9	1	PB170227-1C	MB		1000	832.5009	Unfiltered	03/01/17 08:40	T1	

Comments

Pb210 ICVs and ICBs. MBD was changed to MBC due importing issues.

Spiked By: Rebecca L. Merola **Date:** 2/27/2017

Witnessed By: Macey S. Hall **Date:** 2/27/2017

Spiked By: Rebecca L. Mero

Witnessed By: Macey S. Hall

Tracer/Carrier Solution Information									
Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
T1	LEAD	418231		1.001811	pCi/ml	NA	1	ml	RS-033

Spike Solution Information									
Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
S1	Pb-210	899.4095.66		95.764	DPM/ml	02/27/17	1	ml	RS-033
S1	Po-210	899.4095.66		95.764	DPM/ml	02/27/17	1	ml	RS-033

Reagent Solution IDs*
47171749
97-15251
H04156
J26A03
K37027

Except where otherwise noted, all reagents were applied in accordance with the specifications of the preparation methods associated with this batch.

Radiochemistry Prep Worksheet

ALS -- Fort Collins

Prep Batch: PB170227-1

Prep Procedure: Pb210_LiqS

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 726 Rev: 9

Prep SOP: NONE

Matrix Class: liquid

Prep Analyst: Rebecca L. Merola

Prep Date: 2/27/2017

Prep Dept: RS

Balance: NA

Balance: NA

Cocktail: UGLLT

Cocktail Pipet: T-004

Aliquot Pipet:

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Aliq ml	Fin Aliq ml	Prep Basis	Ingrowth Date/Time	Standards	Prep Notes
1	1	1714006-1	SMP		1000	832.5017	Unfiltered	8/27/17 0840	T1, S1	
2	1	1714006-2	SMP		1000	832.5017	Unfiltered		T1, S1	
3	1	1714006-3	SMP		1000	832.5017	Unfiltered		T1, S1	
4	1	PB170227-1A	MB		1000	832.5009	Unfiltered		T1	
5	1	PB170227-1B	MB		1000	832.5009	Unfiltered		T1	
6	1	PB170227-1CB1	MB		1000	1000	Unfiltered			
7	1	PB170227-1CB2	MB		1000	1000	Unfiltered			
8	1	PB170227-1CB3	MB		1000	1000	Unfiltered			
9	1	PB170227-1D	MB		1000	832.5009	Unfiltered		T1	

Comments

Pb210 ICVs and ICBs

Spiked By: Rebecca L. Merola Date: 2/27/17

Witnessed By: MSH Date: 2/27/17

Tracer/Carrier Solution Information						
Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Pipet ID
T1	LEAD	418231	8/27/17	1,001.811	pCi/ml	NA
						RS-033

Spike Solution Information						
Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Pipet ID
S1	Pb-210	899.4095.66	10/21/17	95.764	DPM/ml	RS-033
S1	Pb-210	899.4095.66		95.764	DPM/ml	RS-033

Reagent Solution IDs*

47171749 97-15251 H04156 J26A03 K37027

*Except where otherwise noted, all reagents were applied in accordance with the specifications of the preparation methods associated with this batch.

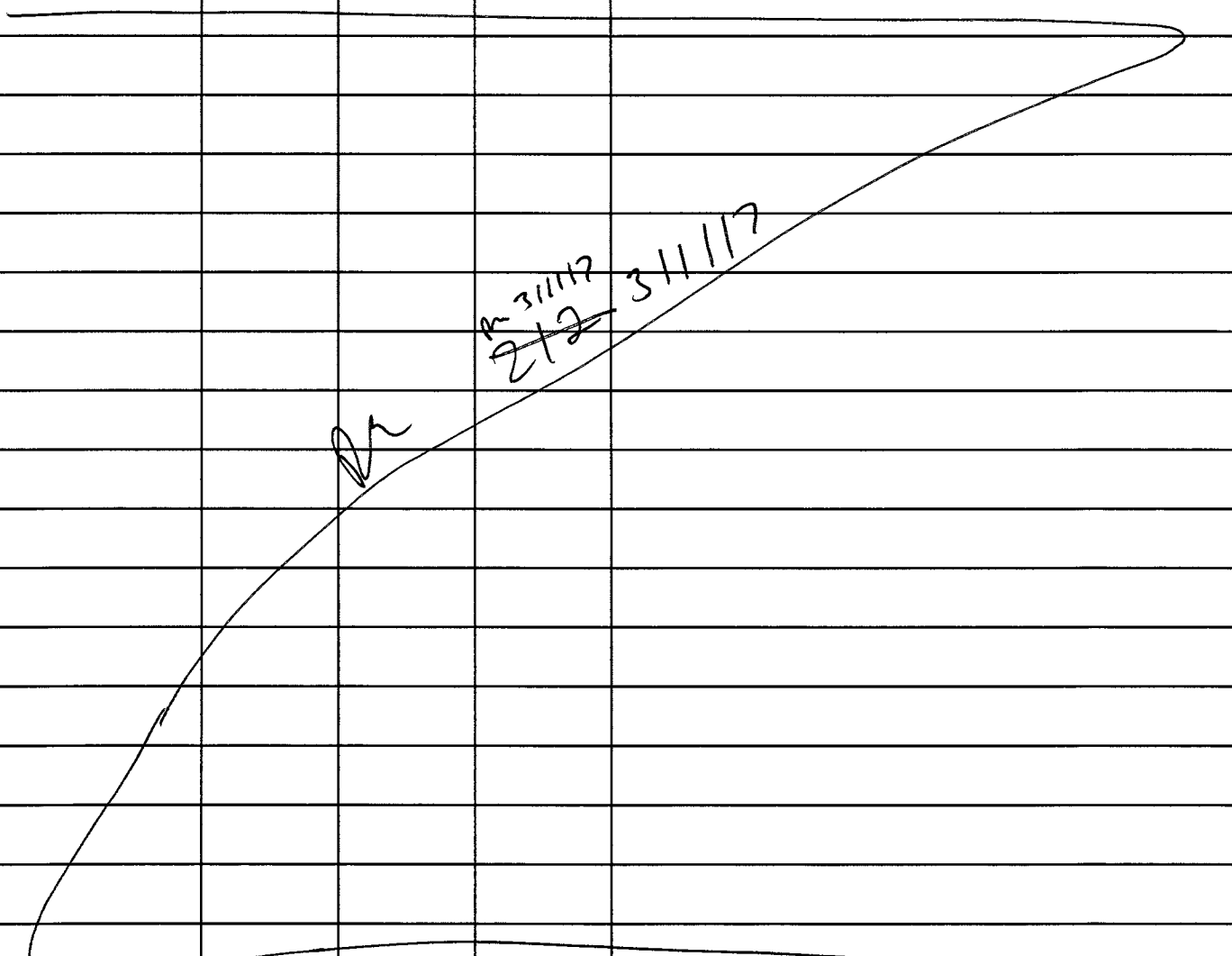
Sample Condition Form (Liquid)

Analyst: PH

Analysis Date: 2/27/17

Method: *Pcep*

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

Work Order	Sample ID	pH	Color	Remarks
1714006	1	6.0	clear	DI water
↓	2	↓	↓	↓
↓	3	↓	↓	↓
				
<p> 2/2 3/1/17 3/1/17 2/2 </p>				

Q1220 Pb-210 Background Determination

Interim control limits are established from the initial calibration for the analysis and geometry of interest OR from the initial batch calibration blank data set acquired after the instrument re-calibration. Limits are +/- 3 standard deviations (counting unc.) from the initial calibration blank data. Once enough historical data is acquired, new historical limits are set as follows: Control limits for reagent blanks are established from 30 individual historical data points (10 batches). Limits are +/- 3 standard deviations from 30 individual historical data points. Individual reagent blanks and the average of reagent blanks from each batch are in control if the Count Rate (CPM) is within the established control limits.

CURRENTLY UNDER HISTORICAL LIMITS

Updated on 05/30/13 NES									
COUNT DATE	#	Sample ID	Count Duration (m)	Count Rate (CPM)	Total Cts.	Mean	Individual Reagent Blanks		
							LCL	UCL	Pass ?
3/1/2017	613	PB170227-1CB1	59.3	2.8	166.04		2.0410	4.2714	PASS
3/1/2017	614	PB170227-1CB2	59.3	3	177.9		2.0410	4.2714	PASS
3/2/2017	615	PB170227-1CB3	59.3	3.35	198.655	3.050	2.0410	4.2714	PASS
							LCL	UCL	Pass ?
							2.0410	4.2714	PASS

AL
3/2/17

Pb-210 "Window 2" Control Limits (Q1220)

The background count rate is determined from the average of the reagent blanks for the batch.
Window 2 control limits are established using the average count rate from the three reagent blanks associated with each prep batch +/- 3X the estimated poisson uncertainty.

Updated on 01/11/2010. MH

COUNT DATE	OBS #	Sample ID	Count Duration (min.)	Average count Duration (min.)	Count Rate (CPM)	Batch Average Reagent Blank	Lower Control Limit	Upper Control Limit
3/1/2017	613	PB170227-1CB1	59.3	59.3	0.57	0.646666667	0.333	0.960
3/1/2017	614	PB170227-1CB2	59.3		0.65			
3/2/2017	615	PB170227-1CB3	59.3		0.72			
		177.7 MIN CTS	177.7				0.466	0.828
		29.6 MIN CTS	29.6				0.203	1.090

M
3/2/17

DAILY INSTRUMENT PERFORMANCE CHECKS - QUANTULUS			
Daily IPCs consist of the following standards:			
Efficiency Checks		Background checks	
PerkinElmer Tritium Standard Lot: Dec. 14, 2015 211100.00 dpm 12/14/15 REF 12/14/20 EXP	PerkinElmer C-14 Standard Lot: Dec. 14, 2015 95600.00 dpm 12/14/15 REF 12/14/20 EXP	ALS-Laboratory Group-Ft Collins Blank EXP 9/25/16 NEW REAGENT BLANK AS OF 9/25/2015	
Historical limits	as of 05/24/2016		
Decay Corrected Tritium 115276.62 114665.81 114055.00	Carbon-14 91586.33 91319.48 91052.63	H3 window cpm 20.71 16.22 11.73	Quench Factor 743.24 735.31 727.39
UCL			C14 window cpm 13.69 10.13 6.58
Mean Value			
LCL			

NEW STANDARDS REC'D 05/2016 LC

Obs	Filename	Date	H-3 CPM	Decay Corrected H-CPM	C-14 CPM	ALS Reagent blank H3 WINDOW CPM	ALS RB Quench SQ(E)	ALS Reagent blank C14 WINDOW CPM
177	QC-0223	2/23/2017	107582.14	115098.47	91413.1	OK	736.3	OK
178	QC-0224	2/24/2017	107366.31	114885.31	91336.65	OK	737.18	OK
179	QC-0225	2/25/2017	107355.5	114891.50	91372.36	OK	739.77	OK
180	QC-0226	2/26/2017	107185.28	114727.06	91220.88	OK	738.2	OK
181	QC-0301	3/1/2017	107736.12	115370.13	91463.42	High	736.27	OK
182	QC-0302	3/2/2017	107505.1	115140.53	91397.33	OK	738.95	OK

AL
3/2/17

Prepare a Calibration Source dilution of
RSO # 901.

Density of 1 M HNO₃ lot # H 24026 + 085045
Mass of 100 ml Volumetric flask 66.4330g
Mass of flask + Acid 169.3090g
Net Mass 102.874g
 $\rho = 1.02874 \text{ g/ml}$

Mass of RSO 901 Transferred
Mass of Open, full Ampule + Beaker 37.7424g
Mass of Empty Ampule + Beaker 32.7255g
Net Mass transferred 5.0169g

Dilute to Final Mass
Mass of Std. Diluent + 1000 ml Xylene 1137.5g
Mass of Xylene (empty) 74.8127g
Net Mass of New dilution 1062.6873g

Final Activity

$$9.037 \text{ KBq} \left(\frac{10^3 \text{ Bq}}{1 \text{ KBq}} \right) \left(\frac{60 \text{ dpm}}{1 \text{ Bq}} \right) \left(\frac{5.0169 \text{ g}}{1062.6873 \text{ g}} \right) \left(\frac{1.02874 \text{ g/ml}}{1 \text{ g}} \right) = 2633.37 \text{ dpm/ml}$$

12/23/09

Std ID: 901.3610.50

Description: Pb-210

Expiration: 10/13/2011

Activity: 2633.37 dpm/mL

2s Uncertainty: 63.20 dpm/mL

Ref. Date: 6/15/2008

Ref Time: N/A

Prep Date: 12/23/2009 Prep by: JD

Matrix/Comp. 1M HNO₃

Half Life (y): 2.22E+01

Reverification Log		
Analysis Date	Initials	Expiration Date
10/11/2011	RG	10/11/2012
10/17/2012	MC	10/17/2013
10/23/2013	JP	10/23/2014
10/27/2014	JP	10/27/2015
10/26/2015	JP	10/26/2016
10/21/2016	JP	10/21/2017

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12/23/09

Date



Signed

11/1/10

Date



National Institute of Standards & Technology Certificate

RSO#
901

REC
11-2-2009

Standard Reference Material 4337 Lead-210 Radioactivity Standard

This Standard Reference Material (SRM) consists of a solution of a standardized and certified quantity of radioactive lead-210 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 lead-210 massic activity value, at a Reference Time of 1200 EST, 15 June 2006, is:

$$(9.037 \pm 0.22) \text{ kBq} \cdot \text{g}^{-1}$$

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. Unterwiesing, Acting Group Leader. The overall technical direction and physical measurements leading to certification were provided by Drs. R. Collé, and L. Laureano-Pérez of the Radioactivity Group with production assistance by D.B. Golas and O. Palabrica, Research Associates of the Nuclear Energy Institute and with measurement assistance by Drs. L. Outola, L. Pibida and R. Fitzgerald 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.

Lisa R. Karam, Deputy Chief
Ionizing Radiation Division

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

Gaithersburg, Maryland 20899
November 2006

SRM 4337 page 1 of 4

*Notes and references are in page 4.

Table 2. Uncertainty evaluation for the massic activity for SRM 4337

Uncertainty component		Assessment Type [†]	Relative standard uncertainty contribution on massic activity of ²¹⁰ Pb (%)
1	LS within measurement precision; typical standard deviation of the mean for 7 to 11 repeated measurements; values ranged from 0.008 % to 0.056 %	A	0.03
2	LS measurement precision; reproducibility in massic activity for 7 to 11 samples in two measurement series with three counters on two to three measurement occasions; standard deviation of the mean for $\nu = 443$ degrees freedom	A	0.067
3	Background LS measurement variability; wholly embodied in components 1 & 2	A	—
4	Scintillator dependencies; wholly embodied in components 1 & 2	A	—
5	LS cocktail stability and composition mismatch effect	B	0.35
6	Gravimetric (mass) measurements for LS sources and for ³ H standard dilution	B	0.07
7	Live time determinations for LS counting time intervals, includes uncorrected dead time effects	B	0.06
8	Decay corrections for ²¹⁰ Pb	B	0.002
9	Decay corrections for ³ H	B	0.0005
10	Limit for photon-emitting impurities	B	0.02
11	Beta endpoint energy, $E_{\beta(\max)}$ for ²¹⁰ Pb for an uncertainty of 0.5 keV	B	0.033
12	Beta decay branching ratios for ²¹⁰ Pb for an uncertainty of 0.03	B	0.39
13	$E_{\beta(\max)}$ for ²¹⁰ Bi for an uncertainty of 1.5 keV	B	0.001
14	Computed β detection efficiency for ²¹⁰ Pb	B	1.1
15	Computed β detection efficiency for ²¹⁰ Bi	B	0.04
16	Assumed α detection efficiency for ²¹⁰ Po, including extrapolation to zero energy	B	0.05
Relative combined standard uncertainty			1.2
Relative expanded uncertainty ($k = 2$)			2.4

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

Table 1. Properties of SRM 4337

Certified values

Radionuclide	Lead-210
Reference time	1200 EST, 15 June 2006
Massic activity of the solution	9.037 kBq·g ⁻¹
Relative expanded uncertainty (<i>k</i> = 2)	2.4 % (see Note 2)*

Uncertified information

Source description	Liquid in flame-sealed, 5 mL NIST borosilicate ampoule (see Note 1)
Solution composition	1.0 mol·L ⁻¹ HNO ₃ with 21 µg Bi ⁺³ and 11 µg Pb ⁺² per gram of solution
Solution density	(1.028 ± 0.002) g·mL ⁻¹ at 20.0 °C [†] (see Note 3)
Solution mass	(5.133 ± 0.002) g (see Note 3)
Photon-emitting impurities	None detected (see Note 4)
Half-lives used	²¹⁰ Pb : (22.20 ± 0.22) a [†] ³ H : (12.32 ± 0.02) a [†]
Nuclear data used in CN2003 computations (beta-particle maximum energies; branching ratios; transitions) [1]	³ H : (18.394 ± 0.008) keV [†] ; 1, allowed ²¹⁰ Pb : (63.5 ± 0.5) keV [†] ; (0.16 ± 0.03); non-unique first forbidden (17.0 ± 0.5) keV [†] ; (0.84 ± 0.03); non-unique first forbidden ²¹⁰ Bi : (1162.1 ± 1.5) keV [†] ; 1; non-unique first forbidden
Calibration method (and instruments)	The certified massic activity for ²¹⁰ Pb in radioactive equilibrium with ²¹⁰ Bi and ²¹⁰ Po was obtained by 4π $\alpha\beta$ liquid scintillation (LS) spectrometry with three commercial LS counters. The LS detection efficiency was calculated using the CN2003 code [2] for the CIEMAT/NIST method with composition matched LS cocktails of a ³ H standard as the efficiency detection monitor. Confirmatory measurements were also performed by high-resolution HPGe gamma-ray spectrometry, by 2π α spectrometry of separated ²¹⁰ Po with a Si surface barrier detector, and by 4π β (LS) - γ (NaI) anticoincidence counting.

[†] See Note 5

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, $U = k u_c$. The quantity u_c is the combined standard uncertainty calculated according to the ISO and NIST Guides (see references [3] and [4]). 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 [4].

Note 4. The estimated lower limits of detection for photon-emitting impurities, expressed as massic photon emission rates, on 27 December 2005, were:

1.7 s⁻¹ g⁻¹ for 20 keV < E < 60 keV

0.3 s⁻¹ g⁻¹ for 60 keV < E < 1800 keV

Note 5. The stated uncertainty is the standard uncertainty. See reference [4].

REFERENCES

- [1] Evaluated Nuclear Structure Data File (ENSDF), online database, National Nuclear Data Center, Brookhaven Laboratory (Upton, NY), October 2006. Refer to <http://www.nndc.bnl.gov/ensdf/>
- [2] E. Gunther, Physikalisch-Technische Bundesanstalt (Braunschweig, Germany), private communication, 2003.
- [3] 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.
- [4] 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.

Pb-210 899.4095.66 working standard

Prepare a working dilution of 899.3610.42

1. Density of 1M HNO₃, lot # 0000084176

Mass of 100mL vol. flask:

56.4468g

Balance # 12

Mass of flask & 100mL acid:

159.4521g

Balance# 12

Net Mass:

103.0053g

Density:

1.0301 g/mL

2. Mass of 899.3610.42 transferred:

Mass of open empty nalgene:

74.5139g

Balance# 12

Mass of nalgene & standard:

77.1985g

Balance# 12

Net mass of standard transferred:

2.6846g

Balance# NA

3. Dilute to final volume:

Mass of nalgene, standard, & diluent:

1147.7g

Balance# 26

Mass of empty nalgene (from above):

74.5139g

Balance# 12

Net mass of new dilution:

1073.1861g

Balance# NA

4. Final activity calculation:

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

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

Std ID: 899.4095.66

Description: Pb-210

Expiration: 10/26/2016

Activity: 121.10 dpm/mL

2s Uncertainty: 3.39 dpm/mL

Ref. Date: 8/10/2009

Ref Time: N/A

Prep Date: 12/8/2014 Prep by: TE

Matrix/Comp. 1 M HNO₃

Half Life (y): 2.22E+01

Reverification Log

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

Continued on Page

Signed

Date

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Signed

Date

R50#
899

rec
8-14-09

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

CERTIFICATE OF CALIBRATION Standard Radionuclide Source

80328-307

Pb-210 8 mL Liquid in Flame Sealed Vial

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

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

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

*Uncertainty: U - Relative expanded uncertainty, k = 2. See NIST Technical Note 1297, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results."

Comments:

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

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

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

Date: 8-13-09



Corporate Office

24937 Avenue Tibbitts Valencia, California 91355

Laboratory

1380 Seaboard Industrial Blvd. Atlanta, Georgia, 30318

50
PROJECT 708

500 12/23/09

901.3610.50

Pb-210

Notebook No. 3610

Continued From Page 4/4

Prepare a Calibration Source dilution of
RSD # 901.

Density of 1 M HNO₃ 1.02874 g/mL
Mass of 100 ml Volumetric flask 66.4330 g
Mass of flask + HNO₃ 169.3090 g
Net Mass 102.874 g
 $\rho = 1.02874 \text{ g/mL}$

Mass of RSD 901 Transferred

Mass of Open, full Ampule + Beaker 37.7424 g
Mass of Empty Ampule + Beaker 32.7255 g
Net Mass transferred 5.0169 g

Dilute to Final Mass

Mass of Std, Diluent + 1000 ml Hexane 1137.5 g
Mass of Hexane (Empty) 74.8123 g
Net Mass of the dilution 1062.6873 g

Final Activity

$9.037 \text{ kBq} (10^3 \text{ Bq}) (60 \text{ dpm}) (5.0169 \text{ g}) (1.02874 \text{ g/mL}) = 2633.37 \text{ dpm/mL}$
 $9.037 \text{ kBq} (10^3 \text{ Bq}) (1 \text{ Bq}) (5.133 \text{ g}) (1062.6873 \text{ g}) = 2633.37 \text{ dpm/mL}$

Std ID: 901.3610.50

Description: Pb-210

Expiration: 10/13/2011

Activity: 2633.37 dpm/mL

2s Uncertainty: 63.20 dpm/mL

Ref. Date: 6/15/2008

Ref Time: N/A

Prep Date: 12/23/2009 Prep by: JD

Matrix/Comp. 1M HNO₃

Half Life (y): 2.22E+01

Reverification Log

Analysis Date	Initials	Expiration Date
10/11/2011	RG	10/11/2012
10/17/2012	MC	10/17/2013
10/23/2013	JP	10/23/2014
10/27/2014	JP	10/27/2015
10/26/2015	JP	10/26/2016
10/21/2016	JP	10/21/2017

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Signed

12/23/09

Date



Signed

1/16/10

Date



National Institute of Standards & Technology

Certificate

RSO#
901

REC
11-2-2009

Standard Reference Material 4337 Lead-210 Radioactivity Standard

This Standard Reference Material (SRM) consists of a solution of a standardized and certified quantity of radioactive lead-210 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 lead-210 massic activity value, at a Reference Time of 1200 EST, 15 June 2006, is:

$$(9.037 \pm 0.22) \text{ kBq} \cdot \text{g}^{-1}$$

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 Drs. R. Collé, and L. Laureano-Pérez of the Radioactivity Group with production assistance by D.B. Golas and O. Palabrica, Research Associates of the Nuclear Energy Institute and with measurement assistance by Drs. I. Outola, L. Pibida and R. Fitzgerald 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.

Lisa R. Karam, Deputy Chief
Ionizing Radiation Division

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

Gaithersburg, Maryland 20899
November 2006

SRM 4337 page 1 of 4

*Notes and references are in page 4

Table 2. Uncertainty evaluation for the massic activity for SRM 4337

Uncertainty component		Assessment Type [†]	Relative standard uncertainty contribution on massic activity of ^{210}Pb (%)
1	LS within measurement precision; typical standard deviation of the mean for 7 to 11 repeated measurements; values ranged from 0.008 % to 0.056 %	A	0.03
2	LS measurement precision; reproducibility in massic activity for 7 to 11 samples in two measurement series with three counters on two to three measurement occasions; standard deviation of the mean for $\nu = 443$ degrees freedom	A	0.067
3	Background LS measurement variability; wholly embodied in components 1 & 2	A	—
4	Scintillator dependencies; wholly embodied in components 1 & 2	A	—
5	LS cocktail stability and composition mismatch effect	B	0.35
6	Gravimetric (mass) measurements for LS sources and for ^3H standard dilution	B	0.07
7	Live time determinations for LS counting time intervals, includes uncorrected dead time effects	B	0.06
8	Decay corrections for ^{210}Pb	B	0.002
9	Decay corrections for ^3H	B	0.0005
10	Limit for photon-emitting impurities	B	0.02
11	Beta endpoint energy, $E_{\beta(\text{max})}$ for ^{210}Pb for an uncertainty of 0.5 keV	B	0.033
12	Beta decay branching ratios for ^{210}Pb for an uncertainty of 0.03	B	0.39
13	$E_{\beta(\text{max})}$ for ^{210}Bi for an uncertainty of 1.5 keV	B	0.001
14	Computed β detection efficiency for ^{210}Pb	B	1.1
15	Computed β detection efficiency for ^{210}Bi	B	0.04
16	Assumed α detection efficiency for ^{210}Po , including extrapolation to zero energy	B	0.05
Relative combined standard uncertainty			1.2
Relative expanded uncertainty ($k = 2$)			2.4

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

Table 1. Properties of SRM 4337

Certified values	
Radionuclide	Lead-210
Reference time	1200 EST, 15 June 2006
Massic activity of the solution	9.037 kBq·g ⁻¹
Relative expanded uncertainty ($k = 2$)	2.4 % (see Note 2)*

Uncertified information	
Source description	Liquid in flame-sealed, 5 mL NIST borosilicate ampoule (see Note 1)
Solution composition	1.0 mol·L ⁻¹ HNO ₃ with 21 µg Bi ⁺³ and 11 µg Pb ⁺² per gram of solution
Solution density	(1.028 ± 0.002) g·mL ⁻¹ at 20.0 °C [†] (see Note 3)
Solution mass	(5.133 ± 0.002) g (see Note 3)
Photon-emitting impurities	None detected (see Note 4)
Half-lives used	²¹⁰ Pb : (22.20 ± 0.22) a [†] ³ H : (12.32 ± 0.02) a [†]
Nuclear data used in CN2003 computations (beta-particle maximum energies; branching ratios; transitions) [1]	³ H : (18.594 ± 0.008) keV [†] ; 1, allowed ²¹⁰ Pb : (63.5 ± 0.5) keV [†] ; (0.16 ± 0.03); non-unique first forbidden (17.0 ± 0.5) keV [†] ; (0.84 ± 0.03); non-unique first forbidden ²¹⁰ Bi : (1162.1 ± 1.5) keV [†] ; 1; non-unique first forbidden
Calibration method (and instruments)	The certified massic activity for ²¹⁰ Pb in radioactive equilibrium with ²¹⁰ Bi and ²¹⁰ Po was obtained by 4πβ liquid scintillation (LS) spectrometry with three commercial LS counters. The LS detection efficiency was calculated using the CN2003 code [2] for the CIEMAT/NIST method with composition matched LS cocktails of a ³ H standard as the efficiency detection monitor. Confirmatory measurements were also performed by high-resolution HPGe gamma-ray spectrometry, by 2πα spectrometry of separated ²¹⁰ Po with a Si surface barrier detector, and by 4πβ(LS) - γ(NaI) anticoincidence counting.

[†] See Note 5

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, $U = k u_c$. The quantity u_c is the combined standard uncertainty calculated according to the ISO and NIST Guides (see references [3] and [4]). 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 [4].

Note 4. The estimated lower limits of detection for photon-emitting impurities, expressed as massic photon emission rates, on 27 December 2005, were:

$1.7 \text{ s}^{-1} \text{ g}^{-1}$ for $20 \text{ keV} < E < 60 \text{ keV}$

$0.3 \text{ s}^{-1} \text{ g}^{-1}$ for $60 \text{ keV} < E < 1800 \text{ keV}$.

Note 5. The stated uncertainty is the standard uncertainty. See reference [4].

REFERENCES

- [1] Evaluated Nuclear Structure Data File (ENSDF), online database, National Nuclear Data Center, Brookhaven Laboratory (Upton, NY), October 2006. Refer to <http://www.nndc.bnl.gov/ensdf/>
- [2] E. Gunther, Physikalisch-Technische Bundesanstalt (Braunschweig, Germany), private communication, 2003.
- [3] 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.
- [4] 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.

Liquid Scintillation Counter

Quality Control Data

Daily Instrument Performance Checks

DAILY INSTRUMENT PERFORMANCE CHECKS - QUANTULUS

Daily IPCs consist of the following standards:

Efficiency Checks		Background checks	
PerkinElmer Tritium Standard Lot: Dec. 14, 2015 211100.00 dpm 12/14/15 REF 12/14/20 EXP		ALS-Laboratory Group-Ft Collins Blank EXP 9/25/17 NEW REAGENT BLANK AS OF 9/25/2016	
Historical limits		as of 05/24/2016	
UCL	Decay Corrected Tritium	H3 window cpm	Quench Factor
Mean Value	115276.62	20.71	743.24
LCL	114665.81	16.22	735.31
	114055.00	11.73	727.39
			C14 window cpm
			13.69
			10.13
			6.58

NEW STANDARDS REC'D 05/2016 LC

Obs	Filename	Date	H-3 CPM	Decay Corrected H-CPM	C-14 CPM	ALS Reagent blank H3 WINDOW CPM	ALS RB Quench SQP(E)	ALS Reagent blank C14 WINDOW CPM
229	QC-0516	5/15/2017	105863.96	114686.90	OK	OK	733.1	OK
230	QC-0517	5/17/2017	106171.9	115056.07	OK	OK	739.65	OK
					91445.02	16.66	733.1	10.09
					91321.27	16.76	739.65	9.59

5/17/17