



facility 755652

facility 755653

project 10243

Gross Alpha/Beta Case Narrative

COGCC

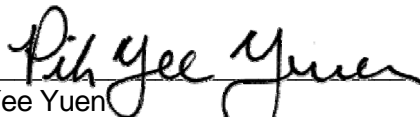
PW NORM 2017 – 10048

Work Order Number: 1706286

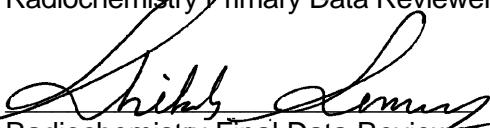
1. This report consists of the analytical results and supporting documentation for two water samples received by ALS on 06/13/2017.
2. These samples were prepared according to the current revisions of SOP 702 and SOP 786.
3. The samples were analyzed for gross alpha and beta activity by gas flow proportional counting according to the current revision of SOP 724. The analyses were completed on 06/18/2017. Gross alpha results are referenced to ^{230}Th . Gross beta results are referenced to ^{137}Cs .
4. The analysis results for these samples are reported in units of pCi/L. The samples were not filtered prior to analysis.
5. 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 in batch GA170614-1.
6. Gross alpha activity is reported in the method blank GA170614-1MB above the achieved minimum detectable concentration value, as indicated with a "B3" qualifier on the final reports. The measured blank activity is below the requested MDC. Results are acceptable according to the current revision of SOP 715, and are submitted without further qualification.
7. The requested MDC for gross alpha/beta for samples 1706286-1 and -3 was not achieved. The reported activity exceeds the achieved MDC. The results are flagged with an "M3" qualifier on the final reports. Results are submitted without further qualification.
8. No further anomalous situations were encountered during the preparation or analysis of these samples. All remaining quality control criteria were met.



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


Pik Yee Yuen
Radiochemistry Primary Data Reviewer

7/24/17
Date


Radiochemistry Final Data Reviewer

7/26/17
Date

Section 1

CHAIN OF CUSTODY

ALS -- Fort Collins

Sample Number(s) Cross-Reference Table

OrderNum: 1706286

Client Name: COGCC

Client Project Name: PW NORM 2017

Client Project Number: 10048

Client PO Number: CT 2017-3066

Client Sample Number	Lab Sample Number	COC Number	Matrix	Date Collected	Time Collected
755652 Coalview	1706286-1		WATER	13-Jun-17	10:16
755652 Coalview	1706286-2		WATER	13-Jun-17	10:16
755653 Oscar Y	1706286-3		WATER	13-Jun-17	11:36
755653 Oscar Y	1706286-4		WATER	13-Jun-17	11:36



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

Chain-of-Custody

ALS WORKORDER #

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

[illegible]



TF: (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 #

17829071

[illegible]



ALS Environmental - Fort Collins
CONDITION OF SAMPLE UPON RECEIPT FORM

Client: COGCC

Workorder No: 1706286

Project Manager: SS

Initials: JNS

Date: 6/13/17

1. Does this project require any special handling in addition to standard ALS procedures?		YES	<u>NO</u>
2. Are custody seals on shipping containers intact?	<u>NONE</u>	YES	NO
3. Are Custody seals on sample containers intact?	<u>NONE</u>	YES	NO
4. Is there a COC (Chain-of-Custody) present or other representative documents?		<u>YES</u>	NO
5. Are the COC and bottle labels complete and legible?		<u>YES</u>	NO
6. Is the COC in agreement with samples received? (IDs, dates, times, no. of samples, no. of containers, matrix, requested analyses, etc.)		<u>YES</u>	NO
7. Were airbills / shipping documents present and/or removable?	<u>DROP OFF</u>	YES	NO
8. Are all aqueous samples requiring preservation preserved correctly? (excluding volatiles)	N/A	<u>YES</u>	NO
9. Are all aqueous non-preserved samples pH 4-9?	N/A	<u>YES</u>	NO
10. Is there sufficient sample for the requested analyses?		<u>YES</u>	NO
11. Were all samples placed in the proper containers for the requested analyses?		<u>YES</u>	NO
12. Are all samples within holding times for the requested analyses?		<u>YES</u>	NO
13. Were all sample containers received intact? (not broken or leaking, etc.)		<u>YES</u>	NO
14. Are all samples requiring no headspace (VOC, GRO, RSK/MEE, Rx CN/S, radon) headspace free? Size of bubble: <u> </u> < green pea <u> </u> > green pea	N/A	<u>YES</u>	NO
15. Do any water samples contain sediment? Amount Amount of sediment: <u> </u> dusting <u>X</u> moderate <u> </u> heavy	N/A	<u>YES</u>	NO
16. Were the samples shipped on ice?		<u>YES</u>	NO
17. Were cooler temperatures measured at 0.1-6.0°C? IR gun used*: #2 <u>#4</u>	RAD ONLY	<u>YES</u>	NO
Cooler #:	<u>1</u>	<u>2</u>	<u>3</u>
Temperature (°C):	<u>amb</u>	<u>amb</u>	<u>4</u>
No. of custody seals on cooler:	<u>0</u>	<u>0</u>	<u>0</u>
External µR/hr reading:	<u>1.2</u>		
Background µR/hr reading:	<u>1.0</u>		
Were external µR/hr readings ≤ two times background and within DOT acceptance criteria? YES / NO <u>NA</u> (If no, see Form 008.)			

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

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

Project Manager Signature / Date: Philab

Section 2



SAMPLE RESULTS SUMMARY

Gross Alpha(Co-Precipitation) Analysis by GFPC Sample Results Summary

Client Name: COGCC

Client Project Name: PW NORM 2017

Client Project Number: 10048

Laboratory Name: ALS -- Fort Collins

PAI Work Order: 1706286

Page: 1 of 1

Reported on: Monday, July 17, 2017

10:18:35 AM

Lab Sample ID	Client Sample ID	Sample Type	Nuclide	Result +/- 2 s TPU	MDC	DL	Units	Matrix	Prep Batch	Date Analyze	Flags
1706286-1	755652 Coalview	Sample	GROSS ALPHA	1.94E+02 +/- 3.2E+01	4E+00	NA	pCi/l	WATER	GA170614-1	6/17/2017	M3
1706286-3	755653 Oscar Y	Sample	GROSS ALPHA	4.59E+01 +/- 8.5E+00	3.9E+00	NA	pCi/l	WATER	GA170614-1	6/17/2017	M3

Comments:

Data Package ID: GB1706286-2

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

Gross Beta by GFPC Sample Results Summary

Client Name: COGCC
Client Project Name: PW NORM 2017
Client Project Number: 10048
Laboratory Name: ALS -- Fort Collins
PAI Work Order: 1706286

Page: 1 of 1
Reported on: Monday, July 17, 2017
10:05:56 AM

Lab Sample ID	Client Sample ID	Sample Type	Nuclide	Result +/- 2 s TPU	MDC	DL	Units	Matrix	Prep Batch	Date Analyze	Flags
1706286-1	755652 Coalview	Sample	GROSS BETA	1.06E+02 +/- 2.5E+01	2.7E+01	NA	pCi/l	WATER	AB170614-1	6/16/2017	M3
1706286-3	755653 Oscar Y	Sample	GROSS BETA	1.18E+02 +/- 2.7E+01	2.9E+01	NA	pCi/l	WATER	AB170614-1	6/16/2017	M3

Comments:

Data Package ID: GB1706286-1

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



Gross Alpha(Co-Precipitation) Analysis by GFPC

PAI 724 Rev 12

Method Blank Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1706286

Client Name: COGCC

ClientProject ID: PW NORM 2017 10048

Lab ID: GA170614-1MB

Sample Matrix: WATER

Prep SOP: PAI 786 Rev 7

Date Collected: 14-Jun-17

Date Prepared: 14-Jun-17

Date Analyzed: 17-Jun-17

Prep Batch: GA170614-1

QCBatchID: GA170614-1-1

Run ID: GA170614-1A

Count Time: 1000 minutes

Final Aliquot: 500 ml

Result Units: pCi/l

File Name: aba0617b

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
12587-46-1	GROSS ALPHA	4.6E-01 +/- 2.1E-01	2.8E-01	3E+00	NA	B3

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: GB1706286-2

Gross Beta by GFPC

PAI 724 Rev 12

Method Blank Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1706286

Client Name: COGCC

ClientProject ID: PW NORM 2017 10048

Lab ID: AB170614-1MB

Sample Matrix: WATER

Prep SOP: PAI 702 Rev 20

Date Collected: 14-Jun-17

Date Prepared: 14-Jun-17

Date Analyzed: 16-Jun-17

Prep Batch: AB170614-1

QCBatchID: AB170614-1-1

Run ID: AB170614-1A

Count Time: 1000 minutes

Final Aliquot: 200 ml

Result Units: pCi/l

File Name: ABC0616E

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
12587-47-2	GROSS BETA	3.7E-01 +/- 7.3E-01	1.21E+00	4E+00	NA	U

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: GB1706286-1

Gross Alpha(Co-Precipitation) Analysis by GFPC

PAI 724 Rev 12

Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1706286

Client Name: COGCC

ClientProject ID: PW NORM 2017 10048

Lab ID: GA170614-1LCS

Sample Matrix: WATER

Prep SOP: PAI 786 Rev 7

Date Collected: 14-Jun-17

Date Prepared: 14-Jun-17

Date Analyzed: 17-Jun-17

Prep Batch: GA170614-1

QCBatchID: GA170614-1-1

Run ID: GA170614-1A

Count Time: 30 minutes

Final Aliquot: 500 ml

Result Units: pCi/l

File Name: aba0617a

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
12587-46-1	GROSS ALPHA	9.6E+01 +/- 1.8E+01	2E+00	8.920E+01	107	75 - 125	P

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: GB1706286-2

Date Printed: Monday, July 17, 2017

ALS -- Fort Collins

LIMS Version: 6.843

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Gross Beta by GFPC

PAI 724 Rev 12

Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1706286

Client Name: COGCC

ClientProject ID: PW NORM 2017 10048

Lab ID: AB170614-1LCS

Sample Matrix: WATER

Prep SOP: PAI 702 Rev 20

Date Collected: 14-Jun-17

Date Prepared: 14-Jun-17

Date Analyzed: 16-Jun-17

Prep Batch: AB170614-1

QCBatchID: AB170614-1-1

Run ID: AB170614-1A

Count Time: 30 minutes

Final Aliquot: 200 ml

Result Units: pCi/l

File Name: ABC0616B

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
12587-47-2	GROSS BETA	2.29E+02 +/- 3.9E+01	8E+00	2.270E+02	101	75 - 125	P,M3

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: GB1706286-1

Date Printed: Monday, July 17, 2017

ALS -- Fort Collins

LIMS Version: 6.843

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Gross Alpha(Co-Precipitation) Analysis by GFPC

PAI 724 Rev 12

Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins

Work Order Number: 1706286

Client Name: COGCC

ClientProject ID: PW NORM 2017 10048

Lab ID: GA170614-1LCSD

Sample Matrix: WATER

Prep SOP: PAI 786 Rev 7

Date Collected: 14-Jun-17

Date Prepared: 14-Jun-17

Date Analyzed: 18-Jun-17

Prep Batch: GA170614-1

QCBatchID: GA170614-1-1

Run ID: GA170614-1A

Count Time: 30 minutes

Final Aliquot: 500 ml

Result Units: pCi/l

File Name: aba0618

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
12587-46-1	GROSS ALPHA	8.4E+01 +/- 1.6E+01	2E+00	8.920E+01	94.7	75 - 125	P

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: GB1706286-2

Gross Alpha(Co-Precipitation) Analysis by GFPC

PAI 724 Rev 12

Duplicate Sample Results (DER)

Lab Name: ALS -- Fort Collins

Work Order Number: 1706286

Client Name: COGCC

ClientProject ID: PW NORM 2017 10048

Field ID:
Lab ID: GA170614-1LCSD

Sample Matrix: WATER

Prep SOP: PAI 786 Rev 7

Date Collected: 14-Jun-17

Date Prepared: 14-Jun-17

Date Analyzed: 18-Jun-17

Prep Batch: GA170614-1

QCBatchID: GA170614-1-1

Run ID: GA170614-1A

Count Time: 30 minutes

Final Aliquot: 500 ml

Prep Basis: Unfiltered

Moisture(%): NA

Result Units: pCi/l

File Name: aba0618

CASNO	Analyte	Sample				Duplicate				DER	DER Lim
		Result +/-	2 s TPU	MDC	Flags	Result +/-	2 s TPU	MDC	Flags		
12587-46-1	GROSS ALPHA	9.6E+01 +/-	1.8E+01	2E+00	P	8.4E+01 +/-	1.6E+01	2E+00	P	0.477	2

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

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: GB1706286-2

Section 4

INDIVIDUAL SAMPLE RESULTS

4

Gross Alpha(Co-Precipitation) Analysis by GFPC

PAI 724 Rev 12

Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1706286

Client Name: COGCC

ClientProject ID: PW NORM 2017 10048

Field ID: 755652 Coalview

Lab ID: 1706286-1

Sample Matrix: WATER

Prep SOP: PAI 786 Rev 7

Date Collected: 13-Jun-17

Date Prepared: 14-Jun-17

Date Analyzed: 17-Jun-17

Prep Batch: GA170614-1

QCBatchID: GA170614-1-1

Run ID: GA170614-1A

Count Time: 1000 minutes

Report Basis: Unfiltered

Final Aliquot: 50.0 ml

Prep Basis: Unfiltered

Moisture(%): NA

Result Units: pCi/l

File Name: aba0617b

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
12587-46-1	GROSS ALPHA	1.94E+02 +/- 3.2E+01	4E+00	3E+00	NA	M3

Comments:

Qualifiers/Flags:

U - Result is less than the sample specific MDC.

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

Y2 - Chemical Yield outside default limits.

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

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

M - The requested MDC was not met.

Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: GB1706286-2

Gross Beta by GFPC

PAI 724 Rev 12

Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1706286

Client Name: COGCC

ClientProject ID: PW NORM 2017 10048

Field ID: 755652 Coalview

Lab ID: 1706286-1

Sample Matrix: WATER

Prep SOP: PAI 702 Rev 20

Date Collected: 13-Jun-17

Date Prepared: 14-Jun-17

Date Analyzed: 16-Jun-17

Prep Batch: AB170614-1

QCBatchID: AB170614-1-1

Run ID: AB170614-1A

Count Time: 1000 minutes

Report Basis: Unfiltered

Final Aliquot: 10.0 ml

Prep Basis: Unfiltered

Moisture(%): NA

Result Units: pCi/l

File Name: ABC0616E

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
12587-47-2	GROSS BETA	1.06E+02 +/- 2.5E+01	2.7E+01	4E+00	NA	M3

Comments:

Qualifiers/Flags:

U - Result is less than the sample specific MDC.

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

Y2 - Chemical Yield outside default limits.

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

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

M - The requested MDC was not met.

Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: GB1706286-1

Gross Alpha(Co-Precipitation) Analysis by GFPC

PAI 724 Rev 12

Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1706286

Client Name: COGCC

ClientProject ID: PW NORM 2017 10048

Field ID: 755653 Oscar Y

Lab ID: 1706286-3

Sample Matrix: WATER

Prep SOP: PAI 786 Rev 7

Date Collected: 13-Jun-17

Date Prepared: 14-Jun-17

Date Analyzed: 17-Jun-17

Prep Batch: GA170614-1

QCBatchID: GA170614-1-1

Run ID: GA170614-1A

Count Time: 1000 minutes

Report Basis: Unfiltered

Final Aliquot: 50.0 ml

Prep Basis: Unfiltered

Moisture(%): NA

Result Units: pCi/l

File Name: aba0617b

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
12587-46-1	GROSS ALPHA	4.59E+01 +/- 8.5E+00	3.9E+00	3E+00	NA	M3

Comments:

Qualifiers/Flags:

U - Result is less than the sample specific MDC.

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

Y2 - Chemical Yield outside default limits.

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

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

M - The requested MDC was not met.

Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: GB1706286-2

Gross Beta by GFPC

PAI 724 Rev 12

Sample Results

Lab Name: ALS -- Fort Collins

Work Order Number: 1706286

Client Name: COGCC

ClientProject ID: PW NORM 2017 10048

Field ID: 755653 Oscar Y

Lab ID: 1706286-3

Sample Matrix: WATER

Prep SOP: PAI 702 Rev 20

Date Collected: 13-Jun-17

Date Prepared: 14-Jun-17

Date Analyzed: 16-Jun-17

Prep Batch: AB170614-1

QCBatchID: AB170614-1-1

Run ID: AB170614-1A

Count Time: 1000 minutes

Report Basis: Unfiltered

Final Aliquot: 10.0 ml

Prep Basis: Unfiltered

Moisture(%): NA

Result Units: pCi/l

File Name: ABC0616E

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
12587-47-2	GROSS BETA	1.18E+02 +/- 2.7E+01	2.9E+01	4E+00	NA	M3

Comments:

Qualifiers/Flags:

U - Result is less than the sample specific MDC.

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

Y2 - Chemical Yield outside default limits.

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

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

M - The requested MDC was not met.

Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: GB1706286-1

Section 5

RAW DATA

5

Gross Alpha(Co-Precipitation) Analysis by GFPC Raw Data Report

Laboratory Name: ALS -- Fort Collins

Prep SOP: PAI 786

Reported on: Thursday, July 06, 2017

PAI Work Order: 1706286

Analytical SOP: PAI 724

12:20:55 PM

Sample ID QC Type	Nuclide Type	Sample Date/Time	Prep Batch QC Batch ID	Ingrowth Date /Time	Decay Date/Time	Matrix %Moist.	Samp Aliq Analy Aliq	Inst ID Det ID	AnRunID File Name	Count Date/Time	GrossCPM BkgCPM	BaseEff ProgEff	CndDur(min) Yield	Activity +/- 2 s TPU	MDC DeclEv	ReportUnits ReportBasis	DER RPD	%Spk. Recov Flags
1706286-1	GROSS ALPHA	6/13/2017	GA170614-1	NA	NA	WATER	50 ml	LB4100-a	GA170614-1A	6/17/2017	3.027	22.82%	1000	1.94E+02	4E+00	pCi/l	NA	M3
SMP	Trg. Analyte	10:16:00 AM	GA170614-1-1	NA	NA	NA	50 ml	A1	aba0617b	1:36 PM	0.141	NA	NA	3.2E+01		Unfiltered	NA	M3
1706286-3	GROSS ALPHA	6/13/2017	GA170614-1	NA	NA	WATER	50 ml	LB4100-a	GA170614-1A	6/17/2017	0.733	22.14%	1000	4.59E+01	3.9E+00	pCi/l	NA	M3
SMP	Trg. Analyte	11:36:00 AM	GA170614-1-1	NA	NA	NA	50 ml	A2	aba0617b	1:36 PM	0.113	NA	NA	8.5E+00		Unfiltered	NA	M3
GA170614-1	GROSS ALPHA	6/14/2017	GA170614-1	NA	NA	WATER	500 ml	LB4100-a	GA170614-1A	6/17/2017	0.179	23.77%	1000	4.6E-01	2.8E-01	pCi/l	NA	B3
MB	Trg. Analyte	2:40:39 PM	GA170614-1-1	NA	NA	NA	500 ml	B1	aba0617b	2:33 PM	0.099	NA	NA	2.1E-01		Unfiltered	NA	B3
GA170614-1	GROSS ALPHA	6/14/2017	GA170614-1	NA	NA	WATER	500 ml	LB4100-a	GA170614-1A	6/17/2017	16.067	22.82%	30	9.6E+01	2E+00	pCi/l	NA	107
LCS	Trg. Analyte	2:40:39 PM	GA170614-1-1	NA	NA	NA	500 ml	A1	aba0617a	12:43 PM	0.141	NA	NA	1.8E+01		Unfiltered	NA	P
GA170614-1	GROSS ALPHA	6/14/2017	GA170614-1	NA	NA	WATER	500 ml	LB4100-a	GA170614-1A	6/18/2017	14.567	23.49%	30	8.4E+01	2E+00	pCi/l	0.48	94.7
LCSD	Trg. Analyte	2:40:39 PM	GA170614-1-1	NA	NA	NA	500 ml	C3	aba0618	10:05 AM	0.097	NA	NA	1.6E+01		Unfiltered	NA	P

Comments:

Data Package ID: GB1706286-2

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
- + - 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: Monday, July 17, 2017

ALS -- Fort Collins

LIMS Version: 6.843

Page 1 of 1

Gross Beta by GFPC Raw Data Report

Laboratory Name: ALS -- Fort Collins
PAI Work Order: 1706286

Prep SOP: PAI 702
Analytical SOP: PAI 724

Reported on: Thursday, July 06, 2017
1:00:52 PM

Sample ID QC Type	Nuclide Type	Sample Date/Time	Prep Batch QC Batch ID	Ingrowth Date /Time	Decay Date/Time	Matrix %Moist.	Samp Aliq Analy Aliq	Inst ID Det ID	AnRunID File Name	Count Date/Time	GrossCPM BkgCPM	BaseEff ProgEff	CntDur(min) Yield	Activity +/- 2 s TPU	MDC DeclEv	ReportUnits ReportBasis	DER RPD	%Spk. Recov Flags
1706286-1	GROSS BETA	6/13/2017	AB170614-1	NA	NA	WATER	10 ml	LB4100-C	AB170614-1A	6/16/2017	2,280	40.13%	1000	1.06E+02	2.7E+01	pCi/l	NA	M3
SMP	Trg. Analyte	10:16:00 AM	AB170614-1-1	NA	NA	NA	10 ml	A1	ABC0616E	2:05 PM	1,436	NA	NA	2.5E+01		Unfiltered	NA	M3
1706286-3	GROSS BETA	6/13/2017	AB170614-1	NA	NA	WATER	10 ml	LB4100-C	AB170614-1A	6/16/2017	2,089	39.50%	1000	1.18E+02	2.9E+01	pCi/l	NA	M3
SMP	Trg. Analyte	11:36:00 AM	AB170614-1-1	NA	NA	NA	10 ml	A2	ABC0616E	2:05 PM	1,336	NA	NA	2.7E+01		Unfiltered	NA	M3
AB170614-1	GROSS BETA	6/14/2017	AB170614-1	NA	NA	WATER	200 ml	LB4100-C	AB170614-1A	6/16/2017	1,710	39.08%	1000	3.7E-01	1.21E+00	pCi/l	NA	U
MB	Trg. Analyte	10:15:17 AM	AB170614-1-1	NA	NA	NA	200 ml	B2	ABC0616E	2:05 PM	1,650	NA	NA	7.3E-01		Unfiltered	NA	U
AB170614-1	GROSS BETA	6/14/2017	AB170614-1	NA	NA	WATER	200 ml	LB4100-C	AB170614-1A	6/16/2017	37,367	38.33%	30	2.29E+02	8E+00	pCi/l	NA	101
LCS	Trg. Analyte	10:15:17 AM	AB170614-1-1	NA	NA	NA	200 ml	D2	ABC0616B	11:58 AM	1,607	NA	NA	3.9E+01		Unfiltered	NA	P, M3

Comments:

Data Package ID: GB1706286-1

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
- + - 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: Monday, July 17, 2017

ALS -- Fort Collins

LIMS Version: 6.843

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Unit Type: LB4100-C
Counting Unit ID: Magenta
High Voltage Mode: Simultaneous
Application Revision: Standard
Rev: 1201708 JCP

Data file name: ABC0616B
Batch ID: AB170614-1, AB170615-6
Count Preset (m): 30
Batch Ended: 6/16/2017 12:35

Background logfile: BKGABW
Date of Bkg. Cal: 6/8/2017
Alpha efficiency logfile: TH230-06/17
Alpha attenuation calibration: ATH0612, 0613
Beta efficiency logfile: CS-137-06/17
Beta attenuation calibration: ACS0614

Alpha prog. logfile: n/a
Alpha prog. attenuation: n/a
Beta prog. logfile: n/a
Beta prog. attenuation: n/a

Alpha Attenuation Calibration	Beta Attenuation Calibration
$y = b'm + (c'(mass-x0))$	$y = b'm + (c'(mass-x0))$
Alpha b=	Beta b=
m=	m=
a=	a=
x0=	x0=
Alpha to Beta X-talk	Beta to Alpha X-talk
$y = b'm + mass$	$y = b'm + m$
a -> b xtalk b=	b -> a xtalk b=
a -> b xtalk m=	b -> a xtalk m=

Det. ID	Sample ID	Count End Date & Time	Count Dur. (min)	Resid. Mass (mg)	Alpha Activity				Beta Activity				Progeny			
					Gross CPM	Bkg. CPM	b>a xtlk CPM	Base Eff	Cor.Fact.	Gross CPM	Bkg. CPM	a>b xtlk CPM	Base Eff	Cor.Fact.	Progeny Eff	Progeny Cor.Fact.
D2	AB170614-1LCS	6/16/2017 12:35	30.00	27.8	0.287	0.087	0.056	0.2229	0.662	37.367	1.607	0.0475	0.3833	0.915	n/a	n/a
D3	AB170615-6LCS	6/16/2017 12:35	30.00	27.4	0.200	0.171	0.053	0.2241	0.665	35.500	1.665	0.0077	0.3931	0.915	n/a	n/a

6/16/17

7/6/17

PAI - Gas Flow Proportional Sample Analysis LB4100-C

Unit Type: LB4100-C
 Counting Unit ID: Magenta
 High Voltage Mode: Simultaneous
 Application Revision: Standard
 Rev.12/01/08 JCP

Data file name: ABC0618E
 Batch ID: AB170614-1, AB170615-5
 Count Preset (m): 1000
 Batch Ended: 6/17/2017 6:47

Background log file: BKGABW
 Date of Bkg. Cal: 5/8/2017
 Alpha efficiency log file: TH230-06/17
 Alpha attenuation calibration: ATH0612, 0613
 Beta efficiency log file: Cs-137-06/17
 Beta attenuation calibration: ACS0614

Alpha prog. log file: n/a
 Alpha prog. attenuation: n/a
 Beta prog. log file: n/a
 Beta prog. attenuation: n/a

Det. ID	Sample ID	Count End Date & Time	Count Dur. (min)	Resid. Mass (mg)	Alpha Activity						Beta Activity							
					Gross CPM	Bkg. CPM	b>a xlik CPM	Base Eff	Cor.Fact.	Progeny Eff	Progeny Cor.Fact.	Gross CPM	Bkg. CPM	a>b xlik CPM	Base Eff	Cor.Fact.	Progeny Eff	Progeny Cor.Fact.
A1	1706286-1	6/17/2017 6:45	1000.00	149.4	0.451	0.078	0.002	0.2305	0.168	n/a	n/a	2.280	1.436	0.1213	0.4013	0.765	n/a	n/a
A2	1706286-3	6/17/2017 6:45	1000.00	219.9	0.194	0.094	0.001	0.2232	0.076	n/a	n/a	2.089	1.336	0.0367	0.3950	0.690	n/a	n/a
A3	1706299-1	6/17/2017 6:45	1000.00	41.2	0.096	0.086	0.000	0.2314	0.569	n/a	n/a	1.539	1.510	0.0000	0.3978	0.897	n/a	n/a
A4	1706299-1D	6/17/2017 6:45	1000.00	41.7	0.139	0.083	0.000	0.2330	0.566	n/a	n/a	1.495	1.532	0.0162	0.3938	0.896	n/a	n/a
C1	1706329-2	6/17/2017 6:46	1000.00	255.5	0.261	0.110	0.018	0.2301	0.051	n/a	n/a	10.613	1.540	0.0588	0.3984	0.655	n/a	n/a
C2	1706341-1	6/17/2017 6:46	1000.00	247.7	0.311	0.112	0.018	0.2306	0.056	n/a	n/a	10.599	1.659	0.0765	0.3953	0.663	n/a	n/a
C3	1706341-3	6/17/2017 6:46	1000.00	257.7	0.655	0.096	0.019	0.2285	0.050	n/a	n/a	11.186	1.640	0.2187	0.3921	0.653	n/a	n/a
C4	AB170615-6MB	6/17/2017 6:46	1000.00	26.3	0.155	0.141	0.000	0.2329	0.673	n/a	n/a	2.866	2.897	0.0037	0.3789	0.917	n/a	n/a
B1	1706299-2	6/17/2017 6:47	1000.00	28.6	0.106	0.091	0.000	0.2316	0.656	n/a	n/a	1.676	1.613	0.0040	0.3934	0.913	n/a	n/a
B2	AB170614-1MB	6/17/2017 6:47	1000.00	26.7	0.122	0.117	0.000	0.2165	0.670	n/a	n/a	1.710	1.850	0.0013	0.3907	0.916	n/a	n/a
B3	1706329-1	6/17/2017 6:47	1000.00	269.8	0.410	0.084	0.019	0.2221	0.043	n/a	n/a	10.548	1.545	0.1302	0.3859	0.641	n/a	n/a
B4	1706329-1D	6/17/2017 6:47	1000.00	263.6	0.439	0.100	0.018	0.2224	0.047	n/a	n/a	10.423	1.591	0.1339	0.3888	0.647	n/a	n/a
D1	1706342-3	6/17/2017 6:47	1000.00	58.1	0.400	0.095	0.001	0.2239	0.420	n/a	n/a	2.345	1.614	0.0864	0.3923	0.862	n/a	n/a
D2	AB170615-5MB	6/17/2017 6:47	1000.00	20.1	0.099	0.087	0.000	0.2229	0.722	n/a	n/a	1.628	1.607	0.0031	0.3933	0.925	n/a	n/a

Un 7-9-17
 7/6/17

Date 6/16/17SOP 724r. 12

ALS
Low Background Gas Flow Proportional Counter Log
Instrument: LB4100C

Instrument Daily Response and Background Checks

Det.	Daily Response Check				Background Check				Det. Status
	Start 1	Status	Start 2	Status	Start 1	Status	Start 2	Status	
1	JP	P			JP	H α	200	P	P
2						H α	↓	↓	
3						P			
4						H α	200	P	
5						P			
6						↓			
7						H α	200	P	
8						P			
9						H β	200	P	
10						P			
11						↓			
12						↓			
13						↓			
14						↓			
15						↓			
16	✓	✓			✓	H β			OLB

Det = Detector; α = Alpha; β = Beta; P = Pass; H = High; L = Low; OL = Offline; R = Recount; W = Weekly; NP = Not Processed

Weekly Background Calibration

	Current Calib. File ID	Weekly Calib. Started	Status	File ID
Dr A	BK00607W			
Dr B	↓			
Dr C				
Dr D	✓			

Dr = Drawer

Gas Supply

P-10 Supply		P-10 Flow	
Tank 1	550	Dr A	10
	↓	Dr B	↓
Tank 2	1800	Dr C	
	↓	Dr D	↓

Comments:

Date 6/16/17SOP 724r 12

ALS

Low Background Gas Flow Proportional Counter Log

Instrument: LB4100C

Det.	Sample ID	Batch	Test	Count Dur. (min)	Start Time	Analyst Initials	File ID	Output Initials
1-16	Daily Eff	—	—	30	7:25	JP	FFC0616	JP
1-16	Daily Bks	—	—	60	7:34	JP	BKC0616	JPB
1,2,4,9	↓	—	—	60	8:50	JPB	BKC0616A	JPB
1	1706051-1	AB170605-1	AP	75	10:27		AB10616	JP
2	↓	↓	↓	↓	↓	↓	↓	↓
3	↓	↓	↓	↓	↓	↓	↓	↓
4	↓	↓	↓	↓	↓	↓	↓	↓
5	↓	↓	↓	↓	↓	↓	↓	↓
6	↓	↓	↓	↓	↓	↓	↓	↓
7	↓	↓	↓	↓	↓	↓	↓	↓
8	AB1706051US	↓	↓	↓	↓	↓	↓	↓
9	1706132-4	AB170613-2	↓	↓	↓	↓	↓	↓
10	↓	↓	↓	↓	↓	↓	↓	↓
11	1706162-1	↓	↓	↓	↓	↓	↓	↓
12	↓	↓	↓	↓	↓	↓	↓	↓
13	↓	↓	↓	↓	↓	↓	↓	↓
14	1706222-15	↓	↓	↓	↓	↓	↓	↓
15	↓	↓	↓	↓	↓	↓	↓	↓
1	1705400-30MS	AB170530-5	↓	30	12:03		AB10616A	
2	AB17053056S	↓	↓	↓	↓	↓	↓	↓
3	1706097-1MS	AB170606-1	↓	↓	↓	↓	↓	↓
4	AB170606-1MS	↓	↓	↓	↓	↓	↓	↓
5	1706057-5MS	AB170609-3	↓	↓	↓	↓	↓	↓
6	AB170609-36S	↓	↓	↓	↓	↓	↓	↓
7	1706162-1MS	AB170613-2	↓	↓	↓	↓	↓	↓
8	AB170613-26S	↓	↓	↓	↓	↓	↓	↓
9	1717013-1	AB170601-13	↓	↓	↓	↓	↓	↓
10	↓	↓	↓	↓	↓	↓	↓	↓
11	↓	↓	↓	↓	↓	↓	↓	↓
12	↓	↓	↓	↓	↓	↓	↓	↓
13	↓	↓	↓	↓	↓	↓	↓	↓
14	AB170614-16S	AB170614-1	↓	↓	12:05		AB10616B	
15	AB170615-66S	AB170615-6	↓	↓	↓	↓	↓	↓
1	1705400-15	AB170530-5	↓	1000	12:59		AB10616C	
2	↓	↓	↓	↓	↓	↓	↓	↓
3	↓	↓	↓	↓	↓	↓	↓	↓
4	↓	↓	↓	↓	↓	↓	↓	↓
5	↓	↓	↓	↓	↓	↓	↓	↓
6	↓	↓	↓	↓	↓	↓	↓	↓
7	↓	↓	↓	↓	↓	↓	↓	↓
8	↓	↓	↓	↓	↓	↓	↓	↓
9	↓	↓	↓	↓	↓	↓	↓	↓
10	↓	↓	↓	↓	↓	↓	↓	↓
11	↓	↓	↓	↓	↓	↓	↓	↓
12	↓	↓	↓	↓	↓	↓	↓	↓
13	↓	↓	↓	↓	↓	↓	↓	↓
14	AB170530-5MS	↓	↓	↓	↓	↓	↓	↓
15	AB170530-1	AB170604-1	↓	↓	↓	↓	↓	↓
Comments:								
15	1706278-3	AB170613-3	AP	720	16:336	JPB	AB10616D	JPB

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(cont. from page NA **B**)

Form 780r8.doc (6/23/06)

Reviewed By / Date JPB 6/16/17

Date 6/16/17

SOP 724r-12

ALS

Low Background Gas Flow Proportional Counter Log

Instrument: LB4100C

Det.	Sample ID	Batch	Test	Count Dur. (min)	Start Time	Analyst Initials	File ID	Output Initials
1	1706286-1	AB170614-1	2P	1000	1402	JP	AB0616E	JP
2	↓ -3	↓	↓	↓	↓	↓	↓	↓
3	1706299-1	↓	↓	↓	↓	↓	↓	↓
4	↓ -10	↓	↓	↓	↓	↓	↓	↓
5	↓ -2	↓	↓	↓	↓	↓	↓	↓
6	AB170614-1MB	↓	↓	↓	↓	↓	↓	↓
7	1706329-1	AB170615-6	↓	↓	↓	↓	↓	↓
8	↓ -10	↓	↓	↓	↓	↓	↓	↓
9	↓ -2	↓	↓	↓	↓	↓	↓	↓
10	1706341-1	↓	↓	↓	↓	↓	↓	↓
11	↓ -3	↓	↓	↓	↓	↓	↓	↓
12	AB170615-6MB	↓	↓	↓	↓	↓	↓	↓
13	1706342-3	AB170615-5	↓	↓	↓	↓	↓	↓
14	AB170615-5MB	↓	↓	↓	↓	↓	↓	↓
<div>JP 6/18/17</div>								

Comments:

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(cont. from page 471499 B)

Form 780r8.doc (6/23/06)

Reviewed By / Date

JP 6/18/17

PAI - Gas Flow Proportional Sample Analysis LB4100-A

Unit Type: LB4100-AW
 Counting Unit ID: Orange
 High Voltage Mode: Simultaneous
 Application Revision: C
 Rev.050913 JP

Data file name: ABA0617A
 Batch ID: GA170614-1, GA170615-1
 Count Preset (m): 30
 Batch Ended: 6/17/17 13:17

Background logfile: BKGABW
 Date of Bkg. Cal: 6/7/17
 Alpha efficiency logfile: TH230-12/16
 Alpha attenuation calibration: ACP0415
 Beta efficiency logfile: CS137-12/16
 Beta attenuation calibration: ACS1207

Alpha prog. logfile: n/a
 Alpha prog. attenuation: n/a
 Beta prog. logfile: n/a
 Beta prog. attenuation: n/a

Alpha Attenuation Calibration		Beta Attenuation Calibration	
$y = b'm^2/(a^2(mass-x0))$		$y = b'm^2/(a^2(mass-x0))$	
Alpha b=	0.81100	Beta b=	0.8455
m=	0.86690	m=	0.9966
a=	0.8371	a=	1.0028
x0=	0.0000	x0=	0.0000
Alpha to Beta X-talk		Beta to Alpha X-talk	
$y = b'm^2 \cdot x$		$y = b'm^2 \cdot x$	
a->b xtalk b=	0.2339	b->a xtalk b=	1.01E-46
a->b xtalk m=	0.5958	b->a xtalk m=	0.0037

Det ID	Sample ID	Count	End Date & Time	Alpha Activity				Beta Activity			
				Resid. Mass (mg)	Gross CPM	Bkg. CPM	b-a xtlk CPM	Base Eff	Base Cor.Fact.	Progeny Eff	Progeny Cor.Fact.
A1	GA170614-1LCS	6/17/17 13:17	6/17/17 13:17	33.9	16.087	0.141	0.017	0.2282	0.557	0.3942	n/a
A2	GA170614-1LCS	6/17/17 13:17	6/17/17 13:17	33.9	0.400	0.113	0.001	0.2214	0.657	0.3972	n/a
A3	GA170615-1LCS	6/17/17 13:17	6/17/17 13:17	33.3	11.967	0.078	0.013	0.2335	0.662	0.4040	n/a
A4	GA170615-1LCS	6/17/17 13:17	6/17/17 13:17	32.3	15.967	0.091	0.017	0.2289	0.669	0.3921	n/a

• plac-out n/a's labeled → MB
 ↳ recounted in A13A0618

6/22 7:27-1/7

6/19/17 MC

PAI - Gas Flow Proportional Sample Analysis LB4100-A

Unit Type: LB4100-JAW
Counting Unit ID: Orange
High Voltage Mode: Simultaneous
Application Revision: C
Application Version: PA
Rev:05/09/13 JP

Data file name: ABA0517B
Batch ID: GA170614-1, GA170615-1
Count Preset (m): 1000
Batch Ended: 6/18/17 7:13

Background logfile: BKGBABW
Date of Bkg. Cal: 6/7/17
Alpha efficiency logfile: Th230-12/16
Alpha attenuation calibration: ACP0415
Beta efficiency logfile: Cs137-12/16
Beta attenuation calibration: ACS1207

Alpha prog. logfile: n/a
Alpha prog. attenuation: n/a
Beta prog. logfile: n/a
Beta prog. attenuation: n/a

Alpha Attenuation Calibration	Beta Attenuation Calibration
$y = b'm^2/(a+mass \cdot x)$	$y = b'm^2/(a+mass \cdot x)$
Alpha b= 0.93100	Beta b= 0.9353
m= 0.96690	m= 0.9798
a= 0.8971	a= 1.0026
x0= 0.0000	x0= 0.0000
Alpha to Beta X-talk	Beta to Alpha X-talk
$y = b'm^2 \cdot x$	$y = b'm^2 \cdot x$
a->b stalk b= 0.2339	b->a stalk b= 1.618E-06
a->b stalk m= 0.9968	b->a stalk m= 0.0037

Det. ID	Sample ID	Count End Date & Time	Count Dur. (min)	Resid. Mass (mg)	Alpha Activity				Beta Activity			
					Gross CPM	Bkg. CPM	b>a xtlk CPM	Base Eff	Cor.Fact.	Progeny Eff	Progeny Cor.Fact.	Progeny Cor.Fact.
A1	1706288-1	6/18/17 6:12	1000.00	43.5	3027	0.141	0.015	0.2282	0.585	n/a	n/a	n/a
A2	1706286-3	6/18/17 6:12	1000.00	48.9	0.733	0.113	0.004	0.2214	0.550	n/a	n/a	n/a
A3	1706289-1	6/18/17 6:12	1000.00	37.2	0.579	0.078	0.003	0.2335	0.532	n/a	n/a	n/a
A4	1706289-2	6/18/17 6:12	1000.00	36.0	0.416	0.091	0.002	0.2289	0.641	n/a	n/a	n/a
C1	1706341-1	6/18/17 6:12	1000.00	58.9	1.432	0.102	0.009	0.2269	0.489	n/a	n/a	n/a
C3	1706341-3	6/18/17 6:12	1000.00	87.9	2.559	0.097	0.020	0.2349	0.347	n/a	n/a	n/a
B1	GA170614-1MB	6/18/17 7:13	1000.00	33.6	0.179	0.099	0.000	0.2377	0.659	n/a	n/a	n/a
E3	1706329-1	6/18/17 7:13	1000.00	66.0	4.448	0.123	0.021	0.2320	0.449	n/a	n/a	n/a
B4	1706329-2	6/18/17 7:13	1000.00	40.8	1.553	0.158	0.006	0.2245	0.605	n/a	n/a	n/a

7/1/17 2/16/17

Date 6/17/17SOP 724r 12

ALS
Low Background Gas Flow Proportional Counter Log
Instrument: LB4100 *JA JCB*
6/17/17

Instrument Daily Response and Background Checks

Det.	Daily Response Check				Background Check				Det. Status
	Start 1	Status	Start 2	Status	Start 1	Status	Start 2	Status	
1	<i>am</i>	<i>P</i>			<i>JB</i>	<i>P</i>			<i>P</i>
2	<i>↓</i>	<i>↓</i>			<i>↓</i>	<i>↓</i>			<i>↓</i>
3	<i>↓</i>	<i>↓</i>			<i>↓</i>	<i>↓</i>			<i>↓</i>
4	<i>↓</i>	<i>↓</i>			<i>↓</i>	<i>↓</i>			<i>↓</i>
5	<i>↓</i>	<i>↓</i>			<i>↓</i>	<i>↓</i>			<i>↓</i>
6	<i>↓</i>	<i>↓</i>			<i>↓</i>	<i>↓</i>			<i>OL</i>
7	<i>↓</i>	<i>Hx</i>	<i>am</i>	<i>P</i>	<i>↓</i>	<i>↓</i>			<i>P</i>
8	<i>↓</i>	<i>P</i>			<i>↓</i>	<i>↓</i>			<i>↓</i>
9	<i>↓</i>	<i>↓</i>			<i>↓</i>	<i>HxP</i>	<i>am</i>	<i>P</i>	<i>↓</i>
10	<i>↓</i>	<i>↓</i>			<i>↓</i>	<i>P</i>			<i>α</i>
11	<i>↓</i>	<i>↓</i>			<i>↓</i>	<i>↓</i>		<i>1</i>	<i>P</i>
12	<i>↓</i>	<i>Hx</i>			<i>↓</i>	<i>↓</i>			<i>OL</i>
13	<i>OL</i>				<i>OL</i>				<i>↓</i>
14	<i>↓</i>				<i>↓</i>				<i>↓</i>
15	<i>↓</i>				<i>↓</i>				<i>↓</i>
16	<i>↓</i>				<i>↓</i>				<i>↓</i>

Det = Detector; α = Alpha; β = Beta; P = Pass; H = High; L = Low; OL = Offline; R = Recount; W = Weekly; NP = Not Processed

Weekly Background Calibration

	Current Calib. File ID	Weekly Calib. Started	Status	File ID
Dr A	<i>BKA06060</i>			
Dr B	<i>↓</i>			
Dr C	<i>↓</i>			
Dr D	<i>OL</i>			

Dr = Drawer

Gas Supply

	P-10 Supply		P-10 Flow
Tank 1	<i>0</i>	Dr A	<i>10</i>
	<i>↓</i>	Dr B	<i>↓</i>
Tank 2	<i>1600</i>	Dr C	<i>↓</i>
	<i>↓</i>	Dr D	<i>↓</i>

Comments:

Date

17
6/16/17
207
6/17/17

SOP 724r12

ALS

Low Background Gas Flow Proportional Counter Log

Instrument: LB4100A

Det.	Sample ID	Batch	Test	Count Dur. (min)	Start Time	Analyst Initials	File ID	Output Initials
1-12	Daily CND	—	—	30	950	JKH	EFA0617	JP 6/17/17
1-12	↓	—	—	30	1001		EFA0617A	
1-12	Daily Bkg	—	—	60	1014		BKA0617	
9	↓	GA170616-1	—	60	1120		BKA0617A	
7	1706374-6	GA170616-1	α	60	1126		ABA0617	JP
3	GA170616-1 MB							
4	↓							
1	1706372-5							
1	GA170614-1 MB	GA170614-1	α	30	1247		MSA0617A	
2	↓							
3	GA170615-1 MB	GA170615-1						
4	↓							
1	1706286-1	GA170614-1	α	1000	14:10		MSA0617B	
7	↓							
3	1706299-1							
4	↓							
9	GA170614-1 MB							
7	1706329-1	GA170619-1						
8	↓							
9	1706341-1							
4	↓							
<div style="position: absolute; bottom: 20px; right: 20px; font-size: 2em; transform: rotate(-15deg);">JP 6/18/17</div>								

Comments:

PAI - Gas Flow Proportional Sample Analysis LB4100-A

Unit Type: LB4100-A/W
 Counting Unit ID: Orange
 High Voltage Mode: Simultaneous
 Application Version: C
 Rev.05/09/13 JP

Background logfile: BKGABW
 Date of Bkg. Cal: 6/7/17
 Alpha efficiency logfile: Th-230-12/16
 Alpha attenuation calibration: ACP0415
 Beta efficiency logfile: Cs137-12/16
 Beta attenuation calibration: ACS1207

Alpha prog. logfile: n/a
 Alpha prog. attenuation: n/a
 Beta prog. logfile: n/a
 Beta prog. attenuation: n/a

Alpha Attenuation Calibration $y = b'm^a/(c(mass-x0))$	Beta Attenuation Calibration $y = b'm^a/(c(mass-x0))$
Alpha B= 0.98100	Beta B= 0.9553
m= 0.98690	m= 0.9866
a= 0.9371	a= 1.6026
x0= 0.0000	x0= 0.0000
Alpha to Beta X-talk $y = b'm^a \cdot x$	Beta to Alpha X-talk $y = b'mass \cdot m$
a -> b xtalk b= 0.2339	b -> a xtalk b= 1.618E-46
a -> b stalk m= 0.9968	b -> a stalk m= 0.0037

Det. ID	Sample ID	Count End Date & Time	Count Dur. (min)	Resid. Mass (mg)	Alpha Activity						Beta Activity					
					Gross CPM	Bkg. CPM	b>a xtlk CPM	Base Eff	Cor.Fact.	Progeny Eff	Progeny Cor.Fact.	Gross CPM	Bkg. CPM	a>b xtlk CPM	Base Eff	Cor.Fact.
C3	GA170614-1LCSD	6/18/17 10:30	30.00	33.9	14.587	0.097	0.019	0.2349	0.857	n/a	n/a	6.867	1.768	3.7729	0.4191	0.302
															n/a	n/a

6/27-9-17
 7/6/17

Date 6/18/17SOP 724r. 12

ALS

Low Background Gas Flow Proportional Counter Log

Instrument: LB4100C → A

Instrument Daily Response and Background Checks

not
7-9-17

Det.	Daily Response Check				Background Check				Det. Status
	Start 1	Status	Start 2	Status	Start 1	Status	Start 2	Status	
1	JP	P			JP	P			P
2									
3									
4									
5									
6						(Hd)			OL
7						P			P
8									
9									
10									OL
11									P
12		(L+H)							OL
13	OL				OL				
14									
15									
16									

Det = Detector; α = Alpha; β = Beta; P = Pass; H = High; L = Low; OL = Offline; R = Recount; W = Weekly; NP = Not Processed

Weekly Background Calibration

	Current Calib. File ID	Weekly Calib. Started	Status	File ID
Dr A	BUSAOLWA			
Dr B				
Dr C				
Dr D	OL			

Dr = Drawer

Gas Supply

	P-10 Supply		P-10 Flow
Tank 1	Q	Dr A	10
	✓	Dr B	
Tank 2	1350	Dr C	
	✓	Dr D	

Comments:

Date

6/18/17

SOP 724r12

ALS

Low Background Gas Flow Proportional Counter Log

Instrument: LB4100A

Det.	Sample ID	Batch	Test	Count Dur. (min)	Start Time	Analyst Initials	File ID	Output Initials
1-12	Daily EQ	—	—	30	8:47	JP	EFA061E	JP
1-12	Daily Bkg	—	—	60	9:42	JP	BKA061E	JP
11	GA170614-1	GA170614-1	α	30	10:08	JP	ABA061E	JP
1	1706237-2	AB170615-1	α1B	10	10:10	JP	ABA061E	JP
2	-3							
3	-4							
4	-5							
5	-6							
7	-7							
8	-8							
9	-10							
1	-11				10:24	JP	ABA061E	
2	-12							
3	-13							
4	-14							
5	-15							
7	-16							
8	-17							
9	-18							
1	-19				10:39	JP	ABA061E	
2	-20							
3	-21							
4	-22							
5	-23							
7	AB170615-1A							
8	BLS							
9	MB							
1	1706237-24	AB170615-2			10:54	JP	ABA061E	
2	-26							
3	-27							
4	-28							
5	-29							
7	-30							
8	-31							
9	-32							
11	-33							
1	-34				11:14	JP	ABA061E	
2	-35							
3	-36							
4	-37							
5	-38							
7	AB170615-2A							
9	BLS							
11	MB							
11	GA170615-1MB	GA170615-1	α1B	1000	11:32	JP	ABA061E	JP
8	1705181-2	AB170509-3	α1B	1000	11:33	JP	ABA061E	JP
9	AB170509-3MB							

Comments:

Page No.: 472257 B

(cont. from page NA B)

Form 780r8.doc (6/23/06)

Reviewed By / Date

JP 6/19/17

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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: AB170614-1

Prep Procedure: GROSS_BETA 1000 min

Analytical QASS / NCR? Y / *NA*

Prep Num	LabID	QC Type	Init Aliq	Fin Aliq	Units	Report Units	Residual Mass (mg)	Cnt 1 File	Cnt 1 Inst/Det	Cnt 1 Pos Chk By	Cnt 2 File	Cnt 2 Inst/Det	Cnt 2 Pos Chk By	Cnt 3 File	Cnt 3 Inst/Det	Cnt 3 Pos Chk By	Notes
1	1706286-1	SMP	10	10	ml	pCi/l	149.4	1706286-1	1	JOB							
1	1706286-3	SMP	10	10	ml	pCi/l	219.9		2								
1	1706299-1	SMP	10	10	ml	pCi/l	41.2		3								
1	1706299-1	DUP	10	10	ml	pCi/l	41.7		4								
1	1706299-2	SMP	10	10	ml	pCi/l	28.6		5								
1	AB170614-1	MB	200	200	ml	pCi/l	26.7		6								
1	AB170614-1	LCS	200	200	ml	pCi/l	27.8										

Spike Solution Information									
Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
S1	Cs-137	1013.4095.77	12/24/13	100.611	DPK/ml	06/14/17	1	ml	RS033

Sample Barcodes

1706286-1 AB170614-1PS1	1706286-3 AB170614-1PS2	1706299-1 AB170614-1PS3
1706299-1DUP AB170614-1PS4	1706299-2 AB170614-1PS5	1706299-1MB AB170614-1PS6
AB170614-1LCS AB170614-1PS7		

Reporting Units

LabID	TstGrpName	RptUnits
1706299-1	GrossB_96h_COGCC Co-pre	pCi/l
1706286-1	GrossB_96h_COGCC Co-pre	pCi/l
1706299-2	GrossB_96h_COGCC Co-pre	pCi/l
1706286-3	GrossB_96h_COGCC Co-pre	pCi/l

count by 6/17

Radiochemistry Prep Worksheet

ALS -- Fort Collins

Prep Batch: AB170614-1

Prep Procedure: GROSS_BETA

Reviewed By: lad LAD Review Date: 6/15/2017

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

Prep QASS / NCR? Y / ☒ NA

Prep SOP: PAI 702 Rev: 20

Prep SOP: NONE

Matrix Class: liquid

Prep Analyst: Lucas A. Daut LAD

Prep Date: 6/14/2017

Prep Dept: RS

Balance: 13

Balance: N/A

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Alq ml	Fin Alq ml	Prep Basis	Standards	Prep Notes
1	1	1706286-1	SMP		10	10	Unfiltered		
2	1	1706286-3	SMP		10	10	Unfiltered		
3	1	1706299-1	SMP		10	10	Unfiltered		
4	1	1706299-1	DUP		10	10	Unfiltered		
5	1	1706299-2	SMP		10	10	Unfiltered		
6	1	AB170614-1	MB		200	200	Unfiltered		
7	1	AB170614-1	LCS		200	200	Unfiltered	S1	

Comments

COGCC 96 hour rush Gross Beta

Spiked By: Lucas A. Daut Date: 6/14/2017

Witnessed By: Rebecca M. Olivares Date: 6/14/2017

Spike Solution Information						
Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Pipet ID
S1	Cs-137	1013.4095.77	12/29/17	100.611	DPM/ml	RS033
			06/14/17	1	ml	

Radiochemistry Prep Worksheet

ALS -- Fort Collins

Prep Batch: AB170614-1

Prep Procedure: GROSS_BETA

Prep Batch Not Validated!!!

Reviewed By: AD Review Date:

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

Prep SOP: PAI 702 Rev: 20

Prep SOP: NONE

Matrix Class: liquid

Prep Analyst: Lucas A. Daut

Prep Date: 6/14/2017

Prep Dept: RS

Balance: 13

Balance: N/A

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Aliq ml	Fin Aliq ml	Prep Basis	Standards	Prep Notes
1	1	1706286-1	SMP		200	200	Unfiltered		
2	1	1706286-3	SMP		200	200	Unfiltered		
3	1	1706299-1	SMP		200	200	Unfiltered		
4	1	1706299-1	DUP		200	200	Unfiltered		
5	1	1706299-2	SMP		200	200	Unfiltered		
6	1	AB170614-1	MB		200	200	Unfiltered		
7	1	AB170614-1	LCS		200	200	Unfiltered	S1	

Comments

COGCC 96 hour rush Gross Beta

Spiked By: Lucas A. Daut Date: 6/14/2017

Witnessed By: MD Date: 6/14/2017


Spike Solution Information						
Soln #	Nuclide	SolnID	Exo Date	Prep Conc	Units	Pipet ID
S1	Cs-137	1013.4095.77	12/27/17	100.611	DPW/ml	RS033
			06/14/17	1	ml	

Radiochemistry Gravimetric Worksheet

ALS -- Fort Collins

Prep Batch: AB170614-1

Prep Procedure: GROSS BETA

Reviewed By: Iad 

Review Date: 6/14/2017

Prep Num	Planc. Num	LabID	QC Type	Test Alq (ml)	Tare Mass (g)	Initial Gross Mass (g)	Initial Net Mass (mg)	Suggested Alq (ml)	Samp Vol Available (ml)	Samp Vol Taken (ml)	Fin Gross Mass (g)	Final Net Mass (mg)	Salt Sol. Added (ml)	Flag
1	1	1706286-1	SMP	10	9.3941	9.5435	149.4	5	200	10	9.5435	149.4	0	
1	2	1706286-3	SMP	10	9.4019	9.6218	219.9	3	200	10	9.6218	219.9	0	
1	3	1706299-1	SMP	10	9.3563	9.3975	41.2	18	200	10	9.3975	41.2	0	
1	4	1706299-1	DUP	10	9.4053	9.4470	41.7	18	200	10	9.4470	41.7	0	
1	5	1706299-2	SMP	10	9.3765	9.4051	28.6	26	200	10	9.4051	28.6	0	
1	6	AB170614-1	MB	0	9.3190	0.0000		0	200	200	9.3457	26.7	0.5	
1	7	AB170614-1	LCS	0	9.4022	0.0000		0	200	200	9.4300	27.8	0.5	

Sample Condition Form (Liquid)

Analyst: Lucas Dant

Analysis Date: 6/14/17

Method: Prep

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

Work Order	Sample ID	pH	Color	Remarks
1706286	1	4.2	Cloudy	Oily
↓	3	↓	yellow	Oily
1706299	1	↓	↓	↓
↓	2	↓	↓	None
LAD 6/14/17				

LAD 6/14/17

Radiochemistry Instrument Worksheet

ALS -- Fort Collins

Prep Batch: GA170614-1

Prep Procedure: GR_ALPHA_CO

Analytical QASS / NCR? Y / *N*

Prep Num	LabID	QC Type	Init Aliq	Fin Aliq	Units	Report Units	Residual Mass (mg)	Cnt 1 File	Cnt 1 Inst/Det	Cnt 1 Pos Chk By	Cnt 2 File	Cnt 2 Inst/Det	Cnt 2 Pos Chk By	Cnt 3 File	Cnt 3 Inst/Det	Cnt 3 Pos Chk By	Notes
1	1706286-1	SMP	50	50	ml	pCi/l	43.5	ASAD0614-1	JP								
1	1706286-3	SMP	50	50	ml	pCi/l	48.9										
1	1706299-1	SMP	200	200	ml	pCi/l	37.2										
1	1706299-2	SMP	200	200	ml	pCi/l	36										
1	GA170614-1	MB	500	500	ml	pCi/l	33.6										
1	GA170614-1	LCS	500	500	ml	pCi/l	33.9	ASAD0614-1	203								
1	GA170614-1	LCSD	500	500	ml	pCi/l	33.9										

Spike Solution Information

Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
S1	Th-230	760.4243.03	4/23/16	98.994	DPM/ml	06/14/17	1	ml	RS-033

Sample Barcodes

1706286-1 GA170614-1PS1		1706286-3 GA170614-1PS2		1706299-1 GA170614-1PS3	
1706299-2 GA170614-1PS4		GA170614-1MB GA170614-1PS5		GA170614-1LCS GA170614-1PS6	
GA170614-1LCSD GA170614-1PS7					

Spent not labeled; MB was counted, re-count

Reporting Units

LabID	TstGrpName	RptUnits
1706299-1	GrossA_96h_COGCC Co-pre	pCi/l
1706286-1	GrossA_96h_COGCC Co-pre	pCi/l
1706299-2	GrossA_96h_COGCC Co-pre	pCi/l
1706286-3	GrossA_96h_COGCC Co-pre	pCi/l

col 6/13

Radiochemistry Prep Worksheet

ALS -- Fort Collins

Prep Batch: GA170614-1

Prep Procedure: GR_ALPH_CO

Reviewed By: lad LAD

Review Date: 6/15/2017

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

Prep QASS / NCR? Y / NA

Prep SOP: PAI 786 Rev: 7

Prep SOP: NONE

Matrix Class: liquid

Prep Analyst: Lucas A. Daut LAD

Prep Date: 6/14/2017

Prep Dept: RS

Balance: 13

Balance: N/A

Sample Num	Prep Num	LabID	QC Type	Dish No.	Init Aliq ml	Fin Aliq ml	Prep Basis	Standards	Prep Notes
1	1	1706286-1	SMP	NA	50	50	Unfiltered	NA	
2	1	1706286-3	SMP		50	50	Unfiltered		
3	1	1706299-1	SMP		200	200	Unfiltered		
4	1	1706299-2	SMP		200	200	Unfiltered		
5	1	GA170614-1	MB		500	500	Unfiltered		LAD 6/15/17
6	1	GA170614-1	LCS		500	500	Unfiltered	S1	
7	1	GA170614-1	LCSD		500	500	Unfiltered	S1	

Comments

COGCC 96hour rush Gross Alpha.

Spiked By: Lucas A. Daut Date: 6/14/2017

Witnessed By: Rebecca M. Olivares Date: 6/14/2017

Spike Solution Information						
Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Pipet ID
S1	Th-230	760.4243.03	4/23/16	98.994	DPW/ml	RS-033
			06/14/17	1	ml	

Radiochemistry Prep Worksheet

ALS -- Fort Collins

Prep Batch: GA170614-1

Prep Procedure: GR_ALPHA_CO

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 786 Rev: 7

Prep SOP: NONE

Matrix Class: liquid

Prep Analyst: Lucas A. Daut

Prep Date: 6/14/2017

Prep Dept: RS

Balance: 13

Balance: N/A

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Aliq ml	Fin Aliq ml	Prep Basis	Standards	Prep Notes
1	1	1706286-1	SMP	50580	500	500	Unfiltered		
2	1	1706286-3	SMP	50580	500	500	Unfiltered		
3	1	1706299-1	SMP	200580	500	500	Unfiltered		
4	1	1706299-2	SMP	200580	500	500	Unfiltered		
5	1	GA170614-1	MB	500	500	500	Unfiltered		
6	1	GA170614-1	LCS	500	500	500	Unfiltered	S1	
7	1	GA170614-1	LCS	500	500	500	Unfiltered	S1	

Comments

Spiked By: Lucas A. Daut Date: 6/14/2017

Witnessed By: Date: 6/14/2017


Spike Solution Information						
Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Pipet ID
S1	Th-230	760.4243.03	4/23/16	98.994	DPM/ml	06/14/17
					1	ml
						RS-033

Radiochemistry Gravimetric Worksheet

ALS -- Fort Collins

Prep Batch: GA170614-1

Prep Procedure: GR_ALPH_CO

Reviewed By: lad 

Review Date: 6/15/2017

Prep Num	Planc. Num	LabID	QC Type	Test Alq (ml)	Tare Mass (g)	Initial Gross Mass (g)	Initial Net Mass (mg)	Suggested Alq (ml)	Samp Vol Available (ml)	Samp Vol Taken (ml)	Fin Gross Mass (g)	Final Net Mass (mg)	Salt Sol. Added (ml)	Flag
1	1	1706286-1	SMP	0	9.3490	0.0000	0	500	500	50	9.3925	43.5	0	
1	2	1706286-3	SMP	0	9.3845	0.0000	0	500	500	50	9.4334	48.9	0	
1	3	1706299-1	SMP	0	9.3772	0.0000	0	500	500	200	9.4144	37.2	0	
1	4	1706299-2	SMP	0	9.3830	0.0000	0	500	500	200	9.4190	36	0	
1	5	GA170614-1	MB	0	9.3928	0.0000	0	500	500	500	9.4264	33.6	0	
1	6	GA170614-1	LCS	0	9.3365	0.0000	0	500	500	500	9.3704	33.9	0	
1	7	GA170614-1	LCSD	0	9.3944	0.0000	0	500	500	500	9.4283	33.9	0	

Sample Condition Form (Liquid)

Analyst: Lucas Daut

Analysis Date: 6/14/17	Method: Prep
------------------------	--------------

Analysis Date: 6/14/17	Method: Prep
------------------------	--------------

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

Work Order	Sample ID	pH	Color	Remarks
1706286	1	4.2	Cloudy	Oily
↓	3	↓	yellow	Oily
1706299	1	↓	↓	↓
↓	2	↓	↓	None
LAD 6/14/17				

Section 8

STANDARDS TRACEABILITY DOCUMENTS



Prepare a working dilution of 1013.4095.76

1. Density of 4% HCl, lot # 0000094396
Mass of 100mL vol. flask: 68.5652g
Mass of flask & 100mL acid: 169.0154g
Net Mass: 100.4502g
Density: 1.0045g/mL

Balance # 12
Balance# 12

2. Mass of 1013.4095.76 transferred:
Mass of empty nalgene: 74.1532g
Mass of nalgene & standard 75.4532g
Net mass of standard transferred: 1.3000g

Balance# 12
Balance# 12

3. Dilute to final volume:

Mass of nalgene, standard, & diluent: 1069.7g
Mass of empty nalgene: 74.1532g
Net mass of new dilution: 995.5468g

Balance# 26
Balance# 12

4. Final activity calculation:

$$100,443.61 \text{ dpm/g} (1.0045 \text{ g/mL}) \left(\frac{1.3000 \text{ g}}{995.5468 \text{ g}} \right) = 131.75 \text{ dpm/mL}$$

Std ID: 1013.4095.77

Description: Cs-137
Expiration: 1/20/2016
Activity: 131.75 dpm/mL

2s Uncertainty: 0.92 dpm/mL

Ref. Date: 9/30/2005

Ref Time: N/A

Prep Date: 1/16/2015 Prep by: TE

Matrix/Comp. 4% HCl

Half Life (y): 3.01E+01

Reverification Log		
Analysis Date	Initials	Expiration Date
12/29/16	JP	12/29/2017

Continued on Page _____

Signed

Date

Read and Understood by

Signed

Date

12/16/15
Prepare an intermediate dilution of RSO#1013

1. Density of 4% HCl, lot # 0000094396

Mass of 100mL vol. flask:

68.5652g

Balance # 12

Mass of flask & 100mL acid:

169.0154g

Balance# 12

Net Mass:

100.4502g

Density:

1.0045g/mL

2. Mass of RSO#1013 transferred:

Mass of open empty bottle:

398.34g

Balance# 26

Mass of bottle and standard:

403.33g

Balance# 26

Net mass of standard transferred:

4.99g

3. Dilute to final volume:

Mass of open empty bottle:

398.34g

Balance# 26

Mass of bottle, standard, & diluent:

1288.4g

Balance# 26

Net mass of new dilution:

890.06g

4. Final activity calculation:

12/16/15

$$298.6 \text{ kBq/g} \left(\frac{1000 \text{ Bq}}{1 \text{ kBq}} \right) \left(\frac{60 \text{ dpm}}{1 \text{ Bq}} \right) \left(\frac{4.99 \text{ g}}{890.06 \text{ g}} \right) = 100,443.61 \text{ dpm/g}$$

12/16/15

Continued on Page

12/16/15
Signed

12/16/15
Date

Read and Understood By
Signed

12/16/15
Date



National Institute of Standards & Technology Certificate

Standard Reference Material 4233E Cesium-137 Radioactivity Standard

This Standard Reference Material (SRM) consists of radioactive cesium-137 chloride, non-radioactive cesium chloride, and hydrochloric acid dissolved in 5 mL of distilled water. The solution is contained in a flame-sealed NIST borosilicate-glass ampoule. The SRM is intended for the calibration of ionization chambers and solid-state gamma-ray spectrometry systems.

Radiological Hazard: The SRM ampoule contains cesium-137 with a total activity of approximately 1.5MBq. Cesium-137 decays by beta-particle emission to barium-137m, which decays by internal conversion. During the decay process X-rays and gamma rays with energies from approximately 3 keV to 662 keV are emitted. Most of these photons escape from the SRM ampoule and can represent a radiation hazard. Approximate unshielded dose rates at several distances (as of the reference time) are given in note [a]*. Appropriate shielding and/or distance should be used to minimize personnel exposure. The SRM should be used only by persons qualified to handle radioactive material.

Chemical Hazard: The SRM ampoule contains hydrochloric acid with a concentration of 1 mole per liter of water. The solution is corrosive and represents a health hazard if it comes in contact with eyes or skin. If the ampoule is to be opened to transfer the solution, the recommended procedure is given on page 2. The ampoule should be opened only by persons qualified to handle both radioactive material and strong acid solution.

Storage and Handling: The SRM should be stored and used at a temperature between 5 and 65 °C. The solution in an unopened ampoule should remain stable and homogeneous until at least September 2015. The ampoule (or any subsequent container) should always be clearly marked as containing radioactive material. If the ampoule is transported, it should be packed, marked, labeled, and shipped in accordance with the applicable national, international, and carrier regulations. The solution in the ampoule is a dangerous good (hazardous material) because of both the radioactivity and the strong acid.

Preparation: This Standard Reference Material was prepared in the Physics Laboratory, Ionizing Radiation Division, Radioactivity Group, M.P. Unterweger, Acting Group Leader. The overall technical direction and physical measurements leading to certification were provided by L.L. Lucas, R. Collé and L. Laureano-Pérez 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

Gaithersburg, Maryland 20899
October 2005

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

Recommended Procedure for Opening the SRM Ampoule

- 1) If the SRM solution is to be diluted, it is recommended that the diluting solution have a composition comparable to that of the SRM solution.
- 2) Wear eye protection, gloves, and protective clothing and work over a tray with absorbent paper in it. Work in a fume hood. In addition to the radioactive material, the solution contains strong acid and is corrosive.
- 3) Shake the ampoule to wet all of the inside surface of the ampoule. Return the ampoule to the upright position.
- 4) Check that all of the liquid has drained out of the neck of the ampoule. If necessary, gently tap the neck to speed the process.
- 5) Holding the ampoule upright, score the narrowest part of the neck with a scribe or diamond pencil.
- 6) Lightly wet the scored line. This reduces the crack propagation velocity and makes for a cleaner break.
- 7) Hold the ampoule upright with a paper towel, a wiper, or a support jig. Position the scored line away from you. Using a paper towel or wiper to avoid contamination, snap off the top of the ampoule by pressing the narrowest part of the neck away from you while pulling the tip of the ampoule towards you.
- 8) Transfer the solution from the ampoule using a pycnometer or a pipet with dispenser handle. NEVER PIPETTE BY MOUTH.
- 9) Seal any unused SRM solution in a flame-sealed glass ampoule, if possible, to minimize the evaporation loss.

See also reference [4]*.

PROPERTIES OF SRM 4233E

Certified values

Radionuclide	Cesium-137
Reference time	1200 EST, 30 September 2005
Massic activity of the solution [c]*	298.6 kBq·g ⁻¹
Relative expanded uncertainty (<i>k</i> =2)	0.70% [d] [e]
Solution mass	(5.0668 ± 0.0009) g [b]
Solution density	(1.015 ± 0.002) g·mL ⁻¹ at 20 °C [b]

Uncertified values

Physical Properties:			
Source description	Liquid in flame-sealed NIST borosilicate-glass ampoule		
Ampoule specifications	Body outside diameter	(16.5 ± 0.5) mm	
	Wall thickness	(0.60 ± 0.04) mm	
	Barium content	Less than 2.5%	
	Lead-oxide content	Less than 0.02%	
	Other heavy elements	Trace quantities	
Chemical Properties:			
Solution composition	Chemical Formula	Concentration (mol·L ⁻¹)	Mass Fraction (g·g ⁻¹)
	H ₂ O	54	0.96
	HCl	1.0	0.04
	CsCl	1.6 × 10 ⁻⁴	2.7 × 10 ⁻⁵
	¹³⁷ CsCl	6.9 × 10 ⁻⁷	1.2 × 10 ⁻⁷
Radiological Properties:			
Photon-emitting impurities	None detected [f]		
Half lives used	Cesium-137: (10983 ± 11) d [g] [5] Radium-226: (1600 ± 7) a [g] [5]		
Calibration method and measuring instrument(s)	Pressurized "4π"γ ionization chamber A calibrated using an cesium-137 solution whose activity was determined by the 4π(e+X)-γ-coincidence efficiency-extrapolation technique.		

EVALUATION OF THE UNCERTAINTY OF THE MASSIC ACTIVITY [d]*

Input Quantity x_i , the source of uncertainty (and individual uncertainty components where appropriate)	Method Used To Evaluate $u(x_i)$, the standard uncertainty of x_i (A) denotes evaluation by statistical methods (B) denotes evaluation by other methods	Relative Uncertainty Of Input Quantity, $u(x_i)/x_i$, (%) [h]	Relative Sensitivity Factor, $ \partial y/\partial x_i \cdot$ (x_i/y) [i]	Relative Uncertainty Of Output Quantity, $u(y)/y$, (%) [j]
PIC A net response per gram of SRM 4233E, measured relative to RRS20 [k]	Standard deviation of the mean (within-measurement precision) for 20 to 100 repeated measurements (A)	0.02	1.0	0.02
	Standard deviation (between- measurement precision) for 4 sets of measurement (A)	0.13	1.0	0.13
PIC A net response per Bq of cesium-137 in solution, measured relative to RRS20.	Standard deviation of the mean (for both between- and within- measurement precision) for >100 repeated measurements (A)	0.01	1.0	0.01
Activity used to calibrate PIC A net response per Bq of cesium-137 in solution	Standard uncertainty of the activity determined by the $4\pi(e+X)$ - γ -coincidence efficiency-extrapolation technique. (B)	0.31	1.0	0.31
Half life of cesium-137 Half life of radium-226	Standard uncertainty of the half life (A)	0.10 [m] 0.44 [m]	0.0001 [n] 0.010 [n]	0.00001 0.004
Gravimetric measurements	Estimated (B)	0.03	1.0	0.03
PIC A charge collection	Estimated (B)	0.05	1.0	0.05
Charge collection measurement time [p]	Estimated (B)	0.05	1.0	0.05
Long-term RRS positioning	Estimated (B)	0.05	1.0	0.05
Photon-emitting impurities	Limit of detection (B) [q]	100.	0.0001	0.01
Relative Combined Standard Uncertainty of the Output Quantity, $u_c(y)/y$, (%)				0.35
Coverage Factor, k				<u>x 2</u>
Relative Expanded Uncertainty of the Output Quantity, U/y , (%)				0.70

NOTES

- [a] The Sievert is the SI unit for dose equivalent. See reference [1]. One μSv is equal to 0.1 mrem.
 Distance from Ampoule (cm): 1 30 100
 Approximate Dose Rate ($\mu\text{Sv/h}$): 300 4 0.3
- [b] The stated uncertainty is two times the standard uncertainty.
- [c] **Massic activity** is the preferred name for the quantity activity divided by the total mass of the sample. See reference [1].
- [d] The reported value, y , of massic activity (activity per unit mass) at the reference time was not measured directly but was derived from measurements and calculations of other quantities. This can be expressed as $y = f(x_1, x_2, x_3, \dots, x_n)$, where f is a mathematical function derived from the assumed model of the measurement process. The value, x_i , used for each input quantity i has a **standard uncertainty**, $u(x_i)$, that generates a corresponding uncertainty in y , $u_i(y) \equiv |\partial y / \partial x_i| \cdot u(x_i)$, called a **component of combined standard uncertainty** of y . The **combined standard uncertainty** of y , $u_c(y)$, is the positive square root of the sum of the squares of the components of combined standard uncertainty. The combined standard uncertainty is multiplied by a **coverage factor** of $k = 2$ to obtain U , the **expanded uncertainty** of y .
- Since it can be assumed that the possible estimated values of the massic activity are approximately normally distributed with approximate standard deviation $u_c(y)$, the unknown value of the massic activity is believed to lie in the interval $y \pm U$ with a level of confidence of approximately 95 percent.
- For further information on the expression of uncertainties, see references [2] and [3].
- [e] The value of each component of combined standard uncertainty, and hence the value of the expanded uncertainty itself, is a best estimate based upon all available information, but is only approximately known. That is to say, the "uncertainty of the uncertainty" is large and not well known. This is true for uncertainties evaluated by statistical methods (e.g., the relative standard deviation of the standard deviation of the mean for the massic response is approximately 50%) and for uncertainties evaluated by other methods (which could easily be over estimated or under estimated by substantial amounts). The unknown value of the expanded uncertainty is believed to lie in the interval $U/2$ to $2U$ (i.e., within a factor of 2 of the estimated value).
- [f] Estimated limits of detection for photon-emitting impurities, as of 3 October 2005 (3 days after the reference time), expressed as massic photon emission rates, are:
 $< 40 \gamma \cdot \text{s}^{-1} \cdot \text{g}^{-1}$ for energies between 40 keV and 1350 keV, and
 $< 4 \gamma \cdot \text{s}^{-1} \cdot \text{g}^{-1}$ for energies between 1350 keV and 3600 keV,
- [g] The stated uncertainty is the standard uncertainty.
- [h] Relative standard uncertainty of the input quantity x_i .
- [i] The relative change in the output quantity y divided by the relative change in the input quantity x_i . If $|\partial y / \partial x_i| \cdot (x_i / y) = 1.0$, then a 1% change in x_i results in a 1% change in y . If $|\partial y / \partial x_i| \cdot (x_i / y) = 0.05$, then a 1% change in x_i results in a 0.05% change in y .

- [j] Relative component of combined standard uncertainty of output quantity y , rounded to two significant figures or less. The relative component of combined standard uncertainty of y is given by $u_i(y)/y \approx |\partial y/\partial x_i| \cdot u(x_i)/y = |\partial y/\partial x_i| \cdot (x_i/y) \cdot u(x_i)/x_i$. The numerical values of $u(x_i)/x_i$, $|\partial y/\partial x_i| \cdot (x_i/y)$, and $u_i(y)/y$, all dimensionless quantities, are listed in columns 3, 4, and 5, respectively. Thus, the value in column 5 is equal to the value in column 4 multiplied by the value in column 3. The input quantities are independent, or very nearly so. Hence the covariances are zero or negligible.
- [k] The response of pressurized ionization chamber A (PIC A) is determined from measurement of the time required to collect a given amount of charge on a stable fixed capacitor. All of the response measurements in the NIST pressurized ionization chambers are made relative to the response of one or more artifact standards. These artifact standards consist of microgram quantities of aged radium-226 in small welded stainless-steel capsules. These capsules are encapsulated in plastic rods whose dimensions are similar to those of the standard NIST ampoule. The artifact standards are called **Radium Reference Sources** and are designated as RRSx, where x is the nominal mass (in micrograms) of radium-226 in the capsule.
- [m] The relative standard uncertainty of $\lambda \cdot t$ is determined by the relative standard uncertainty of λ (i.e., of the half life). The relative standard uncertainty of t is negligible.
- [n] $|\partial y/\partial x_i| \cdot (x_i/y) = |\lambda \cdot t|$
- [p] The charge collection measurement time is determined by counting the pulses from a gated crystal-controlled oscillator.
- [q] The standard uncertainty for each undetected impurity that might reasonably be expected to be present is estimated to be equal to the estimated limit of detection for that impurity, i.e. $u(x_i)/x_i = 100\%$. $|\partial y/\partial x_i| \cdot (x_i/y) = \{(\text{response per Bq of impurity})/(\text{response per Bq of cesium-137})\} \cdot \{(\text{Bq of impurity})/(\text{Bq of cesium-137})\}$. Thus $u_i(y)/y$ is the relative change in y if the impurity were present with a massic activity equal to the estimated limit of detection.

REFERENCES

- [1] International Organization for Standardization (ISO), *ISO Standards Handbook - Quantities and Units*, 1993. Available from Global Engineering Documents, 12 Inverness Way East, Englewood, CO 80112, U.S.A. Telephone 1-800-854-7179.
- [2] International Organization for Standardization (ISO), *Guide to the Expression of Uncertainty in Measurement*, 1993 (corrected and reprinted, 1995). Available from Global Engineering Documents, 12 Inverness Way East, Englewood, CO 80112, U.S.A. Telephone 1-800-854-7179.
- [3] B. N. Taylor and C. E. Kuyatt, *Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results*, NIST Technical Note 1297, 1994. Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20407, U.S.A.
- [4] National Council on Radiation Protection and Measurements Report No. 58, *A Handbook of Radioactivity Measurements Procedures*, Second Edition, 1985. Available from the National Council on Radiation Protection and Measurements, 7910 Woodmont Avenue, Bethesda, MD 20814 U.S.A.
- [5] Evaluated Nuclear Structure Data File (ENSDF), September 2005.

Prepare a working dilution of 760.3020.08

1. Density of 0.5 M HNO₃ lot # 0000127617
Mass of 100mL vol. flask: 68.2961 g Balance # 12
Mass of flask & 100mL acid: 169.4362 g Balance # 12
Net Mass: 101.1401 g
Density: 1.0114 g/mL

2. Mass of 760.3020.08 transferred:
Mass of open empty nalgene: 74.6548 g Balance # 12
Mass of nalgene & standard: 77.6893 g Balance # 12
Net mass of standard transferred: 3.0345 g

3. Dilute to final volume:
Mass of nalgene, standard, & diluent: 897.2 g Balance # 26
Mass of empty nalgene (from above): 74.6548 g Balance # 12
Net mass of new dilution: 822.5452 g

4. Final activity calculation:
$$26,534.43 \frac{\text{dpm}}{\text{g}} \times 1.0114 \frac{\text{g}}{\text{mL}} \times \frac{3.0345 \text{ g}}{822.5452 \text{ g}} = 99.01 \frac{\text{dpm}}{\text{mL}}$$

Std ID: 760.4243.03

Description: Th-230
Expiration: 5/5/2017
Activity: 99.01 dpm/ml

2s Uncertainty: 3.27 dpm/ml

Ref. Date: 7/13/2004

Ref Time: N/A

Prep Date: 4/7/2016 Prep by: TE

Matrix/Comp. 0.5 M HNO₃

Half Life (y): 7.54E+04

Reverification Log		
Analysis Date	Initials	Expiration Date
04/23/17	JP	04/23/2018

Signed

Date

Signed

Date

Continued on Page _____

Prepare a primary dilution of R50 #760 (Analytical # 68750-307) in 0.5 M HNO_3 to a concentration of approx 30,000 dpm/mL.

1) Prepare 0.5 M HNO_3 by diluting 31 mL of conc. (16M) HNO_3 (EMD lot # 44287) to a final volume of 1000 mL.

2) Determine density of 0.5 M HNO_3

Mass of 100 mL volumetric flask = 66.4289 g (Bal 12)

Mass of flask + 0.5 M HNO_3 = 167.5792 g

Net mass of solution = 101.1503 g ^{11/24/06}

$\div 100 \text{ mL} = \text{density} = 1.0115 \text{ g/mL}$

3) Transfer # 760 to a 40 mL VOA vial.

Mass of bottle w/out lid = 21.5801 g (Bal 12)

Mass of std + bottle = 26.5278 g

Net mass of std transferred = 4.9477 g

4) Dilute to volume w/ 0.5 M HNO_3

Mass of bottle + std + soln = 61.8912 g (Bal 12)

Mass of bottle (from above) = 21.5801 g

Net mass of std = 40.3111 g

5) Final activity calc.

$$\frac{(1.832 \times 10^4 \text{ d/sec}) \left(\frac{1600 \text{ sec}}{1 \text{ min}} \right) (4.9477 \text{ g}) \left(\frac{1.0115 \text{ g/mL}}{1} \right)}{(5.08447) (40.3111 \text{ g})} = 26,534.43 \text{ d/g}$$

Continued on Page

Read and Understood By

Deborah Baker

Signed

1/24/06

Date

[Signature]

Signed

1/27/06

Date



ANALYTICS

RSO# 760 Rec'd 7/14/04 JCB

1380 Seaboard Industrial Blvd.
Atlanta, Georgia 30318 - U.S.A.

Phone (404) 352-8577
Fax (404) 352-2837

CERTIFICATE OF CALIBRATION

Standard Radionuclide Source

68750-307

Th-230 5 mL Liquid in Flame Sealed Vial

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.

ANALYTICS maintains traceability to the National Institute of Standards and Technology through Measurements Assurance Programs as described in USNRC Reg. Guide 4.15, Revision 1.

ISOTOPE:	Th-230
ACTIVITY (dps):	1.832 Bq
HALF-LIFE:	7.538 Bq years
CALIBRATION DATE:	July 13, 2004 12:00 EST
RELATIVE EXPANDED UNCERTAINTY (k=2):	3.3%

Impurities: γ -impurities <0.1%, α -impurities <0.01%

5.08447 grams 0.5M HNO₃ solution.

P O NUMBER 70635, Item 1

SOURCE PREPARED BY:

M. D. Currie
M. D. Currie, Radiochemist

Q A APPROVED:

A. C. Currie 7/13/04

Section 9

ADDITIONAL SUPPORTING DOCUMENTATION

Gas Proportional Counter

Instrument Calibration

Background Calibration

LB4100-A Long Background Instrument Calibration
Background Determinations

Detector ID	Alpha			Beta			Flag	Detector ID
	CPM	LCL	UCL	CPM	LCL	UCL		
A1 (01)	0.141	0.0808	0.1920	2.018	1.833	2.488	PASS	A1 (01)
A2 (02)	0.113	0.0778	0.2056	1.986	1.814	2.358	PASS	A2 (02)
A3 (03)	0.078	0.0423	0.1841	2.078	1.882	2.627	PASS	A3 (03)
A4 (04)	0.091	0.0660	0.1534	1.926	1.910	2.350	PASS	A4 (04)
B1 (05)	0.099	0.0565	0.1769	2.028	1.625	2.614	PASS	B1 (05)
B2 (06)	0.088	0.0530	0.1824	1.877	1.673	2.157	PASS	B2 (06)
B3 (07)	0.123	0.0777	0.2003	2.013	1.540	2.483	PASS	B3 (07)
B4 (08)	0.158	0.1055	0.2263	1.871	1.613	2.011	PASS	B4 (08)
C1 (09)	0.102	0.0158	0.2074	1.767	1.267	2.743	PASS	C1 (09)
C2 (10)	0.153	0.1259	0.2317	1.784	1.612	1.987	PASS	C2 (10)
C3 (11)	0.097	0.0310	0.1808	1.768	1.289	2.177	PASS	C3 (11)
C4 (12)	0.122	0.1023	0.2329	1.999	1.719	2.289	PASS	C4 (12)
D1 (13)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	D1 (13)
D2 (14)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	D2 (14)
D3 (15)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	D3 (15)
D4 (16)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	D4 (16)

Reviewed by: JCB

Date: 6/7/17

Historical Control Limits set to AVE 10 POINTS +- 3 Std Dev JP 04/10/2017

LB4100-C
Long Instrument Background Calibration
Background Determination

Detector ID		Alpha				Beta				Detector ID
	CPM	LCL	UCL	Flag	CPM	LCL	UCL	Flag		
A1 (01)	0.078	0.0008	0.1552	PASS	1.436	1.077	2.154	PASS	A1 (01)	
A2 (02)	0.094	0.0009	0.1871	PASS	1.336	1.002	2.004	PASS	A2 (02)	
A3 (03)	0.096	0.0010	0.1910	PASS	1.510	1.133	2.265	PASS	A3 (03)	
A4 (04)	0.083	0.0008	0.1652	PASS	1.532	1.149	2.298	PASS	A4 (04)	
B1 (05)	0.091	0.0009	0.1811	PASS	1.613	1.210	2.420	PASS	B1 (05)	
B2 (06)	0.117	0.0012	0.2328	PASS	1.650	1.238	2.475	PASS	B2 (06)	
B3 (07)	0.084	0.0008	0.1672	PASS	1.545	1.159	2.318	PASS	B3 (07)	
B4 (08)	0.100	0.0010	0.1990	PASS	1.591	1.193	2.387	PASS	B4 (08)	
C1 (09)	0.110	0.0011	0.2189	PASS	1.540	1.155	2.310	PASS	C1 (09)	
C2 (10)	0.112	0.0011	0.2229	PASS	1.659	1.244	2.489	PASS	C2 (10)	
C3 (11)	0.096	0.0010	0.1910	PASS	1.640	1.230	2.460	PASS	C3 (11)	
C4 (12)	0.141	0.0014	0.2806	PASS	2.897	1.449	4.346	PASS	C4 (12)	
D1 (13)	0.095	0.0010	0.1891	PASS	1.614	1.211	2.421	PASS	D1 (13)	
D2 (14)	0.087	0.0009	0.1731	PASS	1.607	1.205	2.411	PASS	D2 (14)	
D3 (15)	0.171	0.0017	0.3403	PASS	1.665	1.249	2.498	PASS	D3 (15)	
D4 (16)	0.101	0.0010	0.2010	PASS	1.607	1.205	2.411	PASS	D4 (16)	

Reviewed by:  Date: 6/10/17

Interim limits for alpha set to be +/- 99%, beta +/-25%
mh 06/07/2017

Gas Proportional Counter

Quality Control Data

Daily Instrument Performance Checks

LB4100-C
Daily Instrument Performance Check-Efficiency Determination

Detector ID	Alpha				Beta				Detector ID
	Eff.	LCL	UCL	Flag	Eff.	LCL	UCL	Flag	
A1 (01)	0.1986	0.1783	0.2179	PASS	0.3808	0.3497	0.4274	PASS	A1 (01)
A2 (02)	0.2081	0.1854	0.2266	PASS	0.3866	0.3493	0.4270	PASS	A2 (02)
A3 (03)	0.2107	0.1917	0.2343	PASS	0.3850	0.3545	0.4333	PASS	A3 (03)
A4 (04)	0.2063	0.1856	0.2269	PASS	0.3852	0.3481	0.4254	PASS	A4 (04)
B1 (05)	0.2263	0.2075	0.2536	PASS	0.4083	0.3709	0.4533	PASS	B1 (05)
B2 (06)	0.1993	0.1734	0.2120	PASS	0.3675	0.3321	0.4060	PASS	B2 (06)
B3 (07)	0.2168	0.1961	0.2396	PASS	0.3955	0.3616	0.4419	PASS	B3 (07)
B4 (08)	0.2141	0.1928	0.2357	PASS	0.3954	0.3566	0.4359	PASS	B4 (08)
C1 (09)	0.2082	0.1913	0.2338	PASS	0.3924	0.3617	0.4421	PASS	C1 (09)
C2 (10)	0.2230	0.1966	0.2403	PASS	0.4084	0.3688	0.4507	PASS	C2 (10)
C3 (11)	0.2115	0.1886	0.2305	PASS	0.3919	0.3594	0.4392	PASS	C3 (11)
C4 (12)	0.2244	0.1972	0.2410	PASS	0.4069	0.3660	0.4473	PASS	C4 (12)
D1 (13)	0.2173	0.1909	0.2333	PASS	0.3828	0.3517	0.4298	PASS	D1 (13)
D2 (14)	0.2146	0.1914	0.2340	PASS	0.3948	0.3534	0.4319	PASS	D2 (14)
D3 (15)	0.2162	0.1933	0.2362	PASS	0.3913	0.3543	0.4330	PASS	D3 (15)
D4 (16)	0.2209	0.1980	0.2420	PASS	0.3971	0.3581	0.4377	PASS	D4 (16)

Reviewed by: JP Date: 6/16/17

Interim Control Limits -- +/-10% of average from last 5 data points
Established: 06/08/17 mh

LB4100-C
Daily Instrument Performance Checks
Background Checks

Detector ID	Alpha				Beta				Detector ID
	CPM	LCL	UCL	Flag	CPM	LCL	UCL	Flag	
A1 (01)	0.233	-0.030	0.186	FLAG-HIGH	1.833	0.972	1.900	PASS	A1 (01)
A2 (02)	0.267	-0.025	0.213	FLAG-HIGH	1.467	0.888	1.784	PASS	A2 (02)
A3 (03)	0.150	-0.024	0.216	PASS	1.983	1.034	1.986	PASS	A3 (03)
A4 (04)	0.267	-0.029	0.195	FLAG-HIGH	1.900	1.053	2.011	PASS	A4 (04)
B1 (05)	0.200	-0.026	0.208	PASS	2.033	1.121	2.105	PASS	B1 (05)
B2 (06)	0.100	-0.015	0.249	PASS	1.900	1.153	2.147	PASS	B2 (06)
B3 (07)	0.217	-0.028	0.196	FLAG-HIGH	1.933	1.064	2.026	PASS	B3 (07)
B4 (08)	0.167	-0.022	0.222	PASS	1.883	1.102	2.080	PASS	B4 (08)
C1 (09)	0.150	-0.018	0.238	PASS	2.467	1.059	2.021	FLAG-HIGH	C1 (09)
C2 (10)	0.233	-0.018	0.242	PASS	2.017	1.160	2.158	PASS	C2 (10)
C3 (11)	0.150	-0.024	0.216	PASS	1.600	1.144	2.136	PASS	C3 (11)
C4 (12)	0.217	-0.004	0.286	PASS	2.817	2.238	3.556	PASS	C4 (12)
D1 (13)	0.150	-0.024	0.214	PASS	1.867	1.122	2.106	PASS	D1 (13)
D2 (14)	0.117	-0.027	0.201	PASS	1.767	1.116	2.098	PASS	D2 (14)
D3 (15)	0.167	0.011	0.331	PASS	1.850	1.165	2.165	PASS	D3 (15)
D4 (16)	0.183	-0.022	0.224	PASS	2.983	1.116	2.098	FLAG-HIGH	D4 (16)

recounted in
BKC0616A

Date: 6/16/17

Reviewed by: JCR

Control Limits established from previous weekly background determinations.
 Weekly Background File: BKC0607W Date: 6/7/2017 Analyst: mh
 0 1/0/1900 0
 0 1/0/1900 0

LB4100-C

$$x1779$$

Date:

Control Limits established from previous weekly background determinations.

Weekly Background File: BKC0607W Date: 6/7/2017 Analyst: [REDACTED]

0 1/0/1900

0 1/0/1900

LB4100-C
Daily Instrument Performance Check-Efficiency Determination

Detector ID	Alpha				Beta				Detector ID
	Eff.	LCL	UCL	Flag	Eff.	LCL	UCL	Flag	
A1 (01)	0.1971	0.1783	0.2179	PASS	0.3794	0.3497	0.4274	PASS	A1 (01)
A2 (02)	0.2066	0.1854	0.2266	PASS	0.3794	0.3493	0.4270	PASS	A2 (02)
A3 (03)	0.2162	0.1917	0.2343	PASS	0.3932	0.3545	0.4333	PASS	A3 (03)
A4 (04)	0.2015	0.1856	0.2269	PASS	0.3832	0.3481	0.4254	PASS	A4 (04)
B1 (05)	0.2291	0.2075	0.2536	PASS	0.4086	0.3709	0.4533	PASS	B1 (05)
B2 (06)	0.1974	0.1734	0.2120	PASS	0.3661	0.3321	0.4060	PASS	B2 (06)
B3 (07)	0.2169	0.1961	0.2396	PASS	0.3953	0.3616	0.4419	PASS	B3 (07)
B4 (08)	0.2142	0.1928	0.2357	PASS	0.3896	0.3566	0.4359	PASS	B4 (08)
C1 (09)	0.2124	0.1913	0.2338	PASS	0.3903	0.3617	0.4421	PASS	C1 (09)
C2 (10)	0.2225	0.1966	0.2403	PASS	0.4038	0.3688	0.4507	PASS	C2 (10)
C3 (11)	0.2065	0.1886	0.2305	PASS	0.3971	0.3594	0.4392	PASS	C3 (11)
C4 (12)	0.2226	0.1972	0.2410	PASS	0.4105	0.3660	0.4473	PASS	C4 (12)
D1 (13)	0.2147	0.1909	0.2333	PASS	0.3925	0.3517	0.4298	PASS	D1 (13)
D2 (14)	0.2100	0.1914	0.2340	PASS	0.3881	0.3534	0.4319	PASS	D2 (14)
D3 (15)	0.2119	0.1933	0.2362	PASS	0.3948	0.3543	0.4330	PASS	D3 (15)
D4 (16)	0.2225	0.1980	0.2420	PASS	0.3928	0.3581	0.4377	PASS	D4 (16)

Reviewed by: _____

365

Date: _____

6/17/17

Interim Control Limits -- +/-10% of average from last 5 data points
 Established: 06/08/17 mh

LB4100-C

Daily Instrument Performance Checks
Background Checks

Detector ID	Alpha				Beta				Detector ID
	CPM	LCL	UCL	Flag	CPM	LCL	UCL	Flag	
A1 (01)	0.267	-0.030	0.186	FLAG-HIGH	1.683	0.972	1.900	PASS	A1 (01)
A2 (02)	0.150	-0.025	0.213	PASS	1.583	0.888	1.784	PASS	A2 (02)
A3 (03)	0.150	-0.024	0.216	PASS	1.650	1.034	1.986	PASS	A3 (03)
A4 (04)	0.100	-0.029	0.195	PASS	1.583	1.053	2.011	PASS	A4 (04)
B1 (05)	0.083	-0.026	0.208	PASS	1.350	1.121	2.105	PASS	B1 (05)
B2 (06)	0.167	-0.015	0.249	PASS	1.533	1.153	2.147	PASS	B2 (06)
B3 (07)	0.150	-0.028	0.196	PASS	1.767	1.064	2.026	PASS	B3 (07)
B4 (08)	0.133	-0.022	0.222	PASS	1.783	1.102	2.080	PASS	B4 (08)
C1 (09)	0.167	-0.018	0.238	PASS	1.450	1.059	2.021	PASS	C1 (09)
C2 (10)	0.117	-0.018	0.242	PASS	1.683	1.160	2.158	PASS	C2 (10)
C3 (11)	0.183	-0.024	0.216	PASS	1.683	1.144	2.136	PASS	C3 (11)
C4 (12)	0.083	-0.004	0.286	PASS	4.017	2.238	3.556	FLAG-HIGH	C4 (12)
D1 (13)	0.267	-0.024	0.214	FLAG-HIGH	1.700	1.122	2.106	PASS	D1 (13)
D2 (14)	0.117	-0.027	0.201	PASS	2.067	1.116	2.098	PASS	D2 (14)
D3 (15)	0.217	0.011	0.331	PASS	1.917	1.165	2.165	PASS	D3 (15)
D4 (16)	0.033	-0.022	0.224	PASS	3.000	1.116	2.098	FLAG-HIGH	D4 (16)

Reviewed by: Date: 6/17/17

Control Limits established from previous weekly background determinations.

Weekly Background File: BKC0607W

Date: 6/7/2017

Analyst: mh

0

1/0/1900

0

0

1/0/1900

0

LB4100-C

Daily Instrument Performance Checks
Background Checks

Detector ID	Alpha			Beta			Flag	Detector ID
	CPM	LCL	UCL	CPM	LCL	UCL		
A1 (01)	0.131	-0.136	0.292	1.633	0.517	2.355	PASS	A1 (01)
A2 (02)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	A2 (02)
A3 (03)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	A3 (03)
A4 (04)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	A4 (04)
B1 (05)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	B1 (05)
B2 (06)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	B2 (06)
B3 (07)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	B3 (07)
B4 (08)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	B4 (08)
C1 (09)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	C1 (09)
C2 (10)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	C2 (10)
C3 (11)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	C3 (11)
C4 (12)	0.131	-0.147	0.429	2.547	1.592	4.202	PASS	C4 (12)
D1 (13)	0.196	-0.141	0.331	1.894	0.640	2.588	PASS	D1 (13)
D2 (14)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	D2 (14)
D3 (15)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	D3 (15)
D4 (16)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	D4 (16)

Reviewed by: WCBDate: 6/17/17

Control Limits established from previous weekly background determinations.

Weekly Background File: BKC0607W

Date: 6/7/2017

Analyst: mh

0

1/0/1900

0

0

1/0/1900

0

LB4100-A Daily Instrument Performance Check
Efficiency Determinations

Detector ID	Alpha				Beta				Detector ID
	Eff.	LCL	UCL	Flag	Eff.	LCL	UCL	Flag	
A1 (01)	0.2115	0.1979	0.2300	PASS	0.2223	0.2088	0.2426	PASS	A1 (01)
A2 (02)	0.2065	0.1918	0.2229	PASS	0.2162	0.2077	0.2414	PASS	A2 (02)
A3 (03)	0.2240	0.2064	0.2399	PASS	0.2300	0.2145	0.2492	PASS	A3 (03)
A4 (04)	0.2327	0.2084	0.2421	PASS	0.2358	0.2166	0.2518	PASS	A4 (04)
B1 (05)	0.2211	0.2064	0.2399	PASS	0.2380	0.2220	0.2580	PASS	B1 (05)
B2 (06)	0.2336	0.2124	0.2468	PASS	0.2487	0.2291	0.2663	PASS	B2 (06)
B3 (07)	0.2365	0.1937	0.2352	FLAG-HIGH	0.2332	0.2051	0.2387	PASS	B3 (07)
B4 (08)	0.2286	0.2003	0.2328	PASS	0.2144	0.1998	0.2322	PASS	B4 (08)
C1 (09)	0.2148	0.1911	0.2221	PASS	0.2357	0.2198	0.2554	PASS	C1 (09)
C2 (10)	0.2162	0.1997	0.2320	PASS	0.2394	0.2225	0.2586	PASS	C2 (10)
C3 (11)	0.2242	0.2004	0.2329	PASS	0.2319	0.2144	0.2492	PASS	C3 (11)
C4 (12)	0.2097	0.1908	0.2217	PASS	0.2743	0.2325	0.2702	FLAG-HIGH	C4 (12)
D1 (13)	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	D1 (13)
D2 (14)	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	D2 (14)
D3 (15)	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	D3 (15)
D4 (16)	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	D4 (16)

• recounted in SIC A0617A
• off line

6/17/17

JKB

Reviewed by: _____ Date: _____

Historical Control Limits -- +/-7.5% of Average of 30 Data Points. JP 02/10/17

**LB4100-A Daily Instrument Performance Check
Efficiency Determinations**

[illegible]

Reviewed by:

Date:

Historical Control Limits -- +/-7.5% of Average of 30Data Points. JP 02/10/17

LB4100-A Daily Instrument Calibration and Check
Background Determinations

Detector ID	Alpha			Flag	Beta			Flag	Detector ID
	CPM	LCL	UCL		CPM	LCL	UCL		
A1 (01)	0.183	-0.0044	0.2864	PASS	2.383	1.468	2.568	PASS	A1 (01)
A2 (02)	0.083	-0.0172	0.2432	PASS	2.233	1.440	2.532	PASS	A2 (02)
A3 (03)	0.133	-0.0302	0.1862	PASS	2.133	1.520	2.636	PASS	A3 (03)
A4 (04)	0.133	-0.0258	0.2078	PASS	1.983	1.389	2.463	PASS	A4 (04)
B1 (05)	0.167	-0.0229	0.2209	PASS	2.167	1.476	2.580	PASS	B1 (05)
B2 (06)	0.067	-0.0269	0.2029	PASS	2.133	1.346	2.408	PASS	B2 (06)
B3 (07)	0.167	-0.0128	0.2588	PASS	2.100	1.464	2.562	PASS	B3 (07)
B4 (08)	0.167	0.0041	0.3119	PASS	2.067	1.341	2.401	PASS	B4 (08)
C1 (09)	0.250	-0.0217	0.2257	FLAG-HIGH	2.683	1.252	2.282	FLAG-HIGH	C1 (09)
C2 (10)	0.167	0.0015	0.3045	PASS	1.883	1.267	2.301	PASS	C2 (10)
C3 (11)	0.100	-0.0236	0.2176	PASS	1.950	1.253	2.283	PASS	C3 (11)
C4 (12)	0.100	-0.0133	0.2573	PASS	2.383	1.451	2.547	PASS	C4 (12)
D1 (13)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	D1 (13)
D2 (14)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	D2 (14)
D3 (15)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	D3 (15)
D4 (16)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	D4 (16)

are counted in
EPA 0617A

6/17/17

JKS

Reviewed by:

Date:

Control Limits established from previous weekly background determinations

Weekly Bkg File: BKA0606W Date: 6/6/17 Analyst: JKB
0 1/0/00 0

LB4100-A Daily Instrument Calibration and Check
Background Determinations

Detector ID	Alpha				Beta				Detector ID
	CPM	LCL	UCL	Flag	CPM	LCL	UCL	Flag	
A1 (01)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	A1 (01)
A2 (02)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	A2 (02)
A3 (03)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	A3 (03)
A4 (04)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	A4 (04)
B1 (05)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	B1 (05)
B2 (06)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	B2 (06)
B3 (07)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	B3 (07)
B4 (08)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	B4 (08)
C1 (09)	0.000	-0.1657	0.3697	PASS	2.264	0.653	2.881	PASS	C1 (09)
C2 (10)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	C2 (10)
C3 (11)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	C3 (11)
C4 (12)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	C4 (12)
D1 (13)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	D1 (13)
D2 (14)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	D2 (14)
D3 (15)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	D3 (15)
D4 (16)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	D4 (16)

Reviewed by: 205

Date: 6/17/17

Control Limits established from previous weekly background determinations

Weekly Bkg File: BKA0606W Date: 6/6/17 Analyst: JKB
0 1/0/00 0

LB4100-A Daily Instrument Performance Check
Efficiency Determinations

Detector ID	Alpha				Beta				Detector ID
	Eff.	LCL	UCL	Flag	Eff.	LCL	UCL	Flag	
A1 (01)	0.2092	0.1979	0.2300	PASS	0.2277	0.2088	0.2426	PASS	A1 (01)
A2 (02)	0.2051	0.1918	0.2229	PASS	0.2251	0.2077	0.2414	PASS	A2 (02)
A3 (03)	0.2248	0.2064	0.2399	PASS	0.2324	0.2145	0.2492	PASS	A3 (03)
A4 (04)	0.2284	0.2084	0.2421	PASS	0.2420	0.2166	0.2518	PASS	A4 (04)
B1 (05)	0.2291	0.2064	0.2399	PASS	0.2394	0.2220	0.2580	PASS	B1 (05)
B2 (06)	0.2318	0.2124	0.2468	PASS	0.2566	0.2291	0.2663	PASS	B2 (06)
B3 (07)	0.2343	0.1937	0.2352	PASS	0.2335	0.2051	0.2387	PASS	B3 (07)
B4 (08)	0.2314	0.2003	0.2328	PASS	0.2216	0.1998	0.2322	PASS	B4 (08)
C1 (09)	0.2144	0.1911	0.2221	PASS	0.2379	0.2198	0.2554	PASS	C1 (09)
C2 (10)	0.2150	0.1997	0.2320	PASS	0.2447	0.2225	0.2586	PASS	C2 (10)
C3 (11)	0.2209	0.2004	0.2329	PASS	0.2357	0.2144	0.2492	PASS	C3 (11)
C4 (12)	0.2098	0.1908	0.2217	PASS	0.2815	0.2325	0.2702	FLAG-HIGH	C4 (12)
D1 (13)	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	D1 (13)
D2 (14)	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	D2 (14)
D3 (15)	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	D3 (15)
D4 (16)	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	D4 (16)

Δ

Δ Detector Offset

Date: 6/18/17

JP

Reviewed by: _____

Historical Control Limits -- +/- 7.5% of Average of 30 Data Points. JP 02/10/17

**LB4100-A Daily Instrument Calibration and Check
Background Determinations**

Detector ID	Alpha			Beta			Flag	Detector ID
	CPM	LCL	UCL	CPM	LCL	UCL		
A1 (01)	0.100	-0.0044	0.2864	2.300	1.468	2.568	PASS	A1 (01)
A2 (02)	0.183	-0.0172	0.2432	1.833	1.440	2.532	PASS	A2 (02)
A3 (03)	0.117	-0.0302	0.1862	1.900	1.520	2.636	PASS	A3 (03)
A4 (04)	0.133	-0.0258	0.2078	2.100	1.389	2.463	PASS	A4 (04)
B1 (05)	0.124	-0.0266	0.2246	1.717	1.460	2.596	PASS	B1 (05)
B2 (06)	0.248	-0.0304	0.2064	2.178	1.330	2.424	PASS	B2 (06)
B3 (07)	0.177	-0.0170	0.2630	2.284	1.447	2.579	PASS	B3 (07)
B4 (08)	0.177	-0.0007	0.3167	1.841	1.325	2.417	PASS	B4 (08)
C1 (09)	0.067	-0.0217	0.2257	2.167	1.252	2.282	PASS	C1 (09)
C2 (10)	0.150	0.0015	0.3045	1.683	1.267	2.301	PASS	C2 (10)
C3 (11)	0.183	-0.0236	0.2176	1.917	1.253	2.283	PASS	C3 (11)
C4 (12)	0.217	-0.0133	0.2573	2.017	1.451	2.547	PASS	C4 (12)
D1 (13)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	D1 (13)
D2 (14)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	D2 (14)
D3 (15)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	D3 (15)
D4 (16)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	D4 (16)

Δ Detector Offset

TP

Reviewed by: _____

Date: 6/18/17

Control Limits established from previous weekly background determinations

Weekly Bkg File: BKA0606W Date: 6/6/17 Analyst: JKB
0 1/0/00 0

LB4100-A Daily Instrument Performance Check
Efficiency Determinations

Detector ID	Alpha				Beta				Detector ID
	Eff.	LCL	UCL	Flag	Eff.	LCL	UCL	Flag	
A1 (01)	0.2072	0.1979	0.2300	PASS	0.2267	0.2088	0.2426	PASS	A1 (01)
A2 (02)	0.2027	0.1918	0.2229	PASS	0.2170	0.2077	0.2414	PASS	A2 (02)
A3 (03)	0.2222	0.2064	0.2399	PASS	0.2349	0.2145	0.2492	PASS	A3 (03)
A4 (04)	0.2196	0.2084	0.2421	PASS	0.2325	0.2166	0.2518	PASS	A4 (04)
B1 (05)	0.2253	0.2064	0.2399	PASS	0.2415	0.2220	0.2580	PASS	B1 (05)
B2 (06)	0.2278	0.2124	0.2468	PASS	0.2516	0.2291	0.2663	PASS	B2 (06)
B3 (07)	0.2352	0.1937	0.2352	PASS	0.2267	0.2051	0.2387	PASS	B3 (07)
B4 (08)	0.2287	0.2003	0.2328	PASS	0.2165	0.1998	0.2322	PASS	B4 (08)
C1 (09)	0.2047	0.1911	0.2221	PASS	0.2353	0.2198	0.2554	PASS	C1 (09)
C2 (10)	0.2153	0.1997	0.2320	PASS	0.2416	0.2225	0.2586	PASS	C2 (10)
C3 (11)	0.2158	0.2004	0.2329	PASS	0.2336	0.2144	0.2492	PASS	C3 (11)
C4 (12)	0.2109	0.1908	0.2217	PASS	0.2731	0.2325	0.2702	FLAG-HIGH	C4 (12)
D1 (13)	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	D1 (13)
D2 (14)	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	D2 (14)
D3 (15)	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	D3 (15)
D4 (16)	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	D4 (16)

Δ

JP Δ Detector 0.22m
Date: 6/19/17

Reviewed by: _____

Historical Control Limits -- +/-7.5% of Average of 30 Data Points. JP 02/10/17

[illegible]

Control Limits established from previous weekly background determinations

Weekly Bkg File:	BKA0606W	Date:	6/6/17	Analyst:	JBK
	0		0		0

Gas Proportional Counter

Instrument Calibration

**Initial Efficiency Calibration
Standards Traceability**

Gross Alpha Co-Precipitation

Instrument: LB4100-A

Calibration: Gross Alpha (Th-230) -- ringed planchet
Drinking Water EPA Method 900.0 Compliant

Date of Calibration: Gross Alpha Eff: 12/07/16
` Attenuation: 04/15/17 & 04/17/17

Efficiency Log Files: **Th230-12/16**

Efficiency Instrument Files: ETH1207A-C
Attenuation Instrument Files: ACP0415, ACP0417

Source ID's: (Th-230 853.3020.89)

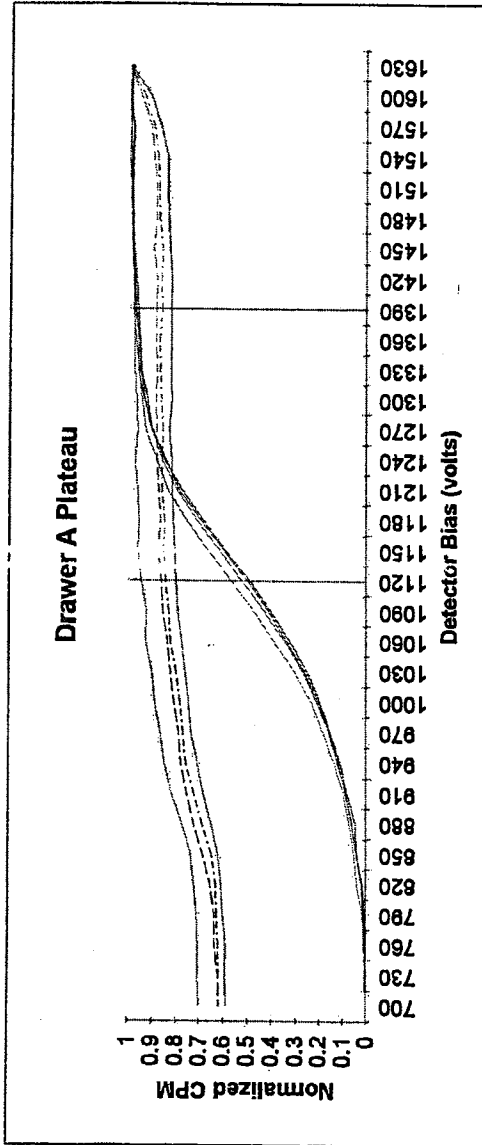
Expires 11/3/2017

OK JP 4/28/17

Instrument Plateaus

Unit Type: LB4100W
 Date Performed: 11/3/16 13:18
 FileName: PTA1103
 Batch ID: PLATEAU CHECK

Unit Id: Orange
 Application Revision: B
 Application Version: Standard



Optimum alpha beta simultaneous operating voltage: **1402.5**

Optimum alpha only operating voltage: **1120**

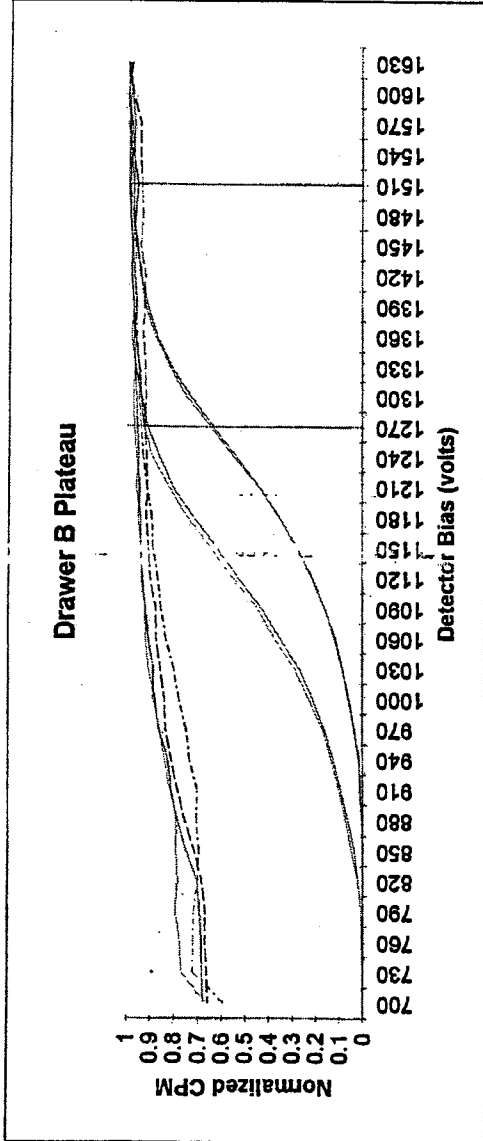
	A1	A2	A3	A4
Beta slope at beta voltage	2.48%	2.17%	3.46%	2.60%
Alpha slope at beta voltage	0.69%	1.09%	0.53%	-0.62%
Alpha slope at alpha voltage	3.21%	3.26%	3.49%	2.70%

OK 11/7/16

Printed 11/4/16 7:03 AM

Unit Type: LB4100/W
 Date Performed: 11/3/16 13:18
 FileName: PTA1103
 Batch ID: PLATEAU CHECK

Unit Id: Orange
 Application Revision: B
 Application Version: Standard



Optimum alpha beta simultaneous operating voltage: 1500

Optimum alpha only operating voltage: 1270

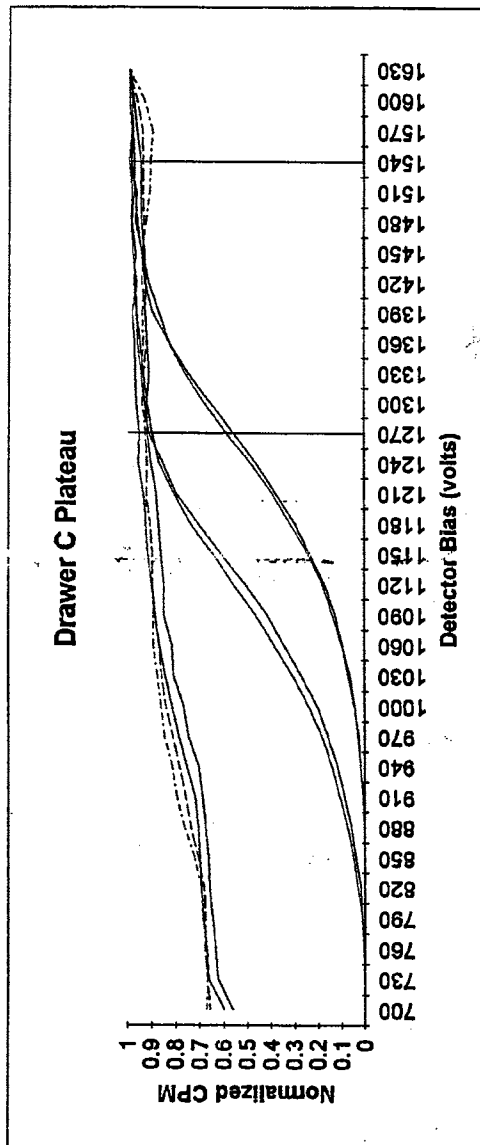
	B1	B2	B3	B4
Beta slope at beta voltage	1.06%	0.81%	1.70%	2.57%
Alpha slope at beta voltage	0.00%	0.72%	1.22%	1.58%
Alpha slope at alpha voltage	0.84%	0.83%	1.99%	3.07%

OK 11/7/16

Printed 11/4/16 7:03 AM

Unit Type: LB4100W
 Date Performed: 11/4/16 07:00
 FileName: PTA1104C
 Batch ID: DRAWER C PLATEAU

Unit Id: Orange
 Application Revision: B
 Application Version: Standard



Optimum alpha beta simultaneous operating voltage: **1530**

Optimum alpha only operating voltage: **1270**

	C1	C2	C3	C4
Beta slope at beta voltage	2.80%	0.60%	1.61%	0.38%
Alpha slope at beta voltage	2.88%	2.32%	-0.15%	-0.03%
Alpha slope at alpha voltage	2.92%	1.27%	2.92%	1.94%

OUT 11/17/16

Printed 11/4/16 1:22 PM

Continued from Page

11-4-15

Plateau checks performed for Drawers A-C

A sources

410 Am-241

A1 B1 C1

406

Sr-90/4-90

PTA1104A

411 17000dpm

A2 B2 C2

407

29600dpm

B

412 2-16-95

A3 B3 C3

408

9-15-92

C

413

A4 B4 C4

409

Parameters

Starting voltage 700

Ct. preset 40,000

Ending voltage 1650

weak check time 0.1

volts/step 30

weak ct. limit 35

Ct. time/step 5

Time between steps 0.1

3-24-16

Power outage. Instrument was turned off. Turned back on when power was restored. Daily checks were performed.

All in control. Instrument on-line.

3-30-16

Memory loss caused computer to crash and files to be lost.

All instrument calibration files were restored from last back-up.

As of 4-1-16 instrument was on-line and resumed as normal.

11-3-16 & 11-4-16

Plateau checks performed for Drawers A-C

A sources

Detectors

P sources

410 Am-241

A1 B1 C1

406

Sr-90/4-90

411 17000dpm

A2 B2 C2

407

29600dpm

412 2-16-95

A3 B3 C3

408

9-15-92

413

A4 B4 C4

409

↓

Parameters

Starting voltage 700

Time between Steps 0.1

Ending voltage 1650

Ct. preset 40,000

Volts/step 30

weak check time 0.1

Ct. time/step 5

weak ct. limit 35

Continued on Page

Signed

Date

Read and Understood By

Signed

Date

11/3/16 / 11/4/16

SOP 724r U

ALS

Low Background Gas Flow Proportional Counter Log

Instrument: LB4100A

Det.	Sample ID	Batch	Test	Count Dur. (min)	Start Time	Analyst Initials	File ID	Output Initials
1-4	Alpha/Beta	Dryer A Plat	Plat	5 Min/Step	13:10	MH	PTA1103	JP
5-6	Beta/Alpha	B						
9-12	Alpha/Beta	C			16:55	JP	PTA11034C	
1-12	Daily Eff.	—	—	.30	14:08	UW	EFA1104	UW
		—	—		14:20		A	
		—	—		14:31		B	
		—	—		14:44		C	
		—	—		14:54		D	
1-12	Weekly bkgd	—	—	1000	15:17	UW	EFA1104W	JP

JP 11/5/16

Comments:

Page No.: 468536 **B**
(cont. from page MP **B**)

Form 780r8.doc (6/23/06)

Reviewed By / Date

JP 11/5/16

Instrument ROIs

LB4100-AW Sample Counting Parameters for LIMS

Certainty requirement for MDA and flags

Maximum count time (min)	95%
Typical Residual Mass (mg)	120.00
Typical Sample Volume (l)	80.00
	1.00

Activity level for flags (pCi/l)	$1.000\text{E}+00$	$8.000\text{E}+00$
Activity Multiplier	$1.000\text{E}+00$	$1.000\text{E}+00$
Mass Error (%)	1.00%	
Volume Error (%)	1.00%	

	Alpha		Beta		MDA (pCi/l)
	eff.	bkg.	eff.	bkg.	
A1	16.35%	0.142	34.64%	2.098	6.404E-01
A2	21.07%	0.125	37.63%	2.008	5.775E-01
A3	22.60%	0.1	36.33%	2.117	6.140E-01
A4	19.36%	0.141	35.10%	2.019	6.206E-01

Batch Specific:

Event	Recycle
Orange 1	0

Drawer Specific:

	Date/Time	Official	Bias	Step
A	11/3/16 13:18	TRUE	1402.5	0
B	11/3/16 13:18	TRUE	1500	0
C	11/4/16 7:00	TRUE	1530	0
D	8/5/08 11:19	TRUE	1500	0

Detector Specific:

	Date/Time	Official	Threshold	bLL	bUL	aLL	aUL	Time
A1	11/4/16 0:00	TRUE	0.1	0	21.51	41.83	100	120
A2	11/4/16 0:00	TRUE	0.1	0	24.68	47.05	100	120
A3	11/4/16 0:00	TRUE	0.1	0	20.53	39.21	100	120
A4	11/4/16 0:00	TRUE	0.1	0	21.8	40.51	100	120
B1	11/4/16 0:00	TRUE	0.1	0	47.74	94.77	100	120
B2	11/4/16 0:00	TRUE	0.1	0	53.65	100	100	120
B3	11/4/16 0:00	TRUE	0.1	0	13.94	32.01	100	120
B4	11/4/16 0:00	TRUE	0.1	0	11.52	27.44	100	120
C1	11/4/16 0:00	TRUE	0.1	0	21.44	47.05	100	120
C2	11/4/16 0:00	TRUE	0.1	0	67.57	100	100	120
C3	11/4/16 0:00	TRUE	0.1	0	23.27	50.98	100	120
C4	11/4/16 0:00	TRUE	0.1	0	88.44	100	100	120
D1	5/2/13 0:00	TRUE	0.1	0	60.52	100	100	120
D2	5/2/13 0:00	TRUE	0.1	0	60.52	100	100	120
D3	5/2/13 0:00	TRUE	0.1	0	60.52	100	100	120
D4	5/2/13 0:00	TRUE	0.1	0	60.52	100	100	120

Calibration Efficiencies

SOURCES.XLS

628	Th-230	Alpha	28124250	5831.9	116.64	6-Nov-07	ALS	Th-230-12/16
629	Cs-137	Beta	10994	3937.1	70.87	9-Feb-15	ALS	Cs137-12/16

Th-230 Ringed Planchet Efficiency Calibration

LB4100-A

Date: 12/7/2016

Source ID: 628

Det ID File Name	A1 ETH1207A	A2 ETH1207A	A3 ETH1207A	A4 ETH1207A	B1 ETH1207B	B2 NA	B3 ETH1207B	B4 ETH1207B
Cnt Time	7.52	7.75	7.35	7.5	7.22	NA	7.39	7.64
Tot Cnts	10008	10009	10011	10011	10010	NA	10000	10001
Bkg CPM	0.122	0.156	0.124	0.095	0.105	NA	0.134	0.158
CPM	1330.7291	1291.3279	1361.9168	1334.705	1386.3216	NA	1353.046	1308.8734
Alpha EFF	0.2281997	0.221443	0.2335479	0.22888153	0.237733	NA	0.2320267	0.2244518
Beta EFF	0.0643288	0.0666528	0.0680612	0.06615498	0.0771242	NA	0.0679839	0.0654528
Efficiency	0.2282	0.2214	0.2335	0.2289	0.2377	NA	0.2320	0.2245

Det ID File Name	C1 ETH1207C	C3 ETH1207C	C2 NA	C4 NA	D1 N.A.	D2 N.A.	D3 N.A.	D4 N.A.
Cnt Time	7.56	7.31	NA	NA	N.A.	N.A.	N.A.	N.A.
Tot Cnts	10005	10016	NA	NA	N.A.	N.A.	N.A.	N.A.
Bkg CPM	0.124	0.115	NA	NA	N.A.	N.A.	N.A.	N.A.
CPM	1323.2887	1370.0628	NA	NA	N.A.	N.A.	N.A.	N.A.
Alpha EFF	0.2269238	0.2349449	NA	NA	N.A.	N.A.	N.A.	N.A.
Beta EFF	0.071381	0.071137	NA	NA	N.A.	N.A.	N.A.	N.A.
Efficiency	0.2269	0.2349	NA	NA	N.A.	N.A.	N.A.	N.A.

		A1	A2	A3	A4	B1	B3	B4	C1	C3
	offset	0	0	1	2	3	4	6	7	8
		0	0	1	2	3	0	1	2	0
	NumRecs	1	1	1	1	1	1	1	1	1
	total time	7.52	7.75	7.75	7.35	7.5	7.22	7.39	7.64	7.56
Alpha	total counts	10008	10009	10011	10011	10011	10010	10000	10001	10005
	reduced chi	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
	chi-square	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
	CPM	1330.729	1291.328	1361.917	1334.705	1386.322	1353.046	1308.873	1323.289	1370.063
	CPM var	354.0915	333.4363	370.8273	356.1425	384.2438	366.2193	342.6957	350.1968	375.1777
	Efficiency	0.2282	0.221443	0.233548	0.228882	0.237733	0.232027	0.224452	0.226924	0.234945
	archived ST	0.00559	0.005424	0.00572	0.005606	0.005823	0.005684	0.005498	0.005558	0.005754
	predicted S	0.002281	0.002214	0.002334	0.002288	0.002376	0.00232	0.002245	0.002269	0.002348
	actual STD	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Beta	total counts	2837	3028	2934	2909	3261	2946	2930	3162	3045
	reduced chi	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
	chi-square	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
	CPM	375.1286	388.6807	396.8937	385.7777	449.744	396.4428	381.6829	416.253	414.8297
	CPM var	64.40233	65.68159	70.24775	66.7617	82.95885	69.83822	64.90702	72.82024	74.33728
	Efficiency	0.064329	0.066653	0.068061	0.066155	0.077124	0.067984	0.065453	0.071381	0.071137
	archived ST	0.001884	0.001926	0.00198	0.001927	0.002195	0.001975	0.001903	0.002044	0.002052
	predicted S	0.001211	0.001214	0.00126	0.00123	0.001353	0.001256	0.001212	0.001272	0.001292
	actual STD	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

Date 12/2/16SOP 724r 11

ALS
Low Background Gas Flow Proportional Counter Log
Instrument: LB4100A

Instrument Daily Response and Background Checks

Det.	Daily Response Check				Background Check				Det. Status
	Start 1	Status	Start 2	Status	Start 1	Status	Start 2	Status	
1	JP	P			JP	P			P
2									
3									
4									
5									
6									OL
7									P
8									
9									
10									OL
11									P
12									OL
13	OL				OL				
14									
15									
16									

Det = Detector; α = Alpha; β = Beta; P = Pass; H = High; L = Low; OL = Offline; R = Recount; W = Weekly; NP = Not Processed

Weekly Background Calibration

	Current Calib. File ID	Weekly Calib. Started	Status	File ID
Dr A	BKA1201W			
Dr B				
Dr C				
Dr D	OL			

Dr = Drawer

Gas Supply

P-10 Supply		P-10 Flow	
Tank 1	0	Dr A	10
		Dr B	
Tank 2	2050	Dr C	
		Dr D	

Comments:Page No.: 468567 **A**

Form 780r8.doc (6/23/06)

Reviewed By / Date

JP 12/7/16

Date 12/7/16

SOP 724r 11

ALS

Low Background Gas Flow Proportional Counter Log

Instrument: LB4100A

[illegible]Comments:

Page No.: 468567 **B**
(cont. from page M **B**)

Form 780r8.doc (6/23/06)

Reviewed By / Date _____

JP 12/8/16

Date 12/8/16SOP 724r 11

ALS
Low Background Gas Flow Proportional Counter Log
Instrument: LB4100A

Instrument Daily Response and Background Checks

Det.	Daily Response Check				Background Check				Det. Status
	Start 1	Status	Start 2	Status	Start 1	Status	Start 2	Status	
1	JP	P			JP	P			P
2									
3									
4									
5									
6									α
7									P
8									
9									
10									α
11									P
12									OL
13	OL				OL				
14									
15									
16									

Det = Detector; α = Alpha; β = Beta; P = Pass; H = High; L = Low; OL = Offline; R = Recount; W = Weekly; NP = Not Processed

Weekly Background Calibration

	Current Calib. File ID	Weekly Calib. Started	Status	File ID
Dr A	BKA1201W			
Dr B				
Dr C				
Dr D	OL			

Dr = Drawer

Gas Supply

P-10 Supply		P-10 Flow	
Tank 1	0	Dr A	LO
		Dr B	
Tank 2	1600	Dr C	
		Dr D	

Comments:Page No.: 468568 **A**

Form 780r8.doc (6/23/06)

Reviewed By / Date

JP 12/8/16

12/16/16
Am 241 Mass Attn Curve
Benchsheet: AB121109-1 Source: 1223001-4 12/16/19
6, 8, 14 JP 12/16/16

Def	8:23	8:52	9:20	9:50	10:21	10:54	11:26	11:57	12:26	12:55	13:23	13:49	14:15	14:39	14:57
A1	19	18	17	16	14	13	12	11	10	9	8	7	4	3	2
A2	2	1	19	18	17	16	14	13	12	11	10	9	8	7	4
A3	3	2	1	19	18	17	16	14	13	12	11	10	9	8	7
A4	4	3	2	1	19	18	17	16	14	13	12	11	10	9	8
B1	7	6	4	3	2	1	19	18	17	16	14	13	12	11	10
B3	8	7	6	4	3	2	1	19	18	17	16	14	13	12	11
B4	9	8	7	6	4	3	2	1	19	18	17	16	14	13	12
C1	10	9	8	7	6	4	3	2	1	19	18	17	16	14	13
C2	11	10	9	8	7	6	4	3	2	1	19	18	17	16	14
C3															

JP 12/16/16

Gross Alpha (Th-230) EFF Calibration

Benchsheet: AB150603-5 Source ID: 628

Log file: Th-230-12/16

Sources	Detectors	Filename
1518003-1	A1 B1 C1	ETH1207A
-2	A2 B3 C3	B
-3	A3 B4	C
-4	A4	

Gross Beta (Cs-137) EFF Calibration

Benchsheet: AB150310-2 Source ID: 629

Log file: Cs137-12/16

Sources	Detectors	Filename
1515003-1	A1 B1 C1	ECS1207A
-3	A2 B3 C3	B
-4	A3 B4	C
-5	A4	

Continued on Page

Read and Understood By

12-12-16

Signed

Date

Signed

Date

Radiochemistry Instrument Worksheet

ALS Environmental -- FC

Prep Batch: AB150603-5

Prep Procedure: GROSS_ALPHA

Base Efficiency

Analytical QASS / NCR? Y N

Prep Num	LabID	QC Type	Init Aliq	Fin Aliq	Units	Report Units	Residual Mass (mg)	Cnt 1 File	Cnt 1 Inst/Det	Cnt 1 Pos Chk By	Cnt 2 File	Cnt 2 Inst/Det	Cnt 2 Pos Chk By	Cnt 3 File	Cnt 3 Inst/Det	Cnt 3 Pos Chk By	Notes
1	1518003-1	SMP	200	200	ml	pCi/l											
1	1518003-2	SMP	200	200	ml	pCi/l											
1	1518003-3	SMP	200	200	ml	pCi/l											
1	1518003-4	SMP	200	200	ml	pCi/l											
1	1518003-5	SMP	200	200	ml	pCi/l											

See Mantrex Log #3974 pg 38

Pr 2/15/17

Other

Spike Solution Information							
Soln #	Nuclide	SolnID	Prep Conc	Units	Prep Date	Aliquot	Pipet ID
S1	Th-230	853.3020.89	1,166.300	DPM/ml	06/03/15	5	ml
							RS-027

Sample Barcodes

1518003-1 AB150603-SPS1		1518003-2 AB150603-SPS2		1518003-3 AB150603-SPS3	
1518003-4 AB150603-SPS4		1518003-5 AB150603-SPS5			

Reporting Units

LabID	TstGrpName	RptUnits
1518003-1	GrossAlpha_DW	pCi/l
1518003-2	GrossAlpha_DW	pCi/l
1518003-3	GrossAlpha_DW	pCi/l
1518003-4	GrossAlpha_DW	pCi/l
1518003-5	GrossAlpha_DW	pCi/l

Radiochemistry Prep Worksheet

ALS Environmental -- FC

Prep Batch: AB150603-5

Prep Procedure: GROSS_ALPHA

Reviewed By: jkb 3709 Review Date: 6/8/2015

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

Prep Analyst: Jennie Kill-Bowden Balance: Balance: Prep Date: 6/3/2015 Matrix Class: liquid Prep Dept: RS

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Aliq ml	Fin Aliq ml	Prep Basis	Standards	Prep Notes
1	1	1518003-1	SMP		200	200	Unfiltered	S1	
2	1	1518003-2	SMP		200	200	Unfiltered	S1	
3	1	1518003-3	SMP		200	200	Unfiltered	S1	
4	1	1518003-4	SMP		200	200	Unfiltered	S1	
5	1	1518003-5	SMP		200	200	Unfiltered	S1	

Comments

Zero Mass Efficiency for Th-230 USGS method

Spiked By: Jennie Kill-Bowden Date: 6/4/2015

Witnessed By: Dayna K. Lewis Date: 6/4/2015

Spike Solution Information					
Soln #	Nuclide	Conc	Units	Prep Date	Pipet ID
S1	Th-230	853.3020.89	1,166.300 DPM/ml	06/03/15	RS-027

Radiochemistry Prep Worksheet

ALS Environmental -- FC

Prep Batch: AB150603-5

Prep Procedure: GROSS_ALPHA

Prep Batch Not Validated!!!

Reviewed By: _____ Review Date: _____

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

Prep QASS / NCR? Y / N

Prep SOP: PAI 702 Rev: 20

Prep Analyst: Jennie Kill-Bowden *JKB*

Balance:

Prep Date: 6/3/2015

Balance:

Matrix Class: liquid

Prep Dept: RS

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Aliq ml	Fin Aliq ml	Prep Basis	Standards	Prep Notes
1	1	1518003-1	SMP		200	200	Unfiltered	S1	
2	1	1518003-2	SMP		200	200	Unfiltered	S1	
3	1	1518003-3	SMP		200	200	Unfiltered	S1	
4	1	1518003-4	SMP		200	200	Unfiltered	S1	
5	1	1518003-5	SMP		200	200	Unfiltered	S1	

Comments

Zero Mass Efficiency for Th-230 USGS method

Spiked By: *JKB* Date: *6/4/15*

Witnessed By: *[Signature]* Date: *6/4/15*

Spike Solution Information					
Soln #	Nuclide	SolnID	Prep Conc	Units	Prep Date
S1	Th-230	853.3020.89	1.166.300	DPM/ml	06/03/15
				5 ml	RS-027

12/13/15

Radiochemistry Instrument Worksheet

Prep Batch: AB150603-5

ALS Environmental -- FC

Prep Procedure: GROSS_ALPHA

Analytical QASS / NCR? Y NA

Prep Num	LabID	QC Type	Init Aliq	Fin Aliq	Units	Report Units	Residual Mass (mg)	Cnt 1 File	Cnt 1 InsIDat	Cnt 1 Pos Chk By	Cnt 2 File	Cnt 2 InsIDat	Cnt 2 Pos Chk By	Cnt 3 File	Cnt 3 InsIDat	Cnt 3 Pos Chk By	Notes
1	1518003-1	SMP	200	200	ml	pCi/l											
1	1518003-2	SMP	200	200	ml	pCi/l											
1	1518003-3	SMP	200	200	ml	pCi/l											
1	1518003-4	SMP	200	200	ml	pCi/l											
1	1518003-5	SMP	200	200	ml	pCi/l											

Soln #	Nuclide	SolnID	Prep Conc	Units	Prep Date	Aliquot Units	Pipet ID
51	Tl-230	853 3020.69	1.166	300	DPW/ml	06/03/15	5 ml RS-027

Sample Barcodes

1518003-1
AB150603-SPS1

1518003-2
AB150603-SPS2

1518003-4
AB150603-SPS4

1518003-5
AB150603-SPS5

Reporting Units

LabID	TestGrpName	RptUnits
1518003-1	GrossAlpha_DW	pCi/l
1518003-2	GrossAlpha_DW	pCi/l
1518003-3	GrossAlpha_DW	pCi/l
1518003-4	GrossAlpha_DW	pCi/l
1518003-5	GrossAlpha_DW	pCi/l

Nx

Radiochemistry Prep Worksheet

Prep Batch: AB150603-5

ALS Environmental - FC

Prep Procedure: GROSS_ALPH

Reviewed By: jkb 3/6/15 Review Date: 6/8/2015

Non-Routine Pre-Treatment? Y (N) Batch: NA Re-Prep? Y (N) Batch: NA
 Prep SOP: PAI 702 Rev: 20 Prep Analyst: Jennie Kil-Bowden
 Prep SOP: NONE Prep Date: 6/3/2015
 Matrix Class: liquid Prep Dept: RS

Balance:
Balance:

Sample Num	Prep Num	LabID	QC Type	Dish No.	Init Aliq ml	Fin Aliq ml	Prep Basis	Standards	Prep Notes
1	1	1518003-1	SMP		200	200	Unfiltered	S1	
2	1	1518003-2	SMP		200	200	Unfiltered	S1	
3	1	1518003-3	SMP		200	200	Unfiltered	S1	
4	1	1518003-4	SMP		200	200	Unfiltered	S1	
5	1	1518003-5	SMP		200	200	Unfiltered	S1	

Comments

Zero Mass Efficiency for Th-230 USGS method

Spiked By: Jennie Kil-Bowden Date: 6/4/2015

Witnessed By: Dayna K. Lewis Date: 6/4/2015

Spiked Solution Information					
Soln #	Nuclide	SolnID	Prep Conc	Units	Prep Date
S1	Th-230	853 3020.89	1,166,300	DPM/ml	06/03/15
				5 ml	RS-027

Radiochemistry Prep Worksheet

Prep Batch: AB150603-5

ALS Environmental - FC

Prep Procedure: GROSS_ALPHA

Prep Batch Not Validated!!!

Review Date:

Reviewed By:

Prep QASS / NCR? Y / N

Re-Prep? Y / N

Non-Routine Pre-Treatment? Y / N

Prep SOP: PAI 702

Prep Analyst: Jennie Kill-Bowden

Balance:

Prep Date: 6/3/2015

Balance:

Prep Dept: RS

Prep SOP: NONE

Matrix Class: liquid

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Aliq ml	Fin Aliq ml	Prep Basis	Standards	Prep Notes
1	1	1518003-1	SMP	200	200	200	Unfiltered	S1	
2	1	1518003-2	SMP	200	200	200	Unfiltered	S1	
3	1	1518003-3	SMP	200	200	200	Unfiltered	S1	
4	1	1518003-4	SMP	200	200	200	Unfiltered	S1	
5	1	1518003-5	SMP	200	200	200	Unfiltered	S1	

Comments

Zero Mass Efficiency for Th-230 USGS method

Spiked By: TEB Date: 6/4/15

Witnessed By: [Signature] Date: 6/11/15

Spiked Solution Information					
Soln #	Nuclide	SolnID	Prep Conc	Units	Pipet ID
S1	Th-230	853.3020.89	1,166,300	DPM/ml	05/03/15
				\$	RS-027

12/13/15

PAI - Gas Flow Proportional Sample Analysis LB4100-C

Unit Type: LB4100-C
 Counting Unit ID: Magenta
 High Voltage Mode: Simultaneous
 Application Revision: Standard
 Rev.1201104 JCP

Data file name: ABC9409
 Batch ID: TH239 OUTLIER
 Count Preset (mg): 10
 Batch Ended: 09/27/15 8:58

Background log file: BKGASW
 Date of Bkg. Cal: 06/22/15
 Alpha activity log file: TH239-56713
 Alpha attenuation calibration: AT10819, 06/20
 Alpha prop. log file: NA
 Alpha prop. attenuation: NA
 Beta efficiency log file: Cs-137-42415
 Beta attenuation calibration: ACS0312
 Beta prop. attenuation: NA

Alpha Attenuation Calibration		Beta Attenuation Calibration	
$y = b \cdot \ln(x/a) + \ln(mass \cdot dO)$		$y = b \cdot \ln(x/a) + \ln(mass \cdot dO)$	
Alpha b	0.51740	Beta b	0.5454
a	0.00050	m	0.9933
a	0.0004	a	1.0446
a	0.0000	a	0.0000
Alpha to Beta Ratio		Beta to Alpha Ratio	
$y = b \cdot \ln(x/a) + \ln(mass \cdot dO)$		$y = b \cdot \ln(x/a) + \ln(mass \cdot dO)$	
a to beta ratio	0.2537	b to alpha ratio	-2.54E-06
a to beta ratio	0.9978	b to alpha ratio	0.0022

Det. ID	Sample ID	Count End Date & Time	Count Dur. (min)	Resid. Mass (mg)	Alpha Activity										Beta Activity									
					Gross CPM	Bkg. CPM	b-a xlik CPM	Base Eff	Progeny Cor.Fact	Base Eff	Progeny Cor.Fact	Gross CPM	Bkg. CPM	b-a xlik CPM	Base Eff	Progeny Cor.Fact	Gross CPM	Bkg. CPM	b-a xlik CPM	Base Eff	Progeny Cor.Fact			
A1	1510503-1	9/20/2015 8:58	10.00	0.9	1379.500	0.124	1.223	0.2188	0.937	0.937	NA	NA	NA	383.780	1.478	340.3178	0.4155	0.949	0.949	NA	NA	NA		

JP 6/9/15

PAI - Gas Flow Proportional Sample Analysis LB4100-C

Unit Type: LB4100-C
 Counting Unit ID: Mupeds
 High Voltage Mode: Simultaneous
 Application Revision: Standard
 Rev.12/01/08 JCP

Data file name: AISC000A
 Batch ID: TH209 OUTLIER
 Count Preset (m): 10
 Batch Ended: 03/2015 9:10

Background log file: BKG000W
 Date of Bkg. Cal: 06/2015
 Alpha efficiency log file: TH209-000T3
 Alpha attenuation calibration: AT140410_0030
 Alpha prep. log file: n/a
 Beta efficiency log file: CS137-00118
 Beta prep. log file: n/a
 Beta attenuation calibration: ACS0312
 Beta prep. attenuation: n/a

Alpha Attenuation Calibration		Beta Attenuation Calibration	
$y = E_{\alpha} \cdot (1 + (mass \cdot a))$		$y = E_{\beta} \cdot (1 + (mass \cdot b))$	
Alpha a	0.33740	Beta b	0.0434
$a \pm$	0.0000	$b \pm$	0.0003
χ^2/ν	0.0000	χ^2/ν	1.0446
Alpha to Beta Ratio		Beta to Alpha Ratio	
$y = E_{\alpha} \cdot (1 + (mass \cdot a))$		$y = E_{\beta} \cdot (1 + (mass \cdot b))$	
$a \rightarrow b$ ratio b	0.2337	$b \rightarrow a$ ratio a	3.54536
$a \rightarrow b$ ratio a	0.0078	$b \rightarrow a$ ratio b	0.0033

Det. ID	Sample ID	Count End Date & Time	Count Dur. (min)	Resid. Mass (mg)	Alpha Activity						Beta Activity					
					Gross CPM	Bkg CPM	$a \rightarrow b$ xilk CPM	Base CPM	Eff	Cor.Fact.	Progeny Eff	Gross CPM	Bkg CPM	$a \rightarrow b$ xilk CPM	Base CPM	Progeny Cor.Fact.
A1	1518003-2	04/2015 8:10	10.00	0.0	1319.700	0.124	1.210	0.2308	0.937	n/a	n/a	376.700	1.476	333.4569	0.4155	0.949

JP 6/9/15

PAI - Gas Flow Proportional Sample Analysis LB4100-C

Unit Type: LB4100-C
 Counting Unit ID: Magsa
 High Voltage Model: Streamsource
 Application Revision: Standard
 Rev: 126104 JCP

Data File Name: ABC06598
 Batch ID: TH230 OUTLIER
 Count Preset (m): 10
 Batch Endset: 6822015 9:24

Background Logfile: BKGBW
 Date of Bkg. Cal: 6/6/2015
 Alpha efficiency logfile: TH230-06/15
 Alpha attenuation calibration: AT08518 08/20
 Alpha prog. logfile: n/a
 Beta efficiency logfile: Ca-137 03/15
 Beta prog. attenuation: n/a
 Beta attenuation calibration: ACS0312

Alpha Attenuation Calibration		Beta Attenuation Calibration	
$y = b \ln(1/(1 - \text{mass}))$		$y = b \ln(1/(1 - \text{mass}))$	
Alpha b	0.33740	Beta b	0.3434
m	0.9999	m	0.9991
a	0.0284	a	1.0444
x	0.0005	x	0.0009
Alpha to Beta X-kill		Beta to Alpha X-kill	
$y = b \ln(1 - \text{mass})$		$y = b \ln(1 - \text{mass})$	
a to beta m	0.2527	b to alpha m	-3.3424
a to beta m	0.9978	b to alpha m	0.0032

Det. ID	Sample ID	Count End Date & Time	Count Dur. (min)	Resid. Mass (mg)	Alpha Activity				Beta Activity				Progeny			
					Gross CPM	Bkg. CPM	Net CPM	Eff	Base Cor.Fact.	Gross CPM	Bkg. CPM	Net CPM	Eff	Base Cor.Fact.	Gross CPM	Progeny Cor.Fact.
A1	1518003-3	6/6/2015 9:24	10.00	0.0	1331.000	0.124	1242	0.2348	8.637	389.590	1.476	390.0178	0.4155	0.849	n/a	n/a

7/6/15

Alpha Attenuation Calibration	Beta Attenuation Calibration
$y = b_0 + b_1 x + b_2 x^2 + b_3 x^3 + b_4 x^4$	$y = b_0 + b_1 x + b_2 x^2 + b_3 x^3 + b_4 x^4$
$R^2 = 0.9743$	$R^2 = 0.9494$
rm	rm
$\sigma^2 = 0.0008$	$\sigma^2 = 0.0003$
$\sigma^2 = 0.0004$	$\sigma^2 = 0.0003$
$\sigma^2 = 0.0004$	$\sigma^2 = 0.0003$
Alpha to Beta Ratio	Beta to Alpha Ratio
$y = b_0 + b_1 x + b_2 x^2 + b_3 x^3 + b_4 x^4$	$y = b_0 + b_1 x + b_2 x^2 + b_3 x^3 + b_4 x^4$
$R^2 = 0.9737$	$R^2 = 0.9494$
rm	rm
$\sigma^2 = 0.0008$	$\sigma^2 = 0.0003$
$\sigma^2 = 0.0004$	$\sigma^2 = 0.0003$
$\sigma^2 = 0.0004$	$\sigma^2 = 0.0003$

Background topology: BKGA5W
Date of Big Cat: 06/2015
Alpha efficiency topology: T023A-0013
Alpha attenuation calibration: A1H0519, 0622
Beta efficiency topology: Co-137-0315
Beta attenuation calibration: AC50312

Del. ID	Sample ID	Count End Date & Time	Count Dur. (min)	Resid. Mass (mg)	Alpha Activity										Beta Activity									
					Gross CPM	Bkg. CPM	b>x1k CPM	Base CPM	Base Eff	Cor.Fact.	Progeny CPM	Progeny Eff	Cor.Fact.	Gross CPM	Bkg. CPM	a+b x1k CPM	Base CPM	Base ER	Cor.Fact.	Progeny CPM	Progeny ER	Cor.Fact.		
A1	1518003-4	8/6/2015 9:47	18.00	0.0	1340.500	0.124	1.278	0.2386	0.937	n/a	n/a	407.100	1.478	340.7348	0.4155	0.848	n/a	n/a	n/a					

Dec 15

PAI - Gas Flow Proportional Sample Analysis LB4100-C

Unit Type: LB4100-C
 Counting Unit ID: Megarita
 High Voltage Mode: Simultaneous
 Application Revision: Standard
 Rev.1201008.JCP

Background logfiles: BKGABW
 Date of Bkg. Csk: 9/9/2015
 Alpha efficiency logfile: NA
 Alpha attenuation calibration: ATN0018, 08/20
 Alpha prog. attenuation: NA
 Beta efficiency logfile: Cs-137-02/15
 Beta prog. attenuation: NA
 Beta attenuation calibration: ACS0012

Alpha prog. logfile: NA
 Alpha prog. attenuation: NA
 Beta prog. logfile: NA
 Beta prog. attenuation: NA

Alpha Attenuation Calibration		Beta Attenuation Calibration	
$y = b \cdot m^a / (y_{max} - d)$		$y = b \cdot m^a / (y_{max} - d)$	
Alpha b	0.8740	Beta b	0.9534
m	0.9490	m	0.9931
a	0.8706	a	1.0464
d	0.0000	d	0.0000
Alpha to Beta X-axis		Beta to Alpha X-axis	
$y = b \cdot m^a$		$y = b \cdot m^a$	
b → a stable b		b → a stable b	
a → b stable m		a → b stable m	
0.9578		0.9419	
0.9878		0.9419	

Det. ID	Sample ID	Count End Date & Time	Count Dur. (min)	Resid. Mass (mg)	Alpha Activity										Beta Activity																			
					Gross					Base					Progeny					Gross					Base					Progeny				
					CPM	b → a xlik CPM	CPM	Eff	Cor.Fact	CPM	Eff	Cor.Fact	CPM	Eff	Cor.Fact	CPM	Bkg. CPM	a → b xlik CPM	CPM	Eff	Cor.Fact	CPM	Bkg. CPM	a → b xlik CPM	CPM	Eff	Cor.Fact	CPM	Bkg. CPM	a → b xlik CPM	CPM	Eff	Cor.Fact	
A1	1518003-5	06/20/15 10:01	10.00	0.0	1288.000	0.124	1.184	0.2366	0.937	0.937	NA	NA	374.506	1.476	320.1143	0.4155	0.949	0.949	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA				

7/6/15

Date 6/9/15

SOP 724r 11

ALS
Low Background Gas Flow Proportional Counter Log
Instrument: LB4100C

Instrument Daily Response and Background Checks

Det.	Daily Response Check				Background Check				Det. Status
	Start 1	Status	Start 2	Status	Start 1	Status	Start 2	Status	
1	JD	P			JD	P			P
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16	✓				✓				✓

Det = Detector; α = Alpha; β = Beta; P = Pass; H = High; L = Low; OL = Offline; R = Recount; W = Weekly; NP = Not Processed

Weekly Background Calibration

	Current Calib. File ID	Weekly Calib. Started	Status	File ID
Dr A	BK00605W			
Dr B				
Dr C				
Dr D				

Dr = Drawer

Gas Supply

P-10 Supply		P-10 Flow	
Tank 1	1850	Dr A	0.1
	↓	Dr B	↓
Tank 2	1200	Dr C	↓
	↓	Dr D	↓

Comments:

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Form 780r8.doc (6/23/06)

Reviewed By / Date J 6/9/15

Date 6/9/15SOP 724r 11

ALS
Low Background Gas Flow Proportional Counter Log
Instrument: LB4100C

Det.	Sample ID	Batch	Test	Count Dur. (min)	Start Time	Analyst Initials	File ID	Output Initials
1-16	Daily ETP	—	—	30	7:13	JP	ETC0609	JP
1-16	Daily BKG	—	—	60	7:22	JP	BK0609	JP
1	1518003-1	AB150603-5	Th230	10	8:47	JP	AB0609	JP
1	-2		Outlier		9:00	JP	A	
1	-3				9:13	JP	B	
1	-4				9:37	JP	C	
1	-5				9:51	JP	D	
1-4	10167	AB150603-5	Th230	30	10:15	JP	ETH0609A	JP
5-8			Th230		10:23		B	
9-12			EFF		10:37		C	
13-16			Cal		10:51		D	
1-16	1518004-1-16	AB150603-6	Th230	30	11:01	JP	ATH0609	JP
1	1505092-1	SR150605-1	Mass/Th	180	16:03	JP	SRC0609	JP
2	-3							
3	-3D							
4	1505234-1							
5	-3							
6	-5							
7	-7							
8	-9							
9	-11							
10	-13							
11	-13D							
12	1505235-1							
14	-3							
15	-3D							
16	1505249-1							
1	-2	SR150605-1	Sr-90	180	22:12	JP	SRC0609A	
2	1505344-1							
3	427-1							
4	-3							
5	SR1506051MB							
6	101							
7	1505379-8	AB150605-1	α15	120	22:13	JP	AB0609	
8	-8D							
9	-10							
10	AB150605-1CS							
11	1505341-1	AB150605-2		480	22:15		AB0609A	
12	-1D							
14	1505448-1							
15	-4							
JP 6/10/15								

Comments:

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(cont. from page NA **B**)

Form 780r8.doc (6/23/06)

Reviewed By / Date

JP 6/10/15

Date 6/10/15SOP 724r 11

ALS
Low Background Gas Flow Proportional Counter Log
Instrument: LB4100C

Instrument Daily Response and Background Checks

Det.	Daily Response Check				Background Check				Det. Status
	Start 1	Status	Start 2	Status	Start 1	Status	Start 2	Status	
1	P	P			P	P			P
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									

Det = Detector; α = Alpha; β = Beta; P = Pass; H = High; L = Low; OL = Offline; R = Recount; W = Weekly; NP = Not Processed*Weekly Background Calibration*

	Current Calib. File ID	Weekly Calib. Started	Status	File ID
Dr A	BKC 01605W			
Dr B				
Dr C				
Dr D				

Dr = Drawer

Gas Supply

P-10 Supply		P-10 Flow	
Tank 1	500	Dr A	0
		Dr B	
Tank 2	200	Dr C	
		Dr D	

Comments:Page No.: 455205 A

Form 780r8.doc (6/23/06)

Reviewed By / Date JP 6/10/15

Prepare an Intermediate dilution of Th-230 RSO# 853 of approximately 1200 dpm/ml

1) Prepare 0.5M HNO_3 , 31 ml HNO_3 and 969 ml DI water.
bottle # 073602

2) Determine density of 0.5M HNO_3 .

Mass of 100 ml vol. flask:

Bal. 12

68.2999 g

Mass of flask + 100 ml 0.5M HNO_3 :

169.4529 g

Net mass of 0.5M HNO_3 :

101.153 g

$$\rho = 1.0115 \text{ g/ml}$$

3) Transfer contents of vial to 100 ml Nalgene.

Bal. 14

Mass of full standard vial:

8.2827

Mass of empty standard vial:

3.2327

Net mass of standard transferred:

5.05 g

4) Dilute with 0.5 M HNO_3

Mass of Nalgene w/o lid (empty):

73.66 g

73.70 g

Mass of Nalgene with standard:

78.71 g

Mass of Nalgene, standard, and diluent:

108.52 g

Net mass of standard:

101.154 g

5) Final activity calculation

$$(1.983 \times 10^4 \text{ Bq}) (5.15119 \text{ g}) = 3849.60 \text{ Bq/g} \times \left(\frac{60 \text{ s}}{1 \text{ min}} \right) = 230,975.755 \text{ dpm}$$

$$(3849.60 \text{ Bq/g}) \cdot \left(\frac{5.05 \text{ g}}{101.154 \text{ g}} \right) \cdot (1.0115 \text{ g/ml}) = 1165.22 \text{ dpm/ml}$$

$$1165.22 \text{ dpm/ml} \times 1.16638 = 1358.4 \text{ dpm/ml}$$

Std ID: 853.3020.89

Description: Th-230

Expiration: 2/5/2009

Activity: 1166.38 dpm/mL

2s Uncertainty: 23.33 dpm/mL

Ref. Date: 11/6/2007

Ref Time: N/A

Prep Date: 12/12/2007 Prep by: DC

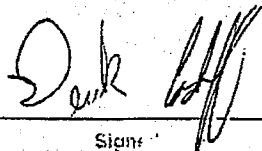
Matrix/Comp. 0.5 M HNO_3

Half Life (y): 7.70E+04

Reverification Log

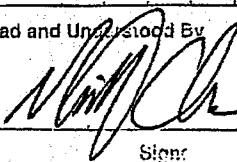
Analysis Date	Initials	Expiration Date
5/5/09	RG	5/5/2010
11/19/10	RG	11/19/2011
12/13/14	JP	12/13/2015

Continued on Page

Signature: 

Date: 12/12/07

Read and Understood By

Signature: 

Date: 2/13/08



Eckert & Ziegler

Analytics

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

CERTIFICATE OF CALIBRATION
Standard Radionuclide Source

76253-307

Th-230 5 mL Liquid in Flame Sealed Vial

Customer: Paragon Analytics / Fort Collins, CO
P.O. No.: 72908-REL 10-30-07, 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.

ANALYTICS maintains traceability to the National Institute of Standards and Technology through Measurements Assurance Programs as described in USNRC Reg. Guide 4.18, Revision 1.

Isotope:	Th-230
Activity (Bq):	1.983 E4
Half-Life:	7.538 E4 years
Calibration Date:	November 8, 2007 12:00 EST
Relative Expanded Uncertainty (k=2):	2.0%

Comments:

Impurities: γ -impurities <0.1%, α -impurities <0.01%,
5.15119 grams 0.5M HNO₃ solution.

Source Prepared By: N. E. Klesman
N. E. Klesman, Radiochemist

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

Date: 11-19-07

End of Certificate

Corporate Office
24937 Avenue Tibbitts Valencia, California 91355

Laboratory
1380 Seaboard Industrial Blvd. Atlanta, Georgia, 30318

Mass Attenuation Curves

[illegible]

LB4100A_Alpha Attenuation Curve -- Th-230

Spike Information		Ref. Date		Activity		Vol.	
Std. ID	853.3020.89	11/6/2007	75380	1166.38	5.0	5831.90	
Mass Range	30.1 mg						
Low							
High	100.2 mg						

Attenuation Equation $y=b \cdot m^a \cdot (x-x_0)$		Cross-Talk Equation $y=b \cdot m^a \cdot x$	
b =	0.9810	b =	0.2339
m =	0.9809	m =	0.9968
a =	0.8971		
x ₀	0		
% Diff Max =	12.2%	% Diff Max =	13.7%

File ID	Detector ID	Sample ID	Mass (mg)	Count Date	Alpha Counts	Beta Counts	Count Time	Alpha CPM	Beta CPM	Base Alpha Eff.	Decay Corr. Act. assisted geom.	Alpha EFF Actual	Alpha ATT Fitted EFF	Ratio Actual/Fit	Obs Atten Fact.	Fitted Atten Fact.	% Diff.	$\alpha > \beta$ X Tilt Actual	$\beta > \alpha$ X Tilt Fitted	% Diff.
ACP0417	A1	1716001-8	60.1	417/2017 12:01	10010	3129	17.06	586.6246	161.1075	0.2282	5831.39	0.1006	0.1089	1.0820	0.4408	0.4814	-9.2%	0.2842	0.3087	8.0%
ACP0417	A2	1716001-8	60.1	417/2017 12:29	10004	3047	17.01	587.9616	176.9349	0.2214	5831.39	0.1008	0.1066	1.0570	0.4554	0.4814	-5.7%	0.2842	0.2842	5.6%
ACP0417	A3	1716001-8	60.1	417/2017 12:58	10004	3105	17.54	590.2475	174.8659	0.2335	5831.39	0.1012	0.1124	1.1105	0.4335	0.4814	-11.0%	0.2963	0.2842	4.1%
ACP0417	A4	1716001-8	60.1	417/2017 13:29	10000	3099	17.52	590.6863	174.8246	0.2289	5831.39	0.1013	0.1012	1.0878	0.4425	0.4814	-8.8%	0.2960	0.2842	4.0%
ACP0417	B1	1716001-8	60.1	417/2017 13:55	10005	2968	15.79	633.5379	186.0681	0.2377	5831.39	0.1086	0.1144	1.0532	0.4571	0.4814	-5.3%	0.2937	0.2842	3.2%
ACP0417	B2	1716001-8	60.1	417/2017 14:18	10006	2897	16.88	592.6305	169.6692	0.2320	5831.39	0.1016	0.1117	1.0989	0.4380	0.4814	-9.9%	0.2863	0.2842	0.7%
ACP0417	B3	1716001-8	60.1	417/2017 14:50	10005	2706	16.66	600.3602	160.8400	0.2245	5831.39	0.1030	0.1081	1.0487	0.4586	0.4814	-5.0%	0.2676	0.2842	-6.2%
ACP0415	C1	1716001-8	60.1	415/2017 9:14	10000	3329	17.21	580.9345	191.1901	0.2269	5831.39	0.0986	0.1092	1.0984	0.4391	0.4814	-9.6%	0.3291	0.2842	13.7%
ACP0415	C3	1716001-8	60.1	415/2017 9:36	10000	3046	16.24	615.6885	185.8746	0.2349	5831.39	0.1056	0.1131	1.0710	0.4485	0.4814	-7.1%	0.3019	0.2842	5.9%
ACP0417	A1	1716001-9	70.1	417/2017 11:29	10012	3138	18.4	544.0024	168.2385	0.2282	5831.39	0.0833	0.0976	1.0460	0.4088	0.4276	-4.6%	0.3093	0.2935	5.1%
ACP0417	A2	1716001-9	70.1	417/2017 12:01	10009	2953	17.31	578.0577	168.4000	0.2214	5831.39	0.0891	0.0947	1.0550	0.4477	0.4276	-4.5%	0.2913	0.2935	-0.8%
ACP0417	A3	1716001-9	70.1	417/2017 12:30	10002	2929	18.16	550.6649	159.1305	0.2335	5831.39	0.0944	0.0998	1.0573	0.4044	0.4276	-5.7%	0.2890	0.2935	-1.6%
ACP0417	A4	1716001-9	70.1	417/2017 12:59	10005	3077	18.29	546.9302	166.1750	0.2289	5831.39	0.0938	0.0979	1.0436	0.4399	0.4276	-4.4%	0.3038	0.2935	3.4%
ACP0417	B1	1716001-9	70.1	417/2017 13:28	10001	2806	16.4	609.7261	169.1986	0.2377	5831.39	0.1046	0.1016	0.9721	0.4145	0.4276	-2.8%	0.2775	0.2935	-5.8%
ACP0417	B2	1716001-9	70.1	417/2017 13:57	10002	2920	17.83	560.8227	161.8149	0.2320	5831.39	0.0962	0.0992	1.0315	0.4145	0.4276	-3.2%	0.2885	0.2935	-1.7%
ACP0417	B3	1716001-9	70.1	417/2017 14:19	10003	2705	17.51	571.0936	152.6982	0.2245	5831.39	0.0979	0.0960	0.9802	0.4362	0.4276	-2.0%	0.2674	0.2935	-9.8%
ACP0417	B4	1716001-9	70.1	417/2017 14:19	10003	2705	17.51	571.0936	152.6982	0.2245	5831.39	0.0979	0.0960	0.9802	0.4362	0.4276	-2.0%	0.2674	0.2935	-9.8%
ACP0417	C1	1716001-9	70.1	417/2017 14:51	10004	3360	18.22	548.9440	182.1687	0.2269	5831.39	0.0941	0.0970	1.0307	0.4149	0.4276	-3.1%	0.3319	0.2935	11.5%
ACP0415	C3	1716001-9	70.1	417/2017 9:15	10001	3253	18.02	554.8955	178.8346	0.2349	5831.39	0.0952	0.1004	1.0555	0.4051	0.4276	-5.6%	0.3223	0.2935	8.9%
ACP0417	A1	1716001-11	80.3	417/2017 10:32	10006	3244	20.61	485.3645	155.0943	0.2282	5831.39	0.0832	0.0865	1.0389	0.3647	0.3789	-3.9%	0.3195	0.3034	5.1%
ACP0417	A2	1716001-11	80.3	417/2017 11:00	10004	3164	20.08	498.0442	155.3747	0.2214	5831.39	0.0854	0.0885	0.9823	0.3858	0.3789	-1.8%	0.3120	0.3034	2.7%
ACP0417	A3	1716001-11	80.3	417/2017 11:30	10001	3117	19.48	513.2924	157.8523	0.2335	5831.39	0.0880	0.0885	1.0052	0.3770	0.3789	-0.5%	0.3075	0.3034	1.3%
ACP0417	A4	1716001-11	80.3	417/2017 12:04	10003	3220	20.86	479.4402	152.3034	0.2289	5831.39	0.0882	0.0887	1.0550	0.3592	0.3789	-5.5%	0.3177	0.3034	4.5%
ACP0417	B1	1716001-11	80.3	417/2017 12:32	10000	3194	20.2	494.9585	156.2198	0.2377	5831.39	0.0845	0.0901	1.0612	0.3571	0.3789	-6.1%	0.3156	0.3034	3.9%
ACP0417	B2	1716001-11	80.3	417/2017 13:01	9999	3048	20.29	492.8623	148.2678	0.2320	5831.39	0.0845	0.0879	1.0406	0.3642	0.3789	-4.1%	0.3301	0.3034	-0.8%
ACP0417	B3	1716001-11	80.3	417/2017 13:31	10001	2794	19.62	509.5550	140.6207	0.2245	5831.39	0.0874	0.0851	0.9735	0.3892	0.3789	-2.6%	0.2760	0.3034	-9.9%
ACP0417	C1	1716001-11	80.3	417/2017 13:59	10000	3257	20.18	495.4171	159.1534	0.2269	5831.39	0.0850	0.0860	1.0120	0.3744	0.3789	-1.2%	0.3213	0.3034	5.8%
ACP0417	C3	1716001-11	80.3	417/2017 14:20	10003	3256	19.41	515.2579	166.0616	0.2349	5831.39	0.0884	0.0890	1.0074	0.3762	0.3789	-0.7%	0.3223	0.3034	5.9%
ACP0415	A1	1716001-12	80.5	417/2017 11:24	10000	3061	19.53	511.9048	154.4292	0.2282	5831.39	0.0878	0.0863	0.9827	0.3847	0.3780	-1.7%	0.3017	0.3036	-0.6%
ACP0417	A2	1716001-12	80.5	417/2017 10:30	10000	2997	18.53	539.5024	159.5427	0.2214	5831.39	0.0925	0.0837	0.9047	0.4179	0.3780	-9.5%	0.2957	0.3036	-2.7%
ACP0417	A3	1716001-12	80.5	417/2017 11:00	10004	3070	19.25	519.5823	157.3225	0.2335	5831.39	0.0891	0.0883	0.9907	0.3816	0.3780	-0.9%	0.3028	0.3036	-0.3%
ACP0417	A4	1716001-12	80.5	417/2017 11:30	10000	3142	19.19	521.0147	161.6721	0.2289	5831.39	0.0893	0.0885	0.9885	0.3903	0.3780	-3.2%	0.3103	0.3036	2.2%
ACP0417	B1	1716001-12	80.5	417/2017 12:02	10000	3137	18.54	539.2833	167.3027	0.2377	5831.39	0.08925	0.0889	0.9717	0.3891	0.3780	-2.8%	0.3102	0.3036	2.1%
ACP0417	B2	1716001-12	80.5	417/2017 12:31	10002	2997	18.79	532.1624	157.5457	0.2320	5831.39	0.0913	0.0877	0.9611	0.3934	0.3780	-3.9%	0.2960	0.3036	-2.8%
ACP0417	B3	1716001-12	80.5	417/2017 13:00	9999	2827	19.09	523.6021	146.3030	0.2245	5831.39	0.0898	0.0849	0.9452	0.4000	0.3780	-5.5%	0.2794	0.3036	-8.7%
ACP0417	C1	1716001-12	80.5	417/2017 13:30	10001	3298	19.09	523.7639	170.1166	0.2269	5831.39	0.0898	0.0858	0.9550	0.3958	0.3780	-4.5%	0.3256	0.3036	6.7%
ACP0417	C3	1716001-12	80.5	417/2017 13:57	10001	3211	18.54	539.3333	171.0631	0.2349	5831.39	0.0925	0.0888	0.9601	0.3937	0.3780	-4.0%	0.3180	0.3036	4.5%
ACP0415	A1	1716001-14	90.3	417/2017 10:33	10002	3246	24.53	407.6176	130.0238	0.2282	5831.39	0.0699	0.0768	1.0989	0.3063	0.3366	-9.9%	0.3190	0.3036	4.5%
ACP0415	A2	1716001-14	90.3	417/2017 10:58	10002	3053	23.1	432.8240	129.9695	0.2214	5831.39	0.0742	0.0745	1.0040	0.3352	0.3366	-0.4%	0.3003	0.3134	1.8%
ACP0415	A3	1716001-14	90.3	417/2017 11:29	10005	3089	24.4	409.9350	124.4404	0.2335	5831.39	0.0703	0.0703	1.1180	0.3011	0.3366	-11.8%	0.3036	0.3134	-4.4%
ACP0417	A4	1716001-14	90.3	417/2017 10:36	10004	3206	24.21	413.1277	130.9656	0.2289	5831.39	0.0708	0.0770	1.0875	0.3095	0.3366	-8.8%	0.3156	0.3134	-3.2%
ACP0417	B1	1716001-14	90.3	417/2017 11:02	10002	3118	22	454.5454	139.9283	0.2377	5831.39	0.0778	0.0800	1.0264	0.3279	0.3366	-2.6%	0.3076	0.3134	-1.9%
ACP0417	B2	1716001-14	90.3	417/2017 11:34	10000	2880	23.1	432.7584	127.0503	0.2320	5831.39	0.0742	0.0791	1.0523	0.3199	0.3366	-5.2%	0.2936	0.3134	-6.7%
ACP0417	B3	1716001-14	90.3	417/2017 12:07	10002	2949	23.25	430.0135	124.7634	0.2245	5831.39	0.0737	0.0756	1.0248	0.3285	0.3366	-2.5%	0.2878	0.3134	-8.9%
ACP0417	C1	1716001-14	90.3	417/2017 12:36	10004	3510	24.12	414.6365	144.5222	0.2269	5831.39	0.0711	0.0764	1.0741	0.3134	0.3366	-7.4%	0.3486	0.3134	10.1%
ACP0417	C3	1716001-14	90.3	417/2017 13:04	10002	3235	23.47	426.0681	139.2636	0.2349	5831.39	0.0731	0.0791	1.0829	0.3110	0.3366	-8.2%	0.3290	0.3134	4.8%
ACP0415	A1	1716001-15	100	417/2017 10:05	10002	3215	22.71	404.2947	139.1663	0.2282	5831.39	0.0755	0.0685	0.9069	0.3309	0.3001	-9.3%	0.3163	0.3234	-2.2%
ACP0																				

LB4100A Alpha Attenuation Curve -- Th-230

WO #	1716001
Mass Range	30.1 mg
Low	30.1 mg
High	100.2 mg

Spike Information	Std. ID 853.3020.89
Ref. Date	11/16/2007
Half-life	75380 yrs
Activity	1166.38 dpm/mL
Vol.	5.0 mL
Act. Added	5831.90 dpm

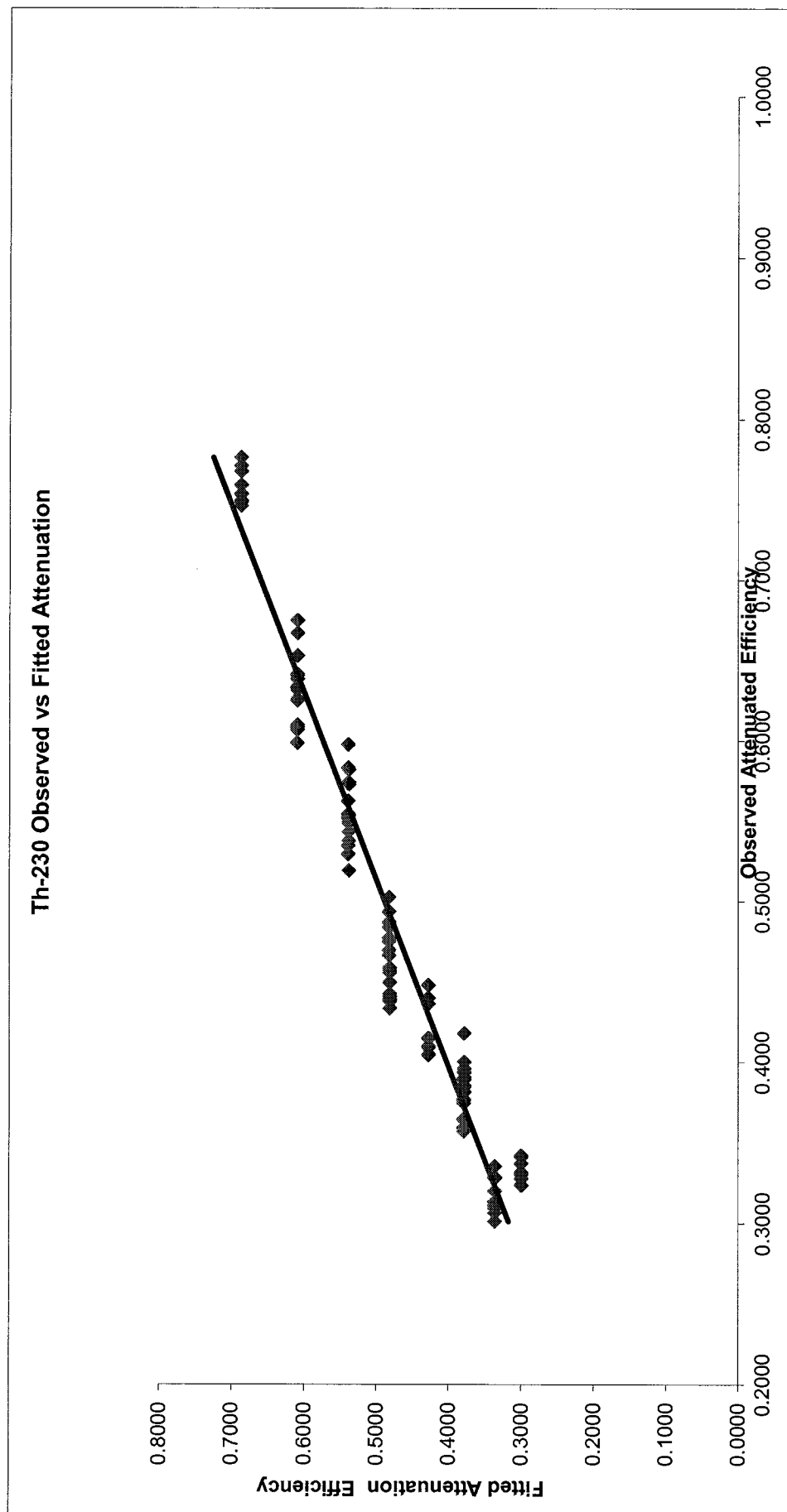
Attenuation Equation	$y=b \cdot m^a \cdot (x-x_0)$
b =	0.9810
m =	0.9869
a =	0.8971
x ₀	0
% Diff Max =	12.2%

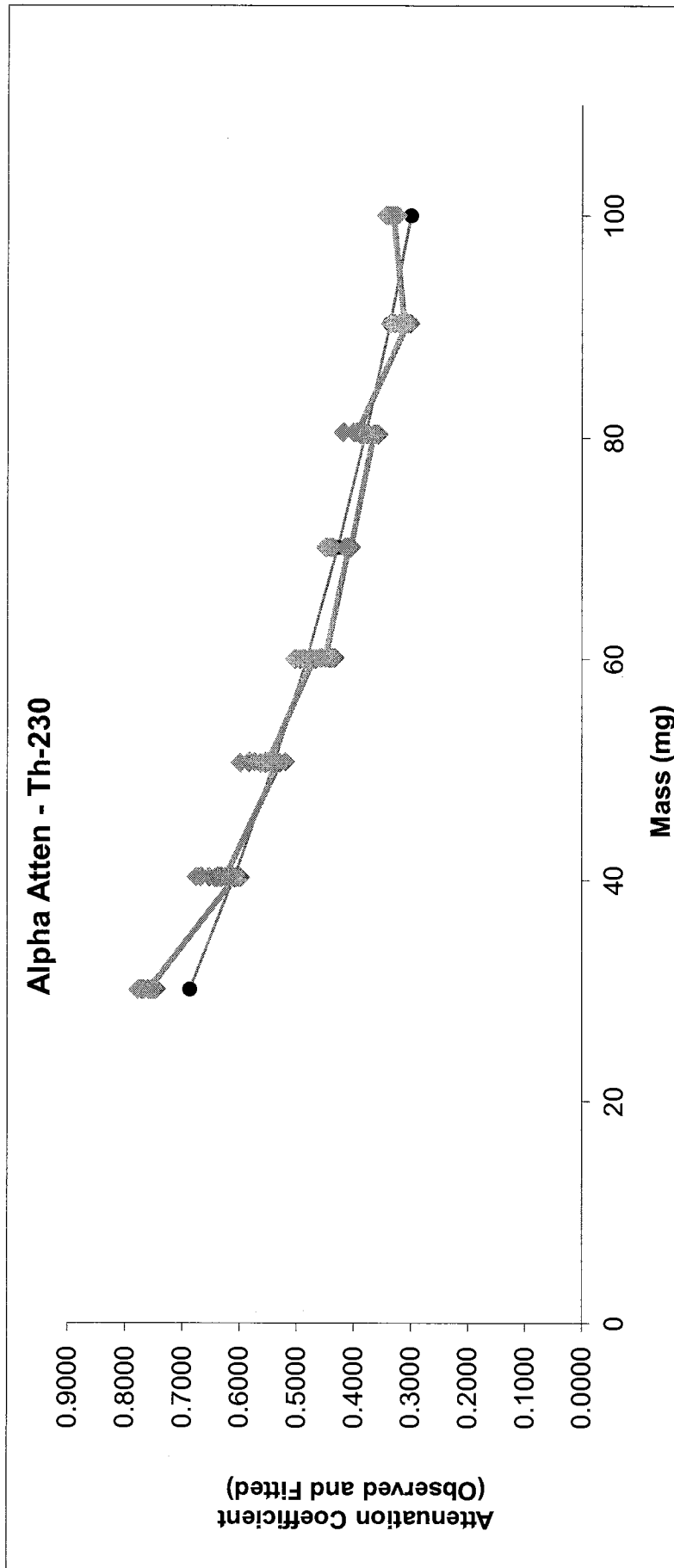
Cross-Talk Equation	$y=b \cdot m^a \cdot x$
b =	0.2339
m =	0.9868
% Diff Max =	13.7%

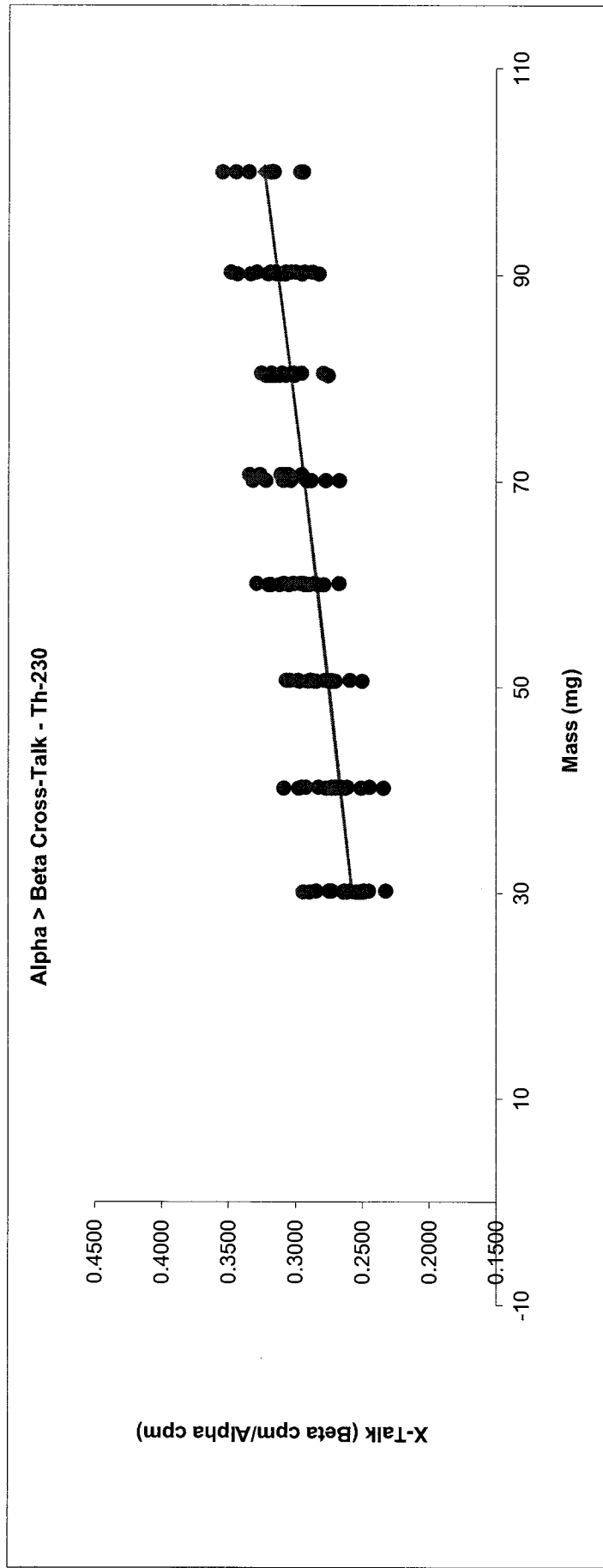
File ID	Detector ID	Sample ID	Mass (mg)	Count	Date	Alpha Counts	Beta Counts	Count Time	Alpha CPM	Beta CPM	Base Alpha Eff.	Decay Corr. Act. added (dpm/L)	Alpha EFF Actual	Alpha Att. Fitted EFF	Actual/Fit Ratio	Obs. Attenu. Fact.	Fitted Attenu. Fact.	% Diff.	$\alpha > \beta \times \text{TN} \alpha > \beta \times \text{TN}$	Actual	Fitted	% Diff.
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OUTLIERS

ACP0417	A1	1716001-2	30.2	4/17/2017 14:43	10002	2771	9.35	1059.6046	294.0566	0.2282	5831.39	0.1834	0.1565	0.8535	0.8038	0.6860	14.7%	0.2749	0.2579	0.2579	0.2579	6.2%
ACP0415	A2	1716001-2	30.2	4/15/2017 9:06	10011	2621	9.04	1107.2485	287.7386	0.2214	5831.39	0.1899	0.1519	0.7999	0.8576	0.6860	20.0%	0.2599	0.2579	0.2579	0.2579	0.7%
ACP0415	A3	1716001-2	30.2	4/15/2017 9:29	10016	2477	8.91	1124.0242	275.8442	0.2335	5831.39	0.1928	0.1602	0.8310	0.8255	0.6860	16.9%	0.2454	0.2579	0.2579	0.2579	-5.1%
ACP0415	A4	1716001-2	30.2	4/15/2017 9:52	10007	2659	9.1	1099.5803	290.1388	0.2289	5831.39	0.1886	0.1570	0.8327	0.8238	0.6860	16.7%	0.2639	0.2579	0.2579	0.2579	2.2%
ACP0415	B1	1716001-2	30.2	4/15/2017 10:17	10015	2503	8.5	1178.1443	292.5716	0.2377	5831.39	0.2020	0.1631	0.8071	0.8500	0.6860	19.3%	0.2483	0.2579	0.2579	0.2579	-3.9%
ACP0415	B3	1716001-2	30.2	4/15/2017 10:44	10003	2514	8.83	1132.7066	282.7572	0.2320	5831.39	0.1942	0.1591	0.8193	0.8372	0.6860	18.1%	0.2496	0.2579	0.2579	0.2579	-3.9%
ACP0415	B4	1716001-2	30.2	4/15/2017 11:14	10007	2344	8.86	1114.1853	259.2395	0.2245	5831.39	0.1911	0.1540	0.8060	0.8511	0.6860	19.4%	0.2327	0.2579	0.2579	0.2579	-10.9%
ACP0417	C1	1716001-2	30.2	4/17/2017 10:21	10010	2754	9.23	1084.3840	296.1309	0.2269	5831.39	0.1960	0.1556	0.8370	0.8196	0.6860	16.3%	0.2731	0.2579	0.2579	0.2579	5.5%
ACP0417	C3	1716001-2	30.2	4/17/2017 10:49	10004	2862	8.82	1134.1454	322.8028	0.2349	5831.39	0.1945	0.1611	0.8285	0.8280	0.6860	17.1%	0.2846	0.2579	0.2579	0.2579	9.4%
ACP0417	A1	1716001-10	70.7	4/17/2017 11:01	10007	3158	20.76	481.9048	149.8155	0.2282	5831.39	0.0826	0.0969	1.1724	0.8621	0.4246	-17.2%	0.3109	0.2941	0.2941	0.2941	5.4%
ACP0417	A2	1716001-10	70.7	4/17/2017 11:31	10002	3129	19.84	503.9701	155.5167	0.2214	5831.39	0.0864	0.0940	1.0877	0.3904	0.4246	-8.8%	0.3086	0.2941	0.2941	0.2941	4.7%
ACP0417	A3	1716001-10	70.7	4/17/2017 12:04	10003	3108	20.59	485.7124	148.7851	0.2335	5831.39	0.0833	0.0931	1.1902	0.3567	0.4246	-19.0%	0.3063	0.2941	0.2941	0.2941	4.0%
ACP0417	A4	1716001-10	70.7	4/17/2017 12:33	10002	3132	21.26	470.3710	145.2599	0.2289	5831.39	0.0807	0.0972	1.2048	0.3624	0.4246	-20.5%	0.3088	0.2941	0.2941	0.2941	4.8%
ACP0417	B1	1716001-10	70.7	4/17/2017 13:00	9999	3090	19.04	525.0666	160.3009	0.2377	5831.39	0.0900	0.1009	1.1208	0.3788	0.4246	-12.1%	0.3055	0.2941	0.2941	0.2941	3.7%
ACP0417	B3	1716001-10	70.7	4/17/2017 13:31	10002	3094	20.06	497.8636	152.1237	0.2320	5831.39	0.0854	0.0985	1.1535	0.3661	0.4246	-15.3%	0.3055	0.2941	0.2941	0.2941	3.7%
ACP0417	B4	1716001-10	70.7	4/17/2017 13:59	10004	2990	19.7	507.6373	149.9916	0.2245	5831.39	0.0871	0.0953	1.0949	0.3878	0.4246	-9.5%	0.2955	0.2941	0.2941	0.2941	0.5%
ACP0417	C1	1716001-10	70.7	4/17/2017 14:21	10002	3314	20.46	488.7333	159.7306	0.2269	5831.39	0.0858	0.0963	1.1494	0.3684	0.4246	-14.9%	0.3268	0.2941	0.2941	0.2941	10.0%
ACP0417	C3	1716001-10	70.7	4/17/2017 14:52	10003	3379	19.99	500.3052	167.5475	0.2349	5831.39	0.0858	0.0987	1.1624	0.3652	0.4246	-16.2%	0.3345	0.2941	0.2941	0.2941	12.1%
ACP0415	A1	1716001-13	90.1	4/15/2017 11:03	9999	3141	27.76	360.0685	110.8444	0.2282	5831.39	0.0817	0.0770	1.2469	0.2706	0.3374	-24.7%	0.3078	0.3132	0.3132	0.3132	-1.7%
ACP0415	A2	1716001-13	90.1	4/15/2017 11:32	10004	3014	26.7	374.5166	110.6869	0.2214	5831.39	0.0642	0.0747	1.1631	0.2901	0.3374	-16.3%	0.2955	0.3132	0.3132	0.3132	-6.0%
ACP0417	A3	1716001-13	90.1	4/17/2017 10:36	10000	3201	26.71	374.2856	117.6848	0.2335	5831.39	0.0642	0.0768	1.2274	0.2749	0.3374	-22.7%	0.3144	0.3132	0.3132	0.3132	0.4%
ACP0417	A4	1716001-13	90.1	4/17/2017 11:07	10002	3261	26.86	372.2853	119.3483	0.2289	5831.39	0.0638	0.0772	1.2097	0.2789	0.3374	-21.0%	0.3206	0.3132	0.3132	0.3132	2.3%
ACP0417	B1	1716001-13	90.1	4/17/2017 11:36	10003	3182	25.02	399.7092	125.2793	0.2377	5831.39	0.0685	0.0802	1.1700	0.2884	0.3374	-17.0%	0.3134	0.3132	0.3132	0.3132	0.1%
ACP0417	B3	1716001-13	90.1	4/17/2017 12:10	9999	3155	26.21	381.3536	118.4199	0.2320	5831.39	0.0654	0.0753	1.1969	0.2819	0.3374	-19.7%	0.3105	0.3132	0.3132	0.3132	-0.9%
ACP0417	B4	1716001-13	90.1	4/17/2017 12:38	9999	2872	26.19	381.6069	107.8752	0.2245	5831.39	0.0654	0.0757	1.1575	0.2915	0.3374	-15.7%	0.2827	0.3132	0.3132	0.3132	-10.8%
ACP0417	C1	1716001-13	90.1	4/17/2017 13:07	10000	3496	26.8	373.0113	128.2038	0.2269	5831.39	0.0640	0.0766	1.1968	0.2819	0.3374	-19.7%	0.3437	0.3132	0.3132	0.3132	8.9%
ACP0417	C3	1716001-13	90.1	4/17/2017 13:36	10004	3380	25.5	392.2187	130.8620	0.2349	5831.39	0.0673	0.0783	1.1783	0.2863	0.3374	-17.8%	0.3336	0.3132	0.3132	0.3132	6.1%
ACP0415	A1	1716001-16	100.2	4/15/2017 9:40	10003	2933	19.69	507.8984	146.6549	0.2282	5831.39	0.0871	0.0863	0.7843	0.2817	0.2993	21.6%	0.2887	0.3236	0.3236	0.3236	-12.1%
ACP0415	A2	1716001-16	100.2	4/15/2017 10:02	10001	2924	18.9	528.9904	152.5140	0.2214	5831.39	0.0907	0.0863	0.7306	0.4057	0.2993	26.9%	0.2883	0.3236	0.3236	0.3236	-12.2%
ACP0415	A3	1716001-16	100.2	4/15/2017 10:28	10002	2827	19.25	519.4784	144.5891	0.2335	5831.39	0.0891	0.0899	0.7846	0.3815	0.2993	21.5%	0.2785	0.3236	0.3236	0.3236	-16.2%
ACP0415	A4	1716001-16	100.2	4/15/2017 10:58	10008	2985	20.26	493.8883	144.8855	0.2289	5831.39	0.0947	0.0895	0.8080	0.3700	0.2993	19.1%	0.2921	0.3236	0.3236	0.3236	-10.8%
ACP0415	B1	1716001-16	100.2	4/15/2017 11:23	10009	2847	17.96	557.0300	156.6199	0.2377	5831.39	0.0956	0.0712	0.7447	0.4020	0.2993	23.5%	0.2811	0.3236	0.3236	0.3236	-15.1%
ACP0417	B3	1716001-16	100.2	4/17/2017 10:31	10004	2626	19.05	525.0024	146.3925	0.2320	5831.39	0.0900	0.0694	0.7714	0.3861	0.2993	22.9%	0.2788	0.3236	0.3236	0.3236	-16.1%
ACP0417	B4	1716001-16	100.2	4/17/2017 10:59	10001	2540	18.96	527.2969	132.1812	0.2245	5831.39	0.0904	0.0672	0.7432	0.4028	0.2993	25.7%	0.2507	0.3236	0.3236	0.3236	-29.1%
ACP0417	C1	1716001-16	100.2	4/17/2017 11:31	10006	3274	19.98	500.8778	161.6199	0.2269	5831.39	0.0959	0.0679	0.7911	0.3784	0.2993	20.9%	0.3228	0.3236	0.3236	0.3236	-0.3%
ACP0417	C3	1716001-16	100.2	4/17/2017 12:02	10000	3148	18.73	533.6078	166.3856	0.2349	5831.39	0.0915	0.0703	0.7682	0.3897	0.2993	23.2%	0.3117	0.3236	0.3236	0.3236	-3.8%







Detector ID	Sample ID	Alpha	Beta	Guard	Count Time	TOD	ALPHA CPM	BETA CPM
A1	30.1	10020	2645	7353	10.09	4/15/17 9:07	992.9344381	259.8367334
A1	80.5	10000	3061	13884	19.53	4/15/17 11:24	511.9047701	154.4292309
A1	90.1	9999	3141	19772	27.76	4/15/17 11:03	360.0665245	110.844415
A1	90.3	10002	3246	17389	24.53	4/15/17 10:33	407.6176176	130.0237619
A1	100	10002	3215	16386	22.71	4/15/17 10:05	440.2947213	139.2635914
A1	100.2	10003	2933	14256	19.69	4/15/17 9:40	507.8963779	146.6548624
A2	30.1	10012	2563	7100	9.7	4/15/17 9:30	1032.001948	262.0318041
A2	30.2	10011	2621	6577	9.04	4/15/17 9:06	1107.248504	287.7386283
A2	90.1	10004	3014	18859	26.7	4/15/17 11:32	374.5186479	110.6888951
A2	90.3	10002	3053	16436	23.1	4/15/17 10:58	432.824013	129.9695022
A2	100	9999	3249	15599	21.96	4/15/17 10:30	455.1648689	145.7558197
A2	100.2	10001	2924	13695	18.9	4/15/17 10:02	528.9904392	152.5139947
A3	30.1	10005	2553	7127	9.68	4/15/17 9:52	1033.46838	261.5816694
A3	30.2	10016	2477	6550	8.91	4/15/17 9:29	1124.024191	275.8442447
A3	40.2	10008	2539	8767	12.08	4/15/17 9:09	828.3708212	208.0241192
A3	90.3	10005	3089	17241	24.4	4/15/17 11:29	409.9349836	124.4403607
A3	100	10006	3015	15835	22.25	4/15/17 10:58	449.6018652	133.347618
A3	100.2	10002	2827	13664	19.25	4/15/17 10:28	519.4784156	144.6991429
A4	30.1	10018	2669	7048	9.96	4/15/17 10:18	1005.733293	265.9128876
A4	30.2	10007	2659	6646	9.1	4/15/17 9:52	1099.58033	290.1388022
A4	40.2	10003	2727	9030	12.35	4/15/17 9:33	809.8695142	218.7507166
A4	40.3	10003	2730	8566	11.82	4/15/17 9:08	846.1874958	228.905467
A4	100	10002	3234	16342	23.16	4/15/17 11:28	431.775285	137.5783057
A4	100.2	10008	2965	14481	20.26	4/15/17 10:56	493.8882823	144.2884827
B1	30.1	10011	2523	6569	9.41	4/15/17 10:45	1063.777225	266.2200223
B1	30.2	10015	2503	6042	8.5	4/15/17 10:17	1178.144294	292.5715882
B1	40.2	10002	2652	8131	11.4	4/15/17 9:54	877.2774211	230.7325789
B1	40.3	10010	2708	8001	11.06	4/15/17 9:31	904.9722911	242.9472929
B1	50.6	10013	2743	9642	13.51	4/15/17 9:10	741.0637002	201.135789
B1	100.2	10009	2847	12818	17.96	4/15/17 11:23	557.2029866	156.619931
B3	30.1	10006	2569	6966	9.87	4/15/17 11:15	1013.637129	258.3296879
B3	30.2	10003	2514	6149	8.83	4/15/17 10:44	1132.700582	282.7572118
B3	40.2	10014	2759	8612	12.14	4/15/17 10:21	824.7344415	225.3112389
B3	40.3	10003	2639	8263	11.58	4/15/17 9:54	863.6749257	225.9389188
B3	50.6	10006	2782	9594	13.34	4/15/17 9:34	749.9329625	206.5917271

B3	50.7	10004	3009	10150	14.24	4/15/17 9:11	702.3860899	209.3521798
B4	30.2	10007	2344	6328	8.98	4/15/17 11:14	1114.185256	259.2394989
B4	40.2	10004	2365	8311	11.93	4/15/17 10:47	838.3782565	196.4547318
B4	40.3	10007	2469	8112	11.46	4/15/17 10:20	873.0311693	213.6600262
B4	50.6	10002	2528	9410	13.1	4/15/17 9:56	763.3314504	191.1920992
B4	50.7	10005	2618	9575	13.31	4/15/17 9:34	751.5104583	194.9092149
B4	60	10005	2820	11264	15.79	4/15/17 9:12	633.448879	176.8090469
C1	40.2	10001	3115	8910	12.43	4/15/17 11:17	804.4626798	248.3593789
C1	40.3	10004	2982	8397	11.95	4/15/17 10:47	837.0318117	247.295749
C1	50.6	10003	3005	9575	13.44	4/15/17 10:22	744.1478333	221.3423095
C1	50.7	10008	3076	9732	13.66	4/15/17 9:56	732.5270732	222.9390161
C1	60	10004	3156	11173	15.52	4/15/17 9:36	644.4646289	201.1065155
C1	60.1	10000	3329	12436	17.21	4/15/17 9:14	580.9345247	191.19005
C3	40.3	10008	2944	8395	11.69	4/15/17 11:16	856.0213388	250.1521788
C3	50.6	10004	2934	9316	13.19	4/15/17 10:48	758.3583738	220.7542434
C3	50.7	10007	3093	9479	13.3	4/15/17 10:21	752.311015	230.869391
C3	60	10007	3212	10928	15.37	4/15/17 9:58	650.9785198	207.2915296
C3	60.1	10000	3046	11688	16.24	4/15/17 9:36	615.6685468	185.8745764
C3	70.1	10001	3253	13008	18.02	4/15/17 9:15	554.8994506	178.8346426
A1	30.2	10002	2771	6495	9.35	4/17/17 14:43	1069.60462	294.0596364
A1	40.2	10006	2800	8830	12.38	4/17/17 14:14	808.1110953	223.8672439
A1	40.3	10006	2860	8420	12.01	4/17/17 13:51	833.0110508	235.8308876
A1	50.6	10007	2881	9857	14.2	4/17/17 13:26	704.5903099	200.5833239
A1	50.7	10005	3077	9544	13.98	4/17/17 12:55	715.5372361	217.7961431
A1	60	10007	3239	10767	16.01	4/17/17 12:28	624.9188457	200.0070556
A1	60.1	10010	3129	11382	17.06	4/17/17 12:01	586.6246377	181.1074889
A1	70.1	10012	3138	13022	18.4	4/17/17 11:29	544.0024348	168.2394783
A1	70.7	10007	3158	14691	20.76	4/17/17 11:01	481.9047553	149.8154605
A1	80.3	10006	3244	14697	20.61	4/17/17 10:32	485.3644794	155.0953207
A2	40.2	10003	2678	8397	12.08	4/17/17 14:45	827.8999139	219.4937417
A2	40.3	10011	2758	8174	11.49	4/17/17 14:13	871.1163734	237.8398129
A2	50.6	10000	2734	9066	12.96	4/17/17 13:52	771.4419383	208.7617901
A2	50.7	10009	2767	9274	13.32	4/17/17 13:25	751.2634264	205.5377327
A2	60	10013	3087	10519	15.43	4/17/17 12:56	648.7676546	197.8698088
A2	60.1	10004	3047	11421	17.01	4/17/17 12:29	587.9616326	176.9349236
A2	70.1	10009	2953	11566	17.31	4/17/17 12:01	578.0576817	168.4000318

A2	70.7	10002	3129	13997	19.84	4/17/17 11:31	503.9700645	155.5166935
A2	80.3	10004	3164	14180	20.08	4/17/17 11:00	498.0441713	155.3747211
A2	80.5	10000	2997	13138	18.53	4/17/17 10:30	539.5024074	159.5427226
A3	40.3	10001	2685	8065	11.63	4/17/17 14:45	859.8252124	228.7104437
A3	50.6	10006	2771	9505	13.32	4/17/17 14:15	751.0952012	205.875033
A3	50.7	10003	2921	9443	13.52	4/17/17 13:52	739.7608639	213.8922959
A3	60	10006	2871	11010	15.76	4/17/17 13:27	634.7924772	180.0120508
A3	60.1	10004	3105	11939	17.54	4/17/17 12:58	570.2474778	174.8659453
A3	70.1	10002	2929	12231	18.16	4/17/17 12:30	550.6649251	159.1305463
A3	70.7	10003	3108	13760	20.59	4/17/17 12:04	485.7123584	148.7890617
A3	80.3	10001	3117	13718	19.48	4/17/17 11:30	513.2923573	157.8522669
A3	80.5	10004	3070	13602	19.25	4/17/17 11:00	519.5823117	157.3225195
A3	90.1	10000	3201	19105	26.71	4/17/17 10:38	374.2856136	117.6847555
A4	50.6	10010	2891	9400	13.58	4/17/17 14:47	737.0234021	210.8275979
A4	50.7	10006	2915	9736	13.66	4/17/17 14:15	732.4136603	211.3377789
A4	60	10008	2956	10964	15.71	4/17/17 13:55	636.9564672	186.1014074
A4	60.1	10000	3099	12256	17.52	4/17/17 13:29	570.6862557	174.8245616
A4	70.1	10005	3077	12429	18.29	4/17/17 12:59	546.9302296	166.1750077
A4	70.7	10002	3132	14385	21.26	4/17/17 12:33	470.3709595	145.2599087
A4	80.3	10003	3220	13942	20.86	4/17/17 12:04	479.4402013	152.3034161
A4	80.5	10000	3142	13524	19.19	4/17/17 11:30	521.0147421	161.67211
A4	90.1	10002	3261	19086	26.86	4/17/17 11:07	372.2852792	119.3482971
A4	90.3	10004	3206	17292	24.21	4/17/17 10:36	413.1276786	130.3656179
B1	50.7	10014	2811	9167	12.61	4/17/17 14:46	794.0406416	221.0193188
B1	60	10007	2964	10394	14.62	4/17/17 14:16	684.3823242	200.8369781
B1	60.1	10005	2968	11534	15.79	4/17/17 13:55	633.537879	186.0680678
B1	70.1	10001	2806	11867	16.4	4/17/17 13:28	609.7260732	169.198561
B1	70.7	9999	3090	13612	19.04	4/17/17 13:00	525.066563	160.390916
B1	80.3	10000	3194	14235	20.2	4/17/17 12:32	494.958505	156.2198119
B1	80.5	10000	3137	12976	18.54	4/17/17 12:02	539.2833258	167.302726
B1	90.1	10003	3182	17684	25.02	4/17/17 11:36	399.7091599	125.2792574
B1	90.3	10002	3118	15442	22	4/17/17 11:02	454.5453636	139.8282727
B1	100	10005	3219	15129	21.16	4/17/17 10:33	472.735087	150.2276541
B3	60	10002	2930	11274	15.5	4/17/17 14:49	645.1483226	187.0782581
B3	60.1	10006	2897	11994	16.88	4/17/17 14:18	592.6305118	169.6692227
B3	70.1	10002	2920	13012	17.83	4/17/17 13:57	560.8226663	161.8149288

B3		70.7	10002	3094	14500	20.08	4/17/17 13:31	497.9655697	152.1296653
B3		80.3	9999	3048	14523	20.29	4/17/17 13:01	492.6623371	148.2677841
B3		80.5	10002	2997	13199	18.79	4/17/17 12:31	532.1624172	157.5457339
B3		90.1	9999	3155	18362	26.21	4/17/17 12:10	381.3536124	118.4199031
B3		90.3	10000	2980	16292	23.1	4/17/17 11:34	432.7584329	127.050329
B3		100.2	10004	2826	13629	19.05	4/17/17 10:31	525.002357	146.3924567
B3		100	10003	3235	15687	22.31	4/17/17 11:03	448.2219623	143.0482411
B4		30.1	10011	2440	6922	9.63	4/17/17 10:21	1039.383863	251.5898702
B4		60.1	10005	2706	12117	16.66	4/17/17 14:50	600.3602161	160.63997
B4		70.1	10003	2705	12418	17.51	4/17/17 14:19	571.093558	152.6981525
B4		70.7	10004	2990	14333	19.7	4/17/17 13:59	507.6372589	149.9916497
B4		80.3	10001	2794	14184	19.62	4/17/17 13:31	509.5549643	140.6207085
B4		80.5	9999	2827	13646	19.09	4/17/17 13:00	523.6020849	146.3030042
B4		90.1	9999	2872	18541	26.19	4/17/17 12:38	381.6069416	107.8751756
B4		90.3	10002	2919	16291	23.25	4/17/17 12:07	430.0135484	123.7633871
B4		100	10000	2985	15786	22.34	4/17/17 11:33	447.4475739	131.8318308
B4		100.2	10001	2540	13258	18.96	4/17/17 10:59	527.298903	132.1812447
C1		30.2	10010	2754	6778	9.23	4/17/17 10:21	1084.384042	296.1308646
C1		70.1	10004	3360	13339	18.22	4/17/17 14:51	548.9439594	182.1687333
C1		70.7	10002	3314	14722	20.46	4/17/17 14:21	488.733305	159.7305846
C1		80.3	10000	3257	14856	20.18	4/17/17 13:59	495.4171388	159.1534232
C1		80.5	10001	3298	13817	19.09	4/17/17 13:30	523.7638518	170.5166076
C1		90.1	10000	3496	19204	26.8	4/17/17 13:07	373.0113284	128.2037612
C1		90.3	10004	3540	17088	24.12	4/17/17 12:36	414.6365357	144.5221692
C1		100	10002	3600	16697	23.07	4/17/17 12:06	433.427065	153.802814
C1		100.2	10006	3274	14494	19.98	4/17/17 11:31	500.6778008	161.6198639
C1		30.1	10003	2967	7238	10.1	4/17/17 10:50	990.2730396	291.5183762
C3		30.1	10002	2913	6858	9.62	4/17/17 11:20	1039.61394	301.1196528
C3		40.2	10003	2998	8946	12.2	4/17/17 10:24	819.8230328	244.0507049
C3		70.7	10003	3379	14599	19.99	4/17/17 14:52	500.3052001	167.3475173
C3		80.3	10003	3256	13940	19.41	4/17/17 14:20	515.2579109	166.0615832
C3		80.5	10001	3211	13733	18.54	4/17/17 13:57	539.3332632	171.506096
C3		90.1	10004	3380	18538	25.5	4/17/17 13:36	392.2187255	130.8620196
C3		90.3	10002	3330	16757	23.47	4/17/17 13:04	426.0660567	140.1962552
C3		100	9999	3483	15590	22.08	4/17/17 12:34	452.7582609	156.0575652
C3		100.2	10000	3148	13509	18.73	4/17/17 12:02	533.8078297	166.3856108

C3		30.2	10004	2862	6287	8.82	4/17/17 10:49	1134.145363	322.8027959
----	--	------	-------	------	------	------	---------------	-------------	-------------

Radiochemistry Instrument Worksheet

ALS -- Fort Collins

Prep Batch: GA170405-1

Prep Procedure: GR_ALPH_CO

Mass Attenuation Curve

Analytical QASS / NCR? Y

NA

Prep Num	LabID	QC Type	Init Alq	Fin Alq	Units	Report Units	Residual Mass (mg)	Cnt 1 File	Cnt 1 Inst/Det	Cnt 1 Pos Chk By	Cnt 2 File	Cnt 2 Inst/Det	Cnt 2 Pos Chk By	Cnt 3 File	Cnt 3 Inst/Det	Cnt 3 Pos Chk By	Notes
1	1716001-1	SMP	500	500	ml	PC/L	30.1										
1	1716001-2	SMP	500	500	ml	PC/L	30.2										
1	1716001-3	SMP	500	500	ml	PC/L	40.2										
1	1716001-4	SMP	500	500	ml	PC/L	40.3										
1	1716001-5	SMP	500	500	ml	PC/L	50.6										
1	1716001-6	SMP	500	500	ml	PC/L	50.7										
1	1716001-7	SMP	500	500	ml	PC/L	60										
1	1716001-8	SMP	500	500	ml	PC/L	60.1										
1	1716001-9	SMP	500	500	ml	PC/L	70.1										
1	1716001-10	SMP	500	500	ml	PC/L	70.7										
1	1716001-11	SMP	500	500	ml	PC/L	80.3										
1	1716001-12	SMP	500	500	ml	PC/L	80.5										
1	1716001-13	SMP	500	500	ml	PC/L	90.1										
1	1716001-14	SMP	500	500	ml	PC/L	90.3										
1	1716001-15	SMP	500	500	ml	PC/L	100										
1	1716001-16	SMP	500	500	ml	PC/L	100.2										

See Maintenance Log Book 3974 pg. 40

7/4/2017

Spike Solution Information

Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
S1	Th-230	853.3020.89	4/7/17	1,166.280	DPM/ml	04/05/17	5	ml	RS-032

Sample Barcodes

1716001-1 GA170405-1PS1		1716001-2 GA170405-1PS2		1716001-3 GA170405-1PS3	
1716001-4 GA170405-1PS4		1716001-5 GA170405-1PS5		1716001-6 GA170405-1PS6	
1716001-7 GA170405-1PS7		1716001-8 GA170405-1PS8		1716001-9 GA170405-1PS9	
1716001-10 GA170405-1PS10		1716001-11 GA170405-1PS11		1716001-12 GA170405-1PS12	

Radiochemistry Instrument Worksheet

ALS -- Fort Collins

Prep Batch: GA170405-1

Prep Procedure: GR_ALPH_CO

Analytical QASS / NCR? Y / N

Prep Num	LabID	QC Type	Init Alq	Fin Alq	Units	Report Units	Residual Mass (mg)	Cnt 1 File	Cnt 1 Inst/Det	Cnt 1 Pos Chk By	Cnt 2 File	Cnt 2 Inst/Det	Cnt 2 Pos Chk By	Cnt 3 File	Cnt 3 Inst/Det	Cnt 3 Pos Chk By	Notes	
1716001-13	GA170405-1PS13							1716001-14	GA170405-1PS14								1716001-15	GA170405-1PS15

Reporting Units

LabID	TstGrpName	RptUnits
1716001-1	GrossAlphaCoprecipitation	PCI/L
1716001-2	GrossAlphaCoprecipitation	PCI/L
1716001-3	GrossAlphaCoprecipitation	PCI/L
1716001-4	GrossAlphaCoprecipitation	PCI/L
1716001-5	GrossAlphaCoprecipitation	PCI/L
1716001-6	GrossAlphaCoprecipitation	PCI/L
1716001-7	GrossAlphaCoprecipitation	PCI/L
1716001-8	GrossAlphaCoprecipitation	PCI/L
1716001-9	GrossAlphaCoprecipitation	PCI/L
1716001-10	GrossAlphaCoprecipitation	PCI/L
1716001-11	GrossAlphaCoprecipitation	PCI/L
1716001-12	GrossAlphaCoprecipitation	PCI/L
1716001-13	GrossAlphaCoprecipitation	PCI/L
1716001-14	GrossAlphaCoprecipitation	PCI/L
1716001-15	GrossAlphaCoprecipitation	PCI/L
1716001-16	GrossAlphaCoprecipitation	PCI/L

Radiochemistry Prep Worksheet

ALS -- Fort Collins

Prep Batch: GA170405-1

Prep Procedure: GR_ALPHA_CO

Reviewed By: msh2 MSH Review Date: 4/13/2017

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

Prep SOP: PAI 786 Rev: 7
Prep SOP: NONE
Matrix Class: liquid
Prep Analyst: Macey S. Hall MSH
Prep Date: 4/5/2017
Prep Dept: RS
Balance: 13
Balance:

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Aliq ml	Fin Aliq ml	Prep Basis	Standards	Prep Notes
1	1	1716001-1	SMP	N/A	500	500	Unfiltered	S1	
2	1	1716001-2	SMP		500	500	Unfiltered	S1	
3	1	1716001-3	SMP		500	500	Unfiltered	S1	
4	1	1716001-4	SMP		500	500	Unfiltered	S1	
5	1	1716001-5	SMP		500	500	Unfiltered	S1	
6	1	1716001-6	SMP		500	500	Unfiltered	S1	
7	1	1716001-7	SMP		500	500	Unfiltered	S1	
8	1	1716001-8	SMP		500	500	Unfiltered	S1	
9	1	1716001-9	SMP		500	500	Unfiltered	S1	
10	1	1716001-10	SMP		500	500	Unfiltered	S1	
11	1	1716001-11	SMP		500	500	Unfiltered	S1	
12	1	1716001-12	SMP		500	500	Unfiltered	S1	
13	1	1716001-13	SMP		500	500	Unfiltered	S1	
14	1	1716001-14	SMP		500	500	Unfiltered	S1	
15	1	1716001-15	SMP		500	500	Unfiltered	S1	
16	1	1716001-16	SMP		500	500	Unfiltered	S1	

Comments

Spike 20 coprecipits with 5ml of the calibration Th-230 standard, run the 20 coprecipits as normal, after planchets have been weighed, print out mass sheet and label the planchets with the lowest masses as 1&2, the second lowest masses as 3&4, etc until you have all planchets numbered (the planchets with the 2 lowest masses will have a target of 40mg, etc until 100mg target is met), add salt in 0.1ml intervals and weigh the planchets each time after salt is added, when the planchets are within 5mg of the target mass, add salt in 0.01 intervals, once all of the masses have hit their target masses, do paperwork per usual and give to instrument lab per usual.

Spiked By: Macey S. Hall Date: 4/5/2017

Witnessed By: Lucas A. Daut Date: 4/5/2017

Spike Solution Information						
Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Pipet ID
S1	Th-230	853.3020.89	4/7/17	1,166.280	DPM/ml	04/05/17
					5 ml	RS-032

Radiochemistry Prep Worksheet

ALS -- Fort Collins

Prep Batch: GA170405-1

Prep Procedure: GR_ALPHA_CO

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 786 Rev: 7

Prep SOP: NONE

Matrix Class: liquid

Prep Analyst: Macey S. Hall *MSH*

Prep Date: 4/5/2017

Prep Dept: RS

Balance: 13

Balance:

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Alq ml	Fin Alq ml	Prep Basis	Standards	Prep Notes
1	1	1716001-1	SMP		500	500	Unfiltered	S1	
2	1	1716001-2	SMP		500	500	Unfiltered	S1	
3	1	1716001-3	SMP		500	500	Unfiltered	S1	
4	1	1716001-4	SMP		500	500	Unfiltered	S1	
5	1	1716001-5	SMP		500	500	Unfiltered	S1	
6	1	1716001-6	SMP		500	500	Unfiltered	S1	
7	1	1716001-7	SMP		500	500	Unfiltered	S1	
8	1	1716001-8	SMP		500	500	Unfiltered	S1	
9	1	1716001-9	SMP		500	500	Unfiltered	S1	
10	1	1716001-10	SMP		500	500	Unfiltered	S1	
11	1	1716001-11	SMP		500	500	Unfiltered	S1	
12	1	1716001-12	SMP		500	500	Unfiltered	S1	
13	1	1716001-13	SMP		500	500	Unfiltered	S1	
14	1	1716001-14	SMP		500	500	Unfiltered	S1	
15	1	1716001-15	SMP		500	500	Unfiltered	S1	
16	1	1716001-16	SMP		500	500	Unfiltered	S1	

Comments

Calibration curve

Spiked By: *MSH* Date: 4/5/17

Witnessed By: *[Signature]* Date: 4/5/17

Spike Solution Information						
Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Pipet ID
S1	Th-230	853.3020.89	4/7/17	1,166.280	DPM/ml	04/05/17
					5	ml

MS
4/5
AW029

Radiochemistry Gravimetric Worksheet

ALS -- Fort Collins

Prep Batch: GA170405-1

Prep Procedure: GR_ALPHA_CO

Reviewed By: msh2 MSH

Review Date: 4/13/2017

Prep Num	Planc. Num	LabID	QC Type	Test Alq (ml)	Tare Mass (g)	Initial Gross Mass (g)	Initial Net Mass (mg)	Suggested Alq (ml)	Samp Vol Available (ml)	Samp Vol Taken (ml)	Fin Gross Mass (g)	Final Net Mass (mg)	Salt Sol. Added (ml)	Flag
1	1	1716001-1	SMP	0	9.4221	0.0000	0	500	500	500	9.4522	30.1	0	
1	2	1716001-2	SMP	0	9.4742	0.0000	0	500	500	500	9.5044	30.2	0	
1	3	1716001-3	SMP	0	9.4630	0.0000	0	500	500	500	9.5032	40.2	0.4	
1	4	1716001-4	SMP	0	9.4972	0.0000	0	500	500	500	9.5375	40.3	0.4	
1	5	1716001-5	SMP	0	9.3886	0.0000	0	500	500	500	9.4392	50.6	0.55	
1	6	1716001-6	SMP	0	9.4390	0.0000	0	500	500	500	9.4897	50.7	0.5	
1	7	1716001-7	SMP	0	9.4143	0.0000	0	500	500	500	9.4743	60	0.66	
1	8	1716001-8	SMP	0	9.4373	0.0000	0	500	500	500	9.4974	60.1	0.69	
1	9	1716001-9	SMP	0	9.4271	0.0000	0	500	500	500	9.4972	70.1	0.75	
1	10	1716001-10	SMP	0	9.3740	0.0000	0	500	500	500	9.4447	70.7	0.8	
1	11	1716001-11	SMP	0	9.4011	0.0000	0	500	500	500	9.4814	80.3	1.1	
1	12	1716001-12	SMP	0	9.4467	0.0000	0	500	500	500	9.5272	80.5	1.15	
1	13	1716001-13	SMP	0	9.4469	0.0000	0	500	500	500	9.5370	90.1	1.55	
1	14	1716001-14	SMP	0	9.4180	0.0000	0	500	500	500	9.5083	90.3	1.2	
1	15	1716001-15	SMP	0	9.4454	0.0000	0	500	500	500	9.5454	100	1.5	
1	16	1716001-16	SMP	0	9.4801	0.0000	0	500	500	500	9.5803	100.2	1.6	

Sample Condition Form (Liquid)

Analyst: MSH

Analysis Date: 4/5/17	Method: Prep
-----------------------	--------------

Analysis Date: 4/5/17	Method: Prep
-----------------------	--------------

Sample Condition (Visual Appearance of Analysis Aliquot at Time of Prep)	
1	2
3	4
5	6
7	8
9	10
11	12
13	14
15	16
17	18
19	20
21	22
23	24
25	26
27	28
29	30
31	32
33	34
35	36
37	38
39	40
41	42
43	44
45	46
47	48
49	50
51	52
53	54
55	56
57	58
59	60
61	62
63	64
65	66
67	68
69	70
71	72
73	74
75	76
77	78
79	80
81	82
83	84
85	86
87	88
89	90
91	92
93	94
95	96
97	98
99	100

Work Order	Sample ID	pH	Color	Remarks
1716001	1	~7	clear	DI H ₂ O
	2			
	3			
	4			
	5			
	6			
	7			
	8			
	9			
	10			
	11			
	12			
	13			
	14			
	15			
	16			
MSH 4/5/17				

3/1/17

I-129 EFF Calibration

Benchsheet: I100910-1 Source ID: 630

Log File: I129-03/01

Sources:

1021015-1

-2

-3

-4

Detectors:

A1 B1 C1

A2 B3 C3

A3 B4

A4

FileNames:

EIA0301A

B

C

CL-36 EFF Calibration

Benchsheet: CL111229-1 Source ID: 631

Log File CL36-03/01

Sources:

1124016-1

-2

-4

-5

~~Detectors:~~~~A1 B1 C1~~

x03/1/17

Detectors:

A1 B1 C1

A2 B3 C3

A3 B4

A4

FileNames:

ECLO301A

B

C

Th230 Alpha Co-Precip. Mass Attenuation Curve. FileNames: ACP0415

Benchsheet: GA170405-1

Sources: 1716001-71-716

ACP0415

	8:50	9:20	9:42	10:08	10:35	11:04	11:12	11:40	11:10	11:43	12:11	12:40	13:10	13:30	14:00	14:32
A1	1	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2
A2	2	1	16	15	14	13	12	11	10	9	8	7	6	5	4	3
A3	3	2	1	16	15	14	13	12	11	10	9	8	7	6	5	4
A4	4	3	2	1	16	15	14	13	12	11	10	9	8	7	6	5
B1	5	4	3	2	1	16	15	14	13	12	11	10	9	8	7	6
B3	6	5	4	3	2	1	16	15	14	13	12	11	10	9	8	7
B4	7	6	5	4	3	2	1	16	15	14	13	12	11	10	9	8
C1	8	7	6	5	4	3	2	1	16	15	14	13	12	11	10	9
C3	9	8	7	6	5	4	3	2	1	16	15	14	13	12	11	10

ACP0415
(4/15/17)ACP0417
(4/17/17)

Continued on Page

Signed

Date

Read and Understood By

Signed

Date

Date 4/15/17SOP 724r 12

ALS
Low Background Gas Flow Proportional Counter Log
Instrument: LB4100A

Instrument Daily Response and Background Checks

Det.	Daily Response Check				Background Check				Det. Status
	Start 1	Status	Start 2	Status	Start 1	Status	Start 2	Status	
1	JP	P			JP	P			P
2									
3									
4									
5									
6									OL
7									P
8									
9									
10									OL
11									P
12									OL
13	α				α				
14									
15									
16									

Det = Detector; α = Alpha; β = Beta; P = Pass; H = High; L = Low; OL = Offline; R = Recount; W = Weekly; NP = Not Processed

Weekly Background Calibration

	Current Calib. File ID	Weekly Calib. Started	Status	File ID
Dr A	BK404116			
Dr B				
Dr C				
Dr D	α			

Dr = Drawer

Gas Supply

P-10 Supply		P-10 Flow	
Tank 1	500	Dr A	10
		Dr B	
Tank 2	1600	Dr C	
		Dr D	

Comments:

Date

4/15/17

SOP 724r

12

ALS

Low Background Gas Flow Proportional Counter Log

Instrument: LB4100A

Det.	Sample ID	Batch	Test	Count Dur. (min)	Start Time	Analyst Initials	File ID	Output Initials
1-12	Dark EP	—	—	30	7:42	JP	EFA0415	JP
1-12	Dark Bk	—	—	60	7:49	JP	BKA0415	JP
1-45	1712001-T-16	0A1704051	α Collec	20	8:56	JP	ACP0415	JP
7-9, 11			Mass Attn					
1	1704200-1	AB170412-2	α B	30	11:37	JP	ABA0415	JP
2	201-1							
3	202-1							
4	203-1							
5	230-1							
7	-10							
8	-1ms							
9	AB170412-2MB							
11	LCs							
1	1704205-1	AB170413-1	α B	1000		JP	ABA0415A	
2	206-1							
3	240-1							
4	-2							
5	-3							
7	247-1							
8	AB170413-1MB							
9	1704179-2	AB170410-1						
11	AB170410-1MB							

Comments:

 Page No.: 470489 **B**
 (cont. from page NA **B**)

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Reviewed By / Date

JP 4/17/17

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Date

4/17/17

SOP 724r

12

ALS

Low Background Gas Flow Proportional Counter Log

Instrument: LB4100A

Instrument Daily Response and Background Checks

Det.	Daily Response Check				Background Check				Det. Status
	Start 1	Status	Start 2	Status	Start 1	Status	Start 2	Status	
1	JP	P			JP	P			P
2									
3									
4									
5									
6									OL
7									P
8									
9									
10									OL
11									P
12									OL
13	OL				OL				
14									
15									
16									

Det = Detector; α = Alpha; β = Beta; P = Pass; H = High; L = Low; OL = Offline; R = Recount; W = Weekly; NP = Not Processed

Weekly Background Calibration

	Current Calib. File ID	Weekly Calib. Started	Status	File ID
Dr A	BVA0411W			
Dr B				
Dr C				
Dr D	OL			

Dr = Drawer

Gas Supply

P-10 Supply		P-10 Flow	
Tank 1	2300	Dr A	10
		Dr B	
Tank 2	1000	Dr C	
		Dr D	

Comments:

Date 4/17/17

SOP 724r12

ALS

Low Background Gas Flow Proportional Counter Log

Instrument: LB4100A

Det.	Sample ID	Batch	Test	Count Dur. (min)	Start Time	Analyst Initials	File ID	Output Initials
1-12	Daily Eff	—	—	30	6:54	JP	EFA0417	JP
1-12	Daily Bkg	—	—	60	7:08	JP	BKA0417	JP
1	1704184-1	12A170411-1	RA228	90	8:26	JKB	RAA0417	JKB
2	↓ 2	↓	↓	↓	↓	↓	↓	↓
3	↓ 3	↓	↓	↓	↓	↓	↓	↓
4	↓ 4	↓	↓	↓	↓	↓	↓	↓
5	↓ 5	↓	↓	↓	↓	↓	↓	↓
7	↓ 6	↓	↓	↓	↓	↓	↓	↓
9	↓ 7	↓	↓	↓	↓	↓	↓	↓
11	1704185-1	↓	↓	↓	↓	↓	↓	↓
1-57	1716001-1-16	GA1704051	2G-Proc. Mass AB	30	10:12	JP	ACP0417	JP
8,9,11	↓	↓	↓	↓	↓	↓	↓	↓
1	1704104-1	SN1704111-1	Sr90	360	16:14	JKB	SRA0417	JKB
2	↓ 2	↓	↓	↓	↓	↓	↓	↓
3	↓ 3	↓	↓	↓	↓	↓	↓	↓
4	↓ 4	↓	↓	↓	↓	↓	↓	↓
9	SN1704111-165	↓	↓	30	16:16	↓	SRA0417A	↓
11	↓ 1650	↓	↓	↓	↓	↓	↓	↓
JP 4/18/17								

Comments:

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(cont. from page NA **B**)

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Reviewed By / Date

JP 4/18/17

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Date 4/18/17SOP 724r 12

ALS
Low Background Gas Flow Proportional Counter Log
Instrument: LB4100A

Instrument Daily Response and Background Checks

Det.	Daily Response Check				Background Check				Det. Status
	Start 1	Status	Start 2	Status	Start 1	Status	Start 2	Status	
1	JP	P			JP	P			P
2									
3									
4									
5									
6									OL
7									P
8									
9									
10									OL
11						Hβ	7KB	P	A
12						P			OL
13	OL				OL	OL			
14									
15									
16									

Det = Detector; α = Alpha; β = Beta; P = Pass; H = High; L = Low; OL = Offline; R = Recount; W = Weekly; NP = Not Processed

Weekly Background Calibration

	Current Calib. File ID	Weekly Calib. Started	Status	File ID
Dr A	BKA0411W			
Dr B				
Dr C				
Dr D	OL			

Dr = Drawer

Gas Supply

P-10 Supply		P-10 Flow	
Tank 1	1950	Dr A	10
		Dr B	
Tank 2	1000	Dr C	
		Dr D	

Comments:JP 4/19/17

Prepare an intermediate dilution of Th-230 P50# 853 of approximately 1200 dpm/ml

1) Prepare 0.5M HNO_3 , 3% HNO_3 and 96% DI water, lot # 073602

2) Determine density of 0.5M HNO_3

Mass of 100 ml vol. flask:

Mass of flask + 100 ml 0.5M HNO_3 :

Net mass of 0.5M HNO_3 :

Bal. 12

68.6999g

167.4539g

101.153g

$$\rho = 1.015 \text{ g/ml}$$

3) Transfer contents of vial to 1000ml Nalgene

Mass of full standard vial:

Mass of empty standard vial:

Net mass of standard transferred:

Bal. 12

81.2827

3.2327

5.05g

4) Dilute with 0.5M HNO_3

Mass of Nalgene w/ lid (empty):

Mass of Nalgene with standard:

Mass of Nalgene, standard, and diluent:

Net mass of standard:

73.66g

73.70g

78.71g

1085.2

1011.54g

Bal. 26

5) Final activity calculation

$$(1.983 \times 10^4 \text{ Bq}) (5.1319 \text{ g}) = 384.60 \text{ Bq/g} \times \left(\frac{60 \text{ s}}{1 \text{ min}} \right) = 230,975.755 \text{ dpm}$$

$$(384.60 \text{ Bq/g}) \cdot \left(\frac{5.05 \text{ g}}{1011.54 \text{ g}} \right) \cdot (1.015 \text{ g/ml}) = 1166.38 \text{ dpm/ml}$$

Std ID: 853.3020.89

Description: Th-230

Expiration: 2/5/2009

Activity: 1166.38 dpm/mL

2s Uncertainty: 23.33 dpm/mL

Ref. Date: 11/6/2007

Ref Time: N/A

Prep Date: 12/12/2007 Prep by: DC

Matrix/Comp. 0.5 M HNO_3

Half Life (y): 7.70E+04

Reverification Log		
Analysis Date	Initials	Expiration Date
5/5/09	RG	5/5/2010
11/19/10	RG	11/19/2011
12/13/14	JP	12/13/2015

Continued on Page

Signature: [Signature]

Date: 12/12/07

Read and Understood By

Signature: [Signature]

Date: 2/13/08



Eckert & Ziegler
Analytics

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

CERTIFICATE OF CALIBRATION
Standard Radionuclide Source

76253-307

Th-230 5 mL Liquid in Flame Sealed Vial

Customer: Paragon Analytics / Fort Collins, CO
P.O. No.: 72909-REL 10-30-07, 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.

ANALYTICS maintains traceability to the National Institute of Standards and Technology through Measurements Assurance Programs as described in USNRC Reg. Guide 4.18, Revision 1.

Isotope:	Th-230
Activity (Bq):	1.983 E4
Half-Life:	7.838 E4 years
Calibration Date:	November 8, 2007 12:00 EST
Relative Expanded Uncertainty (k=2):	2.0%

Comments:

Impurities: γ -impurities <0.1%, α -impurities <0.01%.
5.16119 grams 0.5M HNO₃ solution.

Source Prepared By: N. E. Klesman
N. E. Klesman, Radiochemist

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

Date: 11-19-07

End of Certificate

Corporate Office
24937 Avenue Tibbitts Valencia, California 91353

Laboratory
1380 Seaboard Industrial Blvd. Atlanta, Georgia, 30318

Internal Calculation Verifications

ICBs

&

ICVs

Gross Alpha Co-Precipitation LB4100A ICV's/ICB's Th-230

Atten. Constants		Alpha	
b	0.9810	m	0.9869
a	0.8971	x0	0

X-Talk Constants		$\alpha > \beta$	
m	0.9968	b	0.2339

Detector	Sample ID	Initial Aliquot	Final Sam. Size	Count Date	Count Dur.	Alpha						
						Residual Mass (mg)	Gross CPM	Bkg CPM	$\beta > \alpha$ X-Talk	Net CPM	Atten.	Efficiency
A1	1716007-1	0.500	0.500	4/26/2017	60	30.1	16.783	0.11	0.017	16.656	0.687	0.2282
B1	1716007-2	0.500	0.500	4/26/2017	60	30.4	17.917	0.116	0.015	17.796	0.685	0.2377
C1	1716007-3	0.500	0.500	4/26/2017	60	40.0	16.667	0.152	0.018	16.497	0.611	0.2269
A3	1716007-4	0.500	0.500	4/26/2017	60	40.3	15.183	0.128	0.014	15.041	0.609	0.2335
B3	1716007-5	0.500	0.500	4/26/2017	60	50.2	14.500	0.150	0.013	14.337	0.542	0.2320
A4	1716007-6	0.500	0.500	4/26/2017	60	50.4	13.350	0.111	0.013	13.226	0.540	0.2289
A2	AB161208-2AMB	0.500	0.500	4/26/2017	60	30.2	0.117	0.114	0.001	0.002	0.686	0.2214
B4	AB161208-2BMB	0.500	0.500	4/26/2017	60	30.5	0.283	0.176	0.000	0.107	0.684	0.2245
C3	AB161208-2CMB	0.500	0.500	4/26/2017	60	30.5	0.183	0.119	0.001	0.063	0.684	0.2349

Spike Information				
Alpha Std ID	Ref. Date	Act (dpm/ml)	Spike Vol (mL)	Decay Corr. Spike Act. Added
760.4243.03	7/13/2004	99.100	1.0	97.088

Acceptance criteria for LCS's --> 80-120%

Sample ID	Alpha				
	Act (pCi/L)	TPU (2 sig)	MDC	% Recov.	Act-MDCa
1716007-1	93.70	16.4	1.49	109.4%	NA
1716007-2	98.46	16.8	1.45	112.6%	NA
1716007-3	107.17	18.4	1.90	122.5%	*
1716007-4	95.29	16.8	1.93	108.9%	NA
1716007-5	102.77	17.8	2.06	117.5%	NA
1716007-6	96.32	16.81	1.87	110.1%	NA
AB161208-2AMB	0.01	0.54	1.47	NA	PASS
AB161208-2BMB	0.63	0.83	1.74	NA	PASS
AB161208-2CMB	0.35	0.64	1.42	NA	PASS

* Recovery for 1716007-3 is above 120% but meets USGS acceptance criteria of (Act-2 sigma TPU)< spike amount

OK JX 4/26/17

PAI - Gas Flow Proportional Sample Analysis LB4100-A

Unit Type: LB4100-A/W
Counting Unit ID: Orange
High Voltage Mode: Simultaneous
Application Revision: C
Rev 05/09/13 JP

Data file name: ABA0426
Batch ID: GA170418-1
Count Preset (m): 60
Batch Endet: 4/26/17 8:27

Background logfile: BKGABW
Date of Bkg. Cal: 4/26/17
Alpha efficiency logfile: TH-230-12/16
Alpha attenuation calibration: ACP0415
Beta efficiency logfile: CS137-12/16
Beta attenuation calibration: ACS1207

Alpha prog. logfile: n/a
Alpha prog. attenuation: n/a
Beta prog. logfile: n/a
Beta prog. attenuation: n/a

Alpha Attenuation Calibration		Beta Attenuation Calibration	
y = b'm*(a*(mass-x0))		y = b'm*(a*(mass-x0))	
Alpha b=	0.88100	Beta b=	0.8455
m=	0.98690	m=	0.8986
a=	0.8971	a=	1.0026
x0=	0.0000	x0=	0.0000
Alpha to Beta X-talk		Beta to Alpha X-talk	
y = b'm*-x		y = b'm*mass + m	
a->b xtalk b=	0.2339	b->a xtalk b=	1.618E-46
a->b xtalk m=	0.9968	b->a xtalk m=	0.0037

Det. ID	Sample	Count End Date & Time	Count Dur. (min)	Resid. Mass (mg)	Alpha Activity						Beta Activity						
					Gross CPM	Bkg. CPM	b>a xtlk CPM	Base Eff	Base Cor.Fact.	Progeny Eff	Progeny Cor.Fact.	Gross CPM	Bkg. CPM	a>b xtlk CPM	Base Eff	Base Cor.Fact.	Progeny Eff
C1	1718007-3	4/26/17 8:26	60.00	40.0	16.867	0.152	0.018	0.2269	0.811	n/a	n/a	8.987	2.092	4.3912	0.3974	0.894	n/a
C3	GA170418-1CMB	4/26/17 8:26	60.00	30.5	0.183	0.119	0.001	0.2349	0.684	n/a	n/a	2.133	1.985	0.0166	0.4191	0.906	n/a
A1	1718007-1	4/26/17 8:27	60.00	30.1	16.783	0.110	0.017	0.2282	0.687	n/a	n/a	6.567	2.091	4.2949	0.3942	0.906	n/a
A2	GA170418-1AMB	4/26/17 8:27	60.00	30.2	0.117	0.114	0.001	0.2214	0.686	n/a	n/a	2.250	1.972	0.0007	0.3972	0.906	n/a
A3	1718007-4	4/26/17 8:27	60.00	40.3	15.183	0.128	0.014	0.2335	0.609	n/a	n/a	5.567	2.167	4.0070	0.4040	0.893	n/a
A4	1718007-5	4/26/17 8:27	60.00	50.4	13.350	0.111	0.013	0.2289	0.540	n/a	n/a	5.567	2.128	3.6395	0.3921	0.881	n/a
B1	1718007-2	4/26/17 8:27	60.00	30.4	17.917	0.116	0.015	0.2377	0.685	n/a	n/a	5.500	1.958	4.5897	0.4271	0.906	n/a
B3	1718007-5	4/26/17 8:27	60.00	50.2	14.500	0.150	0.013	0.2320	0.542	n/a	n/a	5.367	1.878	3.9424	0.4171	0.881	n/a
B4	GA170418-1MB	4/26/17 8:27	60.00	30.5	0.283	0.176	0.000	0.2245	0.684	n/a	n/a	1.883	1.787	0.0277	0.3954	0.906	n/a

JP 4/26/17

Date 4/26/17SOP 724r 12

ALS
Low Background Gas Flow Proportional Counter Log
Instrument: LB4100C

Instrument Daily Response and Background Checks

Det.	Daily Response Check				Background Check				Det. Status
	Start 1	Status	Start 2	Status	Start 1	Status	Start 2	Status	
1	JP	P			*				P
2									
3									
4									
5									
6									
7		(H)	JP	P					α
8		P							P
9									
10									α
11									P
12									α
13	OL				OL				
14									
15									
16									

Det = Detector; α = Alpha; β = Beta; P = Pass; H = High; L = Low; OL = Offline; R = Recount; W = Weekly; NP = Not Processed

Weekly Background Calibration

	Current Calib. File ID	Weekly Calib. Started	Status	File ID
Dr A	BKAD425W			
Dr B				
Dr C				
Dr D	OL			

Dr = Drawer

Gas Supply

P-10 Supply		P-10 Flow	
Tank 1	2600	Dr A	10
		Dr B	
Tank 2	650	Dr C	
		Dr D	✓

Comments: * It is not necessary to run daily background checks on the morning following a long background calibration.
 JP 4/26/17

Date

4/26/17

SOP 724r

12

ALS

Low Background Gas Flow Proportional Counter Log

Instrument: LB4100A

Det.	Sample ID	Batch	Test	Count Dur. (min)	Start Time	Analyst Initials	File ID	Output Initials
1-12	Daily EFP			30	7:05	JP	EFA0426	JP
7	Daily EFP			30	7:14	JP	EFA0426A	JP
1	1716007-1	GA170418-1	αβ	60	7:26	JP	ABA0426	JP
5	-2		ICV/EB					
9	-3							
3	-4							
7	-5							
4	-6							
2	GA170418-1AMB							
8	BMB							
11	CMB							
1	1704435-1	AB170425-1	αβ	240	8:12	JP	ABA0426A	JP
2	-10							
3	-2							
4	-3							
9	1704436-1							
11	AB170425-1MB							
5	1704435-3MB			30	9:02		ABA0426B	
2	AB170425-1LCS							
1	1704281-3	AB170424-3	αβ	1000	12:13		ABA0426C	JP
2	-30							
3	1704368-1							
4	AB170424-3MB							
5	1704461-3	AB170422-5	αβ	75	12:35	JP	ABA0426D	
7	-30							
<div style="text-align: right;">JP 4/27/17</div>								

Comments:

 Page No.: 472201 **B**
 (cont. from page NX **B**)

Form 780r8.doc (6/23/06)

Reviewed By / Date

JP 4/27/17

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Date 4/27/17

SOP 724r 12

ALS
Low Background Gas Flow Proportional Counter Log
Instrument: LB4100/A JLD 4/27/17

Instrument Daily Response and Background Checks

Det.	Daily Response Check				Background Check				Det. Status
	Start 1	Status	Start 2	Status	Start 1	Status	Start 2	Status	
1	JP	P			JP	P			P
2									
3									
4									
5									
6									OL
7									P
8									
9									
10									OL
11									D
12									OL
13	OL				OL				
14									
15									
16									

Det = Detector; α = Alpha; β = Beta; P = Pass; H = High; L = Low; OL = Offline; R = Recount; W = Weekly; NP = Not Processed

Weekly Background Calibration

	Current Calib. File ID	Weekly Calib. Started	Status	File ID
Dr A	3KA04250			
Dr B				
Dr C				
Dr D	OL			

Dr = Drawer

Gas Supply

P-10 Supply		P-10 Flow	
Tank 1	1700	Dr A	10
		Dr B	
Tank 2	650	Dr C	
		Dr D	

Comments:

Radiochemistry Instrument Worksheet

ALS -- Fort Collins

Prep Batch: GA170418-1

Prep Procedure: GR_ALPH_CO ICBs/ICBs

Analytical QASS / NCR? Y *N*

Prep Num	LabID	QC Type	Init Aliq	Fin Aliq	Units	Report Units	Residual Mass (mg)	Cnt 1 File	Cnt 1 Inst/Det	Cnt 1 Pos Chk By	Cnt 2 File	Cnt 2 Inst/Det	Cnt 2 Pos Chk By	Cnt 3 File	Cnt 3 Inst/Det	Cnt 3 Pos Chk By	Notes
1	1716007-1	SMP	500	500	ml	PCIL	30.1	ABA04261 JV									
1	1716007-2	SMP	500	500	ml	PCIL	30.4										
1	1716007-3	SMP	500	500	ml	PCIL	40										
1	1716007-4	SMP	500	500	ml	PCIL	40.3										
1	1716007-5	SMP	500	500	ml	PCIL	50.2										
1	1716007-6	SMP	500	500	ml	PCIL	50.4										
1	GA170418-1A	MB	500	500	ml	PCIL	30.2										
1	GA170418-1B	MB	500	500	ml	PCIL	30.5										
1	GA170418-1C	MB	500	500	ml	PCIL	30.5										

JP 4/26/17

Spike Solution Information							
Soln #	Nuclide	Exp Date	SolnID	Prep Conc	Units	Prep Date	Pipet ID
S1	Th-230	760.4243.03	5/5/17	98.994	DPM/ml	04/18/17	1 ml RS-033

Sample Barcodes

1716007-1 GA170418-1PS1		1716007-2 GA170418-1PS2		1716007-3 GA170418-1PS3	
1716007-4 GA170418-1PS4		1716007-5 GA170418-1PS5		1716007-6 GA170418-1PS6	
GA170418-1AMB GA170418-1PS7		GA170418-1BMB GA170418-1PS8		GA170418-1CMB GA170418-1PS9	

Reporting Units

LabID	TstGrpName	RptUnits
1716007-1	GrossAlphaCoprecipitation	PCIL
1716007-2	GrossAlphaCoprecipitation	PCIL
1716007-3	GrossAlphaCoprecipitation	PCIL
1716007-4	GrossAlphaCoprecipitation	PCIL
1716007-5	GrossAlphaCoprecipitation	PCIL
1716007-6	GrossAlphaCoprecipitation	PCIL

Radiochemistry Prep Worksheet

ALS -- Fort Collins

Prep Batch: GA170418-1

Prep Procedure: GR_ALPHA_CO

Reviewed By: msh2 MSH Review Date: 4/25/2017

Non-Routine Pre-Treatment? Y (N) Batch: N/A

Prep QASS / NCR? Y (N) N/A

Prep SOP: PAI 786 Rev: 7

Prep SOP: NONE

Matrix Class: liquid

Prep Analyst: Macey S. Hall MSH

Prep Date: 4/18/2017

Prep Dept: RS

Balance: 13

Balance:

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Alq ml	Fin Alq ml	Prep Basis	Standards	Prep Notes
1	1	1716007-1	SMP	N/A	500	500	Unfiltered	S1	
2	1	1716007-2	SMP		500	500	Unfiltered	S1	
3	1	1716007-3	SMP		500	500	Unfiltered	S1	
4	1	1716007-4	SMP		500	500	Unfiltered	S1	
5	1	1716007-5	SMP		500	500	Unfiltered	S1	
6	1	1716007-6	SMP		500	500	Unfiltered	S1	
7	1	GA170418-1A	MB		500	500	Unfiltered	N/A	
8	1	GA170418-1B	MB		500	500	Unfiltered		
9	1	GA170418-1C	MB		500	500	Unfiltered		

Comments

Spiked By: Macey S. Hall Date: 4/25/2017

Witnessed By: Hunter C. Jordan Date: 4/25/2017

Spike Solution Information						
Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Pipet ID
S1	Th-230	760.4243.03	5/5/17	98.994	DPM/ml	RS-033
					ml	

Radiochemistry Prep Worksheet

ALS -- Fort Collins

Prep Batch: GA170418-1

Prep Procedure: GR_ALPHA_CO

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 786 Rev: 7

Prep Analyst: Macey S. Hall MSH

Balance: 13

Prep Date: 4/18/2017

Balance:

Prep SOP: NONE

Matrix Class: liquid

Prep Dept: RS

Sample Num	Prep Num	LabID	QC Type	Dish No.	Init Aliq ml	Fin Aliq ml	Prep Basis	Standards	Prep Notes
1	1	1716007-1	SMP		500	500		S1	
2	1	1716007-2	SMP		500	500		S1	
3	1	1716007-3	SMP		500	500		S1	
4	1	1716007-4	SMP		500	500		S1	
5	1	1716007-5	SMP		500	500		S1	
6	1	1716007-6	SMP		500	500		S1	
7	1	GA170418-1A	MB		500	500			
8	1	GA170418-1B	MB		500	500			
9	1	GA170418-1C	MB		500	500			

Comments

Spiked By: MSH Date: 4/25/17
Witnessed By: HCS Date: 4-25-17

Spike Solution Information						
Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Pipet ID
S1	Th-230	760.4243.03	5-5-17	98.994	DPM/ml	04/18/17
					1	ml
						RS-033

Radiochemistry Gravimetric Worksheet

ALS -- Fort Collins

Prep Batch: GA170418-1

Prep Procedure: GR_ALPH_CO

Reviewed By: msh2 MSH Review Date: 4/25/2017

Prep Num	Planc. Num	LabID	QC Type	Test Alq (ml)	Tare Mass (g)	Initial Gross Mass (g)	Initial Net Mass (mg)	Suggested Alq (ml)	Samp Vol Available (ml)	Samp Vol Taken (ml)	Fin Gross Mass (g)	Final Net Mass (mg)	Salt Sol. Added (ml)	Flag
1	1	1716007-1	SMP	0	9.3522	0.0000	0	500	500	500	9.3823	30.1	0	
1	2	1716007-2	SMP	0	9.3517	0.0000	0	500	500	500	9.3821	30.4	0	
1	3	1716007-3	SMP	0	9.4168	0.0000	0	500	500	500	9.4568	40	0	
1	4	1716007-4	SMP	0	9.3301	0.0000	0	500	500	500	9.3704	40.3	0.25	
1	5	1716007-5	SMP	0	9.3643	0.0000	0	500	500	500	9.4145	50.2	0.5	
1	6	1716007-6	SMP	0	9.3233	0.0000	0	500	500	500	9.3737	50.4	0.5	
1	7	GA170418-1A	MB	0	9.3748	0.0000	0	500	500	500	9.4050	30.2	0	
1	8	GA170418-1B	MB	0	9.2792	0.0000	0	500	500	500	9.3097	30.5	0	
1	9	GA170418-1C	MB	0	9.3495	0.0000	0	500	500	500	9.3800	30.5	0	

Prepare a working dilution of 760.3020.08

1. Density of 0.5 M HNO₃ lot # 0000127617
Mass of 100mL vol. flask: 68.2961 g Balance # 12
Mass of flask & 100mL acid: 169.4362 g Balance # 12
Net Mass: 101.1401 g
Density: 1.0114 g/mL

2. Mass of 760.3020.08 transferred:
Mass of open empty nalgene: 74.6548 g Balance # 12
Mass of nalgene & standard: 77.6893 g Balance # 12
Net mass of standard transferred: 3.0345 g

3. Dilute to final volume:
Mass of nalgene, standard, & diluent: 897.2 g Balance # 26
Mass of empty nalgene (from above): 74.6548 g Balance # 12
Net mass of new dilution: 822.5452 g

4. Final activity calculation:
$$26,534.43 \frac{\text{dpm}}{\text{g}} \times 1.0114 \frac{\text{g}}{\text{mL}} \times \frac{3.0345 \text{ g}}{822.5452 \text{ g}} = 99.01 \frac{\text{dpm}}{\text{mL}}$$

JP 5/18/16

Std ID: 760.4243.03

Description: Th-230
Expiration: 5/5/2017
Activity: 99.01 dpm/ml
2s Uncertainty: 3.27 dpm/ml
Ref. Date: 7/13/2004
Ref Time: N/A
Prep Date: 4/7/2016 Prep by: TE
Matrix/Comp. 0.5 M HNO₃
Half Life (y): 7.54E+04

Reverification Log		
Analysis Date	Initials	Expiration Date

JP 5/18/16

Continued on Page _____

1 clw

Signed

4/27/16
4/27/16

Date

Read and Understood By

[Signature]

Signed

5/18/16

Date

Prepare a primary dilution of R50 #760 (Analytical # 68750-307) in 0.5 M HNO_3 to a concentration of approx 30,000 dpm/mL.

1) Prepare 0.5M HNO_3 by diluting 31 mL of conc. (16M) HNO_3 (EMD lot # 44287) to a final volume of 1000 mL.

2) Determine density of 0.5M HNO_3

Mass of 100mL volumetric flask = 66.4289g (Bal 1)

Mass of flask + 0.5M HNO_3 = 167.5792g

Net mass of solution = 101.1503g ^{1/24/06}

$\div 100 \text{ mL} = \text{density} = 1.0115 \text{ g/mL}$

3) Transfer # 760 to a 40 mL VOA vial.

Mass of bottle w/out lid = 21.5801g (Bal 1)

Mass of std + bottle = 26.5278g

Net mass of std transferred = 4.9477g

4) Dilute to volume w/ 0.5M HNO_3

Mass of bottle + std + soln = 61.8912g (Bal 1)

Mass of bottle (from above) = 21.5801g

Net mass of std = 40.3111g

5) Final activity calc.

$$\frac{(1.832 \times 10^4 \text{ d/sec}) \left(\frac{1600 \text{ g}}{1000 \text{ mL}} \right) (4.9477 \text{ g})}{(5.08447) (40.3111 \text{ g})} \left(\frac{1.0115 \text{ g/mL}}{1.0115 \text{ g/mL}} \right) = 26,534.83 \text{ d/g}$$

Continued on Page

Read and Understood By

Deborah Baku

Signed

1/24/06

Date

[Signature]

Signed

1/27/06

Date



ANALYTICS

RSO# 760 Rec'd 7/14/04 RB

1380 Seaboard Industrial Blvd.
Atlanta, Georgia 30318 - U.S.A.

Phone (404) 352-8577
Fax (404) 352-2837

CERTIFICATE OF CALIBRATION

Standard Radionuclide Source

68750-307

Th-230 5 mL Liquid in Flame Sealed Vial

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.

ANALYTICS maintains traceability to the National Institute of Standards and Technology through Measurements Assurance Programs as described in USNRC Reg. Guide 4.15, Revision 1.

ISOTOPE:	Th-230
ACTIVITY (dps):	1.832 Bq
HALF-LIFE:	7.538 Bq years
CALIBRATION DATE:	July 13, 2004 12:00 EST
RELATIVE EXPANDED UNCERTAINTY (k=2):	3.3%

Impurities: γ -impurities <0.1%, α -impurities <0.01%

5.08447 grams 0.5M HNO₃ solution.

P O NUMBER 70635, Item 1

SOURCE PREPARED BY:

M. D. Currie
M. D. Currie, Radiochemist

Q A APPROVED:

A. Currie 7/13/04

Instrument: LB4100-C

Calibration: Gross Alpha (Th-230) -- ringed planchet
Gross Beta (Cs-137) -- ringed planchet
Drinking Water EPA Method 900.0 Compliant

Date of Calibration: Gross Alpha 06/09/17
Gross Beta 06/06/17

Efficiency Log Files: **Th230-06/17**
Cs-137-06/17

Efficiency Instrument Files: ETH0609A-D
ECS0606A-D

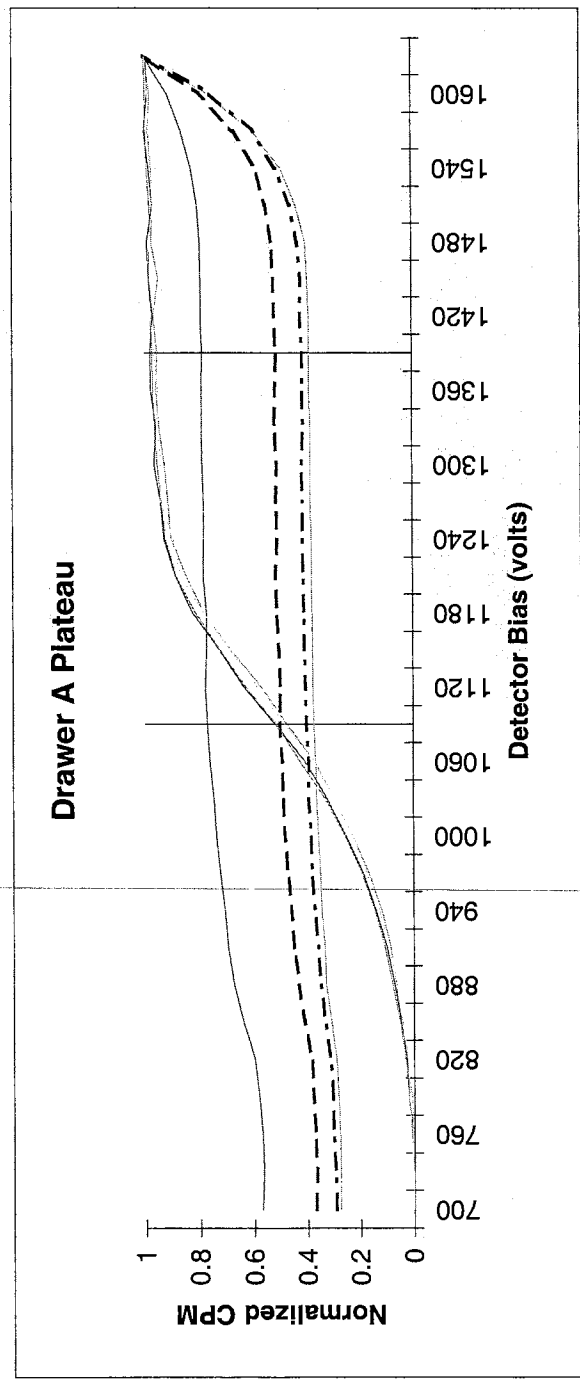
Source ID's: Th-230→853.3020.89
Cs-137→1019.4095.83
ICV ID's: Th-230→760.4095.67
Cs-137→1013.4095.77

OK JP 6/16/17
Expires 06/05/2018

Instrument Plateaus

Unit Type: LB4100/W
 Date Performed: 6/6/17 08:23
 FileName: PTC0606A
 Batch ID: DRAWER A PLATEAU

Unit Id: Magenta
 Application Revision: 2
 Application Version: Standard



Optimum alpha beta simultaneous operating voltage: **1402.5**

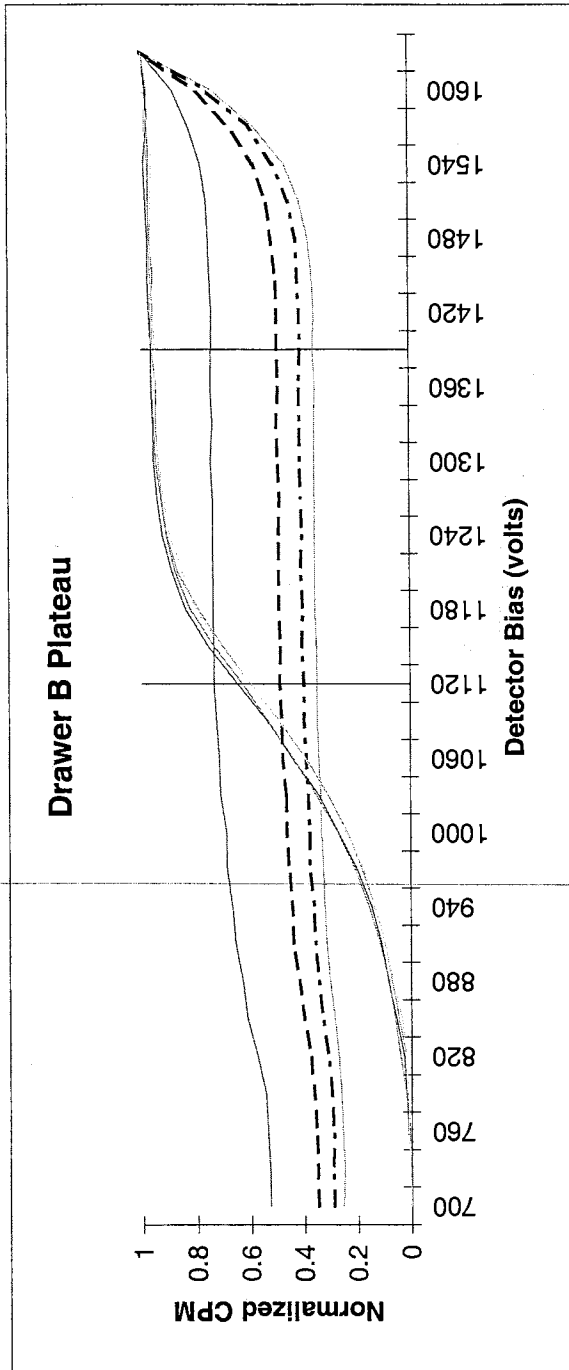
Optimum alpha only operating voltage: **1087.5**

	A1	A2	A3	A4
Beta slope at beta voltage	1.47%	1.71%	0.53%	3.64%
Alpha slope at beta voltage	0.19%	0.63%	1.60%	1.64%
Alpha slope at alpha voltage	3.18%	2.44%	3.36%	3.18%

Ok JRC 6/9/17

Unit Type: LB4100/W
Date Performed: 6/6/17 08:23
FileName: PTC0606B
Batch ID: DRAWER B PLATEAU

Unit Id: Magenta
Application Revision: 2
Application Version: Standard



Optimum alpha beta simultaneous operating voltage: **1402.5**

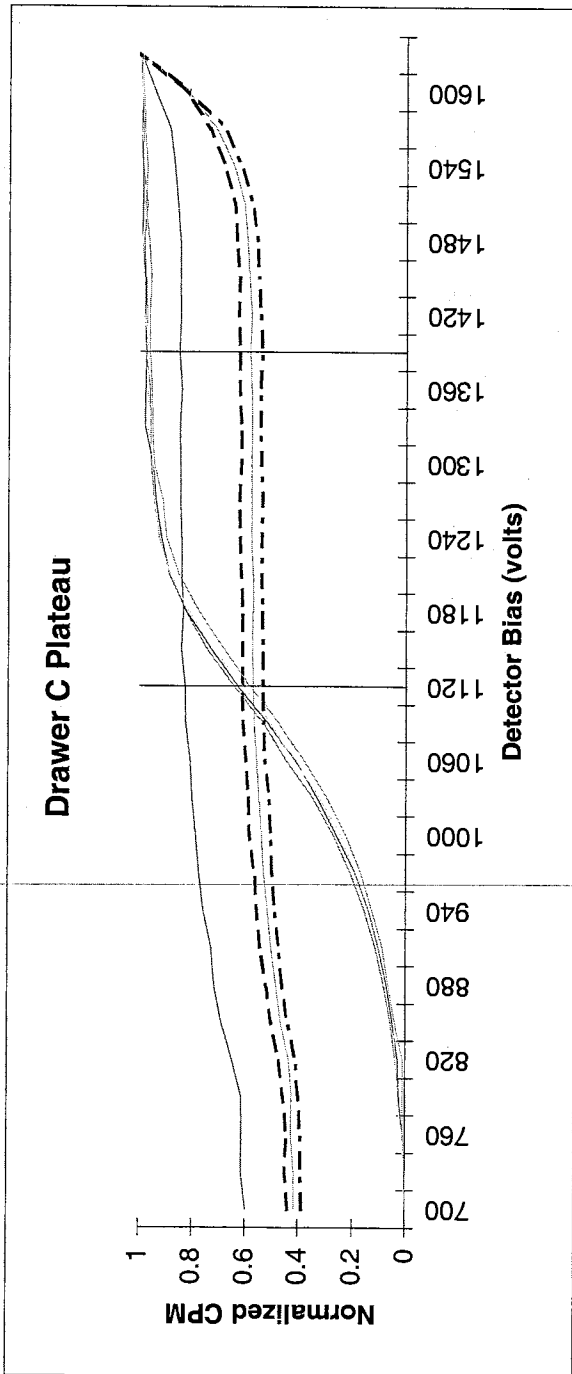
Optimum alpha only operating voltage: **1120**

	B1	B2	B3	B4
Beta slope at beta voltage	1.46%	0.21%	1.67%	1.02%
Alpha slope at beta voltage	0.74%	0.41%	1.47%	0.77%
Alpha slope at alpha voltage	2.44%	2.07%	2.12%	2.16%

OK JP 6/9/17

Unit Type: LB4100/W
Date Performed: 6/5/17 16:24
File Name: PTC0605C
Batch ID: DRAWER C PLATEAU

Unit Id: Magenta
Application Revision: 2
Application Version: Standard

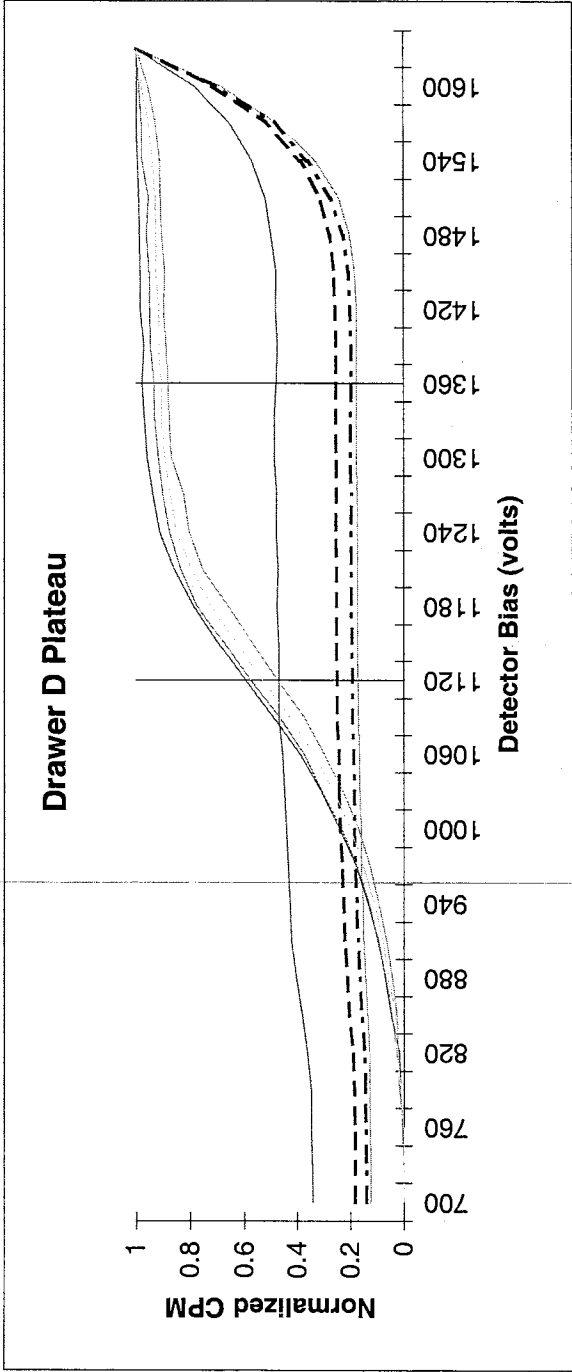


Optimum alpha beta simultaneous operating voltage:		1402.5	
Optimum alpha only operating voltage:		1120	
	C1	C2	C3
Beta slope at beta voltage	0.01%	1.81%	0.66%
Alpha slope at beta voltage	0.09%	0.91%	1.33%
Alpha slope at alpha voltage	2.85%	1.52%	2.04%
	C4		
			1.49%
			0.91%
			1.53%

OK JRC 6/9/17

Unit Type: LB4100/W
Date Performed: 6/5/17 16:24
FileName: PTC0605D
Batch ID: DRAWER D PLATEAU

Unit Id: Magenta
Application Revision: 2
Application Version: Standard



Optimum alpha beta simultaneous operating voltage: 1372.5

Optimum alpha only operating voltage: 1120

	D1	D2	D3	D4
Beta slope at beta voltage	1.86%	2.83%	2.42%	2.14%
Alpha slope at beta voltage	-1.26%	0.56%	0.63%	0.33%
Alpha slope at alpha voltage	3.38%	3.01%	3.50%	3.06%

OK 6/6/17

Date 6/5/17SOP 724r 12

ALS
Low Background Gas Flow Proportional Counter Log
Instrument: LB4100C

Instrument Daily Response and Background Checks

Det.	Daily Response Check				Background Check				Det. Status
	Start 1	Status	Start 2	Status	Start 1	Status	Start 2	Status	
1	<u>7:05</u>	<u>P</u>			<u>7:05</u>	<u>P</u>			<u>P</u>
2									
3									
4									
5									
6									
7									
8									
9						<u>Hβ</u>	<u>7:05</u>	<u>P</u>	
10						<u>P</u>			
11						<u>L</u>			
12						<u>Hβ</u>			<u>OL</u>
13						<u>P</u>			<u>P</u>
14									
15									
16									

Det = Detector; α = Alpha; β = Beta; P = Pass; H = High; L = Low; OL = Offline; R = Recount; W = Weekly; NP = Not Processed

Weekly Background Calibration

	Current Calib. File ID	Weekly Calib. Started	Status	File ID
Dr A	<u>BK0523 BK0524</u>			
Dr B				
Dr C				
Dr D				

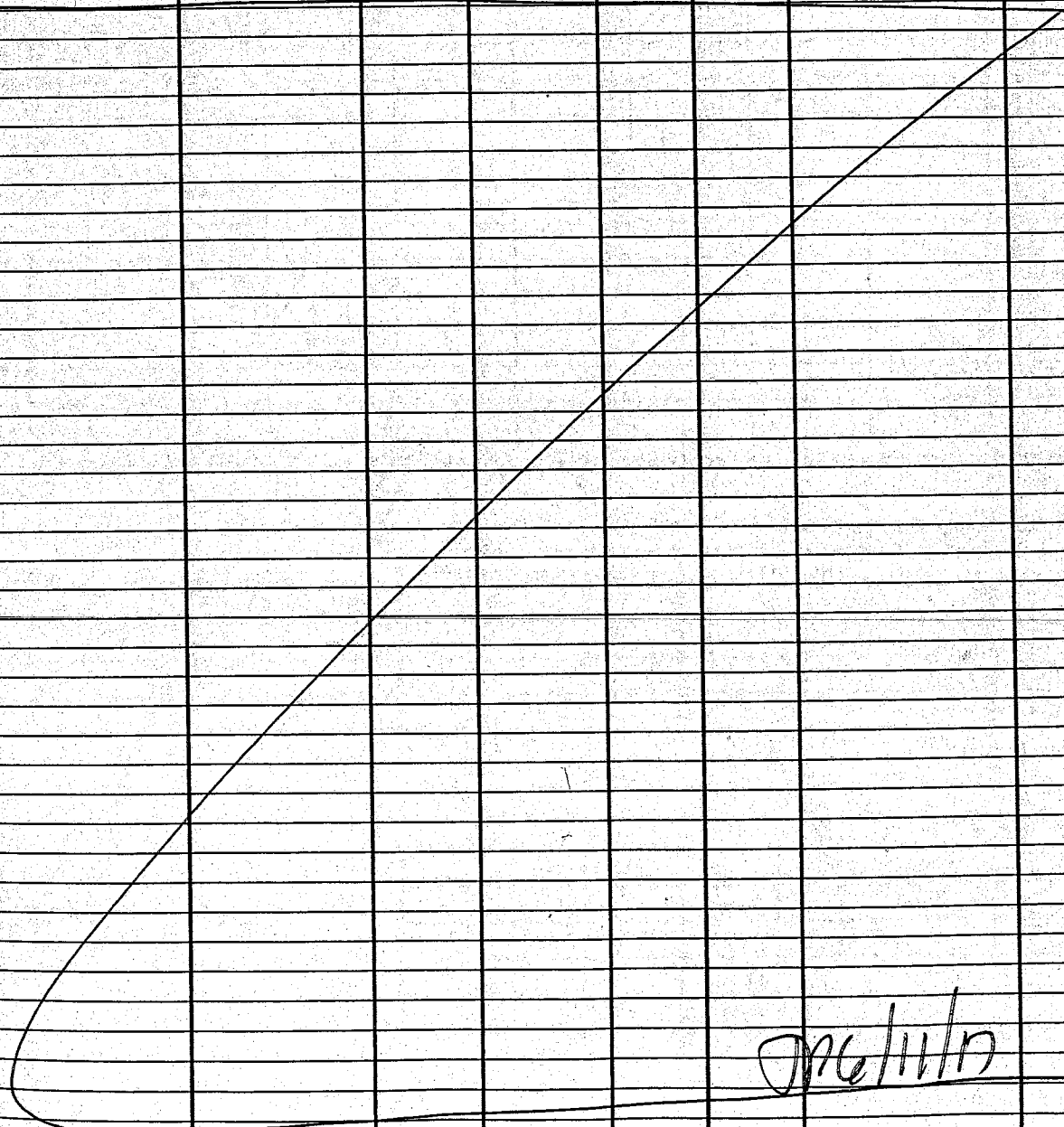
Dr = Drawer

Gas Supply

P-10 Supply		P-10 Flow	
Tank 1		Dr A	<u>10</u>
		Dr B	
Tank 2		Dr C	
		Dr D	

Comments:

Date 6/5/17SOP 724r 12ALS
Low Background Gas Flow Proportional Counter Log
Instrument: LB4100C

Det.	Sample ID	Batch	Test	Count Dur. (min)	Start Time	Analyst Initials	File ID	Output Initials
1-16	Daily Eff	—	—	30	820	JKB	PTC0605	JKB
1-16	Daily Bkgd	—	—	60	833	JKB	BK0605	JKB
9	↓	—	—	60	905	JM	PTC0605A	↓
1-16	Alpha/Beta	Drawer A Plate	Platena	5 min/sip	1009		PTC0605A	↓
5-8	Beta/Mean	Drawer B Plate					PTC0605B	↓
9-12	Alpha/Beta	Drawer C Plate			1630		PTC0605C	↓
13-16	Beta/Alpha	Drawer D Plate			↓		PTC0605D	↓
								

Comments:

Page No.: 471486 **B**
(cont. from page 11 **B**)

Form 780r8.doc (6/23/06)

Reviewed By / Date JPB/MLB

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4/4/17 Drawers A+B removal from Instrument and sent back to Canberra to fix guard detector / Slide tray connection so the 3 guard pins holding the two together don't become loose over time due to opening and closing the drawers resulting in \uparrow beta cpm, \downarrow guard cpm

5/1/17 Drawers A+B received back from Canberra. Drawers re-installed in the instrument, daily performance check run after allowing time for the gas to purge. Weekly Long Background calibration performed. Drawers A+B are now back on line.

6/5/17 Voltage Plateau

Plateau Check run for drawers A-D

α sources used

detectors

β sources used

410 Am-241

A1 B1 C1 D1

406

Sr 90/Y90

411 17800 dpm

A2 B2 C2 D2

407

29600 dpm

412 2/16/95

A3 B3 C3 D3

408

9/15/95

413

A4 B4 C4 D4

409

Parameters:

Starting voltage 700

Count preset 40000

File names:

End voltage 1650

Time bin steps 0.1

PTC0605A

30V/skip

Weak check Pres 0.1

PTC0605B

5min/step

Weak check limits 20

6/7/17

ROIS Set for all drawers using Sr/Y-90 sources

Sources \rightarrow 406, 407, 408, + 409: over 40,000 counts achieved at each detector. α lower limit + β upper limit set to 50% to start

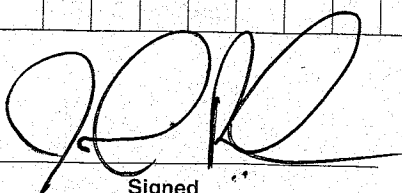
Both α lower limit + β upper limit moved to achieve $\beta \rightarrow \alpha$ talk of

2.5%. α lower limit moved to achieve $\alpha \rightarrow \beta$ talk of 0.10%

All ROIS archived

Continued on Page

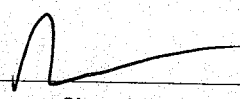
Read and Understood By



Signed

6/11/17

Date



Signed

6/13/17

Date

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Instrument ROIs

LB4100 -C Water Sample Counting Parameters

Certainty requirement for MDA and flags		95%	Action level for flags (pCi/l)	1.200E+02
Maximum count time (min)		360.00		1.000E+00
Typical Residual Mass (mg)		50.00		1.00%
Typical Sample Volume (l)		0.10		1.00%

	Alpha		MDA (pCi/l)	Beta	
	eff.	bkg.		eff.	bkg.
A1	15.92%	0.078	1.812E+00	37.98%	1.436
A2	16.59%	0.094	1.889E+00	37.36%	1.336
A3	16.06%	0.096	1.971E+00	37.67%	1.51
A4	16.20%	0.083	1.831E+00	38.95%	1.532

Batch Specific:

Event	Recycle
1	0

Drawer Specific:

	Date/Time	Official	Bias	Step
A	6-6-17 8:23	TRUE	1402.5	0
B	6-6-17 8:23	TRUE	1402.5	0
C	6-5-17 16:24	TRUE	1402.5	0
D	6-5-17 16:24	TRUE	1372.5	0

Detector Specific:

	Date/Time	Official	Threshold	bLL	bUL	aLL	aUL
A1	6-7-17 0:00	TRUE	0.1	0	40.07	80.17	100
A2	6-7-17 0:00	TRUE	0.1	0	38.87	77.48	100
A3	6-7-17 0:00	TRUE	0.1	0	36.33	74.84	100
A4	6-7-17 0:00	TRUE	0.1	0	35.53	72.18	100
B1	6-7-17 0:00	TRUE	0.1	0	39.75	79.58	100
B2	6-7-17 0:00	TRUE	0.1	0	40.63	77.85	100
B3	6-7-17 0:00	TRUE	0.1	0	36.99	75.53	100
B4	6-7-17 0:00	TRUE	0.1	0	36.53	74.87	100
C1	6-7-17 0:00	TRUE	0.1	0	36.53	73.52	100
C2	6-7-17 0:00	TRUE	0.1	0	37.82	75.5	100
C3	6-7-17 0:00	TRUE	0.1	0	33.33	70.13	100
C4	6-7-17 0:00	TRUE	0.1	0	35.45	72.25	100
D1	6-7-17 0:00	TRUE	0.1	0	25.76	53.3	100
D2	6-7-17 0:00	TRUE	0.1	0	24.2	46.69	100
D3	6-7-17 0:00	TRUE	0.1	0	18.87	40.7	100
D4	6-7-17 0:00	TRUE	0.1	0	22.24	47.03	100

OK JP 6/17

4/4/17 Drawers A+B removal from Instrument and sent back to Canberra to fix guard detector / Slide tray connection so the 3 guard pins holding the two together don't become loose over time due to opening and closing the drawers resulting in \uparrow beta cpm, \downarrow guard cpm

5/1/17 Drawers A+B received back from Canberra. Drawers re-installed in the instrument, daily performance check run after allowing time for the gas to purge. Weekly Long Background calibration performed. Drawers A+B are now back on line.

6/5/17 Voltage Plateau

Plateau Check run for drawers A-D

α sources used	detectors	β sources used
410 Am-241	A1 B1 C1 D1	406 Sr 90/Y 90
411 17800 dpm	A2 B2 C2 D2	407 29660 dpm
412 2/16/95	A3 B3 C3 D3	408 9/15/95
413	A4 B4 C4 D4	409

Parameters:

Starting voltage 700 Count preset 40000
 Ending voltage 1650 Time btm steps 0.1
 30V/skip Weak check Pres 0.1
 5min/step Weak check limits 20

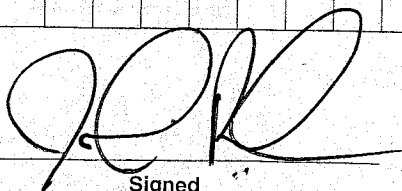
File names:
 PTC0605A
 PTC0605B

6/7/17

ROIS Set for all drawers using Sr/Y-90 sources

Sources \rightarrow 406, 407, 408, + 409: over 40,000 counts achieved at each detector. α lower limit + β upper limit set to 50% to start
 Both α lower limit + β upper limit moved to achieve $\beta \rightarrow \alpha$ talk of 2.5%
 $\alpha \rightarrow \beta$ talk of 0.10%
 All ROIS archived

Continued on Page

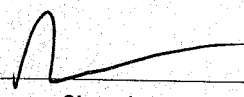


Signed

6/11/17

Date

Read and Understood By



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6/13/17

Date

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Calibration Efficiencies

Source Database for OSUM

Number of sources in table: 139

Application Revision:

Control ID	Isotope	Type	Half-Life	DPM	Std dev	Date	Status	Alpha/Beta Archive File
1078	Th-230	ALPHA	28124250	5831.907	116.63814	6-Nov-07	ALS	Th230-06/17
1079	Cs-137	Beta	10990	3937.1	70.87	9-Feb-15	ALS	Cs-137-06/17

Th-230 Ringed Planchet Efficiency Calibration
LB4100-C

Date: 6/9/2017

Source ID: 1078

Det ID File Name	A1 ETH0609A	A2 ETH0609A	A3 ETH0609A	A4 ETH0609A	B1 ETH0609B	B2 ETH0609B	B3 ETH0609B	B4 ETH0609B
Cnt Time	7.45	7.69	7.41	7.37	7.41	7.92	7.73	7.72
Tot Cnts	10015	10008	10000	10014	10007	10001	10011	10015
Bkg CPM	0.078	0.094	0.096	0.083	0.091	0.117	0.084	0.100
CPM	1344.217	1301.336	1349.432	1358.669	1350.381	1262.636	1295.000	1297.180
Alpha Efficiency	0.230514	0.223160	0.231408	0.232992	0.231571	0.216523	0.222073	0.222447
Beta Efficiency	0.061396	0.058687	0.057875	0.060257	0.059523	0.058113	0.062805	0.058059
Efficiency	0.2305	0.2232	0.2314	0.2330	0.2316	0.2165	0.2221	0.2224

Det ID File Name	C1 ETH0609C	C2 ETH0609C	C3 ETH0609C	C4 ETH0609C	D1 ETH0609D	D2 ETH0609D	D3 ETH0609D	D4 ETH0609D
Cnt Time	7.46	7.44	7.51	7.37	7.67	7.7	7.66	7.69
Tot Cnts	10011	10005	10006	10010	10016	10008	10010	10019
Bkg CPM	0.110	0.112	0.096	0.141	0.095	0.087	0.171	0.101
CPM	1341.847	1344.646	1332.261	1358.068	1305.772	1299.653	1306.618	1302.760
Alpha Efficiency	0.230107	0.230587	0.228463	0.232889	0.223921	0.222871	0.224066	0.223404
Beta Efficiency	0.064261	0.060081	0.062262	0.061443	0.062974	0.058720	0.057719	0.056076
Efficiency	0.2301	0.2306	0.2285	0.2329	0.2239	0.2229	0.2241	0.2234

Jh230 EQ

	A1	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3	C4	D1	D2	D3	D4
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
offset		0	1	2	3	0	1	2	3	0	1	2	3	0	1	2
NumRecs	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
total time	7.45	7.69	7.41	7.37	7.41	7.41	7.92	7.73	7.72	7.46	7.44	7.51	7.37	7.67	7.7	7.66
total count	10015	10008	10000	10014	10007	10001	10001	10011	10015	10011	10005	10006	10010	10016	10008	10019
reduced ch	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
chi-square	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
CPM	1344.217	1301.336	1349.432	1358.669	1350.381	1262.636	1295	1297.18	1341.847	1344.646	1332.261	1358.068	1305.772	1299.653	1306.618	1302.76
CPM var	361.1554	338.6089	364.2451	368.9832	364.6276	318.893	335.2643	336.335	359.972	361.5846	354.9286	368.7622	340.7854	337.73	341.3688	339.1675
Efficiency	0.230514	0.22316	0.231408	0.232992	0.231571	0.216523	0.222073	0.222447	0.230107	0.230587	0.228463	0.232889	0.223921	0.222871	0.224066	0.223404
archived S	0.005646	0.005466	0.005668	0.005707	0.005672	0.005304	0.005439	0.005448	0.005636	0.005648	0.005596	0.005704	0.005484	0.005459	0.005488	0.005472
predicted S	0.002303	0.002231	0.002314	0.002328	0.002315	0.002165	0.00222	0.002223	0.0023	0.002305	0.002284	0.002328	0.002237	0.002228	0.002224	0.002232
actual STD	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
total count	2678	2642	2512	2601	2584	2697	2843	2626	2626	2807	2619	2739	2662	2829	2649	2527
reduced ch	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
chi-square	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
CPM	358.0271	342.2271	337.4913	351.3852	347.1049	338.8803	366.2428	338.5644	374.7335	350.3571	363.0737	358.297	367.2256	342.419	336.5857	327.0016
CPM var	61.17289	56.4815	57.24287	60.34224	59.22249	54.59399	61.10762	55.63375	64.59851	59.70719	61.86699	62.0577	61.69449	56.51569	55.60106	53.5319
Efficiency	0.061396	0.058687	0.057875	0.060257	0.059523	0.058113	0.062805	0.058059	0.064261	0.060081	0.062262	0.061443	0.062974	0.05872	0.057719	0.056076
archived S	0.001818	0.001743	0.001739	0.001796	0.001777	0.001719	0.001837	0.001728	0.001885	0.001789	0.001836	0.001826	0.001844	0.001744	0.001723	0.001683
predicted S	0.001189	0.001144	0.001157	0.001184	0.001174	0.001122	0.00118	0.001136	0.001215	0.001177	0.001192	0.001196	0.001187	0.001144	0.001137	0.001118
actual STD	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

Cs-137 Ringed Planchet Efficiency Calibration
LB4100-C

Date: 6/9/2017

Source ID: 1079

Det ID	A1	A2	A3	A4	B1	B2	B3	B4
File Name	ECS0609A	ECS0609A	ECS0609A	ECS0609A	ECS0609B	ECS0609B	ECS0609B	ECS0609B
Cnt Time	6.68	6.78	6.74	6.8	6.81	6.86	6.95	6.89
Tot Cnts	10012	10001	10014	10002	10006	10013	10018	10006
Bkg CPM	1.436	1.336	1.510	1.532	1.613	1.650	1.545	1.591
CPM	1497.366	1473.738	1484.247	1469.350	1467.697	1457.971	1439.894	1450.659
Alpha Efficiency	0.001303	0.001556	0.002002	0.001988	0.001865	0.001531	0.001674	0.001646
Beta Efficiency	0.401309	0.394976	0.397792	0.393800	0.393357	0.390750	0.385905	0.388790
Efficiency	0.4013	0.3950	0.3978	0.3938	0.3934	0.3907	0.3859	0.3888

Det ID	C1	C2	C3	C4	D1	D2	D3	D4
File Name	ECS0609C	ECS0609C	ECS0609C	ECS0609C	ECS0609D	ECS0609D	ECS0609D	ECS0609D
Cnt Time	6.73	6.79	6.84	7.07	6.84	6.99	6.82	7.02
Tot Cnts	10014	10027	10017	10015	10023	10007	10014	10018
Bkg CPM	1.540	1.659	1.640	2.897	1.614	1.607	1.665	1.607
CPM	1486.424	1475.071	1462.834	1413.652	1463.737	1430.010	1466.663	1425.459
Alpha Efficiency	0.001962	0.001154	0.001620	0.001971	0.001620	0.002201	0.001290	0.001844
Beta Efficiency	0.398376	0.395333	0.392053	0.378872	0.392295	0.383256	0.393079	0.382036
Efficiency	0.3984	0.3953	0.3921	0.3789	0.3923	0.3833	0.3931	0.3820

C5137 ECR

	A1	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3	C4	D1	D2	D3	D4
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
offset		0	1	2	3	0	1	2	3	0	1	2	3	0	1	2
NumRecs		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
total time	6.68	6.78	6.74	6.8	6.81	6.86	6.86	6.95	6.89	6.73	6.79	6.84	7.07	6.84	6.99	6.82
total counts	33	40	51	51	51	48	40	44	43	50	30	42	53	42	58	34
reduced ch	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
chi-square	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
CPM	4.86212	5.805705	7.470766	7.417	6.957458	5.713904	6.246935	6.140929	7.319421	4.306262	6.044351	7.355464	6.045351	8.210568	4.814337	6.879057
CPM var	0.742057	0.873738	1.128487	1.108649	1.040075	0.853503	0.915018	0.909379	1.109555	0.652765	0.901579	1.066081	0.901578	1.194035	0.733644	0.999283
Efficiency	0.001303	0.001556	0.002002	0.001988	0.001865	0.001531	0.001674	0.001646	0.001646	0.001154	0.00162	0.00162	0.001971	0.00162	0.002201	0.001844
archived S	0.000232	0.000252	0.000287	0.000284	0.000275	0.000249	0.000258	0.000257	0.000285	0.000218	0.000256	0.000279	0.000256	0.000256	0.000231	0.00027
predicted S	0.000229	0.000248	0.000282	0.00028	0.000271	0.000245	0.000254	0.000254	0.000253	0.000279	0.000213	0.000252	0.000273	0.000252	0.000225	0.000265
actual STD	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
total counts	10012	10001	10014	10002	10006	10006	10013	10018	10006	10014	10027	10017	10015	10023	10007	10018
reduced ch	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
chi-square	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
CPM	1497.366	1473.738	1484.247	1469.35	1467.697	1457.971	1439.894	1450.659	1486.424	1475.071	1462.834	1413.652	1463.737	1430.01	1466.663	1425.459
CPM var	449.0139	435.1481	441.1875	432.6572	431.6464	425.8237	415.1774	421.6809	442.4996	435.561	428.5743	401.0245	428.9595	409.7635	430.8979	406.9389
Efficiency	0.401309	0.394976	0.397792	0.3938	0.393357	0.39075	0.385905	0.38879	0.398376	0.395333	0.392053	0.378872	0.392295	0.383256	0.393079	0.382036
archived S	0.009189	0.009045	0.009108	0.009018	0.009008	0.008948	0.008836	0.008836	0.008903	0.009122	0.009051	0.008977	0.008678	0.008982	0.008776	0.008748
predicted S	0.004013	0.003951	0.003977	0.00394	0.003935	0.003907	0.003858	0.003858	0.003889	0.003983	0.00395	0.003919	0.00379	0.003921	0.003833	0.003819
actual STD	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

Date 6/9/17SOP 724r 12

ALS
Low Background Gas Flow Proportional Counter Log
Instrument: LB4100C

Instrument Daily Response and Background Checks

Det.	Daily Response Check				Background Check				Det. Status
	Start 1	Status	Start 2	Status	Start 1	Status	Start 2	Status	
1	200	P			200				P
2						H α	200	P	
3						L	L	L	
4									
5									
6		H α	200	P					
7		P							
8									
9						H β	200	P	
10									
11									
12									
13									
14									
15									
16	2	L			✓	H β	200	(H β)	OLB

Det = Detector; α = Alpha; β = Beta; P = Pass; H = High; L = Low; OL = Offline; R = Recount; W = Weekly; NP = Not Processed

Weekly Background Calibration

	Current Calib. File ID	Weekly Calib. Started	Status	File ID
Dr A	0K0607W			
Dr B				
Dr C				
Dr D				

Dr = Drawer

Gas Supply

P-10 Supply		P-10 Flow	
Tank 1	500	Dr A	10
	L	Dr B	
Tank 2	200	Dr C	
	L	Dr D	✓

Comments:

Date 6/9/17

SOP 724r 12

ALS
Low Background Gas Flow Proportional Counter Log
Instrument: LB4100C

Det.	Sample ID	Batch	Test	Count Dur. (min)	Start Time	Analyst Initials	File ID	Output Initials
1-16	Daily Eff	—	—	30	9:14	JP	ETC0609	JP
6	↓	—	—	30	9:29	JP	ETC0609A	↓
1-16	Daily Bkgd	—	—	60	9:44	JP	BK0609	↓
23,9,16	↓	—	—	60	11:07	↓	BK0609A	↓
1-4	1077	AB121109-1	Am 241 eff cal	30	12:13	JP	EAM0609A	JP
5-8	↓	↓	↓	↓	12:28	↓	EAM0609B	↓
9-12	↓	↓	↓	↓	12:39	↓	EAM0609C	↓
13-16	↓	↓	↓	↓	12:53	↓	EAM0609D	↓
13-16	1076	AB110616-3	Sm 90 eff cal	↓	12:14	↓	ESR0609D	↓
9-12	↓	↓	↓	↓	12:19	↓	ESR0609C	↓
5-8	↓	↓	↓	↓	12:39	↓	ESR0609B	↓
1-4	↓	↓	↓	↓	12:27	↓	ESR0609A	↓
1-4	1078	AB150603-5	Th 230 EFCa	30	13:54	JP	ETH0609A	↓
5-8	↓	↓	↓	↓	14:10	JP	B	↓
9-12	↓	↓	↓	↓	14:21	JP	C	↓
13-16	↓	↓	↓	↓	14:45	JP	D	↓
13-16	1079	AB150810-2	Cs 137 EFCa	↓	13:54	JP	ECS0609D	↓
9-12	↓	↓	↓	↓	14:10	JP	C	↓
5-8	↓	↓	↓	↓	14:21	JP	B	↓
1-4	↓	↓	↓	↓	14:45	JP	A	↓

Comments:

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(cont. from page NA **B**)

Form 780r8.doc (6/23/06)

Reviewed By / Date

JP 6/10/17

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Date 6/10/17

SOP 724r 12

ALS
Low Background Gas Flow Proportional Counter Log
Instrument: LB4100C

Instrument Daily Response and Background Checks

Det.	Daily Response Check				Background Check				Det. Status
	Start 1	Status	Start 2	Status	Start 1	Status	Start 2	Status	
1	JP	P			JP	P			P
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16						(HB)			(HB)

Det = Detector; α = Alpha; β = Beta; P = Pass; H = High; L = Low; OL = Offline; R = Recount; W = Weekly; NP = Not Processed

Weekly Background Calibration

	Current Calib. File ID	Weekly Calib. Started	Status	File ID
Dr A	BK00607W			
Dr B				
Dr C				
Dr D				

Dr = Drawer

Gas Supply

P-10 Supply		P-10 Flow	
Tank 1	0	Dr A	10
		Dr B	
Tank 2	2000	Dr C	
		Dr D	

Comments:

6/9/2017

Gross Alpha - Th-230 Efficiency Calibration

Benchsheet: AB150603-5

Source ID: 1078

Logfile: Th230-06/17

Sources

1518003-1

-2

-3

-4

Detectors

A1 B1 C1 D1

A2 B2 C2 D2

A3 B3 C3 D3

A4 B4 C4 D4

Filenames

ETH0609A

B

C

D

6/9/2017

Gross Beta - Cs-137 Efficiency Calibration

Benchsheet: AB150310-2

Source ID: 1079

Logfile: CS-137-06/17

Sources

1515003-1

-3

-4

-5

Detectors

A1 B1 C1 D1

A2 B2 C2 D2

A3 B3 C3 D3

A4 B4 C4 D4

Filenames

ECS0609A

B

C

D

JP 6/13/17

Continued on Page

Read and Understood By

Signed

Date

6/13/17

Signed

Date

6/13/17

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Radiochemistry Instrument Worksheet

ALS Environmental -- FC

Prep Batch: AB150603-5

Prep Procedure: GROSS_ALPHA

Base Efficiency

Analytical QASS / NCR? Y N

Prep Num	LabID	QC Type	Init Aliq	Fin Aliq	Units	Report Units	Residual Mass (mg)	Cnt 1 Inst/Det	Cnt 1 Pos Chk By	Cnt 2 File	Cnt 2 Inst/Det	Cnt 2 Pos Chk By	Cnt 3 File	Cnt 3 Inst/Det	Cnt 3 Pos Chk By	Notes
1	1518003-1	SMP	200	200	ml	pCi/l										
1	1518003-2	SMP	200	200	ml	pCi/l										
1	1518003-3	SMP	200	200	ml	pCi/l										
1	1518003-4	SMP	200	200	ml	pCi/l										
1	1518003-5	SMP	200	200	ml	pCi/l										

See Maintenance log 3710pp83

MP6/6/15

Outlier

Spike Solution Information

Soln #	Nuclide	SolnID	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
S1	Th-230	853.3020.89	1,166.300	DPM/ml	06/03/15	5	ml	RS-027

Sample Barcodes

1518003-1 AB150603-5PS1		1518003-2 AB150603-5PS2		1518003-3 AB150603-5PS3	
1518003-4 AB150603-5PS4		1518003-5 AB150603-5PS5			

Reporting Units

LabID	TstGrpName	RptUnits
1518003-1	GrossAlpha_DW	pCi/l
1518003-2	GrossAlpha_DW	pCi/l
1518003-3	GrossAlpha_DW	pCi/l
1518003-4	GrossAlpha_DW	pCi/l
1518003-5	GrossAlpha_DW	pCi/l

Radiochemistry Prep Worksheet

ALS Environmental -- FC

Prep Procedure: GROSS_ALPHA

Prep Batch: AB150603-5

Reviewed By: jkb 3/09 Review Date: 6/8/2015

Non-Routine Pre-Treatment? ☒ Y ☐ N Batch: NA Prep Analyst: Jennie Kill-Bowden
 Prep SOP: PAI 702 Rev: 20 Prep Date: 6/3/2015
 Prep SOP: NONE Matrix Class: liquid Prep Dept: RS
 Balance: Balance:

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Aliq ml	Fin Aliq ml	Prep Basis	Standards	Prep Notes
1	1	1518003-1	SMP		200	200	Unfiltered	S1	
2	1	1518003-2	SMP		200	200	Unfiltered	S1	
3	1	1518003-3	SMP		200	200	Unfiltered	S1	
4	1	1518003-4	SMP		200	200	Unfiltered	S1	
5	1	1518003-5	SMP		200	200	Unfiltered	S1	

Comments

Zero Mass Efficiency for Th-230 USGS method

Spiked By: Jennie Kill-Bowden Date: 6/4/2015

Witnessed By: Dayna K. Lewis Date: 6/4/2015

Spike Solution Information						
Soln #	Nuclide	SolnID	Prep Conc	Units	Prep Date	Pipet ID
S1	Th-230	853.3020.89	1,166.300	DPM/ml	06/03/15	RS-027
				ml	5	

Radiochemistry Prep Worksheet

ALS Environmental -- FC

Prep Batch: AB150603-5

Prep Procedure: GROSS_ALPHA

Prep Batch Not Validated!!!

Reviewed By: Review Date:

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

Prep QASS / NCR? Y / N

Prep SOP: PAI 702 Rev: 20

Prep SOP: NONE

Matrix Class: liquid

Prep Analyst: Jennie Kill-Bowden *JKB*
Prep Date: 6/3/2015
Prep Dept: RS

Balance:
Balance:

Sample Num	Prep Num	LabID	QC Type	Dish No.	Init Alq ml	Fin Alq ml	Prep Basis	Standards	Prep Notes
1	1	1518003-1	SMP	200	200	200	Unfiltered	S1	
2	1	1518003-2	SMP	200	200	200	Unfiltered	S1	
3	1	1518003-3	SMP	200	200	200	Unfiltered	S1	
4	1	1518003-4	SMP	200	200	200	Unfiltered	S1	
5	1	1518003-5	SMP	200	200	200	Unfiltered	S1	

Comments

Zero Mass Efficiency for Th-230 USGS method

Spiked By: *JKB* Date: *6/4/15*
Witnessed By: *JKB* Date: *6/4/15*

Spike Solution Information						
Soln #	Nuclide	SolnID	Prep Conc	Units	Prep Date	Pipet ID
S1	Th-230	853.3020.89	1,166.300	DPM/ml	06/03/15	RS-027

12/13/15

Radiochemistry Instrument Worksheet

Prep Batch: AB150603-5

ALS Environmental -- FC

Prep Procedure: GROSS_ALPHA

Outlier

Analytical QASS / NCR? Y NA

Prep Num	LabID	QC Type	Init Aliq	Fin Aliq	Units	Report Units	Residual Mass (mg)	Cnt 1 File	Cnt 1 Insat/Det	Cnt 1 Pos Chk By	Cnt 2 File	Cnt 2 Insat/Det	Cnt 2 Pos Chk By	Cnt 3 File	Cnt 3 Insat/Det	Cnt 3 Pos Chk By	Notes
1	1518003-1	SMP	200	200	ml	pCi/l		ABC0609		JP							
1	1518003-2	SMP	200	200	ml	pCi/l		A									
1	1518003-3	SMP	200	200	ml	pCi/l		B									JP 6/9/15
1	1518003-4	SMP	200	200	ml	pCi/l		C									
1	1518003-5	SMP	200	200	ml	pCi/l		D									Outlier

Spike Solution Information					
Soln #	Nuclide	SolnID	Prep Conc	Units	Prep Date
S1	Th-230	853 3020.69	1,166,300	DPM/ml	06/03/15
					5 ml
					RS-027

Sample Barcodes

1518003-1 AB150603-SPS1	1518003-2 AB150603-SPS2	1518003-3 AB150603-SPS3
1518003-4 AB150603-SPS4	1518003-5 AB150603-SPS5	

Reporting Units

LabID	TestGrpName	RptUnits
1518003-1	GrossAlpha_DW	pCi/l
1518003-2	GrossAlpha_DW	pCi/l
1518003-3	GrossAlpha_DW	pCi/l
1518003-4	GrossAlpha_DW	pCi/l
1518003-5	GrossAlpha_DW	pCi/l

ALS Environmental -- FC

Supersedes: NA

Page 1 of 1 GROSS_ALPHA Instrument Sheet

Date Printed: 6/8/2015 17:17

LIAS Version: 6.764

Radiochemistry Prep Worksheet

Prep Batch: AB150603-5

ALS Environmental -- FC

Prep Procedure: GROSS_ALPH

Reviewed By: jkb 3/6/15 Review Date: 6/8/2015

Non-Routine Pre-Treatment? Y ☒ N ☐ Batch: NA

Prep QASS / NCR? Y ☒ N ☐ NA

Prep SOP: PAI 702 Rev: 20

Prep Analyst: Jennie Kill-Bowden

Prep SOP: NONE

Prep Date: 6/3/2015

Matrix Class: liquid

Prep Dept: RS

Balance:

Balance:

Samp Num	Prep Num	LabID	QC Type	Dish No.	Intl Aliq ml	Fin Aliq ml	Prep Basis	Standards	Prep Notes
1	1	1518003-1	SMP		200	200	Unfiltered	S1	
2	1	1518003-2	SMP		200	200	Unfiltered	S1	
3	1	1518003-3	SMP		200	200	Unfiltered	S1	
4	1	1518003-4	SMP		200	200	Unfiltered	S1	
5	1	1518003-5	SMP		200	200	Unfiltered	S1	

Comments

Zero Mass Efficiency for Th-230 USGS method

Spiked By: Jennie Kill-Bowden Date: 6/4/2015

Witnessed By: Dayna K. Lewis Date: 6/4/2015

Spike Solution Information					
Soln #	Nuclide	ScdnID	Prep Conc	Units	Prep Date
S1	Th-230	853.3020.89	1.166.300	DFM/ml	06/03/15
				5 ml	RS-027

Radiochemistry Prep Worksheet

ALS Environmental -- FC

Prep Batch: AB150603-5

Prep Procedure: GROSS_ALPH

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 702 Rev: 20

Prep SOP: NONE

Matrix Class: liquid

Prep Analyst: Jennie Kill-Bowden *JKB*

Prep Date: 6/3/2015

Prep Dept: RS

Balance:

Balance:

Sample Num	LabID	QC Type	Dish No.	Init Aliq ml	Fin Aliq ml	Prep Basis	Standards	Prep Notes
1	1518003-1	SMP		200	200	Unfiltered	S1	
2	1518003-2	SMP		200	200	Unfiltered	S1	
3	1518003-3	SMP		200	200	Unfiltered	S1	
4	1518003-4	SMP		200	200	Unfiltered	S1	
5	1518003-5	SMP		200	200	Unfiltered	S1	

Comments

Zero Mass Efficiency for Th-230 USGS method

Spiked By: *JKB*

Date: *6/4/15*

Witnessed By: *JKB*

Date: *6/4/15*

Spike Solution Information					
Soln #	Nuclide	SolnID	Prep Conc	Units	Prep Date
S1	Th-230	853.3020.89	1,166.300	DPN/ml	06/03/15
				5 ml	RS-027

ra/13/15

PAI - Gas Flow Proportional Sample Analysis LB4100-C

Unit Type: LB4100-C
 Counting Unit ID: Magenta
 High Voltage Mode: Simultaneous
 Application Revision: Standard
 Rev.120108 JCP

Data File Name: ABC0009
 Batch ID: TH208 OUTLIER
 Count Preset (mg): 10
 Batch End: 6/20/15 6:58

Background Logfile: BKGBRW
 Date of Bkg. Cal: 5/6/2015
 Alpha efficiency logfile: TH208-06/13
 Alpha attenuation calibration: AT10819_0629
 Beta efficiency logfile: Co-137-03/15
 Beta attenuation calibration: AC50412

Alpha Attenuation Calibration		Beta Attenuation Calibration	
$y = b \cdot m^a$ (mass-corr)		$y = b \cdot m^a$ (mass-corr)	
Alpha b	0.03160	Beta b	0.3484
a	0.95080	a	0.9983
a	0.9208	a	1.0484
a	0.0000	a	0.0000
Alpha to Beta X-Data		Beta to Alpha X-Data	
$y = b \cdot m^a$ (mass-corr)		$y = b \cdot m^a$ (mass-corr)	
a to beta stat b	0.3337	b to a stat b	-3.54E-06
a to beta stat a	0.9971	b to a stat a	0.0033

Det. ID	Sample ID	Count End Date & Time	Count Dur. (min)	Resid. Mass (mg)	Alpha Activity						Beta Activity					
					Gross CPM	Bkg. CPM	a>b xilk CPM	Base Cor.Fact	Progeny Eff	Progeny Cor.Fact	Gross CPM	Bkg. CPM	a>b xilk CPM	Base Cor.Fact	Progeny Eff	Progeny Cor.Fact
A1	1518003-1	6/20/15 6:58	10.00	0.0	1378.360	0.124	1.223	0.2386	0.937	na	381.780	7.478	348.3178	0.4155	na	na

JP 6/9/15

PAI - Gas Flow Proportional Sample Analysis LB4100-C

Unit Type: LB4100-C
 Counting Unit ID: Mayans
 High Voltage Mode: Simultaneous
 Application Revision: Standard
 Rev: 120168 JCP

Data File Name: ABC0809A
 Batch ID: TH200 OUTLIER
 Count Preset (m): 10
 Batch Ended: 6/9/2015 9:18

Background Logfile: BKGABW
 Date of Bkg. Cal: 08/20/15
 Alpha efficiency logfile: TH200-0813
 Alpha attenuation calibration: ATH0813L.D610
 Beta efficiency logfile: C6-137-0315
 Beta attenuation calibration: ACS0312

Alpha prog. logfile: n/a
 Alpha prog. attenuation: n/a
 Beta prog. logfile: n/a
 Beta prog. attenuation: n/a

Alpha Attenuation Calibration		Beta Attenuation Calibration	
$y = b \cdot m^a$ (a = mass - 0)		$y = b \cdot m^a$ (a = mass - 0)	
Alpha b =	0.53210	Beta b =	0.9434
a =	0.99090	a =	0.9913
z =	0.9300	z =	1.0449
z =	0.0000	z =	0.0000
Alpha to Beta X-axis		Beta to Alpha X-axis	
$y = b \cdot m^a$ (a = mass)		$y = b \cdot m^a$ (a = mass)	
w > 0 stable br		w > 0 stable br	
w > 0 stable br		w > 0 stable br	
0.9978		0.9978	

Det. ID	Sample ID	Count End Date & Time	Count Dur. (min)	Resid. Mass (mg)	Alpha Activity				Beta Activity				Progeny			
					Gross CPM	Bkg. CPM	b > a xlik CPM	Base Cor.Fact.	Progeny Eff	Base Cor.Fact.	Progeny Eff	Base Cor.Fact.	Progeny Eff	Base Cor.Fact.	Progeny Eff	Cor.Fact.
A1	1518003-2	6/9/2015 9:18	10.08	0.0	1318.700	0.124	1.210	0.2388	0.037	0.4155	0.949	0.4155	n/a	0.949	n/a	n/a

JP 6/9/15

Alpha Attenuation Calibration		Beta Attenuation Calibration	
	$y = b \cdot \ln(x) + c$		$y = b \cdot \ln(x) + c$
Alpha	0.93740	Beta	0.9448
ms	0.00020	ms	0.00031
ss	0.0204	ss	1.0448
sd	0.0002	sd	0.0000
Alpha to Alpha X-404		Beta to Alpha X-404	
$y = b \cdot \ln(x) + c$	$y = b \cdot \ln(x) + c$	$y = b \cdot \ln(x) + c$	$y = b \cdot \ln(x) + c$
a = 0.93740	a = 0.93740	a = 0.93740	a = 0.93740
b = 0.00020	b = 0.00020	b = 0.00020	b = 0.00020
c = 0.0204	c = 0.0204	c = 0.0204	c = 0.0204
d = 0.0002	d = 0.0002	d = 0.0002	d = 0.0002

```

Background logfile: BK045W
Data of Bkg. Cal: 6/6/2015
Alpha efficiency logfile: T1230-06413
Alpha attenuation calibration: AT19818, 0830
Beta efficiency logfile: CA-137-03745
Beta attenuation calibration: AC50212
Alpha prog. logfile: NA
Alpha prog. attenuation: NA
Beta prog. logfile: NA
Beta prog. attenuation: NA

```

Dnt.	Sample ID	Count End Date & Time	Count Dur. (min)	Resid. Mass (mg)	Alpha Activity						Beta Activity											
					Gross			Base			Property			Gross			Base			Property		
					Bkg CPM	b>a xlik CPM	Eff Cor.Fact	Bkg CPM	b>a xlik CPM	Eff Cor.Fact	Gross CPM	Property CPM	Cor.Fact Eff	Gross CPM	Property CPM	Cor.Fact Eff	Gross CPM	Property CPM	Cor.Fact Eff			
A1	1519031-3	5/8/2015 9:24	19.00	0.0	1332.000	0.124	1.242	0.2366	0.927	n/a	n/a	385.500	1.476	350.0178	0.4715	0.949	n/a	n/a				

206/915

PAI - Gas Flow Proportional Sample Analysis LB4100-C

Unit Type: LB4100-C
 Counting Unit ID: Magenta
 High Voltage Mode: Simultaneous
 Application Revision: Standard
 Rev: 120108 JCP

Background Logfile: BKGBRW
 Date of Bkg. Cal: 06/20/15
 Alpha efficiency logfile: T1210-0013
 Alpha attenuation calibration: AT100119_0013
 Beta efficiency logfile: Ca-137-03115
 Beta attenuation calibration: AC030112

Alpha prog. logfile: na
 Alpha prog. attenuation: na
 Beta prog. logfile: na
 Beta prog. attenuation: na

Alpha Attenuation Calibration	
$y = b \cdot m^a \cdot (x - \text{mass} - c)^d$	
Alpha b =	0.83740
a =	0.99990
d =	0.0000
Alpha to Beta X-fact	
$y = b \cdot m^a \cdot (x - \text{mass} - c)^d$	
a -> b stat b =	0.2337
a -> b stat m =	0.9813

Det. ID	Sample ID	Count End Date & Time	Count Dur. (min)	Resid. Mass (mg)	Alpha Activity				Beta Activity				Alpha Attenuation Calibration			
					Gross CPM	Bkg. CPM	B>a xlik CPM	Base CPM	Progeny CPM	Base CPM	Progeny CPM	Base CPM	Progeny CPM	Base CPM	Progeny CPM	Base CPM
A1	1518003-4	06/20/15 9:47	18.00	0.0	1346.500	0.124	1.278	0.2386	0.037	na	na	0.4155	0.848	na	na	na

TruCal

Alpha Attenuation Calibration	Beta Attenuation Calibration
$y = \beta \cdot \ln(x)$ (mass-40)	$y = \beta \cdot \ln(x)$ (mass-40)
Alpha β	Beta β
0.93740	0.9454
0.90660	0.9093
0.9208	0.9168
0.9000	0.9000
Alpha to Beta X-axis	Beta to Alpha X-axis
$y = \ln(x)$ (mass-40)	$y = \ln(x)$ (mass-40)
0.2527	-3.5456
0.9974	0.0032

Background logfile: BRCASW
Date of Bag. Cat: 06/2015
Alpha efficacy logfiles: T1234-0013
Alpha attenuation calibration: A1N0015, 0020
Beta efficacy logfiles: C-137-00115
Beta attenuation calibration: AC50112
Alpha prog. logfiles: n/a
Alpha prog. attenuation: n/a
Beta prog. logfiles: n/a
Beta prog. attenuation: n/a

Beta Activity			
Base Eff	Base Cor.Fact	Progeny Eff	Progeny Cor.Fact
0.4155	0.9416	na	na

5/16/95

Date 6/9/15

SOP 724r 11

ALS
Low Background Gas Flow Proportional Counter Log
Instrument: LB4100C

Instrument Daily Response and Background Checks

Det.	Daily Response Check				Background Check				Det. Status
	Start 1	Status	Start 2	Status	Start 1	Status	Start 2	Status	
1	✓	P			✓	P			P
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16	✓					✓			✓

Det = Detector; α = Alpha; β = Beta; P = Pass; H = High; L = Low; OL = Offline; R = Recount; W = Weekly; NP = Not Processed

Weekly Background Calibration

	Current Calib. File ID	Weekly Calib. Started	Status	File ID
Dr A	BK 00605W			
Dr B				
Dr C				
Dr D				

Dr = Drawer

Gas Supply

	P-10 Supply		P-10 Flow
Tank 1	1850	Dr A	0.1
	✓	Dr B	
Tank 2	1200	Dr C	
	✓	Dr D	

Comments:

Page No.: 455204 **A**

Form 780r8.doc (6/23/06)

Reviewed By / Date J 6/9/15

Date

6/9/15

SOP 724r/11

ALS

Low Background Gas Flow Proportional Counter Log

Instrument: LB4100C

Det.	Sample ID	Batch	Test	Count Dur. (min)	Start Time	Analyst Initials	File ID	Output Initials
1-16	Daily Eff	—	—	30	7:13	JP	EFF0609	JP
1-16	Daily Bkg	—	—	60	7:22	JP	BKG0609	JP
1	1518003-1	AB1506035	Th230	10	8:47	JP	AB0609	JP
1	-2		auther		9:00	JP	A	
1	-3				9:13	JP	B	
1	-4				9:37	JP	C	
1	-5				9:51	JP	D	
1-4	1067	AB1506035	Th230	30	10:15	JP	ETH0609	JP
5-8			Th230		10:23		B	
9-12			Eff		10:37		C	
13-16			1a		10:51		D	
1-16	1518004-1-116	AB1506036	Th230	30	11:01	JP	ATH0609	JP
			Mass Ath					
1	1505092-1	SR150605-1	Sr90	180	16:03	JP	SRC0609	JP
2	-3							
3	-30							
4	1505234-1							
5	-3							
6	-5							
7	-7							
8	-9							
9	-11							
10	-13							
11	-180							
12	1505235-1							
14	-3							
15	-30							
16	1505249-1							
1	-2	SR150605-1	Sr90	180	22:12	JP	SRC0609	
2	1505344-1							
3	427-1							
4	-3							
5	SR1506051MB							
6	101							
7	1505379-8	AB150605-1	915	120	22:13	JP	AB0609	
8	-80							
9	-10							
10	AB150605-116							
11	1505341-1	AB150605-2		480	22:15		AB0609	
12	-10							
14	1505448-1							
15	-4							

Comments:

 Page No.: 455204 B
 (cont. from page 11 B)

Form 780r8.doc (6/23/06)

Reviewed By / Date

JP 6/10/15

Date 6/10/15

SOP 724r 11

ALS
Low Background Gas Flow Proportional Counter Log
Instrument: LB4100C

Instrument Daily Response and Background Checks

Det.	Daily Response Check				Background Check				Det. Status
	Start 1	Status	Start 2	Status	Start 1	Status	Start 2	Status	
1	P	P			P	P			P
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									

Det = Detector; α = Alpha; β = Beta; P = Pass; H = High; L = Low; OL = Offline; R = Recount; W = Weekly; NP = Not Processed

Weekly Background Calibration

	Current Calib. File ID	Weekly Calib. Started	Status	File ID
Dr A	BKC 0605W			
Dr B				
Dr C				
Dr D				

Dr = Drawer

Gas Supply

P-10 Supply		P-10 Flow	
Tank 1	1500	Dr A	0
		Dr B	
Tank 2	1200	Dr C	
		Dr D	

Comments:

Page No.: 455205 A

Form 780r8.doc (6/23/06)

Reviewed By / Date JP 6/10/15

Prepare an intermediate dilution of Th-230 RSO# 853 of approximately 1000 dpm/ml

1) Prepare 0.5M HNO₃, 31ml HNO₃ and 969ml DI water.
bottle # 073602

2) Determine density of 0.5M HNO₃.

Mass of 100 ml vol. flask:

Mass of flask + 100 ml 0.5M HNO₃:

Net mass of 0.5M HNO₃:

$$\rho = 1.015 \text{ g/ml}$$

3) Transfer contents of vial to 1000ml Nalgene.

Mass of full standard vial:

Mass of empty standard vial:

Net mass of standard transferred:

4) Dilute with 0.5 M HNO₃

Mass of Nalgene w/ lid (empty):

Mass of Nalgene with standard:

Mass of Nalgene, standard, and diluent:

Net mass of standard:

5) Final activity calculation

$$(1.983 \times 10^4 \text{ Bq}) / (5.13119 \text{ g}) = 3849.60 \text{ Bq/g} \times (60 \text{ s/min}) = 230,975.755 \text{ dpm}$$

$$(3849.60 \text{ Bq/g}) \cdot (5.05 \text{ g}) \cdot (1.015 \text{ g/ml}) = 1985.22 \text{ dpm/ml}$$

Std ID: 853.3020.89

Description: Th-230

Expiration: 2/5/2009

Activity: 1166.38 dpm/mL

2s Uncertainty: 23.33 dpm/mL

Ref. Date: 11/6/2007

Ref Time: N/A

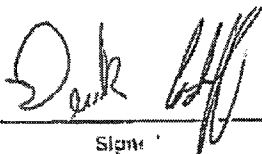
Prep Date: 12/12/2007 Prep by: DC

Matrix/Comp. 0.5 M HNO₃

Half Life (y): 7.70E+04

Reverification Log		
Analysis Date	Initials	Expiration Date
5/5/09	RG	5/5/2010
11/19/10	RG	11/19/2011
12/13/14	JP	12/13/2015

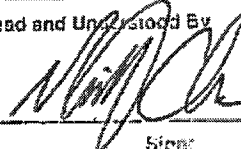
Continued on Page

Signature: 

12/12/07

DC

Read and Understood By

Signature: 

RG

2/13/08



Eckert & Ziegler
Analytics

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

CERTIFICATE OF CALIBRATION
Standard Radionuclide Source

76253-307

Th-230 5 mL Liquid in Flame Sealed Vial

Customer: Paragon Analytics / Fort Collins, CO
P.O. No.: 72803-REL 10-30-07, 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.

ANALYTICS maintains traceability to the National Institute of Standards and Technology through Measurements Assurance Programs as described in USNRC Reg. Guide 4.18, Revision 1.

Isotope:	Th-230
Activity (Bq):	1.993 E4
Half-Life:	7.338 E4 years
Calibration Date:	November 8, 2007 12:00 EST
Relative Expanded Uncertainty (k=2):	2.0%

Comments:

Impurities: γ -impurities <0.1%, α -impurities <0.01%,
5.15119 grams 0.5M HNO₃ solution.

Source Prepared By: N. E. Klesman
N. E. Klesman, Radiochemist

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

Date: 11-19-07

End of Certificate

Corporate Office
24937 Avenue Tibbitts Valencia, California 91355

Laboratory
1380 Seaboard Industrial Blvd. Atlanta, Georgia, 30318

Radiochemistry Instrument Worksheet

ALS Environmental -- FC

JP 3/10/15

Prep Batch: AB150310-2

Prep Procedure: GROSS ~~ALPHA~~ BETA BASE EFFICIENCY

Analytical QASS / NCR? Y NO

Prep Num	LabID	QC Type	Init Alq	Fin Alq	Units	Report Units	Residual Mass (mg)	Cnt 1 File	Cnt 1 InstIDet	Cnt 1 Pos Chk By	Cnt 2 File	Cnt 2 InstIDet	Cnt 2 Pos Chk By	Cnt 3 File	Cnt 3 InstIDet	Cnt 3 Pos Chk By	Notes
1	1515003-1	SMP	200	200	ml	pCi/l	0										
1	1515003-2	SMP	200	200	ml	pCi/l	0										
1	1515003-3	SMP	200	200	ml	pCi/l	0										
1	1515003-4	SMP	200	200	ml	pCi/l	0										
1	1515003-5	SMP	200	200	ml	pCi/l	0										

See Maintenance log 3710 pg 83

Other

JP 3/10/15

Spike Solution Information							
Soln #	Nuclide	SolnID	Prep Conc	Units	Prep Date	Aliquot Units	Pipet ID
S1	Cs-137	1019.4095.83	3.929.815	DPM/ml	03/10/15	1 ml	RS-005

Sample Barcodes

1515003-1 AB150310-2PS1		1515003-2 AB150310-2PS2		1515003-3 AB150310-2PS3	
1515003-4 AB150310-2PS4		1515003-5 AB150310-2PS5			

Reporting Units

LabID	TstGrpName	RptUnits
1515003-1	GrossAlpha_DW	pCi/l
1515003-2	GrossAlpha_DW	pCi/l
1515003-3	GrossAlpha_DW	pCi/l
1515003-4	GrossAlpha_DW	pCi/l
1515003-5	GrossAlpha_DW	pCi/l

Radiochemistry Prep Worksheet

ALS Environmental -- FC

Prep Batch: AB150310-2

Prep Procedure: GROSS_ALPH

Reviewed By: jkb Review Date: 3/10/2015

Non-Routine Pre-Treatment? Y ☒ N ☐ Batch: NA Prep QASS / NCR? Y ☒ N ☐ Balance: NA

Prep SOP: PAI 702 Rev: 20 Prep Analyst: Jennie Kill-Bowden Balance: NA

Prep SOP: NONE Prep Date: 3/10/2015 Matrix Class: liquid Prep Dept: RS

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Aliq ml	Fin Aliq ml	Prep Basis	Standards	Prep Notes
1	1	1515003-1	SMP		200	200	As Received	S1	
2	1	1515003-2	SMP		200	200	As Received	S1	
3	1	1515003-3	SMP		200	200	As Received	S1	
4	1	1515003-4	SMP		200	200	As Received	S1	
5	1	1515003-5	SMP		200	200	As Received	S1	

Comments

Cs-137 efficiencies

Spiked By: Jennie Kill-Bowden Date: 3/10/2015

Witnessed By: Dayna K. Lewis Date: 3/10/2015

Spike Solution Information						
Soln #	Nuclide	SolnID	Prep Conc	Units	Prep Date	Pipet ID
S1	Cs-137	1019.4095.83	3.929.815	DPM/ml	03/10/15	RS-005

Radiochemistry Prep Worksheet

ALS Environmental -- FC

Prep Batch: AB150310-2

Prep Procedure: GROSS_ALPHA

Prep Batch Not Validated!!!

Reviewed By:

Review Date:

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

Prep QASS / NCR? Y / N

Prep SOP: PAI 702 Rev: 20

Prep SOP: NONE

Matrix Class: liquid

Prep Analyst: Jennie Kill-Bowden

Prep Date: 3/10/2015

Prep Dept: RS

Balance:

Balance:

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Aliq ml	Fin Aliq ml	Prep Basis	Standards	Prep Notes
1	1	1515003-1	SMP	200	200	200	As Received	S1	
2	1	1515003-2	SMP	200	200	200	As Received	S1	
3	1	1515003-3	SMP	200	200	200	As Received	S1	
4	1	1515003-4	SMP	200	200	200	As Received	S1	
5	1	1515003-5	SMP	200	200	200	As Received	S1	

Comments

Cs-137 efficiencies

Spiked By:

Date:

Witnessed By:

Date:

Spike Solution Information						
Soln #	Nuclide	SolnID	Prep Conc	Units	Prep Date	Pipet ID
S1	Cs-137	1019.4095.83	3.929.815	DPM/ml	03/10/15	RS-005

exp: 3/5/16

Radiochemistry Instrument Worksheet

ALS Environmental -- FC JP 3/10/15

Prep Batch: AB150310-2

Prep Procedure: GROSS ALPHA BETA BASE EFFICIENCY

Prep Num	LabID	QC Type	Init Alq	Fin Alq	Report Units	Residual Mass (mg)	Cnt 1 Inst/Det	Cnt 1 Pos Chk By	Cnt 2 File	Cnt 2 Inst/Det	Cnt 2 Pos Chk By	Cnt 3 File	Cnt 3 Inst/Det	Cnt 3 Pos Chk By	Notes
----------	-------	---------	----------	---------	--------------	--------------------	----------------	------------------	------------	----------------	------------------	------------	----------------	------------------	-------

1	1515003-1	SMP	200	200	ml	pCi/l	0	ABC031Z	JP						
1	1515003-2	SMP	200	200	ml	pCi/l	0	A	JP						OUTLIER
1	1515003-3	SMP	200	200	ml	pCi/l	5.170	B	JP						
1	1515003-4	SMP	200	200	ml	pCi/l	90.6.6	C	JP						
1	1515003-5	SMP	200	200	ml	pCi/l	90.6.9	D	JP						JP 4/2/16

Soln #	Nuclide	SolnID	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
S1	Cs-137	1019.4095.83	3.929.815	DPM/ml	03/10/15	1	ml	RS-005

Sample Barcodes

1515003-1 AB150310-2PS1	1515003-2 AB150310-2PS2	1515003-3 AB150310-2PS3
1515003-4 AB150310-2PS4	1515003-5 AB150310-2PS5	

Reporting Units

LabID	Sample Name	Reporting Units
1515003-1	GrossAlpha_DW	pCi/l
1515003-2	GrossAlpha_DW	pCi/l
1515003-3	GrossAlpha_DW	pCi/l
1515003-4	GrossAlpha_DW	pCi/l
1515003-5	GrossAlpha_DW	pCi/l

Radiochemistry Prep Worksheet

ALS Environmental -- FC

Prep Batch: AB150310-2

Prep Procedure: GROSS_ALPHA

Reviewed By: jkb Review Date: 3/10/2015

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

Prep Analyst: Jennie Kill-Bowden
 Prep Date: 3/10/2015
 Prep Dept: RS

Balance: _____
 Balance: _____

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Aliq ml	Fin Aliq ml	Prep Basis	Standards	Prep Notes
1	1	1515003-1	SMP		200	200	As Received	S1	
2	1	1515003-2	SMP		200	200	As Received	S1	
3	1	1515003-3	SMP		200	200	As Received	S1	
4	1	1515003-4	SMP		200	200	As Received	S1	
5	1	1515003-5	SMP		200	200	As Received	S1	

Comments

Cs-137 efficiencies

Spiked By: Jennie Kill-Bowden Date: 3/10/2015

Witnessed By: Dayna K. Lewis Date: 3/10/2015

Spike Solution Information					
Soln #	Nuclide	SolnID	Prep Conc	Units	Pipet ID
S1	Cs-137	1019.4095.83	3.929.815	DPM/ml	03/10/15

Radiochemistry Prep Worksheet

ALS Environmental -- FC

Prep Batch: AB150310-2

Prep Procedure: GROSS_ALPH

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 702 Rev: 20

Prep SOP: NONE

Matrix Class: liquid

Prep Analyst: Jennie Kill-Bowden

Prep Date: 3/10/2015

Prep Dept: RS

Balance:

Balance:

Sample Num	Prep Num	LabID	QC Type	Dish No.	Init Aliq ml	Fin Aliq ml	Prep Basis	Standards	Prep Notes
1	1	1515003-1	SMP		200	200	As Received	S1	
2	1	1515003-2	SMP		200	200	As Received	S1	
3	1	1515003-3	SMP		200	200	As Received	S1	
4	1	1515003-4	SMP		200	200	As Received	S1	
5	1	1515003-5	SMP		200	200	As Received	S1	

Comments

Cs-137 efficiencies

Spiked By: *SKB*

Date: 3/10/15

Witnessed By: *B*

Date: 3/10/15

Spike Solution Information					
Soln #	Nuclide	SolnID	Prep Conc	Units	Pipet ID
S1	Cs-137	1019.4095.83	3.929.815	DPM/ml	03/10/15
				1 ml	RS-005

exp: 3/5/16

OUTLIER TEST

FILE	DET	SAMPLE ID	Beta CPM	Relative % diff. from mean	Within acceptability range	Outlier?
ABC0312	A1(1)	1515003-1	1620.1	0.64%	YES	NO
ABC0312A	A1(1)	1515003-2	1587.29	1.41%	YES	OUTLIER!
ABC0312B	A1(1)	1515003-3	1625.29	0.95%	YES	NO
ABC0312C	A1(1)	1515003-4	1622.57	0.79%	YES	NO
ABC0312D	A1(1)	1515003-5	1594.29	0.97%	YES	NO

Mean of all five planchets:

Average= 1609.91

Std dev= 17.7299

2 Std Dev= 35.46

Acceptability range

1645.37

1574.45

Relative range

+/- 1.49%

2.20%**Sample 1515003-2 rejected as outlier.**

Criteria: Potential outliers fall outside acceptability range; which is the mean of all five measurements +/- 2 std dev per the Grubbs statistical test.

PAI - Gas Flow Proportional Sample Analysis LB4100-C

Unit Type: LB4100 -C
Counting Unit ID: Magenta
High Voltage Mode: Simultaneous
Application Revision: Standard
Rev.12/01/08 JCP

Data file name: ABC0312
Batch ID: AB150310-2 OUTLIER
Count Preset (m): 7
Batch Ended: 3/12/2015 7:20

Background logfile: BKGABW
Date of Bkg. Cal: 3/12/2015
Alpha efficiency logfile: Anz41R-06/13
Alpha attenuation calibration: AAM0610_0611
Beta efficiency logfile: S99R-06/13
Beta attenuation calibration: ASR0611

Alpha prog. logfile: n/a
Alpha prog. attenuation: n/a
Beta prog. logfile: n/a
Beta prog. attenuation: n/a

Alpha Attenuation Calibration	Beta Attenuation Calibration
$y = b \cdot m^a (a \cdot (\text{mass} - x_0))$	$y = b \cdot m^a (a \cdot (\text{mass} - x_0))$
Alpha b= 0.90570	Beta b= 0.9782
m= 0.99140	m= 0.9993
a= 0.8487	a= 1.0249
x0= 21.4873	x0= 0.0000
Alpha to Beta X-talk	Beta to Alpha X-talk
$y = b \cdot m^a - \text{mass}$	$y = b \cdot m^a + m$
a -> b xtalk b= 0.2510	b -> a xtalk b= -1.82E-05
a -> b xtalk m= 0.9987	b -> a xtalk m= 0.0032

Det. ID	Sample ID	Count End Date & Time	Count Dur. (min)	Resid. Mass (mg)	Alpha Activity				Beta Activity				Progeny			
					Gross CPM	Bkg. CPM	a>b xtlk CPM	Base Eff	Progeny Cor.Fact.	Base Eff	Progeny Cor.Fact.	Base Eff	Progeny Cor.Fact.	Base Eff	Progeny Cor.Fact.	Base Eff
A1	1515003-1	3/12/2015 7:20	7.00	0.0	3.000	0.109	5.180	0.2102	1.060	n/a	n/a	0.4355	0.7256	0.978	n/a	n/a

JP 3/12/15

Dr 3/12/15

Det. ID	Sample ID	Count End Date & Time	Count Dur. (min)	Resid. Mass (mg)	Alpha Activity										Beta Activity									
					Gross		Bkg.		b>a xtlk		Base		Progeny		Gross		Bkg.		a>b xtlk		Base		Progeny	
					CPM	CPM	CPM	CPM	CPM	CPM	Eff	Cor.Fact.	Eff	Cor.Fact.	CPM	CPM	CPM	CPM	Eff	Cor.Fact.	Eff	Cor.Fact.	Eff	Cor.Fact.
A1	1515003-2	3/12/2015 7:33	7.00	0.0	2.286	0.109	5.075	0.2102	1.060	n/a	n/a	1587.286	1.399	0.5464	0.4355	0.978	n/a	n/a	n/a	n/a	n/a			

PAI - Gas Flow Proportional Sample Analysis LB4100-C

Unit Type: LB4100 -C
Counting Unit ID: Magenta
High Voltage Mode: Simultaneous
Application Revision: Standard
Rev.12/01/08 JCP

2

Data file name: ABC0312B
Batch ID: AB150310-2 OUTLIER
Count Preset (m): 7
Batch Ended: 3/12/2015 7:41

Background logfile: BKGABW
Date of Bkg. Cal: 3/12/2015
Alpha efficiency logfile: AAM0610, 0611
Alpha prog. logfile: n/a
Alpha attenuation calibration: SR0R-06/13
Beta efficiency logfile: SR0R-06/13
Beta prog. logfile: n/a
Beta attenuation calibration: ASR0611
Beta prog. attenuation: n/a

Alpha Attenuation Calibration		Beta Attenuation Calibration	
$y = b \cdot m^a (a \cdot (mass - x0))$		$y = b \cdot m^a (a \cdot (mass - x0))$	
Alpha b=	0.90570	Beta b=	0.9782
m=	0.99140	m=	0.9993
a=	0.8487	a=	1.0249
x0=	21.4875	x0=	0.0000
Alpha to Beta X-talk		Beta to Alpha X-talk	
$y = b \cdot m^a - mass$		$y = b \cdot m^a - mass + m$	
a -> b xtalk b=	0.2510	b -> a xtalk b=	-1.82E-05
a -> b xtalk m=	0.9987	b -> a xtalk m=	0.0032

Det. ID	Sample ID	Count End Date & Time	Count Dur. (min)	Resid. Mass (mg)	Alpha Activity								Beta Activity							
					Gross CPM	Bkg. CPM	b>a xtlk CPM	Base Eff	Base Cor.Fact.	Progeny Eff	Progeny Cor.Fact.	Gross CPM	Bkg. CPM	a>b xtlk CPM	Base Eff	Base Cor.Fact.	Progeny Eff	Progeny Cor.Fact.		
A1	1515003-3	3/12/2015 7:41	7.00	0.0	4.286	0.109	5.196	0.2102	1.060	n/a	0.4355	0.978	n/a	1.0484	1.399	1825.286	n/a	n/a	n/a	

JP 3/12/15

PAI - Gas Flow Proportional Sample Analysis LB4100-C

Alpha Attenuation Calibration		Beta Attenuation Calibration	
$y = b \cdot m^a (a \cdot (\text{mass} - x_0))$		$y = b \cdot m^a (a \cdot (\text{mass} - x_0))$	
Alpha b= 0.90570		Beta b= 0.9782	
m= 0.99140		m= 0.9993	
a= 0.8487		a= 1.0249	
x0= 21.4875		x0= 0.0009	
Alpha to Beta X-talk		Beta to Alpha X-talk	
$y = b \cdot m^a - \text{mass}$		$y = b \cdot \text{mass} + m$	
a -> b xtalk b= 0.2510		b -> a xtalk b= -1.82E-05	
a -> b xtalk m= 0.9987		b -> a xtalk m= 0.0032	

Unit Type: LB4100 -C
Counting Unit ID: Magenta
High Voltage Mode: Simultaneous
Application Revision: Standard
Rev: 12/01/08 JCP

Data file name: ABC0312C
Batch ID: AB150310-2 OUTLIER
Count Preset (m): 7
Batch Ended: 3/12/2015 7:51

Background logfile: BKGABW
Date of Bkg. Cal: 3/12/2015
Alpha efficiency logfile: An241R-06/13
Alpha prog. logfile: n/a
Alpha attenuation calibration: AAM0610_0611
Alpha prog. attenuation: n/a
Beta efficiency logfile: Sr90R-06/13
Beta prog. logfile: n/a
Beta attenuation calibration: ASR0611
Beta prog. attenuation: n/a

Det. ID	Sample ID	Count End Date & Time	Count Dur. (min)	Resid. Mass (mg)	Alpha Activity				Beta Activity			
					Gross CPM	Bkg. CPM	a>b xtlk CPM	a>b xtlk CPM	Base Eff	Progeny Eff	Base Cor.Fact.	Progeny Cor.Fact.
A1	1515003-4	3/12/2015 7:51	7.00	0.0	3.571	0.109	5.188	0.2102	1.060	n/a	0.4355	0.978
												n/a

JP 3/12/15

PAI - Gas Flow Proportional Sample Analysis LB4100-C

Unit Type: LB4100 -C
Counting Unit ID: Magenta
High Voltage Mode: Simultaneous
Application Revision: Standard
Rev.12/01/08 JCP

Data file name: ABC0312D
Batch ID: AB150310-2 OUTLIER
Count Preset (m): 7
Batch Ended: 3/12/2015 8:06

Background logfile: BKGABW
Date of Bkg. Cal: 3/12/2015
Alpha efficiency logfile: Am241R-06/13
Alpha attenuation calibration: AAM0610, 0611
Beta efficiency logfile: SR0R-06/13
Beta attenuation calibration: ASR0611

Alpha prog. logfile: n/a
Alpha prog. attenuation: n/a
Beta prog. logfile: n/a
Beta prog. attenuation: n/a

Alpha Attenuation Calibration	Beta Attenuation Calibration
$y = b \cdot m^a (a'(\text{mass} \cdot x))$	$y = b' \cdot m^{a'} (a'(\text{mass} \cdot x))$
Alpha b= m= a= x0=	Beta b= m= a= x0=
Alpha to Beta X-talk $y = b' \cdot m^{a' - \text{mass}}$	Beta to Alpha X-talk $y = b' \cdot m^{a' + m}$
a -> b xtalk b= a -> b xtalk m=	b -> a xtalk b= b -> a xtalk m=

Det. ID	Sample ID	Count End Date & Time	Count Dur. (min)	Resid. Mass (mg)	Alpha Activity					Beta Activity				
					Gross CPM	Bkg. CPM	b>a xtlk CPM	a>b xtlk CPM	Progeny Eff	Base Cor.Fact.	Gross CPM	Bkg. CPM	Progeny Cor.Fact.	Progeny Eff
A1	1515003-5	3/12/2015 8:06	7.00	0.0	3.571	0.109	5.097	0.2102	1.060	n/a	1584.286	1.389	0.8661	n/a

DP 3/12/15

Date 3/12/15SOP 724r 11

ALS
Low Background Gas Flow Proportional Counter Log
Instrument: LB4100C

Instrument Daily Response and Background Checks

Det.	Daily Response Check				Background Check				Det. Status
	Start 1	Status	Start 2	Status	Start 1	Status	Start 2	Status	
1	JP	P			*				P
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									

Det = Detector; α = Alpha; β = Beta; P = Pass; H = High; L = Low; OL = Offline; R = Recount; W = Weekly; NP = Not Processed

Weekly Background Calibration

	Current Calib. File ID	Weekly Calib. Started	Status	File ID
Dr A	BK0311W			
Dr B				
Dr C				
Dr D				

Dr = Drawer

Gas Supply

P-10 Supply		P-10 Flow	
Tank 1	2100	Dr A	0.1
		Dr B	
Tank 2	1900	Dr C	
		Dr D	

Comments: * It is not necessary to run daily background checks on the morning following a weekly background calibration.

Date 3/12/15SOP 724r 11ALS
Low Background Gas Flow Proportional Counter Log
Instrument: LB4100C

Det.	Sample ID	Batch	Test	Count Dur. (min)	Start Time	Analyst Initials	File ID	Output Initials
1-16	Dab. EFL			30	6:52	JP	EFC0312	JP
1	1515003-1	AB150310-2	B-Qtlm	7	7:13	JP	ABC0312	JP
1	-2				7:26	JP	A	JP
1	-3				7:34	JP	B	JP
1	-4				7:44	JP	C	JP
1	-5				7:59	JP	D	JP
1-4	1061		(S)37EFL	30	8:20	JP	ECS0312A	JP
5-8			CAL		8:28	JP	B	
9-12					8:36	JP	C	
13-16					8:43	JP	D	
1-16	1515002-1-24	AB150310-1	ATTN (CUB)	30	8:53	JP	ACS0312	JP
1	1503144-1	AB150311-1	α 1B	240	13:15:42	JP	ABC0312E	JP
2	-10							
3	AB150311-MD							
4	(L)							
5	1503192-1	AB150312-4		300	15:43	JP	ABC03124F	
6	-10							
7	-2							
8	AB1503124MB							
9	(L)							
10	15031160-1	AB150311-3		1006	15:44	JP	ABC03126	
11	-7							
12	-2D							
13	-3			120	15:45		H	
14	AB1503113MB			1006	15:44		G	
15	(L)			120	15:45		H	

JP 3/12/15

JP 3/12/15

JP 3/13/15

Comments:

Page No.: 450690 **B**
(cont. from page NA **B**)

Form 780r8.doc (6/23/06)

Reviewed By / Date

JP 3/13/15

Date 3/13/15SOP 724r 11

ALS
Low Background Gas Flow Proportional Counter Log
Instrument: LB4100C

Instrument Daily Response and Background Checks

Det.	Daily Response Check				Background Check				Det. Status
	Start 1	Status	Start 2	Status	Start 1	Status	Start 2	Status	
1	JP	P			JP	P			P
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									

Det = Detector; α = Alpha; β = Beta; P = Pass; H = High; L = Low; OL = Offline; R = Recount; W = Weekly; NP = Not Processed*Weekly Background Calibration*

	Current Calib. File ID	Weekly Calib. Started	Status	File ID
Dr A	13kco311w			
Dr B				
Dr C				
Dr D				

Dr = Drawer

Gas Supply

P-10 Supply		P-10 Flow	
Tank 1	1850	Dr A	0.1
		Dr B	
Tank 2	1900	Dr C	
		Dr D	

Comments:JP 3/13/15

Prepare a working dilution of RSO #1019

12/31/15

1. Density of 0.1M HCl, lot # 0000094396

Mass of 100mL vol. flask: 56.4421g

Balance # 12

Mass of flask & 100mL acid: 156.2152g

Balance# 12

Net Mass: 99.7731g

Density: 0.9977g/mL

2. Mass of RSO #1019 transferred:

Mass of empty nalgene: 74.1899g

Balance# 12

Mass of nalgene & standard: 79.0859g

Balance# 12

Net mass of standard transferred: 4.8960g

3. Dilute to final volume:

Mass of nalgene, standard, & diluent: 629.3g

Balance# 26

Mass of empty nalgene: 74.1899g

Balance# 12

Net mass of new dilution: 555.1101g

4. Final activity calculation:

$$3,727,039 \text{ Bq} \left(\frac{60 \text{ dpm}}{1 \text{ Bq}} \right) \left(\frac{4.8960 \text{ g}}{4.99800 \text{ g}} \right) \left(\frac{0.9977 \text{ g/mL}}{555.1101 \text{ g}} \right) = 39,37.10 \text{ dpm/mL}$$

12/31/15

Std ID: 1019.4095.83

Description: Cs-137

Expiration: 3/6/2016

Activity: 3937.10 dpm/mL

2s Uncertainty: 70.87 dpm/mL

Ref. Date: 2/9/2015

Ref Time: N/A

Prep Date: 3/5/2015 Prep by: TE

Matrix/Comp. 0.1 MHCl

Half Life (y): 3.01E+01

Reverification Log		
Analysis Date	Initials	Expiration Date
12/29/16	JN	12/29/2017

JP 4/2/15

JP 4/2/15
JP 4/2/15

Continued on Page _____

TE

Signed

3/5/15

Date

[Signature]

Read and Understood By

Signed

4/2/15

Date



Eckert & Ziegler

Analytics

RSO#
1019

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

CERTIFICATE OF CALIBRATION

Standard Reference Source

99875

Cs-137 5 mL Liquid in Flame Sealed Vial

Customer: ALS Laboratory Group
P.O. No.: FC000610, Item 3 **Product Code:** 8137

This standard radionuclide source was prepared gravimetrically from a master solution calibrated with an ionization chamber. The ionization chamber was calibrated by the National Physical Laboratory, Teddington, U.K., and is traceable to national standards. Radionuclide calibration and purity were checked by germanium gamma-ray spectrometry, liquid scintillation counting, and/or alpha spectrometry, as applicable. The nuclear decay rate and reference date for this source are given below. 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 2, July 2007, and compliance with ANSI N42.22-1995, "Traceability of Radioactive Sources to NIST."

Isotope	Half-Life, Days	Activity (Bq)	Uncertainty*, %			Reference Date (12:00 PM EST)
			u _A	u _B	U	
Cs-137	1.099E+04	3.727E+04	0.1	0.9	1.8	02/09/2015

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

Comments:

Impurities: γ -impurities < 0.1%.

4.99800 g 0.1M HCl solution with approximately 30 μ g/g Cs carrier.

Source Prepared by:

K. Eardley, Radiochemist

QC Approved:

A. Chen, Spectroscopist

Date:

7 Feb 15

Mass Attenuation Curves

LB4100C Alpha Attenuation Curve -- Th-230

Mass Range	
Low	12.4 mg
High	100.0 mg

Spike Information	
Std. ID	853.3020.89
Ref. Date	11/6/2007
Half-life	77000 y/s
Activity	1166.38 dpm/mL
Vol.	5.0 mL
Act. Added	5831.90 dpm

Attenuation Equation	
$y = b \cdot m^a$	$y = b \cdot m^a$
b = 0.9050	b = 0.9050
m = 0.9875	m = 0.9875
a = 0.8948	a = 0.8948
% Diff Max. = 13.6%	

Cross-Talk Equation	
$y = b \cdot m^a$	$y = b \cdot m^a$
b = 0.2523	b = 0.2523
m = 0.9883	m = 0.9883
% Diff Max. = 15.0%	

File ID	Detector ID	Sample ID	Mass (mg)	Count	Date	Alpha Counts	Beta Counts	Count Time	Alpha CPM	Beta CPM	Base Alpha Eff.	Decay Corr. Act. added dpm/mL	Alpha Att. Eff Actual	Alpha Att. Fitted	Actual/Fit Ratio	Obs. Attenu. Fact.	Fitted Attenu. Fact.	% Diff.	$\alpha > \beta$ X Tlx $\alpha > \beta$ X Tlx	% Diff.
ATH0613	A1	1518004-2	12.4	6/13/17 10:57	10015	2590	2590	10.28	974.14	250.51	0.2305	5831.40	0.1671	0.1814	1.0861	0.7247	0.7871	-8.6%	0.2572	-0.2%
ATH0612	A2	1518004-2	12.4	6/12/17 11:20	10018	2584	2584	10.32	970.64	247.11	0.2332	5831.40	0.1665	0.1757	1.0555	0.7457	0.7871	-5.5%	0.2576	-1.2%
ATH0612	A3	1518004-2	12.4	6/12/17 11:49	10014	2713	2713	10.18	983.60	264.99	0.2234	5831.40	0.1687	0.1821	1.0798	0.7289	0.7871	-8.0%	0.2576	4.4%
ATH0612	A4	1518004-2	12.4	6/12/17 12:18	10005	2656	2656	10.06	994.45	262.48	0.2330	5831.40	0.1705	0.1834	1.0754	0.7319	0.7871	-7.5%	0.2576	2.4%
ATH0612	B1	1518004-2	12.4	6/12/17 12:45	10009	2779	2779	10.52	995.33	262.55	0.2316	5831.40	0.1631	0.1823	1.1174	0.7044	0.7871	-11.7%	0.2576	6.1%
ATH0612	B2	1518004-2	12.4	6/12/17 13:13	10012	2769	2769	10.63	990.37	258.48	0.2165	5831.40	0.1595	0.1704	1.0681	0.7369	0.7871	-6.8%	0.2576	7.3%
ATH0612	B3	1518004-2	12.4	6/12/17 13:40	10012	2818	2818	10.76	941.78	263.55	0.2221	5831.40	0.1615	0.1748	1.0824	0.7272	0.7871	-8.2%	0.2576	8.1%
ATH0612	B4	1518004-2	12.4	6/12/17 14:06	10013	2762	2762	10.58	946.31	259.47	0.2224	5831.40	0.1623	0.1751	1.0787	0.7297	0.7871	-7.9%	0.2576	6.1%
ATH0612	C1	1518004-2	12.4	6/12/17 14:34	10009	2700	2700	10.06	994.82	266.85	0.2301	5831.40	0.1706	0.1811	1.0616	0.7414	0.7871	-6.2%	0.2576	4.0%
ATH0613	C2	1518004-2	12.4	6/13/17 7:51	10012	2569	2569	10.14	987.26	251.69	0.2306	5831.40	0.1693	0.1815	1.0721	0.7342	0.7871	-7.2%	0.2576	-1.0%
ATH0613	C3	1518004-2	12.4	6/13/17 8:19	10009	2552	2552	10.36	966.02	244.69	0.2285	5831.40	0.1657	0.1799	1.0857	0.7250	0.7871	-8.6%	0.2576	-1.7%
ATH0613	C4	1518004-2	12.4	6/13/17 8:45	10008	2539	2539	10.19	982.00	246.27	0.2329	5831.40	0.1684	0.1833	1.0886	0.7231	0.7871	-8.9%	0.2576	-2.7%
ATH0613	D1	1518004-2	12.4	6/13/17 9:11	10004	2584	2584	10.54	949.05	243.55	0.2239	5831.40	0.1627	0.1762	1.0829	0.7269	0.7871	-8.3%	0.2576	-0.4%
ATH0613	D2	1518004-2	12.4	6/13/17 9:37	10023	2576	2576	10.70	936.64	239.14	0.2229	5831.40	0.1606	0.1754	1.0923	0.7206	0.7871	-9.2%	0.2576	-0.8%
ATH0613	D3	1518004-2	12.4	6/13/17 10:02	10010	2470	2470	10.28	973.56	238.61	0.2241	5831.40	0.1670	0.1784	1.0565	0.7450	0.7871	-5.7%	0.2576	-5.1%
ATH0613	D4	1518004-2	12.4	6/13/17 10:29	10008	2499	2499	10.62	942.27	232.76	0.2234	5831.40	0.1616	0.1758	1.0882	0.7233	0.7871	-8.9%	0.2576	-4.3%
ATH0612	A1	1518004-1	13.2	6/12/17 11:20	10003	2719	2719	10.51	951.68	257.27	0.2305	5831.40	0.1632	0.1798	1.1017	0.7080	0.7801	-10.2%	0.2579	4.8%
ATH0612	A2	1518004-1	13.2	6/12/17 11:50	10014	2644	2644	10.52	951.81	249.99	0.2232	5831.40	0.1632	0.1741	1.0667	0.7313	0.7801	-6.7%	0.2579	1.8%
ATH0612	A3	1518004-1	13.2	6/12/17 12:18	10005	2488	2488	10.13	987.56	244.10	0.2314	5831.40	0.1634	0.1805	1.0658	0.7319	0.7801	-6.6%	0.2579	-4.3%
ATH0612	A4	1518004-1	13.2	6/12/17 12:45	10013	2572	2572	10.32	970.17	247.69	0.2330	5831.40	0.1644	0.1818	1.0925	0.7140	0.7801	-9.2%	0.2579	-1.0%
ATH0612	B1	1518004-1	13.2	6/12/17 13:12	10010	2601	2601	10.47	955.97	246.81	0.2316	5831.40	0.1639	0.1807	1.1020	0.7078	0.7801	-10.2%	0.2579	0.1%
ATH0612	B2	1518004-1	13.2	6/12/17 13:40	10010	2601	2601	10.76	930.18	240.08	0.2165	5831.40	0.1595	0.1689	1.0587	0.7368	0.7801	-5.9%	0.2579	0.1%
ATH0612	B3	1518004-1	13.2	6/12/17 14:06	10007	2763	2763	10.70	935.15	256.68	0.2221	5831.40	0.1604	0.1732	1.0804	0.7220	0.7801	-8.0%	0.2579	6.0%
ATH0612	B4	1518004-1	13.2	6/12/17 14:36	10013	2786	2786	10.72	933.95	258.30	0.2224	5831.40	0.1604	0.1735	1.0832	0.7201	0.7801	-8.3%	0.2579	6.7%
ATH0613	C1	1518004-1	13.2	6/13/17 7:51	10008	2538	2538	10.17	983.96	248.02	0.2301	5831.40	0.1687	0.1795	1.0637	0.7333	0.7801	-6.4%	0.2579	-2.3%
ATH0613	C2	1518004-1	13.2	6/13/17 8:19	10006	2543	2543	10.19	981.83	247.90	0.2306	5831.40	0.1684	0.1799	1.0684	0.7301	0.7801	-6.8%	0.2579	-2.1%
ATH0613	C3	1518004-1	13.2	6/13/17 8:46	10017	2512	2512	10.39	964.00	240.13	0.2285	5831.40	0.1653	0.1782	1.0782	0.7235	0.7801	-7.8%	0.2579	-3.5%
ATH0613	C4	1518004-1	13.2	6/13/17 9:11	10009	2631	2631	10.35	966.91	251.31	0.2329	5831.40	0.1658	0.1817	1.0957	0.7119	0.7801	-9.8%	0.2579	0.8%
ATH0613	D1	1518004-1	13.2	6/13/17 9:37	10007	2501	2501	10.70	935.14	232.12	0.2239	5831.40	0.1604	0.1747	1.0891	0.7162	0.7801	-8.9%	0.2579	-3.9%
ATH0613	D2	1518004-1	13.2	6/13/17 10:03	10014	2475	2475	10.88	920.32	225.87	0.2229	5831.40	0.1578	0.1739	1.1017	0.7080	0.7801	-10.2%	0.2579	-5.1%
ATH0613	D3	1518004-1	13.2	6/13/17 10:29	10000	2319	2319	10.58	945.01	217.52	0.2241	5831.40	0.1621	0.1748	1.0787	0.7231	0.7801	-7.9%	0.2579	-12.0%
ATH0613	D4	1518004-1	13.2	6/13/17 10:58	10009	2416	2416	10.91	916.79	225.46	0.2234	5831.40	0.1613	0.1743	1.0804	0.7220	0.7801	-8.0%	0.2579	-7.8%
ATH0613	A1	1518004-3	25.8	6/13/17 10:29	10003	2614	2614	10.31	916.79	238.16	0.2305	5831.40	0.1572	0.1560	0.9924	0.6821	0.6769	0.8%	0.2634	-1.4%
ATH0613	A2	1518004-3	25.8	6/13/17 10:58	10016	2548	2548	10.94	885.45	231.57	0.2232	5831.40	0.1518	0.1511	0.9950	0.6803	0.6769	0.5%	0.2634	-0.6%
ATH0612	A3	1518004-3	25.8	6/12/17 11:20	10004	2706	2706	11.05	905.24	243.38	0.2314	5831.40	0.1552	0.1566	1.0090	0.6709	0.6769	-0.9%	0.2634	2.0%
ATH0612	A4	1518004-3	25.8	6/12/17 11:50	10014	2643	2643	10.89	919.48	241.17	0.2330	5831.40	0.1577	0.1577	1.0003	0.6767	0.6769	0.0%	0.2634	-0.4%
ATH0612	B1	1518004-3	25.8	6/12/17 12:19	10004	2663	2663	11.45	873.62	230.96	0.2316	5831.40	0.1496	0.1568	1.0465	0.6469	0.6769	-4.6%	0.2634	0.4%
ATH0612	B2	1518004-3	25.8	6/12/17 12:46	10013	2692	2692	11.32	864.42	235.28	0.2165	5831.40	0.1482	0.1466	0.9886	0.6847	0.6769	1.1%	0.2634	3.2%
ATH0612	B3	1518004-3	25.8	6/12/17 13:13	10009	2811	2811	11.47	872.54	243.53	0.2221	5831.40	0.1496	0.1503	1.0048	0.6737	0.6769	-0.5%	0.2634	5.6%
ATH0612	B4	1518004-3	25.8	6/12/17 13:40	10014	2692	2692	11.27	888.45	237.27	0.2224	5831.40	0.1524	0.1505	0.9881	0.6851	0.6769	1.2%	0.2634	1.4%
ATH0612	C1	1518004-3	25.8	6/12/17 14:06	10009	2705	2705	10.88	914.79	245.72	0.2301	5831.40	0.1569	0.1568	0.9929	0.6818	0.6769	0.0%	0.2634	1.9%
ATH0612	C2	1518004-3	25.8	6/12/17 14:34	10003	2586	2586	10.98	919.28	236.02	0.2306	5831.40	0.1576	0.1561	0.9902	0.6836	0.6769	1.0%	0.2634	-2.8%
ATH0613	C3	1518004-3	25.8	6/13/17 7:52	10003	2533	2533	11.08	902.70	226.97	0.2285	5831.40	0.1548	0.1547	0.9982	0.6775	0.6769	0.1%	0.2634	-4.8%
ATH0613	C4	1518004-3	25.8	6/13/17 8:20	10013	2621	2621	11.17	896.28	231.75	0.2329	5831.40	0.1537	0.1577	1.0257	0.6899	0.6769	-2.6%	0.2634	-1.9%
ATH0613	D1	1518004-3	25.8	6/13/17 8:47	10011	2516	2516	11.41	877.29	218.89	0.2239	5831.40	0.1504	0.1516	1.0074	0.6719	0.6769	-0.7%	0.2634	-5.6%
ATH0613	D2	1518004-3	25.8	6/13/17 9:12	10002	2493	2493	11.34	881.92	217.35	0.2241	5831.40	0.1512	0.1509	0.9977	0.6785	0.6769	0.2%	0.2634	-6.8%
ATH0613	D3	1518004-3	25.8	6/13/17 9:37	10005	2409	2409	11.36	880.55	210.39	0.2229	5831.40	0.1510	0.1517	1.0046	0.6738	0.6769	-0.5%	0.2634	-10.2%
ATH0613	D4	1518004-3	25.8	6/13/17 10:03	10005	2432	2432	11.25	889.23	214.57	0.2234	5831.40	0.1525	0.1512	0.9917	0.6826	0.6769	0.8%	0.2634	-9.2%

LB4100C Alpha Attenuation Curve -- Th-230

Spike Information		Spike Information	
Std. ID	853.30/20.89	Std. ID	853.30/20.89
Ref. Date	11/6/2007	Ref. Date	11/6/2007
Half-life	77000	Half-life	77000
Activity	1166.38	Activity	1166.38
Vol.	5.0	Vol.	5.0
Act. Added	5831.90	Act. Added	5831.90
	dpn		dpn

Attenuation Equation		y=b*m*(a^x)	
b =	0.9050	b =	0.9050
m =	0.9875	m =	0.9875
a =	0.8948	a =	0.8948
% Diff Max. =		13.6%	

Cross-Talk Equation		y=b*m*x	
b =	0.2523	b =	0.2523
m =	0.9983	m =	0.9983
% Diff Max. =		15.0%	

File ID	Detector ID	Sample ID	Mass (mg)	Count Date	Alpha Counts	Beta Counts	Count Time	Alpha CPM	Beta CPM	Base Alpha Eff.	Decay Corr. Act. added dpm/mL	Alpha Att. Fitted	Alpha Att. Eff Actual	Actual/Fit Ratio	Obs. Atten Fact.	Fitted Atten Fact.	% Diff.	$\alpha > [\beta \times T] \times [\beta \times T]$	% Diff.
ATH0613	A1	1518004-5	43.9	6/13/17 9:40	10005	2799	14.50	689.92	191.60	0.2305	5831.40	0.1183	0.1183	1.0577	0.5133	0.5522	-7.6%	0.2777	0.2715
ATH0613	A2	1518004-5	43.9	6/13/17 10:06	10002	2650	14.68	681.24	179.18	0.2232	5831.40	0.1168	0.1168	1.0549	0.5234	0.5522	-8.5%	0.2630	0.2715
ATH0613	A3	1518004-5	43.9	6/13/17 10:33	9999	2534	14.49	689.97	173.37	0.2314	5831.40	0.1163	0.1163	1.0799	0.5113	0.5522	-8.0%	0.2513	0.2715
ATH0613	A4	1518004-5	43.9	6/13/17 11:01	10003	2551	14.04	712.38	180.16	0.2330	5831.40	0.1222	0.1222	1.0531	0.5243	0.5522	-5.3%	0.2529	0.2715
ATH0612	B1	1518004-5	43.9	6/12/17 11:24	10003	2818	15.07	663.68	185.38	0.2316	5831.40	0.1138	0.1138	1.1236	0.4914	0.5522	-12.4%	0.2793	0.2715
ATH0612	B2	1518004-5	43.9	6/12/17 11:55	10003	2935	15.38	660.27	189.18	0.2165	5831.40	0.1115	0.1115	1.0720	0.5151	0.5522	-7.2%	0.2909	0.2715
ATH0612	B3	1518004-5	43.9	6/12/17 12:23	10006	2925	15.02	666.09	193.20	0.2221	5831.40	0.1142	0.1142	1.0736	0.5143	0.5522	-7.4%	0.2900	0.2715
ATH0612	B4	1518004-5	43.9	6/12/17 12:50	10006	3000	15.33	652.61	194.10	0.2224	5831.40	0.1119	0.1119	1.0973	0.5032	0.5522	-9.7%	0.2974	0.2715
ATH0612	C1	1518004-5	43.9	6/12/17 13:16	10010	2730	14.38	696.00	188.31	0.2301	5831.40	0.1194	0.1194	1.0845	0.5187	0.5522	-6.4%	0.2706	0.2715
ATH0612	C2	1518004-5	43.9	6/12/17 13:43	10011	2801	14.38	696.06	193.13	0.2306	5831.40	0.1194	0.1194	1.0667	0.5176	0.5522	-6.4%	0.2775	0.2715
ATH0612	C3	1518004-5	43.9	6/12/17 14:10	10001	2843	14.60	684.90	193.09	0.2285	5831.40	0.1175	0.1175	1.0742	0.5140	0.5522	-7.4%	0.2819	0.2715
ATH0612	C4	1518004-5	43.9	6/12/17 14:38	10004	2834	14.87	672.62	187.69	0.2239	5831.40	0.1153	0.1153	1.1149	0.4953	0.5522	-11.5%	0.2790	0.2715
ATH0613	D1	1518004-5	43.9	6/13/17 7:56	10005	2803	15.24	656.40	182.31	0.2229	5831.40	0.1126	0.1126	1.0983	0.5027	0.5522	-8.9%	0.2777	0.2715
ATH0613	D2	1518004-5	43.9	6/13/17 8:24	9999	2609	15.04	664.74	171.86	0.2239	5831.40	0.1140	0.1140	1.0797	0.5114	0.5522	-8.0%	0.2585	0.2715
ATH0613	D3	1518004-5	43.9	6/13/17 8:50	10004	2608	14.87	672.59	173.72	0.2241	5831.40	0.1153	0.1153	1.0728	0.5147	0.5522	-7.3%	0.2583	0.2715
ATH0613	D4	1518004-5	43.9	6/13/17 9:16	10001	2555	15.04	684.86	188.27	0.2234	5831.40	0.1140	0.1140	1.0819	0.5104	0.5522	-8.2%	0.2531	0.2715
ATH0613	A1	1518004-8	49.5	6/13/17 8:23	10011	2619	14.67	682.34	177.09	0.2305	5831.40	0.1170	0.1170	1.0212	0.5076	0.5184	-2.1%	0.2595	0.2741
ATH0613	A2	1518004-8	49.5	6/13/17 8:50	10000	2537	14.85	673.31	169.51	0.2232	5831.40	0.1155	0.1155	1.0022	0.5173	0.5184	-0.2%	0.2518	0.2741
ATH0613	A3	1518004-8	49.5	6/13/17 9:15	10004	2570	14.58	686.05	174.76	0.2314	5831.40	0.1176	0.1176	1.0197	0.5084	0.5184	-2.0%	0.2547	0.2741
ATH0613	A4	1518004-8	49.5	6/13/17 9:40	10008	2533	14.32	698.80	175.35	0.2330	5831.40	0.1198	0.1198	1.0080	0.5143	0.5184	-0.8%	0.2509	0.2741
ATH0613	B1	1518004-8	49.5	6/13/17 10:07	10004	2593	15.14	660.88	169.66	0.2316	5831.40	0.1133	0.1133	1.0588	0.4992	0.5184	-6.0%	0.2568	0.2741
ATH0613	B2	1518004-8	49.5	6/13/17 10:33	10002	2598	15.21	657.48	169.16	0.2165	5831.40	0.1127	0.1127	0.9655	0.5208	0.5184	0.5%	0.2573	0.2741
ATH0613	B3	1518004-8	49.5	6/13/17 11:02	10003	2573	15.20	658.01	167.73	0.2221	5831.40	0.1128	0.1128	1.0204	0.5081	0.5184	-2.0%	0.2549	0.2741
ATH0613	B4	1518004-8	49.5	6/12/17 11:25	10006	2923	15.51	645.03	186.87	0.2224	5831.40	0.1106	0.1106	1.0423	0.4974	0.5184	-4.2%	0.2897	0.2741
ATH0612	C1	1518004-8	49.5	6/12/17 11:54	10014	2749	14.66	682.97	185.98	0.2301	5831.40	0.1171	0.1171	1.0185	0.5090	0.5184	-1.9%	0.2723	0.2741
ATH0612	C2	1518004-8	49.5	6/12/17 12:23	10012	2695	14.68	681.90	181.92	0.2306	5831.40	0.1169	0.1169	1.0223	0.5071	0.5184	-2.2%	0.2668	0.2741
ATH0612	C3	1518004-8	49.5	6/12/17 12:49	10004	2764	15.01	666.39	182.50	0.2285	5831.40	0.1143	0.1143	1.0366	0.5001	0.5184	-3.7%	0.2739	0.2741
ATH0612	C4	1518004-8	49.5	6/12/17 13:17	10001	2761	14.92	670.17	182.16	0.2329	5831.40	0.1149	0.1149	1.0506	0.4934	0.5184	-5.1%	0.2718	0.2741
ATH0612	D1	1518004-8	49.5	6/12/17 13:44	10005	2778	15.48	646.22	177.84	0.2239	5831.40	0.1108	0.1108	1.0474	0.4949	0.5184	-4.7%	0.2752	0.2741
ATH0612	D2	1518004-8	49.5	6/12/17 14:11	10002	2848	15.58	641.89	181.19	0.2229	5831.40	0.1101	0.1101	1.0498	0.4938	0.5184	-5.0%	0.2823	0.2741
ATH0612	D3	1518004-8	49.5	6/12/17 14:39	10001	2773	15.47	646.31	177.59	0.2241	5831.40	0.1108	0.1108	1.0482	0.4946	0.5184	-4.8%	0.2748	0.2741
ATH0613	D4	1518004-8	49.5	6/12/17 14:39	9999	2531	15.29	653.96	183.93	0.2234	5831.40	0.1121	0.1121	1.0329	0.5019	0.5184	-3.3%	0.2507	0.2741
ATH0613	A1	1518004-7	49.9	6/13/17 8:49	10003	2505	13.75	727.41	180.75	0.2305	5831.40	0.1247	0.1247	0.9537	0.5412	0.5161	-4.6%	0.2485	0.2743
ATH0613	A2	1518004-7	49.9	6/13/17 9:15	10004	2404	14.00	714.48	170.38	0.2232	5831.40	0.1225	0.1225	0.9402	0.5489	0.5161	6.0%	0.2385	0.2743
ATH0613	A3	1518004-7	49.9	6/13/17 9:40	10004	2461	13.9	719.62	175.54	0.2314	5831.40	0.1234	0.1234	0.9678	0.5333	0.5161	3.2%	0.2439	0.2743
ATH0613	A4	1518004-7	49.9	6/13/17 10:05	10005	2442	13.49	741.58	179.49	0.2330	5831.40	0.1272	0.1272	0.9456	0.5458	0.5161	5.4%	0.2420	0.2743
ATH0613	B1	1518004-7	49.9	6/13/17 10:32	10006	2633	14.09	710.06	185.26	0.2316	5831.40	0.1218	0.1218	0.9816	0.5258	0.5161	1.8%	0.2609	0.2743
ATH0613	B2	1518004-7	49.9	6/13/17 11:02	10006	2588	14.70	680.56	173.04	0.2185	5831.40	0.1167	0.1167	0.9574	0.5391	0.5161	-4.3%	0.2543	0.2743
ATH0612	B3	1518004-7	49.9	6/12/17 11:24	10007	3081	15.13	661.32	202.09	0.2221	5831.40	0.1134	0.1134	1.0107	0.5106	0.5161	-1.1%	0.3056	0.2743
ATH0612	B4	1518004-7	49.9	6/12/17 11:54	10001	2682	14.5	689.62	183.37	0.2224	5831.40	0.1183	0.1183	0.9706	0.5317	0.5161	2.9%	0.2859	0.2743
ATH0612	C1	1518004-7	49.9	6/12/17 12:22	10002	2628	13.84	722.58	188.34	0.2306	5831.40	0.1239	0.1239	0.9584	0.5385	0.5161	4.2%	0.2607	0.2743
ATH0612	C2	1518004-7	49.9	6/12/17 12:48	10009	2750	13.8	725.18	197.62	0.2306	5831.40	0.1244	0.1244	0.9570	0.5393	0.5161	4.3%	0.2725	0.2743
ATH0612	C3	1518004-7	49.9	6/12/17 13:16	10004	2653	14.27	700.96	184.27	0.2295	5831.40	0.1202	0.1202	0.9811	0.5261	0.5161	1.9%	0.2629	0.2743
ATH0612	C4	1518004-7	49.9	6/12/17 13:43	10002	2642	14.17	705.72	183.55	0.2329	5831.40	0.1210	0.1210	0.9932	0.5196	0.5161	0.7%	0.2601	0.2743
ATH0612	D1	1518004-7	49.9	6/12/17 14:10	10005	2701	14.70	680.52	182.13	0.2239	5831.40	0.1167	0.1167	0.9802	0.5312	0.5161	1.0%	0.2876	0.2743
ATH0612	D2	1518004-7	49.9	6/12/17 14:39	10002	2869	15.07	663.62	188.77	0.2229	5831.40	0.1138	0.1138	1.0109	0.5105	0.5161	-1.1%	0.2845	0.2743
ATH0612	D3	1518004-7	49.9	6/13/17 7:55	10012	2555	14.18	705.89	178.52	0.2241	5831.40	0.1211	0.1211	0.9554	0.5402	0.5161	4.5%	0.2529	0.2743
ATH0613	D4	1518004-7	49.9	6/13/17 8:23	10002	2461	14.57	696.38	167.30	0.2234	5831.40	0.1177	0.1177	0.9795	0.5269	0.5161	2.0%	0.2437	0.2743

LB4100C Alpha Attenuation Curve -- Th-230

Spike Information										Attenuation Equation										Cross-Talk Equation									
Std. ID 853.3020.89										b = 0.9050										b = 0.2523									
Ref. Date 11/6/2007										m = 0.9875										m = 0.9983									
Half-life 77000 yrs										a = 0.8948																			
Activity 1166.38 dpm/mL																													
Vol. 5.0 mL																													
Act. Added 5831.90 dpm																													
File ID	Detector ID	Sample ID	Mass (mg)	Count Date	Alpha Counts	Beta Counts	Count Time	Alpha CPM	Beta CPM	Base Alpha Eff.	Decay Corr. Act. added dpm/mL	Alpha Att. Eff Actual	Alpha Att. Fitted	Actual/Fit Ratio	Obs Atten Fact.	Fitted Atten Fact.	% Diff.	$\alpha > \beta \times T_{1/2} > \beta \times T_{1/2}$	% Diff.										
ATH0613	A1	1518004-9	67.8	6/13/17 7:57	10001	2796	16.96	589.60	163.42	0.2305	5831.40	0.1011	0.0973	0.9619	0.4386	0.4219	3.9%	0.2772	0.2826	-2.0%									
ATH0613	A2	1518004-9	67.8	6/13/17 8:26	10002	2726	17.05	586.53	158.55	0.2232	5831.40	0.106	0.0942	0.9363	0.4506	0.4219	6.4%	0.2703	0.2826	-4.6%									
ATH0613	A3	1518004-9	67.8	6/13/17 8:52	10003	2546	16.94	590.49	148.79	0.2314	5831.40	0.1012	0.0976	0.9643	0.4375	0.4219	3.6%	0.2520	0.2826	-12.1%									
ATH0613	A4	1518004-9	67.8	6/13/17 9:17	10005	2614	16.44	608.49	157.47	0.2330	5831.40	0.1043	0.0983	0.9421	0.4478	0.4219	5.8%	0.2688	0.2826	-9.2%									
ATH0613	B1	1518004-9	67.8	6/13/17 9:43	10002	2683	17.54	570.15	151.35	0.2316	5831.40	0.0978	0.0977	0.9994	0.4422	0.4219	0.1%	0.2655	0.2826	-6.5%									
ATH0613	B2	1518004-9	67.8	6/13/17 10:09	9999	2769	17.77	562.57	154.17	0.2165	5831.40	0.0965	0.0913	0.9469	0.4456	0.4219	5.3%	0.2741	0.2826	-3.1%									
ATH0613	B3	1518004-9	67.8	6/13/17 10:36	10004	2778	17.45	573.21	157.65	0.2221	5831.40	0.0983	0.0937	0.9533	0.4426	0.4219	4.7%	0.2750	0.2826	-2.6%									
ATH0613	B4	1518004-9	67.8	6/13/17 11:06	10004	2749	17.62	567.66	154.42	0.2224	5831.40	0.0973	0.0938	0.9839	0.4377	0.4219	3.6%	0.2720	0.2826	-3.9%									
ATH0612	C1	1518004-9	67.8	6/12/17 11:27	10008	2958	17.46	573.09	167.88	0.2301	5831.40	0.0983	0.0971	0.9879	0.4271	0.4219	1.2%	0.2929	0.2826	3.5%									
ATH0612	C2	1518004-9	67.8	6/12/17 11:57	10005	2958	17.28	578.86	169.52	0.2306	5831.40	0.0983	0.0973	0.9801	0.4305	0.4219	2.0%	0.2928	0.2826	3.5%									
ATH0612	C3	1518004-9	67.8	6/12/17 12:25	10005	2779	17.22	580.91	159.74	0.2285	5831.40	0.0996	0.0964	0.9678	0.4360	0.4219	3.2%	0.2750	0.2826	-2.8%									
ATH0612	C4	1518004-9	67.8	6/12/17 12:52	9999	2944	17.37	575.51	166.59	0.2329	5831.40	0.0987	0.0983	0.9957	0.4237	0.4219	0.4%	0.2895	0.2826	2.4%									
ATH0612	D1	1518004-9	67.8	6/12/17 13:20	10003	2869	18.03	554.70	157.51	0.2239	5831.40	0.0951	0.0945	0.9931	0.4248	0.4219	0.7%	0.2940	0.2826	0.5%									
ATH0612	D2	1518004-9	67.8	6/12/17 13:47	10003	3017	18.52	540.03	161.30	0.2229	5831.40	0.0926	0.0940	1.0155	0.4155	0.4219	-1.6%	0.2987	0.2826	5.4%									
ATH0612	D3	1518004-9	67.8	6/12/17 14:14	10000	3213	18.24	548.07	174.49	0.2241	5831.40	0.0940	0.0946	1.0060	0.4194	0.4219	-0.6%	0.3184	0.2826	11.2%									
ATH0612	D4	1518004-9	67.8	6/12/17 14:42	10001	2999	18.01	555.20	164.91	0.2234	5831.40	0.0952	0.0943	0.9900	0.4262	0.4219	1.0%	0.2970	0.2826	4.1%									
ATH0612	A1	1518004-10	70	6/12/17 14:41	10002	2808	17.23	580.42	161.54	0.2305	5831.40	0.0995	0.0949	0.9532	0.4318	0.4116	4.7%	0.2783	0.2837	-1.9%									
ATH0613	A2	1518004-10	70	6/13/17 7:57	10007	2643	16.78	596.27	156.17	0.2232	5831.40	0.1023	0.0919	0.8985	0.4581	0.4116	10.2%	0.2619	0.2837	-8.3%									
ATH0613	A3	1518004-10	70	6/13/17 8:25	10010	2511	16.88	592.91	147.25	0.2314	5831.40	0.1017	0.0952	0.9367	0.4394	0.4116	6.3%	0.2483	0.2837	-14.2%									
ATH0613	A4	1518004-10	70	6/13/17 8:51	10006	2598	16.48	607.08	156.11	0.2310	5831.40	0.1041	0.0959	0.9212	0.4468	0.4116	7.9%	0.2572	0.2837	-10.3%									
ATH0613	B1	1518004-10	70	6/13/17 9:18	10006	2760	17.39	575.30	157.10	0.2316	5831.40	0.0987	0.0953	0.9663	0.4260	0.4116	3.4%	0.2731	0.2837	-3.9%									
ATH0613	B2	1518004-10	70	6/13/17 9:43	10001	2740	17.52	570.72	154.74	0.2165	5831.40	0.0979	0.0891	0.9105	0.4521	0.4116	8.9%	0.2711	0.2837	-4.6%									
ATH0613	B3	1518004-10	70	6/13/17 10:09	10002	2535	17.12	584.14	146.53	0.2221	5831.40	0.1002	0.0914	0.9126	0.4510	0.4116	8.7%	0.2508	0.2837	-13.1%									
ATH0613	B4	1518004-10	70	6/13/17 10:36	10002	2624	17.40	574.73	149.21	0.2224	5831.40	0.0986	0.0915	0.9288	0.4432	0.4116	7.1%	0.2596	0.2837	-9.3%									
ATH0613	C1	1518004-10	70	6/13/17 11:04	10000	2752	16.50	605.95	165.25	0.2301	5831.40	0.1039	0.0947	0.9114	0.4516	0.4116	8.9%	0.2727	0.2837	-4.0%									
ATH0612	C2	1518004-10	70	6/12/17 11:27	10006	2930	17.26	579.61	168.10	0.2306	5831.40	0.0994	0.0949	0.9549	0.4310	0.4116	4.5%	0.2900	0.2837	2.2%									
ATH0612	C3	1518004-10	70	6/12/17 11:57	10006	2891	17.43	573.97	164.22	0.2285	5831.40	0.0984	0.0941	0.9555	0.4308	0.4116	4.4%	0.2861	0.2837	0.9%									
ATH0612	C4	1518004-10	70	6/12/17 12:25	10005	2759	17.22	580.87	157.32	0.2329	5831.40	0.0996	0.0959	0.9624	0.4277	0.4116	3.8%	0.2708	0.2837	-4.7%									
ATH0612	D1	1518004-10	70	6/12/17 12:52	10007	2825	17.89	559.27	156.30	0.2239	5831.40	0.0959	0.0922	0.9609	0.4283	0.4116	3.9%	0.2795	0.2837	-1.5%									
ATH0612	D2	1518004-10	70	6/12/17 13:20	10000	3033	18.15	550.88	165.50	0.2229	5831.40	0.0945	0.0917	0.9712	0.4238	0.4116	2.9%	0.3004	0.2837	5.6%									
ATH0612	D3	1518004-10	70	6/12/17 13:47	10002	2999	18.03	554.57	164.67	0.2241	5831.40	0.0951	0.0922	0.9689	0.4244	0.4116	3.0%	0.2969	0.2837	4.5%									
ATH0612	D4	1518004-10	70	6/12/17 14:13	10002	2872	17.91	556.36	158.75	0.2234	5831.40	0.0958	0.0920	0.9603	0.4266	0.4116	4.0%	0.2843	0.2837	0.2%									
ATH0612	A1	1518004-12	77.3	6/12/17 13:48	10003	2822	16.68	535.41	149.63	0.2305	5831.40	0.0918	0.0874	0.9518	0.3983	0.3791	4.8%	0.2795	0.2872	-2.7%									
ATH0612	A2	1518004-12	77.3	6/12/17 14:15	10007	2746	18.94	528.26	143.65	0.2232	5831.40	0.0906	0.0846	0.9341	0.4059	0.3791	6.6%	0.2719	0.2872	-5.6%									
ATH0612	A3	1518004-12	77.3	6/12/17 14:43	10002	2805	18.8	531.93	147.69	0.2314	5831.40	0.0912	0.0877	0.9618	0.3942	0.3791	3.8%	0.2777	0.2872	-3.4%									
ATH0613	A4	1518004-12	77.3	6/13/17 7:59	10001	2714	18.48	541.10	145.33	0.233	5831.40	0.0928	0.0883	0.9520	0.3982	0.3791	4.8%	0.2686	0.2872	-6.9%									
ATH0613	B1	1518004-12	77.3	6/13/17 8:28	10001	2796	19.24	519.71	143.71	0.2316	5831.40	0.0891	0.0878	0.9852	0.3648	0.3791	1.5%	0.2765	0.2872	-3.8%									
ATH0613	B2	1518004-12	77.3	6/13/17 8:55	10003	2898	19.58	510.76	146.36	0.2165	5831.40	0.0876	0.0821	0.9371	0.4046	0.3791	6.3%	0.2685	0.2872	-2.2%									
ATH0613	B3	1518004-12	77.3	6/13/17 9:20	10001	2813	19.19	521.07	145.04	0.2221	5831.40	0.0894	0.0842	0.9424	0.4023	0.3791	5.8%	0.2784	0.2872	-3.2%									
ATH0613	B4	1518004-12	77.3	6/13/17 9:45	9999	2860	19.36	516.38	146.14	0.2224	5831.40	0.0886	0.0843	0.9522	0.3982	0.3791	4.8%	0.2830	0.2872	-1.5%									
ATH0613	C1	1518004-12	77.3	6/13/17 10:10	10004	2750	18.14	551.38	150.06	0.2301	5831.40	0.0946	0.0872	0.9226	0.4109	0.3791	7.7%	0.2722	0.2872	-5.5%									
ATH0613	C2	1518004-12	77.3	6/13/17 10:36	10002	2657	18.03	554.63	145.71	0.2306	5831.40	0.0951	0.0874	0.9192	0.4125	0.3791	8.1%	0.2627	0.2872	-9.3%									
ATH0613	C3	1518004-12	77.3	6/13/17 11:06	10007	2640	18.65	536.47	139.91	0.2285	5831.40	0.0920	0.0866	0.9417	0.4026	0.3791	5.8%	0.2608	0.2872	-10.1%									
ATH0612	D1	1518004-12	77.3	6/12/17 11:29	10006	3012	19.50	512.99	151.56	0.2329	5831.40	0.0880	0.0863	1.0038	0.3777	0.3791	-0.4%	0.2965	0.2872	2.8%									
ATH0612	D2	1518004-12	77.3	6/12/17 11:59	10006	3055	20.19	495.50	149.70	0.2239	5831.40	0.0850	0.0849	0.9990	0.3795	0.3791	0.1%	0.3021	0.2872	5.0%									
ATH0612	D3	1518004-12	77.3	6/12/17 12:28	10001	3097	20.13	496.73	152.24	0.2229	5831.40	0.0852	0.0845	0.9872	0.3791	0.3791	0.8%	0.3065	0.2872	6.3%									
ATH0612	D4	1518004-12	77.3	6/12/17 12:54	10002	3131	19.80	504.98	156.47	0.2234	5831.40	0.0866	0.0864	0.9811	0.3864	0.3791	1.9%	0.3068	0.2872	7.3%									
ATH0612	D4	1518004-12	77.3	6/12/17 13:22	10000	3079	19.92	501.91	152.96	0.2241	5831.40	0.0861	0.0847	0.9841	0.3853	0.3791	1.6%	0.3048	0.2872	5.8%									

LB4100C Alpha Attenuation Curve -- Th-230

WFO# 1518004		Spike Information	
Mass Range		Std. ID	853.3020.89
Low 12.4 mg		Ref. Date	11/6/2007
High 100.0 mg		Half-life	77000 yrs
		Activity	1166.38 dpm/mL
		Vol.	5.0 mL
		Act. Added	5831.90 dpm

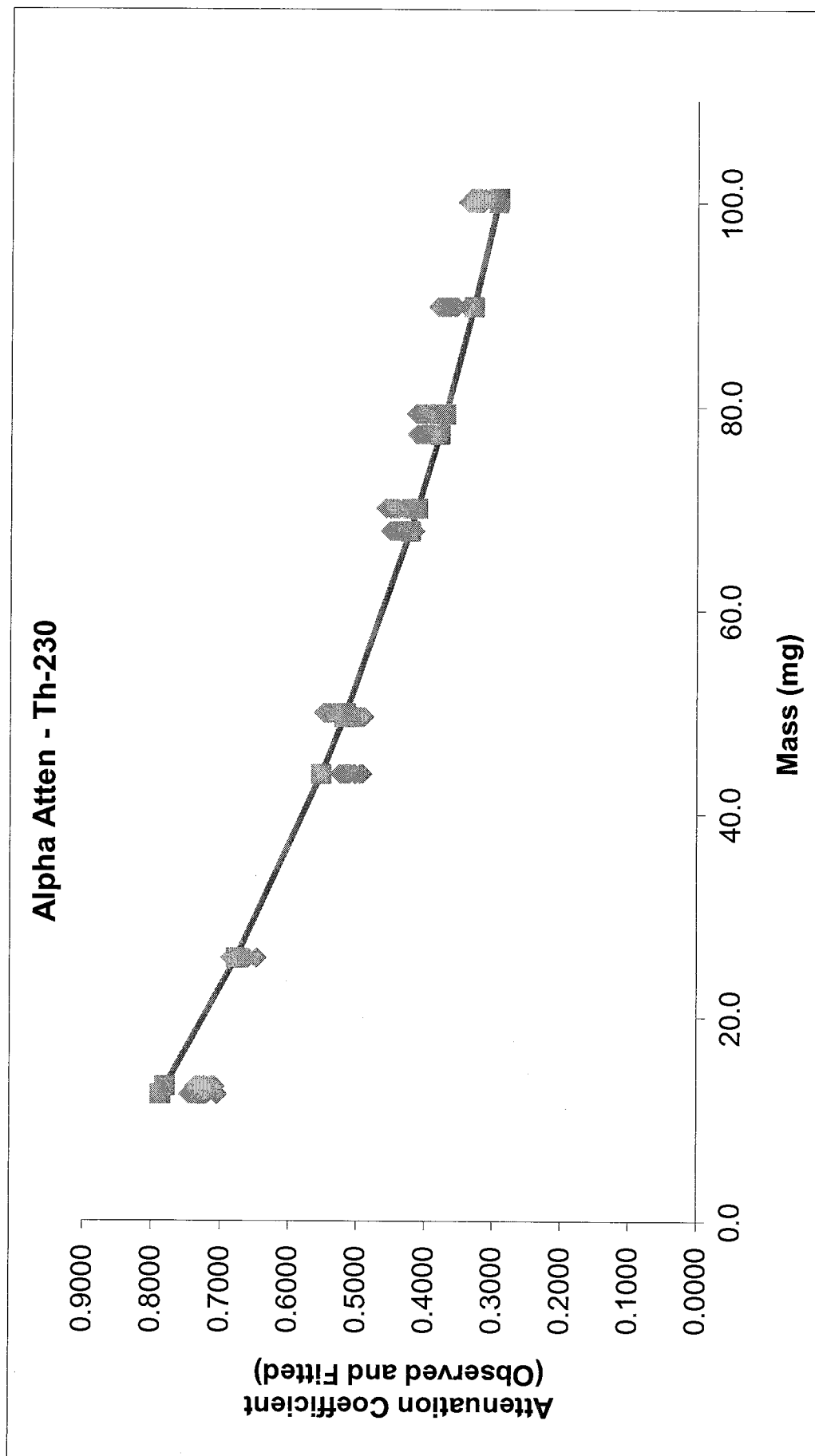
Attenuation Equation		y=bm ^a (a ^x)	
b =	0.9050	b =	0.9050
m =	0.9875	m =	0.9875
a =	0.8948	a =	0.8948
% Diff Max. = 13.6%			

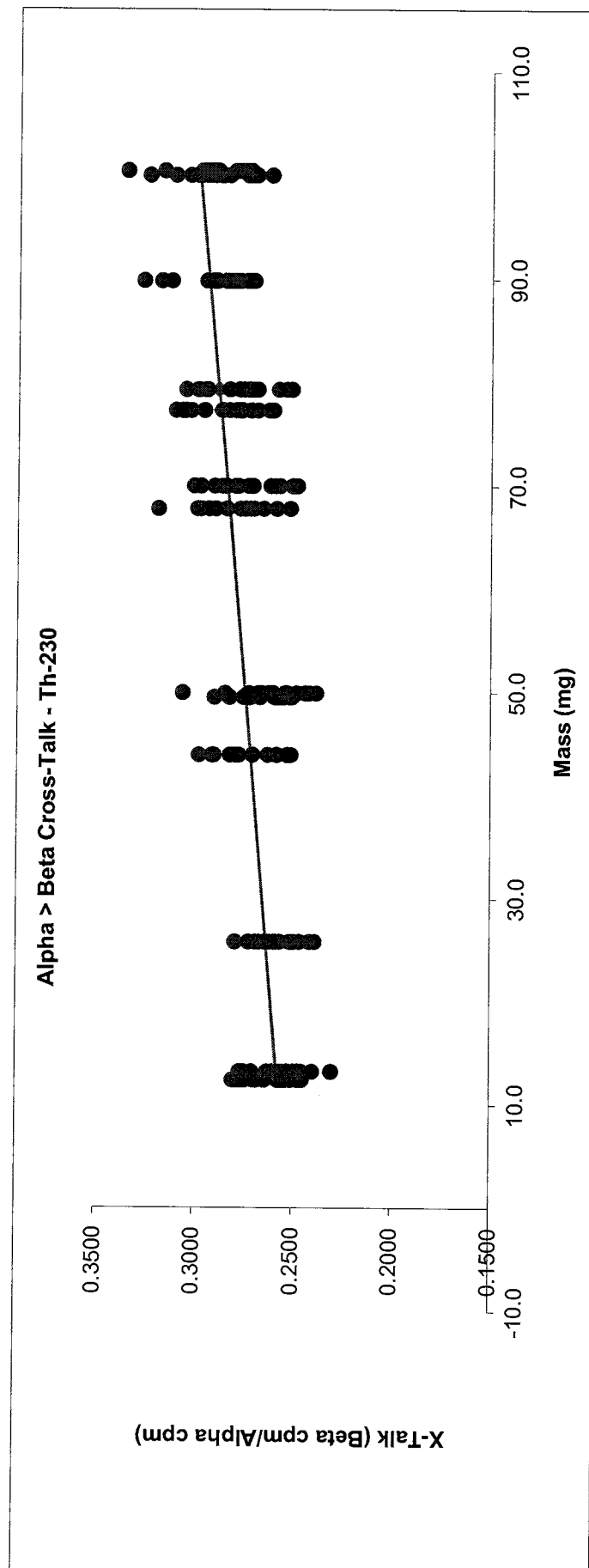
Cross-Talk Equation		y=b ^m -x	
b =	0.2523	b =	0.2523
m =	0.9983	m =	0.9983
% Diff Max. = 15.0%			

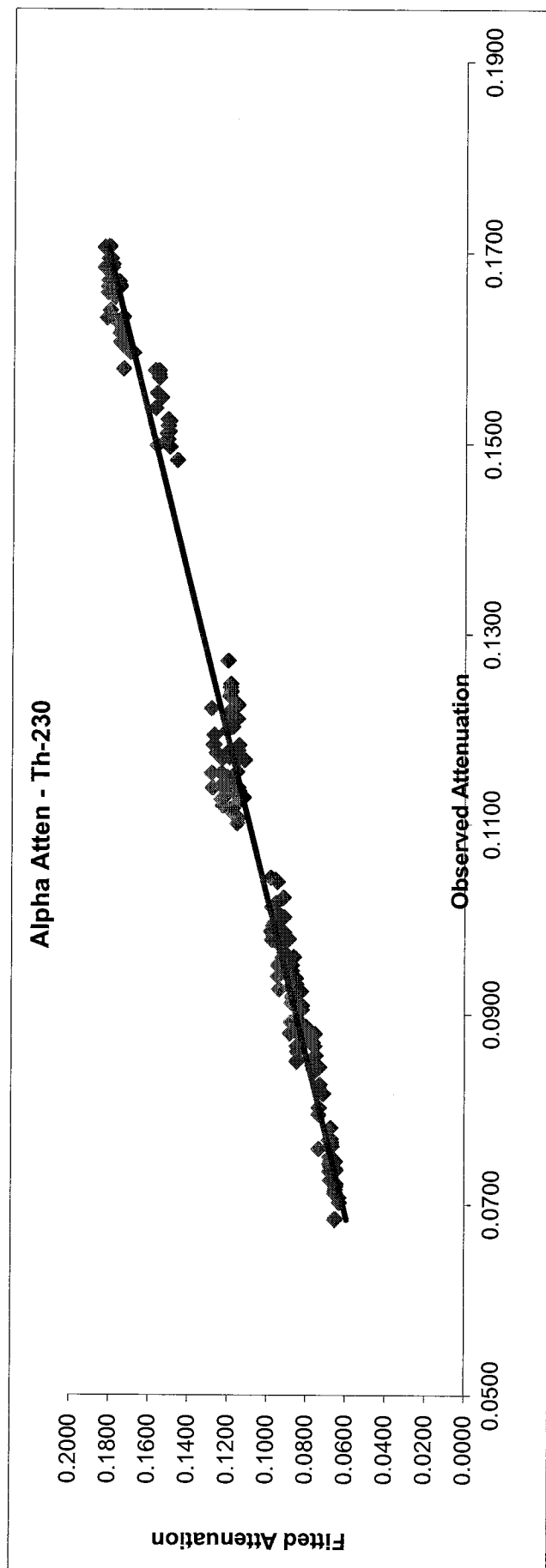
File ID	Detector ID	Sample ID	Mass (mg)	Count Date	Alpha Counts	Beta Counts	Count Time	Alpha CPM	Beta CPM	Base Alpha Eff.	Decay Corr. Act. added dpm/mL	Alpha Att. Fitted	Actual/Fit Ratio	Obs. Att. Fitted	Fitted Att. Fitted	% Diff.	a > β X Tlk > β X Tlk	% Diff.
ATH0612	A1	1518004-11	79.3	6/12/17 14:14	10002	2967	18.61	537.37	157.99	0.2305	5831.40	0.0922	0.9272	0.3998	0.3707	7.3%	0.2940	0.2861
ATH0612	A2	1518004-11	79.3	6/12/17 14:43	10005	2729	18.57	538.68	145.62	0.2332	5831.40	0.0924	0.8957	0.4139	0.3707	10.4%	0.2703	0.2861
ATH0612	A3	1518004-11	79.3	6/13/17 7:59	10001	2542	18.39	543.73	136.72	0.2314	5831.40	0.0932	0.9200	0.4029	0.3707	8.0%	0.2514	0.2861
ATH0613	B1	1518004-11	79.3	6/13/17 8:26	10007	2607	17.87	559.91	142.12	0.2336	5831.40	0.0960	0.8996	0.4121	0.3707	10.0%	0.2538	0.2861
ATH0613	B2	1518004-11	79.3	6/13/17 8:54	10000	2561	18.35	540.45	139.47	0.2313	5831.40	0.0927	0.9253	0.4002	0.3707	7.4%	0.2581	0.2861
ATH0613	B3	1518004-11	79.3	6/13/17 9:20	10007	2788	19.35	517.04	142.43	0.2165	5831.40	0.0897	0.9052	0.4095	0.3707	9.5%	0.2755	0.2861
ATH0613	B4	1518004-11	79.3	6/13/17 9:45	10004	2859	18.88	529.79	149.89	0.2221	5831.40	0.0909	0.9062	0.4091	0.3707	9.4%	0.2829	0.2861
ATH0613	C1	1518004-11	79.3	6/13/17 10:10	10000	2749	18.95	527.60	143.47	0.2224	5831.40	0.0905	0.9112	0.4068	0.3707	8.9%	0.2719	0.2861
ATH0613	C2	1518004-11	79.3	6/13/17 10:37	10002	2722	18.41	543.18	146.31	0.2301	5831.40	0.0931	0.9157	0.4048	0.3707	8.4%	0.2694	0.2861
ATH0613	C3	1518004-11	79.3	6/13/17 11:06	10003	2763	18.29	546.60	149.41	0.2306	5831.40	0.0938	0.9116	0.4066	0.3707	8.8%	0.2732	0.2861
ATH0612	C4	1518004-11	79.3	6/12/17 11:28	10008	2981	19.17	521.97	153.86	0.2285	5831.40	0.0895	0.9463	0.3917	0.3707	5.4%	0.2948	0.2861
ATH0612	D1	1518004-11	79.3	6/12/17 11:58	10005	2742	18.85	530.63	142.57	0.2329	5831.40	0.0910	0.9488	0.3907	0.3707	5.1%	0.2987	0.2861
ATH0612	D2	1518004-11	79.3	6/12/17 12:28	10007	3020	19.77	506.08	151.14	0.2239	5831.40	0.0868	0.9564	0.3876	0.3707	4.4%	0.2987	0.2861
ATH0612	D3	1518004-11	79.3	6/12/17 12:54	10000	2810	19.54	511.68	142.20	0.2229	5831.40	0.0877	0.9417	0.3937	0.3707	5.6%	0.2779	0.2861
ATH0612	D4	1518004-11	79.3	6/12/17 13:21	10006	3079	19.79	505.44	153.92	0.2241	5831.40	0.0867	0.9584	0.3868	0.3707	4.2%	0.3045	0.2861
ATH0612	D5	1518004-11	79.3	6/12/17 13:48	10003	3013	19.50	512.87	152.91	0.2234	5831.40	0.0880	0.9416	0.3937	0.3707	5.8%	0.2981	0.2861
ATH0612	A1	1518004-14	89.8	6/12/17 12:55	10001	2941	20.41	489.93	142.66	0.2305	5831.40	0.0840	0.9037	0.3645	0.3294	9.6%	0.2912	0.2932
ATH0612	A2	1518004-14	89.8	6/12/17 13:22	10000	2875	20.31	492.27	140.22	0.2332	5831.40	0.0844	0.8709	0.3782	0.3294	12.8%	0.2932	0.2932
ATH0612	A3	1518004-14	89.8	6/12/17 13:49	10006	2976	20.34	491.84	144.80	0.2314	5831.40	0.0843	0.9037	0.3645	0.3294	9.6%	0.2944	0.2932
ATH0612	B1	1518004-14	89.8	6/12/17 14:16	10003	2863	19.71	507.43	143.72	0.2330	5831.40	0.0870	0.8920	0.3735	0.3294	11.8%	0.2932	0.2932
ATH0613	B2	1518004-14	89.8	6/12/17 14:45	10000	2811	20.37	490.83	136.38	0.2316	5831.40	0.0842	0.9063	0.3634	0.3294	9.4%	0.2779	0.2932
ATH0613	B3	1518004-14	89.8	6/13/17 8:02	10006	2952	21.01	476.13	138.85	0.2165	5831.40	0.0816	0.8734	0.3711	0.3294	12.7%	0.2932	0.2932
ATH0613	B4	1518004-14	89.8	6/13/17 8:29	10000	2868	20.76	481.61	136.61	0.2221	5831.40	0.0826	0.8858	0.3719	0.3294	11.4%	0.2836	0.2932
ATH0613	C1	1518004-14	89.8	6/13/17 8:56	10004	2846	20.92	478.10	134.45	0.2224	5831.40	0.0820	0.8935	0.3686	0.3294	10.7%	0.2812	0.2932
ATH0613	C2	1518004-14	89.8	6/13/17 9:21	10003	2923	19.80	505.09	146.09	0.2301	5831.40	0.0866	0.8750	0.3764	0.3294	12.6%	0.2892	0.2932
ATH0613	C3	1518004-14	89.8	6/13/17 9:45	10000	2740	19.5	512.71	138.85	0.2306	5831.40	0.0879	0.8639	0.3813	0.3294	13.6%	0.2708	0.2932
ATH0613	C4	1518004-14	89.8	6/13/17 10:12	10006	2761	20.04	489.21	136.13	0.2285	5831.40	0.0856	0.8792	0.3746	0.3294	12.1%	0.2727	0.2932
ATH0613	D1	1518004-14	89.8	6/13/17 10:39	10001	2799	20.27	493.25	135.19	0.2329	5831.40	0.0846	0.9069	0.3632	0.3294	9.3%	0.2741	0.2932
ATH0613	D2	1518004-14	89.8	6/13/17 11:08	10004	2836	20.83	480.17	134.54	0.2239	5831.40	0.0823	0.8956	0.3678	0.3294	10.4%	0.2802	0.2932
ATH0612	D3	1518004-14	89.8	6/12/17 11:32	10003	3299	22.61	442.33	144.30	0.2229	5831.40	0.0759	0.9679	0.3403	0.3294	32.2%	0.3262	0.2932
ATH0612	D4	1518004-14	89.8	6/12/17 12:01	9999	3207	21.58	463.17	146.94	0.2241	5831.40	0.0794	0.9293	0.3544	0.3294	7.1%	0.3173	0.2932
ATH0612	D5	1518004-14	89.8	6/12/17 12:29	10000	3156	21.39	467.41	145.94	0.2234	5831.40	0.0802	0.9180	0.3588	0.3294	8.2%	0.3122	0.2932
ATH0612	A1	1518004-16	100	6/12/17 12:02	10001	3008	23.01	434.56	129.29	0.2305	5831.40	0.0745	0.9083	0.3233	0.2937	9.2%	0.2975	0.2983
ATH0612	A2	1518004-16	100	6/12/17 12:31	10000	3020	23.32	428.72	128.17	0.2332	5831.40	0.0735	0.8915	0.3294	0.2937	10.9%	0.2969	0.2983
ATH0612	A3	1518004-16	100	6/12/17 12:58	10003	2900	23.07	433.50	124.19	0.2314	5831.40	0.0743	0.9141	0.3213	0.2937	8.6%	0.2965	0.2983
ATH0612	B1	1518004-16	100	6/12/17 13:24	10001	2941	22.55	443.42	128.89	0.2336	5831.40	0.0760	0.8998	0.3264	0.2937	10.0%	0.2907	0.2983
ATH0612	B2	1518004-16	100	6/12/17 13:52	9999	2978	23.34	428.32	125.98	0.2316	5831.40	0.0734	0.9259	0.3171	0.2937	7.4%	0.2941	0.2983
ATH0612	B3	1518004-16	100	6/12/17 14:20	9999	3068	24.24	412.38	124.92	0.2165	5831.40	0.0707	0.8990	0.3266	0.2937	10.1%	0.3029	0.2983
ATH0612	B4	1518004-16	100	6/12/17 14:48	10004	3141	23.96	417.45	129.55	0.2221	5831.40	0.0716	0.9111	0.3223	0.2937	8.9%	0.3103	0.2983
ATH0613	C1	1518004-16	100	6/13/17 8:04	10003	2911	23.02	434.44	124.86	0.2306	5831.40	0.0745	0.8766	0.3350	0.2937	12.3%	0.2874	0.2983
ATH0613	C2	1518004-16	100	6/13/17 8:31	10002	2867	22.31	448.21	126.91	0.2301	5831.40	0.0769	0.8791	0.3340	0.2937	12.1%	0.2833	0.2983
ATH0613	C3	1518004-16	100	6/13/17 8:57	10004	2739	21.97	455.24	123.01	0.2306	5831.40	0.0781	0.8674	0.3385	0.2937	13.3%	0.2702	0.2983
ATH0613	C4	1518004-16	100	6/13/17 9:23	10006	2766	22.55	443.63	121.02	0.2285	5831.40	0.0761	0.8820	0.3329	0.2937	11.8%	0.2728	0.2983
ATH0613	D1	1518004-16	100	6/13/17 9:48	10000	2805	22.34	447.49	122.66	0.2329	5831.40	0.0767	0.8912	0.3295	0.2937	10.9%	0.2741	0.2983
ATH0613	D2	1518004-16	100	6/13/17 10:15	10001	2733	23.27	429.69	115.83	0.2239	5831.40	0.0737	0.8923	0.3291	0.2937	10.8%	0.2686	0.2983
ATH0613	D3	1518004-16	100	6/13/17 10:42	10000	2657	23.32	428.72	112.32	0.2229	5831.40	0.0735	0.8903	0.3298	0.2937	10.7%	0.2620	0.2983
ATH0613	D4	1518004-16	100	6/13/17 11:11	10000	2767	23.26	429.75	117.29	0.2241	5831.40	0.0737	0.8930	0.3289	0.2937	10.7%	0.2729	0.2983
ATH0612	D5	1518004-16	100	6/12/17 11:35	10003	3530	25.98	414.93	134.27	0.2234	5831.40	0.0712	0.9220	0.3185	0.2937	7.8%	0.3236	0.2983

[illegible]

ATH0613	A1	1518004-4	28.1	6/13/17 10:05	10001	2625	13.42	745.15	194.17	0.2305	5831.40	0.1278	0.1520	1.1898	0.5544	0.6596	-19.0%	0.2606	0.2644	-1.5%
ATH0613	A2	1518004-4	28.1	6/13/17 10:32	10009	2547	13.47	742.96	187.75	0.2232	5831.40	0.1274	0.1472	1.1556	0.5708	0.6596	-15.6%	0.2527	0.2644	-4.6%
ATH0613	A3	1518004-4	28.1	6/13/17 11:00	10008	2501	13.16	760.39	188.54	0.2314	5831.40	0.1304	0.1526	1.1705	0.5635	0.6596	-17.1%	0.2479	0.2644	-6.6%
ATH0612	A1	1518004-4	28.1	6/12/17 11:23	10001	2721	13.58	736.37	198.84	0.2330	5831.40	0.1263	0.1537	1.2171	0.5420	0.6596	-21.7%	0.2700	0.2644	2.1%
ATH0612	B1	1518004-4	28.1	6/12/17 11:53	10007	2740	13.57	737.34	200.30	0.2316	5831.40	0.1264	0.1528	1.2082	0.5460	0.6596	-20.6%	0.2717	0.2644	2.7%
ATH0612	B2	1518004-4	28.1	6/12/17 12:22	10002	2830	14.19	704.65	197.79	0.2165	5831.40	0.1209	0.1428	1.1816	0.5582	0.6596	-18.2%	0.2806	0.2644	5.6%
ATH0612	B3	1518004-4	28.1	6/12/17 12:49	10000	3020	14.07	710.75	213.10	0.2221	5831.40	0.1219	0.1465	1.2021	0.5487	0.6596	-20.2%	0.2989	0.2644	11.8%
ATH0612	B4	1518004-4	28.1	6/12/17 13:16	10007	2876	13.85	722.43	206.06	0.2224	5831.40	0.1239	0.1467	1.1641	0.5570	0.6596	-18.4%	0.2989	0.2644	11.8%
ATH0612	C1	1518004-4	28.1	6/12/17 13:42	10015	2825	13.62	735.21	195.18	0.2301	5831.40	0.1261	0.1518	1.2038	0.5479	0.6596	-22.4%	0.2800	0.2644	5.6%
ATH0612	C2	1518004-4	28.1	6/12/17 14:09	10004	2767	13.78	725.87	198.84	0.2306	5831.40	0.1245	0.1521	1.2220	0.5398	0.6596	-22.2%	0.2743	0.2644	3.6%
ATH0612	C3	1518004-4	28.1	6/12/17 14:37	10002	2831	13.69	730.51	205.15	0.2285	5831.40	0.1253	0.1507	1.2032	0.5462	0.6596	-20.3%	0.2808	0.2644	5.6%
ATH0613	C4	1518004-4	28.1	6/13/17 7:55	10002	2795	13.96	716.33	197.32	0.2329	5831.40	0.1228	0.1536	1.2506	0.5274	0.6596	-25.1%	0.2755	0.2644	4.0%
ATH0613	D1	1518004-4	28.1	6/13/17 8:23	10005	2662	13.92	718.66	189.66	0.2329	5831.40	0.1232	0.1477	1.1984	0.5604	0.6596	-19.6%	0.2639	0.2644	-0.2%
ATH0613	D2	1518004-4	28.1	6/13/17 8:49	10004	2647	14.06	711.44	186.66	0.2229	5831.40	0.1220	0.1470	1.2051	0.5473	0.6596	-20.5%	0.2624	0.2644	-0.8%
ATH0613	D3	1518004-4	28.1	6/13/17 9:15	10007	2522	13.84	722.88	180.56	0.2241	5831.40	0.1240	0.1478	1.1924	0.5532	0.6596	-19.2%	0.2498	0.2644	-5.9%
ATH0613	D4	1518004-4	28.1	6/13/17 9:40	10011	2491	13.70	730.63	180.22	0.2234	5831.40	0.1253	0.1474	1.1761	0.5608	0.6596	-17.6%	0.2487	0.2644	-7.2%
ATH0612	A1	1518004-13	83.5	6/12/17 13:20	10006	2814	17.75	563.64	157.10	0.2305	5831.40	0.0967	0.0815	0.8432	0.4193	0.3536	15.7%	0.2787	0.2902	-4.1%
ATH0612	A2	1518004-13	83.5	6/12/17 13:47	10005	2662	17.66	566.44	149.40	0.2232	5831.40	0.0971	0.0789	0.8125	0.4352	0.3536	18.8%	0.2		







LB4100C Beta Attenuation Curve -- Cs137

Mass Range		mg
Low	0.0	mg
High	299.7	mg

Spike Information	
Sid. ID	1019.4036.83
Ref. Date	2/9/2015
Halllife	30.1 yrs
Activity	3937.10 dpm/mL
Vol.	1.0 mL
Act. Added	3937.10 dpm

Attenuation Equation		$y=b \cdot m^a(a \cdot x)$
b =	0.9526	
m =	0.9985	
a =	0.9766	
% Diff Max =		9.0%

Cross-Talk Equation		$y=b \cdot x+m$
b =	2.06E-06	
m =	0.0015	
% Diff Max =		78.0%

File ID	Detector ID	Sample ID	Mass (mg)	Count Date	Alpha Counts	Beta Counts	Count Time	Alpha CPM	Beta CPM	Base Beta Eff.	Decay Corr. Act added dpm/mL	Beta Att. Eff Actual	Beta Att. Fitted	Actual/Fit Ratio	Obs. Atten Fact.	Fitted Atten Fact.	% Diff.	$\beta > \alpha$ Tlk Actual	$\beta > \alpha$ Tlk Fitted	% Diff.
ACS0614	A1	1617003-1	0	6/14/17 11:24	38	1002	6.77	5.53	1475.96	0.4013	3730.14	0.3957	0.3823	1.0351	0.9860	0.9526	3.5%	0.0038	0.0015	-60.9%
ACS0614	A2	1617003-1	0	6/14/17 11:40	38	1008	6.84	5.46	1475.96	0.3950	3730.14	0.3919	0.3763	1.0415	0.9921	0.9526	4.2%	0.0037	0.0015	-60.7%
ACS0614	A3	1617003-1	0	6/14/17 11:54	30	1006	6.95	4.22	1438.20	0.3978	3730.13	0.3856	0.3789	1.0175	0.9692	0.9526	1.7%	0.0029	0.0015	-50.0%
ACS0614	A4	1617003-1	0	6/14/17 12:09	42	1009	6.84	6.06	1463.23	0.3938	3730.13	0.3923	0.3751	1.0457	0.9661	0.9526	4.6%	0.0041	0.0015	-64.5%
ACS0614	B1	1617003-1	0	6/14/17 12:23	60	1021	6.92	8.58	1446.51	0.3934	3730.13	0.3878	0.3748	1.0348	0.9857	0.9526	3.5%	0.0059	0.0015	-75.3%
ACS0614	B2	1617003-1	0	6/14/17 12:37	44	1007	7.09	6.09	1409.77	0.3907	3730.13	0.3779	0.3722	1.0155	0.9873	0.9526	1.5%	0.0043	0.0015	-66.0%
ACS0614	B3	1617003-1	0	6/14/17 12:51	27	1001	6.97	3.79	1434.75	0.3869	3730.13	0.3846	0.3676	1.0463	0.9967	0.9526	4.8%	0.0026	0.0015	-44.4%
ACS0614	B4	1617003-1	0	6/14/17 13:08	38	1009	6.91	5.40	1448.34	0.3888	3730.12	0.3883	0.3704	1.0484	0.9987	0.9526	4.8%	0.0037	0.0015	-60.6%
ACS0614	C1	1617003-1	0	6/14/17 13:34	45	1008	6.91	6.40	1448.24	0.3984	3730.12	0.3883	0.3795	1.0230	0.9887	0.9526	2.3%	0.0034	0.0015	-66.8%
ACS0614	C2	1617003-1	0	6/14/17 13:50	35	1020	6.86	4.99	1458.98	0.3953	3730.12	0.3911	0.3766	1.0387	0.9895	0.9526	3.9%	0.0034	0.0015	-57.1%
ACS0614	C3	1617003-1	0	6/14/17 14:18	46	1017	6.86	6.03	1458.56	0.3921	3730.11	0.3910	0.3735	1.0469	0.9973	0.9526	4.7%	0.0045	0.0015	-67.6%
ACS0614	C4	1617003-1	0	6/14/17 14:34	42	1001	6.81	6.61	1467.15	0.3789	3730.11	0.3833	0.3609	1.0897	1.0381	0.9526	9.0%	0.0041	0.0015	-64.3%
ACS0614	D1	1617003-1	0	6/14/17 14:48	40	9999	7.04	5.89	1418.70	0.3923	3730.11	0.3803	0.3737	1.0177	0.9695	0.9526	1.8%	0.0039	0.0015	-62.7%
ACS0614	D2	1617003-1	0	6/14/17 15:03	65	1027	7.07	9.11	1416.64	0.3833	3730.10	0.3798	0.3651	1.0401	0.9908	0.9526	4.0%	0.0064	0.0015	-77.2%
ACS0614	D3	1617003-1	0	6/14/17 15:17	26	1001	7.09	3.50	1410.32	0.3931	3730.10	0.3781	0.3745	1.0097	0.9618	0.9526	1.0%	0.0025	0.0015	-40.8%
ACS0614	D4	1617003-1	0	6/14/17 15:40	64	1018	6.97	9.08	1435.70	0.3820	3730.10	0.3749	0.3639	1.0577	1.0076	0.9526	5.8%	0.0063	0.0015	-76.8%
ACS0614	A1	1617003-2	16.3	6/14/17 16:10	38	10030	7.15	5.24	1401.36	0.4013	3730.09	0.3757	0.3735	1.0060	0.9362	0.9306	0.6%	0.0037	0.0015	-59.8%
ACS0614	A2	1617003-2	16.3	6/14/17 11:25	29	10016	7.04	4.12	1421.39	0.3950	3730.14	0.3811	0.3676	1.0763	0.9647	0.9306	3.7%	0.0028	0.0015	-47.0%
ACS0614	A3	1617003-2	16.3	6/14/17 11:40	30	10013	7.12	4.12	1404.81	0.3978	3730.14	0.3766	0.3702	1.0173	0.9467	0.9306	1.7%	0.0029	0.0015	-48.8%
ACS0614	A4	1617003-2	16.3	6/14/17 11:54	43	10026	7.19	5.90	1392.90	0.3938	3730.13	0.3734	0.3665	1.0189	0.9482	0.9306	1.9%	0.0042	0.0015	-64.5%
ACS0614	B1	1617003-2	16.3	6/14/17 12:10	41	10011	7.34	5.49	1382.28	0.3934	3730.13	0.3652	0.3661	0.9975	0.9283	0.9306	-0.2%	0.0040	0.0015	-62.8%
ACS0614	B2	1617003-2	16.3	6/14/17 12:24	52	10017	7.41	6.90	1350.17	0.3907	3730.13	0.3620	0.3636	0.9955	0.9264	0.9306	-0.4%	0.0051	0.0015	-70.6%
ACS0614	B3	1617003-2	16.3	6/14/17 12:37	45	10011	7.16	6.20	1366.64	0.3859	3730.13	0.3744	0.3591	1.0426	0.9439	0.9306	4.3%	0.0044	0.0015	-66.2%
ACS0614	B4	1617003-2	16.3	6/14/17 12:51	37	10018	7.31	4.96	1368.86	0.3888	3730.13	0.3670	0.3618	1.0142	0.9439	0.9306	1.4%	0.0036	0.0015	-58.6%
ACS0614	C1	1617003-2	16.3	6/14/17 13:08	39	10012	7.21	5.30	1387.09	0.3984	3730.12	0.3719	0.3708	1.0030	0.9334	0.9306	0.3%	0.0038	0.0015	-60.7%
ACS0614	C2	1617003-2	16.3	6/14/17 13:34	41	10017	7.15	5.62	1399.32	0.3953	3730.12	0.3751	0.3679	1.0197	0.9490	0.9306	2.0%	0.0040	0.0015	-62.6%
ACS0614	C3	1617003-2	16.3	6/14/17 13:50	34	10012	7.24	4.80	1381.23	0.3921	3730.12	0.3703	0.3649	1.0148	0.9444	0.9306	1.5%	0.0033	0.0015	-54.9%
ACS0614	C4	1617003-2	16.3	6/14/17 14:18	49	10016	7.24	6.63	1380.53	0.3789	3730.11	0.3701	0.3526	1.0496	0.9768	0.9306	5.0%	0.0048	0.0015	-68.7%
ACS0614	D1	1617003-2	16.3	6/14/17 14:34	41	10020	7.35	5.48	1361.65	0.3923	3730.11	0.3650	0.3651	0.9999	0.9305	0.9306	0.0%	0.0040	0.0015	-62.7%
ACS0614	D2	1617003-2	16.3	6/14/17 14:49	67	10008	7.41	8.95	1349.00	0.3833	3730.11	0.3617	0.3567	1.0139	0.9435	0.9306	1.4%	0.0066	0.0015	-77.4%
ACS0614	D3	1617003-2	16.3	6/14/17 15:03	42	10004	7.35	5.54	1359.42	0.3931	3730.10	0.3644	0.3658	0.9962	0.9271	0.9306	-0.4%	0.0041	0.0015	-63.2%
ACS0614	D4	1617003-2	16.3	6/14/17 15:17	57	10008	7.49	7.51	1334.57	0.3820	3730.10	0.3578	0.3555	1.0064	0.9366	0.9306	0.6%	0.0056	0.0015	-73.3%
ACS0614	A1	1617003-3	30.4	6/14/17 15:54	27	10008	7.03	3.76	1422.18	0.4013	3730.10	0.3813	0.3660	1.0417	0.9501	0.9120	4.2%	0.0026	0.0015	-42.2%
ACS0614	A2	1617003-3	30.4	6/14/17 16:10	35	10020	7.04	4.88	1421.96	0.3950	3730.09	0.3812	0.3603	1.0582	0.9651	0.9120	5.8%	0.0034	0.0015	-55.4%
ACS0614	A3	1617003-3	30.4	6/14/17 11:25	43	10019	7.15	5.92	1399.75	0.3978	3730.14	0.3753	0.3628	1.0343	0.9433	0.9120	3.4%	0.0042	0.0015	-63.8%
ACS0614	A4	1617003-3	30.4	6/14/17 11:40	46	10010	7.12	6.38	1404.37	0.3938	3730.14	0.3765	0.3592	1.0483	0.9560	0.9120	4.8%	0.0045	0.0015	-66.3%
ACS0614	B1	1617003-3	30.4	6/14/17 11:54	36	9999	7.20	4.91	1387.14	0.3934	3730.13	0.3719	0.3588	1.0364	0.9453	0.9120	3.6%	0.0035	0.0015	-56.8%
ACS0614	B2	1617003-3	30.4	6/14/17 12:10	47	10005	7.16	6.45	1395.70	0.3907	3730.13	0.3742	0.3563	1.0501	0.9577	0.9120	5.0%	0.0046	0.0015	-66.9%
ACS0614	B3	1617003-3	30.4	6/14/17 12:23	40	10022	7.13	5.53	1404.07	0.3869	3730.13	0.3764	0.3520	1.0695	0.9754	0.9120	6.9%	0.0039	0.0015	-81.1%
ACS0614	B4	1617003-3	30.4	6/14/17 12:37	38	10011	7.20	5.18	1388.83	0.3888	3730.13	0.3723	0.3546	1.0500	0.9576	0.9120	5.0%	0.0037	0.0015	-58.9%
ACS0614	C1	1617003-3	30.4	6/14/17 12:51	45	10008	6.92	6.39	1444.70	0.3984	3730.13	0.3873	0.3634	1.0659	0.9722	0.9120	6.6%	0.0044	0.0015	-65.4%
ACS0614	C2	1617003-3	30.4	6/14/17 13:08	33	10001	6.98	4.62	1431.15	0.3953	3730.12	0.3837	0.3605	1.0642	0.9706	0.9120	6.4%	0.0032	0.0015	-52.5%
ACS0614	C3	1617003-3	30.4	6/14/17 13:34	34	10015	7.03	4.74	1422.97	0.3921	3730.12	0.3815	0.3576	1.0668	0.9729	0.9120	6.7%	0.0033	0.0015	-54.1%
ACS0614	C4	1617003-3	30.4	6/14/17 13:50	46	10021	7.16	6.28	1396.68	0.3789	3730.12	0.3744	0.3466	1.0835	0.9882	0.9120	8.4%	0.0045	0.0015	-66.0%
ACS0614	D1	1617003-3	30.4	6/14/17 14:18	42	10014	7.21	5.73	1387.29	0.3923	3730.11	0.3719	0.3578	1.0395	0.9480	0.9120	3.9%	0.0041	0.0015	-62.9%
ACS0614	D2	1617003-3	30.4	6/14/17 14:34	51	10016	7.32	6.88	1366.70	0.3833	3730.11	0.3664	0.3496	1.0481	0.9559	0.9120	4.8%	0.0050	0.0015	-69.6%
ACS0614	D3	1617003-3	30.4	6/14/17 14:48	24	10022	7.14	3.19	1401.98	0.3931	3730.11	0.3759	0.3585	1.0483	0.9561	0.9120	4.8%	0.0023	0.0015	-32.7%
ACS0614	D4	1617003-3	30.4	6/14/17 15:03	43	10018	7.24	5.84	1382.09	0.3820	3730.10	0.3705	0.3484	1.0635	0.9700	0.9120	6.4%	0.0042	0.0015	-63.8%

LB4100C Beta Attenuation Curve -- Cs137

Spike Information	
Std. ID	1019.4095.83
Ref. Date	2/19/2015
Half-life	30.1 yrs
Activity	3937.10 dpm/mL
Vol.	1.0 mL
Act. Added	3937.10 dpm

Attenuation Equation	
$y = b \cdot m^a$	
b =	0.9526
m =	0.9985
a =	0.9766
% Diff Max. = 9.0%	

Cross-Talk Equation	
$y = b \cdot x^m$	
b =	2.06E-06
m =	0.0015
% Diff Max. = 78.0%	

File ID	Detector ID	Sample ID	Mass (mg)	Count Date	Alpha Counts	Beta Counts	Count Time	Alpha CPM	Beta CPM	Beta Eff.	Base Beta	Decay Corr. added	Act. added	Beta Att. Fitted	Actual/Fit Ratio	Obs. Atten. Fact.	Fitted Atten. Fact.	% Diff.	$\beta > \alpha$ Tlk Actual	$\beta > \alpha$ Tlk Fitted	% Diff.
ACS0614	A1	1617003-4	49.6	6/14/17 15:41	31	1006	8.22	3.69	1215.84	0.4013	0.4013	3730.10	0.3260	0.3661	0.9154	0.8122	0.8873	-8.5%	0.0030	0.0016	-48.3%
ACS0614	A2	1617003-4	49.6	6/14/17 15:55	32	1009	7.98	3.92	1252.90	0.3950	0.3950	3730.10	0.3359	0.3505	0.9584	0.8504	0.8873	-4.2%	0.0031	0.0016	-49.8%
ACS0614	A3	1617003-4	49.6	6/14/17 16:11	51	1005	8.18	6.14	1221.60	0.3978	0.3978	3730.09	0.3275	0.3530	0.9278	0.8630	0.8873	-7.2%	0.0050	0.0016	-68.8%
ACS0614	B1	1617003-4	49.6	6/14/17 11:26	41	1006	8.13	5.27	1229.22	0.3938	0.3938	3730.14	0.3295	0.3494	0.9431	0.8368	0.8873	-5.7%	0.0050	0.0016	-68.8%
ACS0614	B2	1617003-4	49.6	6/14/17 11:41	44	10014	8.21	5.19	1218.12	0.3934	0.3934	3730.14	0.3266	0.3491	0.9355	0.8301	0.8873	-6.4%	0.0043	0.0016	-67.7%
ACS0614	B3	1617003-4	49.6	6/14/17 11:55	38	10017	8.16	4.54	1225.92	0.3907	0.3907	3730.13	0.3287	0.3467	0.9480	0.8412	0.8873	-5.2%	0.0037	0.0016	-57.6%
ACS0614	B4	1617003-4	49.6	6/14/17 12:11	35	10011	8.39	4.09	1191.66	0.3859	0.3859	3730.13	0.3195	0.3424	0.9330	0.8279	0.8873	-6.7%	0.0034	0.0016	-54.2%
ACS0614	C1	1617003-4	49.6	6/14/17 12:25	48	10009	8.36	5.64	1195.66	0.3888	0.3888	3730.13	0.3205	0.3450	0.9291	0.8244	0.8873	-7.1%	0.0047	0.0016	-56.7%
ACS0614	C2	1617003-4	49.6	6/14/17 12:38	40	10019	8.11	4.82	1233.85	0.3984	0.3984	3730.13	0.3308	0.3535	0.9357	0.8303	0.8873	-6.4%	0.0039	0.0016	-59.8%
ACS0614	C3	1617003-4	49.6	6/14/17 12:52	31	10004	8.08	3.72	1236.46	0.3953	0.3953	3730.13	0.3315	0.3508	0.9450	0.8366	0.8873	-5.5%	0.0030	0.0016	-47.9%
ACS0614	C4	1617003-4	49.6	6/14/17 13:09	55	10005	8.25	6.57	1211.09	0.3921	0.3921	3730.12	0.3247	0.3479	0.9332	0.8280	0.8873	-6.7%	0.0054	0.0016	-71.1%
ACS0614	D1	1617003-4	49.6	6/14/17 13:35	35	10009	8.13	4.16	1228.22	0.3789	0.3789	3730.12	0.3293	0.3362	0.9794	0.8690	0.8873	-2.1%	0.0034	0.0016	-53.7%
ACS0614	D2	1617003-4	49.6	6/14/17 13:52	47	10012	8.37	5.52	1194.56	0.3923	0.3923	3730.12	0.3202	0.3481	0.9200	0.8163	0.8873	-8.0%	0.0046	0.0016	-58.0%
ACS0614	D3	1617003-4	49.6	6/14/17 14:20	72	10019	8.42	8.46	1188.30	0.3833	0.3833	3730.11	0.3186	0.3401	0.9367	0.8311	0.8873	-6.3%	0.0071	0.0016	-78.0%
ACS0614	D4	1617003-4	49.6	6/14/17 14:35	39	10011	8.29	4.53	1205.93	0.3931	0.3931	3730.11	0.3233	0.3488	0.9269	0.8224	0.8873	-7.3%	0.0038	0.0016	-58.2%
ACS0614	A1	1617003-5	63.4	6/14/17 14:50	55	10005	8.35	6.49	1196.60	0.3820	0.3820	3730.11	0.3208	0.3390	0.9464	0.8398	0.8873	-5.4%	0.0054	0.0016	-71.0%
ACS0614	A2	1617003-5	63.4	6/14/17 15:18	52	10010	8.34	6.16	1198.80	0.4013	0.4013	3730.10	0.3214	0.3491	0.9206	0.8009	0.8700	-7.9%	0.0051	0.0016	-58.9%
ACS0614	A3	1617003-5	63.4	6/14/17 15:41	49	10012	8.24	5.85	1213.71	0.3950	0.3950	3730.10	0.3254	0.3436	0.9469	0.8238	0.8700	-5.3%	0.0048	0.0016	-66.8%
ACS0614	A4	1617003-5	63.4	6/14/17 15:55	40	10013	8.12	4.83	1231.62	0.3978	0.3978	3730.10	0.3302	0.3461	0.9541	0.8300	0.8700	-4.6%	0.0039	0.0016	-59.2%
ACS0614	B1	1617003-5	63.4	6/14/17 16:11	44	10010	8.07	5.37	1238.86	0.3938	0.3938	3730.09	0.3321	0.3426	0.9695	0.8434	0.8700	-3.1%	0.0043	0.0016	-63.1%
ACS0614	B2	1617003-5	63.4	6/14/17 11:26	52	10001	8.59	5.96	1162.65	0.3934	0.3934	3730.14	0.3117	0.3422	0.9107	0.7923	0.8700	-8.9%	0.0051	0.0016	-68.8%
ACS0614	B3	1617003-5	63.4	6/14/17 11:42	43	10009	8.39	5.01	1191.32	0.3907	0.3907	3730.14	0.3194	0.3399	0.9396	0.8174	0.8700	-6.0%	0.0042	0.0016	-62.0%
ACS0614	B4	1617003-5	63.4	6/14/17 11:55	33	10018	8.46	3.82	1182.62	0.3859	0.3859	3730.13	0.3170	0.3357	0.9444	0.8216	0.8700	-5.6%	0.0032	0.0016	-50.5%
ACS0614	C1	1617003-5	63.4	6/14/17 12:11	45	10013	8.56	5.16	1168.15	0.3888	0.3888	3730.13	0.3132	0.3382	0.9259	0.8055	0.8700	-7.4%	0.0044	0.0016	-63.8%
ACS0614	C2	1617003-5	63.4	6/14/17 12:25	40	10011	8.32	4.70	1201.71	0.3964	0.3964	3730.13	0.3222	0.3466	0.9295	0.8086	0.8700	-7.0%	0.0039	0.0016	-59.1%
ACS0614	C3	1617003-5	63.4	6/14/17 12:38	31	10012	8.38	3.99	1193.09	0.3953	0.3953	3730.13	0.3199	0.3439	0.9301	0.8091	0.8700	-7.0%	0.0030	0.0016	-46.8%
ACS0614	C4	1617003-5	63.4	6/14/17 12:53	34	10013	8.40	3.95	1190.38	0.3921	0.3921	3730.13	0.3191	0.3411	0.9356	0.8139	0.8700	-6.4%	0.0033	0.0016	-51.8%
ACS0614	D1	1617003-5	63.4	6/14/17 13:09	46	10009	8.56	5.23	1166.38	0.3789	0.3789	3730.12	0.3127	0.3296	0.9486	0.8253	0.8700	-5.1%	0.0045	0.0016	-64.4%
ACS0614	D2	1617003-5	63.4	6/14/17 13:35	39	10002	8.54	4.47	1169.58	0.3923	0.3923	3730.12	0.3136	0.3413	0.9187	0.7993	0.8700	-8.1%	0.0038	0.0016	-58.2%
ACS0614	D3	1617003-5	63.4	6/14/17 13:52	37	10002	8.44	6.19	1183.46	0.3833	0.3833	3730.12	0.3173	0.3335	0.9515	0.8277	0.8700	-4.9%	0.0052	0.0016	-69.4%
ACS0614	D4	1617003-5	63.4	6/14/17 14:20	37	10012	8.61	4.13	1161.17	0.3931	0.3931	3730.11	0.3113	0.3420	0.9103	0.7919	0.8700	-9.0%	0.0036	0.0016	-55.0%
ACS0614	A1	1617003-6	75.3	6/14/17 14:35	38	10004	8.45	4.40	1182.30	0.3820	0.3820	3730.11	0.3170	0.3323	0.9538	0.8297	0.8700	-4.6%	0.0037	0.0016	-57.0%
ACS0614	A2	1617003-6	75.3	6/14/17 15:03	29	10009	8.15	3.48	1226.66	0.4013	0.4013	3730.10	0.3289	0.3432	0.9582	0.8195	0.8553	-4.2%	0.0028	0.0016	-42.8%
ACS0614	A3	1617003-6	75.3	6/14/17 15:18	33	10016	8.11	3.98	1233.68	0.3950	0.3950	3730.10	0.3307	0.3378	0.9790	0.8373	0.8553	-2.1%	0.0032	0.0016	-49.6%
ACS0614	A4	1617003-6	75.3	6/14/17 15:41	38	10008	8.31	4.48	1202.82	0.3978	0.3978	3730.10	0.3255	0.3402	0.9478	0.8106	0.8553	-5.2%	0.0037	0.0016	-56.4%
ACS0614	B1	1617003-6	75.3	6/14/17 15:55	43	10012	8.16	5.19	1225.43	0.3938	0.3938	3730.10	0.3285	0.3368	0.9754	0.8342	0.8553	-2.5%	0.0042	0.0016	-61.7%
ACS0614	B2	1617003-6	75.3	6/14/17 16:11	47	10006	8.33	5.55	1199.59	0.3934	0.3934	3730.09	0.3216	0.3365	0.9558	0.8175	0.8553	-4.4%	0.0046	0.0016	-64.9%
ACS0614	B3	1617003-6	75.3	6/14/17 11:26	41	10008	8.49	4.71	1177.15	0.3907	0.3907	3730.14	0.3156	0.3342	0.9444	0.8077	0.8553	-5.6%	0.0040	0.0016	-59.5%
ACS0614	B4	1617003-6	75.3	6/14/17 11:42	39	10016	8.41	4.55	1189.42	0.3859	0.3859	3730.14	0.3189	0.3300	0.9661	0.8263	0.8553	-3.4%	0.0038	0.0016	-57.6%
ACS0614	C1	1617003-6	75.3	6/14/17 11:55	40	10004	8.50	4.61	1175.35	0.3888	0.3888	3730.13	0.3151	0.3325	0.9476	0.8104	0.8553	-5.2%	0.0039	0.0016	-58.6%
ACS0614	C2	1617003-6	75.3	6/14/17 12:11	28	10022	8.07	3.36	1240.34	0.3984	0.3984	3730.13	0.3325	0.3407	0.9759	0.8346	0.8553	-2.4%	0.0027	0.0016	-40.1%
ACS0614	C3	1617003-6	75.3	6/14/17 12:25	24	10015	8.21	2.81	1218.19	0.3953	0.3953	3730.13	0.3266	0.3381	0.9660	0.8262	0.8553	-3.4%	0.0023	0.0016	-29.7%
ACS0614	C4	1617003-6	75.3	6/14/17 12:38	33	10011	8.21	3.92	1217.73	0.3921	0.3921	3730.13	0.3265	0.3353	0.9735	0.8326	0.8553	-2.7%	0.0032	0.0016	-49.6%
ACS0614	D1	1617003-6	75.3	6/14/17 12:52	42	10005	8.28	4.93	1205.44	0.3789	0.3789	3730.13	0.3232	0.3241	0.9732	0.8529	0.8553	-0.9%	0.0041	0.0016	-60.3%
ACS0614	D2	1617003-6	75.3	6/14/17 13:09	24	10015	8.34	2.78	1199.23	0.3923	0.3923	3730.12	0.3215	0.3355	0.9682	0.8195	0.8553	-4.2%	0.0023	0.0016	-30.1%
ACS0614	D3	1617003-6	75.3	6/14/17 13:35	49	10018	8.32	5.80	1202.48	0.3833	0.3833	3730.12	0.3278	0.3378	0.9634	0.8410	0.8553	-1.7%	0.0048	0.0016	-66.4%
ACS0614	D4	1617003-6	75.3	6/14/17 13:52	39	10004	8.42	4.46	1186.46	0.3931	0.3931	3730.12	0.3181	0.3362	0.9461	0.8091	0.8553	-5.4%	0.0038	0.0016	-56.8%
ACS0614	D4	1617003-6	75.3	6/14/17 14:20	53	10016	8.44	6.18	1185.12	0.3820	0.3820	3730.11	0.3177	0.3267	0.9725	0.8317	0.8553	-2.8%	0.0052	0.0016	-68.9%

LB4100C Beta Attenuation Curve -- Cs137

Spike Information	
Std. ID	1019.40958.83
Ref. Date	2/9/2015
Half-life	30.1 yrs
Activity	3837.10 dpm/mL
Vol.	1.0 mL
Act. Added	3837.10 dpm

Attenuation Equation	
$y = b \cdot m^a$	$y = b \cdot x^m$
b = 0.9526	b = 2.06E-06
m = 0.9985	m = 0.0015
a = 0.9766	
% Diff Max. = 9.0%	

Cross-Talk Equation	
$y = b \cdot x^m$	$y = b \cdot x^m$
b = 0.9526	b = 2.06E-06
m = 0.9985	m = 0.0015
a = 0.9766	
% Diff Max. = 78.0%	

File ID	Detector ID	Sample ID	Mass (mg)	Count Date	Alpha Counts	Beta Counts	Count Time	Alpha CPM	Beta CPM	Base Beta Eff	Decay Corr. added dpm/mL	Beta Att. Eff	Beta Att. Fitted	Actual/Fit Ratio	Obs. Atten Fact.	Fitted Atten Fact.	% Diff.	$\beta > \alpha$ Tlk Actual	$\beta > \alpha$ Tlk Fitted	% Diff.
ACS0614	A1	1617003-7	95.8	6/14/17 14:49	35	10007	8.48	4.05	1176.63	0.4013	3730.11	0.3160	0.3333	0.9481	0.7874	0.8305	-5.2%	0.0034	0.0017	-51.5%
ACS0614	A2	1617003-7	95.8	6/14/17 15:03	45	10022	8.29	5.33	1207.59	0.3970	3730.10	0.3237	0.3281	0.9868	0.8196	0.8305	-1.3%	0.0044	0.0017	-62.3%
ACS0614	A3	1617003-7	95.8	6/14/17 15:18	45	10024	8.26	5.35	1212.05	0.3978	3730.10	0.3237	0.3304	0.9835	0.8168	0.8305	-1.8%	0.0044	0.0017	-62.3%
ACS0614	B1	1617003-7	95.8	6/14/17 15:41	41	10020	8.32	4.84	1202.79	0.3938	3730.10	0.3225	0.3271	0.9859	0.8188	0.8305	-1.4%	0.0040	0.0017	-58.7%
ACS0614	B2	1617003-7	95.8	6/14/17 15:56	37	10015	8.55	4.24	1169.73	0.3934	3730.10	0.3136	0.3267	0.9598	0.7971	0.8305	-4.0%	0.0036	0.0017	-54.0%
ACS0614	B3	1617003-7	95.8	6/14/17 16:11	37	10007	8.31	4.34	1202.56	0.3907	3730.09	0.3224	0.3245	0.9935	0.8252	0.8305	-0.8%	0.0036	0.0017	-53.8%
ACS0614	B4	1617003-7	95.8	6/14/17 11:26	27	10009	8.47	3.10	1180.16	0.3859	3730.14	0.3164	0.3205	0.9871	0.8199	0.8305	-1.3%	0.0026	0.0017	-36.7%
ACS0614	C1	1617003-7	95.8	6/14/17 11:42	32	10011	8.40	3.71	1190.19	0.3888	3730.14	0.3164	0.3205	0.9871	0.8199	0.8305	-1.3%	0.0026	0.0017	-36.7%
ACS0614	C2	1617003-7	95.8	6/14/17 11:55	35	10015	8.48	4.02	1179.47	0.3984	3730.13	0.3162	0.3229	0.9881	0.8207	0.8305	-1.2%	0.0031	0.0017	-46.6%
ACS0614	C3	1617003-7	95.8	6/14/17 12:11	29	10003	8.31	3.38	1202.07	0.3953	3730.13	0.3223	0.3309	0.9556	0.7937	0.8305	-4.4%	0.0034	0.0017	-51.1%
ACS0614	C4	1617003-7	95.8	6/14/17 12:25	31	10017	8.40	3.59	1189.67	0.3921	3730.13	0.3189	0.3257	0.9816	0.8152	0.8305	-1.8%	0.0028	0.0017	-40.7%
ACS0614	D1	1617003-7	95.8	6/14/17 12:38	41	10011	8.27	4.82	1207.62	0.3789	3730.13	0.3237	0.3147	1.0288	0.8544	0.8305	-2.1%	0.0030	0.0017	-44.9%
ACS0614	D2	1617003-7	95.8	6/14/17 12:53	32	10009	8.66	3.60	1154.16	0.3923	3730.13	0.3094	0.3258	0.9497	0.7887	0.8305	-5.0%	0.0031	0.0017	-58.2%
ACS0614	D3	1617003-7	95.8	6/14/17 13:10	43	10007	8.70	4.86	1148.62	0.3833	3730.12	0.3079	0.3183	0.9673	0.8034	0.8305	-3.3%	0.0042	0.0017	-46.8%
ACS0614	D4	1617003-7	95.8	6/14/17 13:35	23	10010	8.47	2.54	1180.15	0.3931	3730.12	0.3164	0.3265	0.9691	0.8048	0.8305	-3.1%	0.0022	0.0017	-22.8%
ACS0614	A1	1617003-8	102.6	6/14/17 14:35	43	10034	8.61	4.89	1160.30	0.3820	3730.12	0.3111	0.3173	0.9805	0.8143	0.8305	-2.0%	0.0042	0.0017	-60.5%
ACS0614	A2	1617003-8	102.6	6/14/17 14:50	25	10002	8.86	2.74	1127.46	0.4013	3730.11	0.3023	0.3301	0.9158	0.7632	0.8225	-8.4%	0.0024	0.0017	-31.0%
ACS0614	A3	1617003-8	102.6	6/14/17 15:04	31	10013	8.82	3.42	1133.92	0.3950	3730.11	0.3040	0.3249	0.9357	0.7696	0.8225	-6.4%	0.0030	0.0017	-44.3%
ACS0614	A4	1617003-8	102.6	6/14/17 15:18	37	10003	8.89	4.07	1123.69	0.3978	3730.10	0.3012	0.3272	0.9207	0.7573	0.8225	-7.9%	0.0036	0.0017	-53.6%
ACS0614	B1	1617003-8	102.6	6/14/17 15:42	38	10011	8.99	4.14	1111.96	0.3938	3730.10	0.3057	0.3239	0.9439	0.7764	0.8225	-8.6%	0.0035	0.0017	-52.4%
ACS0614	B2	1617003-8	102.6	6/14/17 15:56	40	10011	8.99	4.19	1111.96	0.3934	3730.10	0.2981	0.3236	0.9213	0.7578	0.8225	-7.9%	0.0037	0.0017	-54.8%
ACS0614	B3	1617003-8	102.6	6/14/17 16:12	20	10006	9.11	2.11	1096.81	0.3907	3730.10	0.2955	0.3213	0.9174	0.7562	0.8225	-8.1%	0.0019	0.0017	-56.9%
ACS0614	B4	1617003-8	102.6	6/14/17 11:27	43	10006	9.03	4.66	1106.49	0.3888	3730.09	0.2940	0.3174	0.9264	0.7620	0.8225	-7.4%	0.0019	0.0017	-12.8%
ACS0614	C1	1617003-8	102.6	6/14/17 11:42	38	10010	8.96	4.13	1115.65	0.3984	3730.14	0.2991	0.3277	0.9128	0.7507	0.8225	-7.2%	0.0042	0.0017	-60.1%
ACS0614	C2	1617003-8	102.6	6/14/17 11:56	20	10026	8.76	2.17	1142.86	0.3953	3730.13	0.3064	0.3251	0.9424	0.7751	0.8225	-8.7%	0.0037	0.0017	-54.6%
ACS0614	C3	1617003-8	102.6	6/14/17 12:11	33	10007	8.81	3.65	1134.23	0.3921	3730.13	0.3041	0.3225	0.9429	0.7755	0.8225	-5.8%	0.0019	0.0017	-11.6%
ACS0614	C4	1617003-8	102.6	6/14/17 12:25	34	10012	8.89	3.68	1123.31	0.3789	3730.13	0.3011	0.3116	0.9663	0.7948	0.8225	-5.7%	0.0032	0.0017	-47.8%
ACS0614	D1	1617003-8	102.6	6/14/17 12:39	37	10011	9.00	4.02	1110.72	0.3923	3730.13	0.2978	0.3227	0.9229	0.7590	0.8225	-3.4%	0.0033	0.0017	-48.8%
ACS0614	D2	1617003-8	102.6	6/14/17 12:53	45	10011	9.19	4.81	1087.73	0.3833	3730.13	0.2916	0.3153	0.9250	0.7608	0.8225	-7.7%	0.0036	0.0017	-53.6%
ACS0614	D3	1617003-8	102.6	6/14/17 13:10	36	10000	8.84	3.90	1129.56	0.3931	3730.12	0.3028	0.3233	0.9366	0.7703	0.8225	-6.3%	0.0044	0.0017	-62.0%
ACS0614	D4	1617003-8	102.6	6/14/17 13:36	37	10007	9.13	3.95	1094.45	0.3820	3730.12	0.2934	0.3142	0.9339	0.7681	0.8225	-6.5%	0.0035	0.0017	-51.4%
ACS0614	A1	1617003-9	129.6	6/14/17 14:20	29	10021	8.70	3.26	1150.40	0.4013	3730.11	0.3084	0.3176	0.9172	0.7686	0.8225	-2.9%	0.0037	0.0017	-53.7%
ACS0614	A2	1617003-9	129.6	6/14/17 14:35	38	10012	8.72	4.26	1146.83	0.3950	3730.11	0.3075	0.3126	0.9836	0.7784	0.7913	-1.6%	0.0037	0.0017	-53.3%
ACS0614	A3	1617003-9	129.6	6/14/17 14:49	31	10008	8.68	3.52	1164.92	0.3978	3730.11	0.3123	0.3148	0.9821	0.7851	0.7913	-0.8%	0.0030	0.0017	-42.5%
ACS0614	A4	1617003-9	129.6	6/14/17 15:04	41	10002	8.61	4.68	1160.14	0.3938	3730.10	0.3110	0.3116	0.9881	0.7898	0.7913	-0.2%	0.0040	0.0017	-57.0%
ACS0614	B1	1617003-9	129.6	6/14/17 15:18	43	10007	8.70	4.85	1148.62	0.3934	3730.10	0.3079	0.3113	0.9892	0.7827	0.7913	-1.1%	0.0042	0.0017	-58.9%
ACS0614	B2	1617003-9	129.6	6/14/17 15:42	39	10019	8.87	4.28	1127.89	0.3907	3730.10	0.3024	0.3082	0.9780	0.7739	0.7913	-2.2%	0.0038	0.0017	-54.3%
ACS0614	B3	1617003-9	129.6	6/14/17 15:56	38	10008	8.71	4.28	1147.48	0.3859	3730.10	0.3076	0.3054	1.0074	0.7972	0.7913	0.7%	0.0037	0.0017	-53.5%
ACS0614	B4	1617003-9	129.6	6/14/17 16:11	39	10004	8.79	4.34	1136.52	0.3888	3730.09	0.3047	0.3077	0.9903	0.7837	0.7913	-1.0%	0.0038	0.0017	-53.5%
ACS0614	C1	1617003-9	129.6	6/14/17 11:26	49	10008	8.87	5.41	1126.76	0.3984	3730.14	0.3021	0.3153	0.9582	0.7582	0.7913	-4.2%	0.0048	0.0017	-54.5%
ACS0614	C2	1617003-9	129.6	6/14/17 11:42	23	10012	8.62	2.56	1159.83	0.3953	3730.14	0.3061	0.3128	0.9940	0.7866	0.7913	-0.6%	0.0022	0.0017	-31.3%
ACS0614	C3	1617003-9	129.6	6/14/17 11:56	27	10005	8.75	2.99	1141.79	0.3921	3730.13	0.3019	0.3103	0.9866	0.7807	0.7913	-1.3%	0.0026	0.0017	-33.7%
ACS0614	C4	1617003-9	129.6	6/14/17 12:11	36	9999	8.66	4.02	1151.72	0.3789	3730.13	0.3088	0.2988	1.0298	0.8149	0.7913	3.0%	0.0035	0.0017	-50.2%
ACS0614	D1	1617003-9	129.6	6/14/17 12:25	30	10009	8.94	3.26	1177.96	0.3923	3730.13	0.2987	0.3104	0.9655	0.7640	0.7913	-3.5%	0.0029	0.0017	-40.5%
ACS0614	D2	1617003-9	129.6	6/14/17 12:39	47	10018	8.79	5.26	1138.10	0.3833	3730.13	0.3051	0.3033	1.0059	0.7960	0.7913	0.6%	0.0046	0.0017	-62.5%
ACS0614	D3	1617003-9	129.6	6/14/17 12:53	23	10002	8.94	2.40	1117.13	0.3931	3730.13	0.2995	0.3111	0.9628	0.7619	0.7913	-3.7%	0.0021	0.0017	-19.3%
ACS0614	D4	1617003-9	129.6	6/14/17 13:10	50	10004	8.75	5.61	1141.71	0.3820	3730.12	0.3061	0.3023	1.0126	0.8013	0.7913	1.3%	0.0049	0.0017	-64.7%

LB4100C Beta Attenuation Curve -- Cs137

WO # 1617003		Spike Information				Attenuation Equation				Cross-Talk Equation				y=b*x+m						
Mass Range		Std. ID 1019-04965.83				y=b* π m ^{1/2} (a*x)				b = 0.9526				m = 0.0015						
Low	mg	Ref. Date 29/2015				b = 0.9985				b = 0.9985										
High	299.7	Half-life 30.1				m = 0.9766				m = 0.9766										
		Activity 3937.10				a = 0.9766														
		Vol. 1.0																		
		Act. Added 3937.10																		
		dpm																		
File ID	Detector ID	Sample ID	Mass (mg)	Count Date	Alpha Counts	Beta Counts	Count Time	Alpha CPM	Beta CPM	Base Beta Eff.	Decay Corr. Act. added dpm/mL	Beta Att. Eff Actual	Beta Att. Fitted	Actual/Fit Ratio	Obs Atten Fact.	Fitted Atten Fact.	% Diff.	$\beta > \alpha \times \text{Titk}$ Actual	$\beta > \alpha \times \text{Titk}$ Fitted	% Diff.
ACS0614 A1	1617003-10	1617003-10	139	614/17 13:52	25	10022	8.72	2.79	1147.88	0.4013	3730.12	0.3077	0.3133	0.9822	0.7668	0.7607	-1.8%	0.0024	0.0018	-27.8%
ACS0614 A2	1617003-10	1617003-10	139	614/17 14:20	34	10005	8.78	3.78	1138.19	0.3950	3730.11	0.3051	0.3084	0.9894	0.7725	0.7807	-1.1%	0.0033	0.0018	-47.1%
ACS0614 A3	1617003-10	1617003-10	139	614/17 14:35	34	10016	8.60	3.86	1163.14	0.3978	3730.11	0.3118	0.3106	1.0040	0.7839	0.7807	0.4%	0.0033	0.0018	-47.1%
ACS0614 B1	1617003-10	1617003-10	139	614/17 14:49	44	10012	8.74	4.95	1144.01	0.3938	3730.11	0.3067	0.3075	0.9935	0.7788	0.7807	-0.2%	0.0043	0.0018	-58.5%
ACS0614 B2	1617003-10	1617003-10	139	614/17 15:04	39	10012	8.78	4.45	1138.71	0.3934	3730.10	0.3053	0.3071	0.9939	0.7760	0.7807	-0.6%	0.0038	0.0018	-54.1%
ACS0614 B3	1617003-10	1617003-10	139	614/17 15:18	37	10015	8.79	4.09	1137.71	0.3907	3730.10	0.3050	0.3050	0.9999	0.7807	0.7807	0.0%	0.0036	0.0018	-51.2%
ACS0614 B4	1617003-10	1617003-10	139	614/17 15:42	34	10014	8.93	3.72	1119.84	0.3859	3730.10	0.3002	0.3013	0.9965	0.7780	0.7807	-0.4%	0.0033	0.0018	-47.2%
ACS0614 C1	1617003-10	1617003-10	139	614/17 15:56	32	10008	8.85	3.52	1129.26	0.3888	3730.10	0.3027	0.3035	0.9973	0.7787	0.7807	-0.3%	0.0031	0.0018	-43.6%
ACS0614 C2	1617003-10	1617003-10	139	614/17 11:26	26	10020	8.65	3.24	1157.07	0.3984	3730.09	0.3102	0.3110	0.9973	0.7786	0.7807	-0.3%	0.0028	0.0018	-37.4%
ACS0614 C3	1617003-10	1617003-10	139	614/17 11:42	26	10007	9.00	2.79	1170.25	0.3953	3730.14	0.3145	0.3086	1.0189	0.7955	0.7807	1.9%	0.0025	0.0018	-29.9%
ACS0614 C4	1617003-10	1617003-10	139	614/17 11:56	32	10005	8.63	3.57	1156.43	0.3921	3730.14	0.2976	0.3061	0.9723	0.7591	0.7807	-2.8%	0.0025	0.0018	-30.3%
ACS0614 D1	1617003-10	1617003-10	139	614/17 12:11	50	10005	8.83	5.57	1156.43	0.3789	3730.13	0.3100	0.2958	1.0480	0.8182	0.7807	4.8%	0.0031	0.0018	-43.1%
ACS0614 D2	1617003-10	1617003-10	139	614/17 12:25	48	10024	8.85	5.34	1131.05	0.3923	3730.13	0.3033	0.3063	0.9904	0.7732	0.7807	-1.0%	0.0049	0.0018	-64.3%
ACS0614 D3	1617003-10	1617003-10	139	614/17 12:39	35	10010	8.93	3.75	1119.28	0.3853	3730.13	0.3032	0.2993	1.0133	0.7911	0.7807	1.3%	0.0047	0.0018	-62.8%
ACS0614 D4	1617003-10	1617003-10	139	614/17 12:53	50	10005	8.91	5.51	1121.92	0.3931	3730.13	0.3001	0.3069	0.9777	0.7633	0.7807	-2.2%	0.0033	0.0018	-47.6%
ACS0614 A1	1617003-11	1617003-11	164	614/17 13:36	27	10002	8.88	2.96	1124.92	0.4013	3730.12	0.3016	0.3021	0.9992	0.7515	0.7529	-0.2%	0.0026	0.0018	-31.4%
ACS0614 A2	1617003-11	1617003-11	164	614/17 13:52	33	10015	8.78	3.66	1139.32	0.3950	3730.12	0.3054	0.2974	1.0271	0.7733	0.7529	2.7%	0.0032	0.0018	-43.8%
ACS0614 A3	1617003-11	1617003-11	164	614/17 14:20	28	10021	8.86	3.06	1129.53	0.3978	3730.11	0.3028	0.2985	1.0111	0.7612	0.7529	1.1%	0.0027	0.0018	-33.4%
ACS0614 A4	1617003-11	1617003-11	164	614/17 14:35	35	10007	8.96	3.82	1115.32	0.3938	3730.11	0.2990	0.2965	1.0085	0.7593	0.7529	0.9%	0.0034	0.0018	-47.3%
ACS0614 B1	1617003-11	1617003-11	164	614/17 14:50	34	10005	8.94	3.71	1117.51	0.3934	3730.11	0.2996	0.2962	1.0115	0.7615	0.7529	1.2%	0.0033	0.0018	-45.6%
ACS0614 B2	1617003-11	1617003-11	164	614/17 15:18	34	10008	9.01	3.66	1109.12	0.3907	3730.10	0.2973	0.2941	1.0109	0.7610	0.7529	1.1%	0.0033	0.0018	-45.2%
ACS0614 B3	1617003-11	1617003-11	164	614/17 15:18	43	10003	9.06	4.66	1102.54	0.3859	3730.10	0.2956	0.2905	1.0174	0.7659	0.7529	1.7%	0.0042	0.0018	-57.3%
ACS0614 B4	1617003-11	1617003-11	164	614/17 15:42	32	10007	9.11	3.41	1096.87	0.3888	3730.10	0.2941	0.2927	1.0046	0.7563	0.7529	0.5%	0.0031	0.0018	-41.9%
ACS0614 C1	1617003-11	1617003-11	164	614/17 15:57	23	10011	8.86	2.49	1128.71	0.3984	3730.10	0.3026	0.2989	1.0089	0.7596	0.7529	0.9%	0.0022	0.0018	-18.0%
ACS0614 C2	1617003-11	1617003-11	164	614/17 16:12	31	10014	8.98	3.34	1113.15	0.3953	3730.09	0.2984	0.2976	1.0028	0.7549	0.7529	0.3%	0.0030	0.0018	-39.8%
ACS0614 C3	1617003-11	1617003-11	164	614/17 11:27	18	10010	9.07	1.89	1102.00	0.3921	3730.14	0.2954	0.2952	1.0008	0.7535	0.7529	0.1%	0.0017	0.0018	5.4%
ACS0614 C4	1617003-11	1617003-11	164	614/17 11:42	33	10005	8.91	3.56	1120.00	0.3789	3730.14	0.3003	0.2853	1.0526	0.7924	0.7529	5.3%	0.0032	0.0018	-43.2%
ACS0614 D1	1617003-11	1617003-11	164	614/17 11:56	31	10008	9.06	3.33	1103.02	0.3923	3730.13	0.2957	0.2953	1.0012	0.7538	0.7529	0.1%	0.0030	0.0018	-40.2%
ACS0614 D2	1617003-11	1617003-11	164	614/17 12:12	45	10004	8.97	4.93	1113.67	0.3833	3730.13	0.2986	0.2866	1.0346	0.7899	0.7529	3.5%	0.0044	0.0018	-58.2%
ACS0614 D3	1617003-11	1617003-11	164	614/17 12:25	27	10004	8.97	2.84	1113.61	0.3931	3730.13	0.2985	0.2959	1.0088	0.7585	0.7529	0.9%	0.0025	0.0018	-29.1%
ACS0614 D4	1617003-11	1617003-11	164	614/17 12:39	42	10007	9.11	4.51	1096.86	0.3820	3730.13	0.2941	0.2876	1.0225	0.7698	0.7529	2.2%	0.0041	0.0018	-56.0%
ACS0614 A1	1617003-12	1617003-12	181	614/17 13:10	38	10014	9.21	3.83	1085.86	0.4013	3730.12	0.2911	0.2904	0.9967	0.7254	0.7352	-1.3%	0.0035	0.0018	-47.8%
ACS0614 A2	1617003-12	1617003-12	181	614/17 13:36	26	10011	9.44	2.87	1059.15	0.3950	3730.12	0.2839	0.2904	0.9778	0.7189	0.7352	-2.2%	0.0027	0.0018	-32.1%
ACS0614 A3	1617003-12	1617003-12	181	614/17 13:52	25	10008	9.30	2.59	1074.62	0.3978	3730.12	0.2881	0.2925	0.9851	0.7242	0.7352	-1.5%	0.0024	0.0018	-23.7%
ACS0614 A4	1617003-12	1617003-12	181	614/17 14:20	41	10015	9.16	4.39	1091.81	0.3938	3730.11	0.2927	0.2895	1.0110	0.7433	0.7352	1.1%	0.0040	0.0018	-64.2%
ACS0614 B1	1617003-12	1617003-12	181	614/17 14:36	40	10007	9.42	4.16	1060.70	0.3934	3730.11	0.2844	0.2892	0.9832	0.7228	0.7352	-1.7%	0.0039	0.0018	-53.0%
ACS0614 B2	1617003-12	1617003-12	181	614/17 14:50	35	10007	9.32	3.64	1072.06	0.3907	3730.11	0.2874	0.2872	1.0006	0.7356	0.7352	0.1%	0.0034	0.0018	-45.8%
ACS0614 B3	1617003-12	1617003-12	181	614/17 15:04	34	10007	9.43	3.52	1059.64	0.3859	3730.10	0.2841	0.2837	1.0013	0.7361	0.7352	0.1%	0.0033	0.0018	-44.6%
ACS0614 B4	1617003-12	1617003-12	181	614/17 15:19	43	10012	9.47	4.44	1055.64	0.3888	3730.10	0.2830	0.2858	0.9901	0.7279	0.7352	-1.0%	0.0042	0.0018	-56.2%
ACS0614 C1	1617003-12	1617003-12	181	614/17 15:42	34	10011	9.23	3.57	1085.08	0.3984	3730.10	0.2904	0.2929	0.9913	0.7288	0.7352	-0.9%	0.0033	0.0018	-44.2%
ACS0614 C2	1617003-12	1617003-12	181	614/17 15:57	23	10010	9.19	2.39	1087.57	0.3953	3730.10	0.2916	0.2906	1.0033	0.7376	0.7352	0.3%	0.0022	0.0018	-16.2%
ACS0614 C3	1617003-12	1617003-12	181	614/17 16:12	32	10006	9.28	3.35	1076.59	0.3921	3730.10	0.2886	0.2883	1.0012	0.7361	0.7352	0.1%	0.0031	0.0018	-40.9%
ACS0614 C4	1617003-12	1617003-12	181	614/17 11:27	31	10015	9.29	3.20	1075.14	0.3789	3730.14	0.2882	0.2786	1.0347	0.7607	0.7352	3.5%	0.0030	0.0018	-38.1%
ACS0614 D1	1617003-12	1617003-12	181	614/17 11:43	27	10011	9.29	2.76	1055.51	0.3923	3730.14	0.2830	0.2884	0.9811	0.7213	0.7352	-1.9%	0.0026	0.0018	-29.5%
ACS0614 D2	1617003-12	1617003-12	181	614/17 11:56	36	10001	9.29	3.79	1074.93	0.3933	3730.13	0.2882	0.2818	1.0226	0.7518	0.7352	2.3%	0.0035	0.0018	-47.8%
ACS0614 D3	1617003-12	1617003-12	181	614/17 12:12	26	10001	9.60	2.54	1040.11	0.3931	3730.13	0.2788	0.2890	0.9648	0.7093	0.7352	-3.5%	0.0024	0.0018	-24.5%
ACS0614 D4	1617003-12	1617003-12	181	614/17 12:26	29	10002	9.46	2.96	1055.69	0.3920	3730.13	0.2830	0.2800	1.0078	0.7409	0.7352	0.7%	0.0028	0.0018	-34.4%

LB4100C Beta Attenuation Curve -- Cs137

Spike Information	
Std. ID	1019.4095.83
Ref. Date	2/9/2015
Half-life	30.1 yrs
Activity	3937.10 dpm/mL
Vol.	1.0 mL
Act. Added	3937.10 dpm

Attenuation Equation	
b =	0.9526
m =	0.9985
a =	0.9766

Cross-Talk Equation	
b =	2.06E-06
m =	0.0015

File ID	Detector ID	Sample ID	Mass (mg)	Count Date	Alpha Counts	Beta Counts	Count Time	Alpha CPM	Beta CPM	Base Beta Eff	Decay Corr. Act. added dpm/mL	Eff Beta Att.	Beta Att. Fitted	Actual/Fit Ratio	Obs Atten Fact.	Fitted Atten Fact.	% Diff.	$\beta > \alpha \times \text{Titk}$ Actual	$\beta > \alpha \times \text{Titk}$ Fitted	% Diff.
ACS0614	A1	1617003-13	195.7	6/14/17 12:53	35	10017	9.12	3.76	1096.92	0.4013	3730.13	0.2941	0.2889	1.0180	0.7328	0.7189	1.8%	0.0034	0.0019	-45.4%
ACS0614	A2	1617003-13	195.7	6/14/17 13:10	37	10018	9.15	3.95	1093.53	0.3970	3730.12	0.2932	0.2843	1.0304	0.7422	0.7199	3.1%	0.0036	0.0019	-48.2%
ACS0614	A3	1617003-13	195.7	6/14/17 13:36	28	10005	9.31	2.91	1073.14	0.3978	3730.12	0.2877	0.2864	1.0047	0.7232	0.7199	0.5%	0.0027	0.0019	-31.0%
ACS0614	B1	1617003-13	195.7	6/14/17 13:52	38	10020	8.98	4.15	1114.28	0.3938	3730.12	0.2987	0.2935	1.0538	0.7586	0.7199	5.4%	0.0037	0.0019	-49.7%
ACS0614	B2	1617003-13	195.7	6/14/17 14:20	37	10016	9.15	3.95	1093.03	0.3934	3730.11	0.2930	0.2832	1.0347	0.7449	0.7199	3.5%	0.0036	0.0019	-48.3%
ACS0614	B3	1617003-13	195.7	6/14/17 14:36	30	10006	9.16	3.16	1090.71	0.3907	3730.11	0.2924	0.2813	1.0397	0.7484	0.7199	4.0%	0.0029	0.0019	-35.4%
ACS0614	B4	1617003-13	195.7	6/14/17 14:50	47	10009	9.35	4.94	1088.94	0.3859	3730.11	0.2866	0.2778	1.0316	0.7426	0.7199	3.2%	0.0046	0.0019	-59.5%
ACS0614	C1	1617003-13	195.7	6/14/17 15:04	41	10003	9.28	4.32	1076.32	0.3888	3730.10	0.2885	0.2799	1.0310	0.7422	0.7199	3.1%	0.0040	0.0019	-53.4%
ACS0614	C2	1617003-13	195.7	6/14/17 15:19	35	10007	9.04	3.76	1105.43	0.3994	3730.10	0.2964	0.2868	1.0333	0.7439	0.7199	3.3%	0.0034	0.0019	-45.0%
ACS0614	C3	1617003-13	195.7	6/14/17 15:42	22	10011	9.03	2.32	1106.98	0.3953	3730.10	0.2968	0.2846	1.0429	0.7507	0.7199	4.3%	0.0021	0.0019	-10.9%
ACS0614	C4	1617003-13	195.7	6/14/17 15:57	39	10012	9.21	4.14	1085.44	0.3921	3730.10	0.2910	0.2823	1.0309	0.7421	0.7199	3.1%	0.0038	0.0019	-50.9%
ACS0614	D1	1617003-13	195.7	6/14/17 16:12	30	10013	9.21	3.12	1084.29	0.3789	3730.09	0.2907	0.2728	1.0657	0.7672	0.7199	6.6%	0.0029	0.0019	-34.9%
ACS0614	D2	1617003-13	195.7	6/14/17 11:27	20	10009	9.50	2.01	1051.96	0.3823	3730.14	0.2820	0.2824	0.9986	0.7189	0.7199	-0.1%	0.0019	0.0019	-2.1%
ACS0614	D3	1617003-13	195.7	6/14/17 11:43	33	10009	9.30	3.46	1074.63	0.3833	3730.14	0.2881	0.2759	1.0441	0.7516	0.7199	4.4%	0.0032	0.0019	-41.9%
ACS0614	D4	1617003-13	195.7	6/14/17 11:56	20	10005	9.32	1.97	1071.83	0.3931	3730.13	0.2873	0.2830	1.0154	0.7310	0.7199	1.5%	0.0018	0.0019	1.6%
ACS0614	A1	1617003-14	239.1	6/14/17 12:12	37	10015	9.31	3.87	1074.12	0.3820	3730.13	0.2880	0.2750	1.0472	0.7538	0.7199	4.7%	0.0036	0.0019	-48.1%
ACS0614	A2	1617003-14	239.1	6/14/17 12:40	19	10003	10.27	1.77	972.57	0.4013	3730.13	0.2807	0.2715	1.0604	0.6497	0.6765	-4.0%	0.0018	0.0020	7.6%
ACS0614	A3	1617003-14	239.1	6/14/17 12:54	22	10003	10.16	2.07	983.21	0.3950	3730.12	0.2836	0.2672	1.0964	0.6673	0.6765	-1.4%	0.0021	0.0020	-6.9%
ACS0614	A4	1617003-14	239.1	6/14/17 13:11	30	10019	10.19	2.85	981.71	0.3978	3730.12	0.2832	0.2691	1.0780	0.6616	0.6765	-2.2%	0.0029	0.0020	-32.4%
ACS0614	B1	1617003-14	239.1	6/14/17 13:37	47	10008	10.30	4.48	970.12	0.3938	3730.12	0.2801	0.2664	1.0962	0.6804	0.6765	-2.4%	0.0046	0.0020	-57.5%
ACS0614	B2	1617003-14	239.1	6/14/17 13:53	44	10004	10.23	4.21	976.30	0.3934	3730.11	0.2817	0.2661	1.0934	0.6653	0.6765	-1.7%	0.0043	0.0020	-54.5%
ACS0614	B3	1617003-14	239.1	6/14/17 14:21	34	10002	10.57	3.10	944.61	0.3907	3730.11	0.2832	0.2643	1.0981	0.6482	0.6765	-4.2%	0.0033	0.0020	-40.2%
ACS0614	B4	1617003-14	239.1	6/14/17 14:37	30	10006	10.43	2.85	977.12	0.3859	3730.11	0.2820	0.2611	1.0934	0.6788	0.6765	-0.3%	0.0029	0.0020	-32.8%
ACS0614	C1	1617003-14	239.1	6/14/17 14:51	41	10006	10.43	3.83	957.76	0.3888	3730.11	0.2868	0.2630	1.0962	0.6604	0.6765	-2.4%	0.0040	0.0020	-51.0%
ACS0614	C2	1617003-14	239.1	6/14/17 15:05	26	10005	10.12	2.46	987.10	0.3984	3730.10	0.2846	0.2695	1.0918	0.6642	0.6765	-1.8%	0.0025	0.0020	-21.3%
ACS0614	C3	1617003-14	239.1	6/14/17 15:20	25	10006	10.04	2.38	994.95	0.3953	3730.10	0.2867	0.2674	1.0974	0.6748	0.6765	-0.3%	0.0024	0.0020	-18.0%
ACS0614	C4	1617003-14	239.1	6/14/17 15:43	36	10003	10.05	3.49	993.68	0.3921	3730.10	0.2864	0.2653	1.0943	0.6794	0.6765	-0.4%	0.0035	0.0020	-44.1%
ACS0614	D1	1617003-14	239.1	6/14/17 15:58	46	10008	10.34	4.31	964.99	0.3789	3730.09	0.2587	0.2563	1.0093	0.6828	0.6765	0.9%	0.0045	0.0020	-56.1%
ACS0614	D2	1617003-14	239.1	6/14/17 16:14	29	10007	10.54	2.66	947.82	0.3923	3730.09	0.2541	0.2544	0.9974	0.6477	0.6765	-4.3%	0.0028	0.0020	-30.0%
ACS0614	D3	1617003-14	239.1	6/14/17 11:28	38	10007	10.35	3.58	965.25	0.3833	3730.14	0.2588	0.2593	0.9979	0.6751	0.6765	-0.2%	0.0037	0.0020	-47.2%
ACS0614	D4	1617003-14	239.1	6/14/17 11:44	13	10011	10.56	1.06	946.35	0.3931	3730.14	0.2537	0.2659	0.9540	0.6454	0.6765	-4.6%	0.0011	0.0020	75.1%
ACS0614	A1	1617003-15	252.6	6/14/17 11:57	37	10004	10.45	3.44	955.71	0.3820	3730.13	0.2862	0.2584	1.0914	0.6707	0.6765	-0.9%	0.0036	0.0020	-45.5%
ACS0614	A2	1617003-15	252.6	6/14/17 12:26	28	10007	9.97	2.73	1002.28	0.4013	3730.13	0.2887	0.2663	1.0900	0.6896	0.6636	0.3%	0.0027	0.0020	-27.0%
ACS0614	A3	1617003-15	252.6	6/14/17 12:40	28	10011	9.82	2.76	1018.11	0.3950	3730.13	0.2729	0.2621	1.0413	0.6910	0.6636	4.1%	0.0027	0.0020	-26.6%
ACS0614	A4	1617003-15	252.6	6/14/17 12:54	28	10013	9.75	2.78	1025.46	0.3978	3730.12	0.2749	0.2640	1.0415	0.6911	0.6636	4.1%	0.0027	0.0020	-26.6%
ACS0614	B1	1617003-15	252.6	6/14/17 13:10	25	10007	9.57	2.53	1044.13	0.3938	3730.12	0.2799	0.2613	1.0712	0.7108	0.6636	7.1%	0.0024	0.0020	-17.9%
ACS0614	B2	1617003-15	252.6	6/14/17 13:37	34	10004	10.01	3.31	997.79	0.3934	3730.12	0.2675	0.2610	1.0247	0.6800	0.6636	2.5%	0.0033	0.0020	-40.0%
ACS0614	B3	1617003-15	252.6	6/14/17 13:53	34	10002	9.89	3.32	1009.67	0.3907	3730.12	0.2707	0.2593	1.0441	0.6928	0.6636	4.4%	0.0033	0.0020	-39.5%
ACS0614	B4	1617003-15	252.6	6/14/17 14:21	32	10009	9.95	3.13	1004.38	0.3859	3730.11	0.2693	0.2581	1.0515	0.6978	0.6636	5.2%	0.0031	0.0020	-36.2%
ACS0614	C1	1617003-15	252.6	6/14/17 14:36	24	10002	9.73	2.37	1026.36	0.3888	3730.11	0.2752	0.2590	1.0665	0.7077	0.6636	6.7%	0.0023	0.0020	-33.7%
ACS0614	C2	1617003-15	252.6	6/14/17 14:51	27	10012	9.75	2.66	1025.33	0.3984	3730.11	0.2749	0.2644	1.0398	0.6900	0.6636	4.0%	0.0026	0.0020	-23.3%
ACS0614	C3	1617003-15	252.6	6/14/17 15:05	18	10007	9.89	1.71	1010.56	0.3953	3730.10	0.2708	0.2623	1.0324	0.6851	0.6636	3.2%	0.0017	0.0020	17.6%
ACS0614	C4	1617003-15	252.6	6/14/17 15:20	27	10002	9.98	2.61	1000.17	0.3921	3730.10	0.2682	0.2602	1.0310	0.6841	0.6636	3.1%	0.0026	0.0020	-23.7%
ACS0614	D1	1617003-15	252.6	6/14/17 15:43	30	10006	9.96	2.87	1001.72	0.3789	3730.10	0.2686	0.2514	1.0681	0.7088	0.6636	6.8%	0.0029	0.0020	-30.6%
ACS0614	D2	1617003-15	252.6	6/14/17 15:58	33	10013	9.91	3.23	1008.78	0.3923	3730.09	0.2704	0.2603	1.0389	0.6894	0.6636	3.9%	0.0032	0.0020	-38.0%
ACS0614	D3	1617003-15	252.6	6/14/17 16:14	71	10010	10.15	6.91	994.60	0.3833	3730.09	0.2640	0.2543	1.0378	0.6887	0.6636	3.8%	0.0016	0.0020	-71.7%
ACS0614	D4	1617003-15	252.6	6/14/17 11:28	18	10005	10.15	1.60	984.05	0.3931	3730.14	0.2638	0.2608	1.0114	0.6711	0.6636	1.1%	0.0016	0.0020	22.1%
ACS0614	A1	1617003-15	252.6	6/14/17 11:43	32	10004	9.87	3.14	1011.97	0.3820	3730.14	0.2713	0.2535	1.0703	0.7102	0.6636	7.0%	0.0031	0.0020	-35.9%

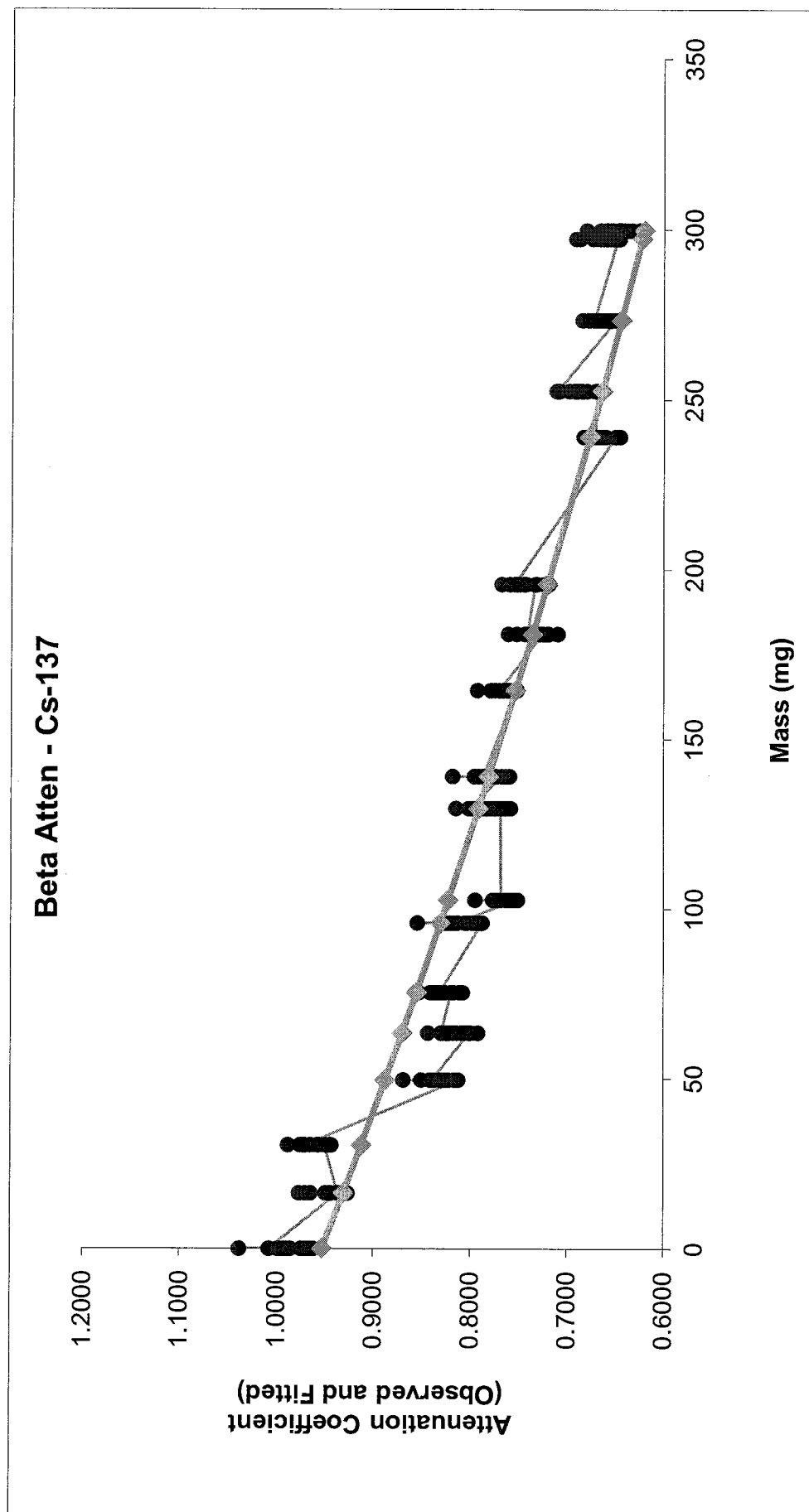
LB4100C Beta Attenuation Curve -- Cs137

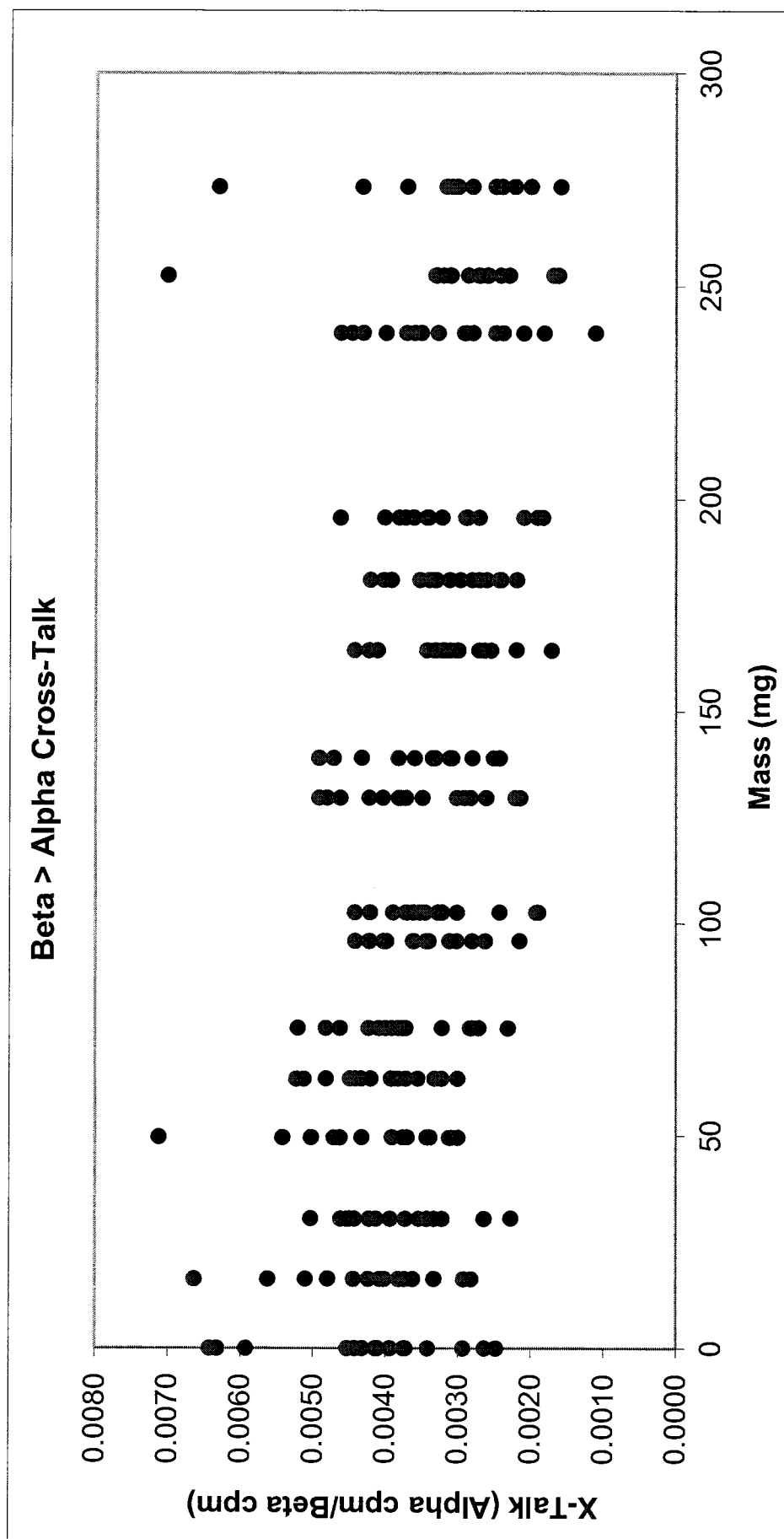
Wt # 1617003		Spike Information	
Mass Range		Std. ID	1019.4095.83
Low 0.0	mg	Ref. Date	2/19/2015
High 299.7	mg	Half-life	30.1 yrs
		Activity	3937.10 dpm/mL
		Vol.	1.0 mL
		Act. Added	3937.10 dpm

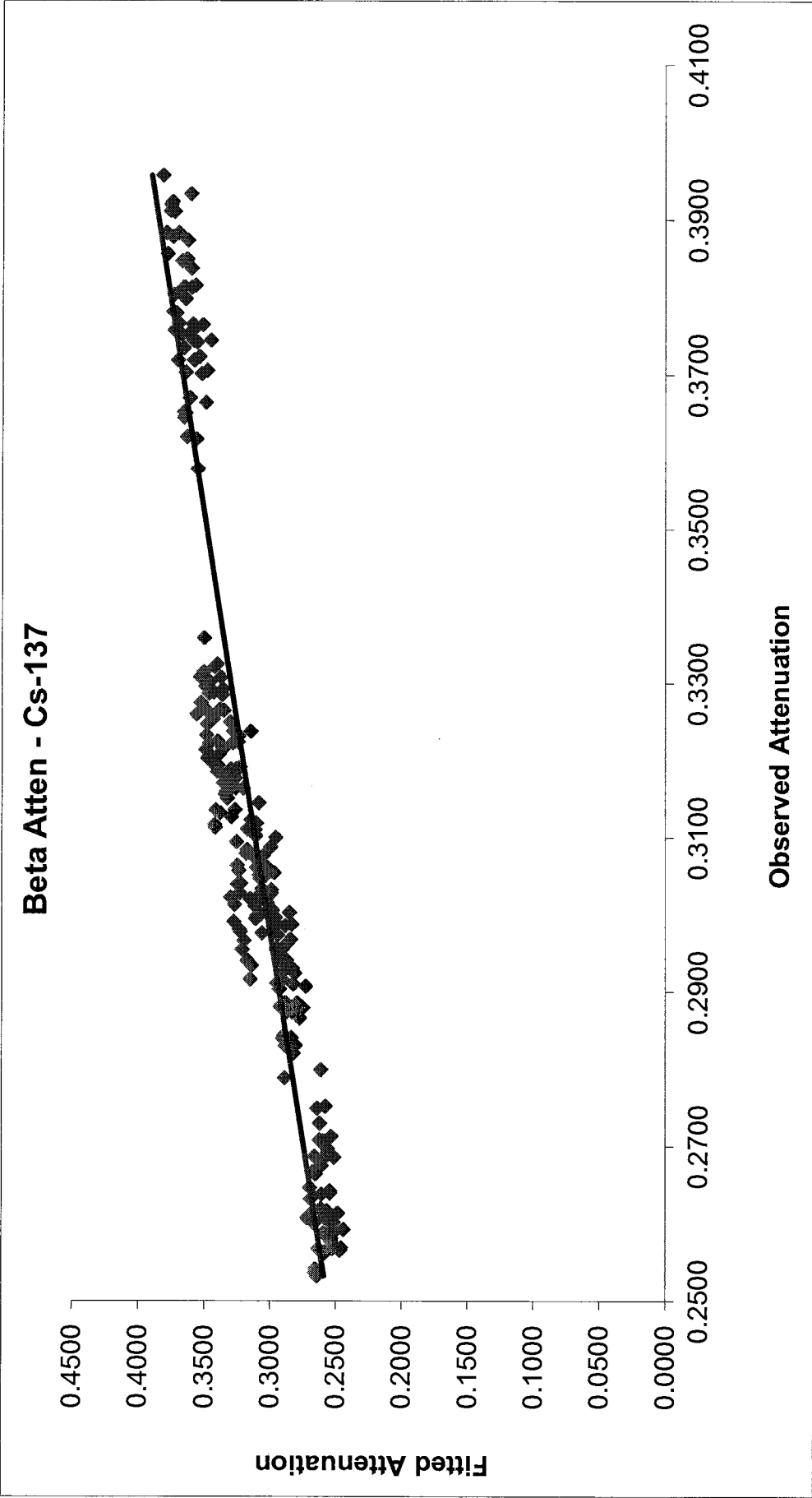
Attenuation Equation		y=b*x ^m (a*x)	
b =	0.9526	b =	0.9585
m =	0.9985	m =	0.9766
a =	0.9766		

Cross-Talk Equation		y=b*x ^m	
b =	2.06E-06	b =	2.06E-06
m =	0.0015	m =	0.0015

File ID	Detector ID	Sample ID	Mass (mg)	Count Date	Alpha Counts	Beta Counts	Count Time	Alpha CPM	Beta CPM	Base Beta Eff.	Decay Corr. Act. added dpm/mL	Beta Att. Eff. Actual	Beta Att. Fitted	Actual/Fit Ratio	Obs. Atten. Fact.	Fitted Atten. Fact.	% Diff.	$\beta > \alpha$ Tlk Actual	$\beta > \alpha$ Tlk Fitted	% Diff.
ACS0614	A1	1617003-16	273.4	6/14/17 12:13	23	10004	10.27	2.16	972.66	0.4013	3730.13	0.2585	0.2585	1.0088	0.6498	0.6441	0.9%	0.0022	0.0020	-8.6%
ACS0614	A2	1617003-16	273.4	6/14/17 12:26	29	10006	10.14	2.77	985.45	0.3950	3730.13	0.2584	0.2584	1.0384	0.6688	0.6441	3.8%	0.0028	0.0020	-27.6%
ACS0614	A3	1617003-16	273.4	6/14/17 12:40	21	10011	9.94	2.02	1005.63	0.3978	3730.13	0.2696	0.2696	1.0522	0.6777	0.6441	5.2%	0.0020	0.0020	1.3%
ACS0614	B1	1617003-16	273.4	6/14/17 12:54	44	10005	10.39	4.15	961.41	0.3938	3730.12	0.2577	0.2536	1.0162	0.6545	0.6441	1.6%	0.0043	0.0020	-63.0%
ACS0614	B2	1617003-16	273.4	6/14/17 13:11	31	10007	10.38	2.90	962.45	0.3934	3730.12	0.2580	0.2534	1.0183	0.6559	0.6441	1.8%	0.0030	0.0020	-32.5%
ACS0614	B3	1617003-16	273.4	6/14/17 13:37	32	10002	10.29	2.99	970.36	0.3907	3730.12	0.2601	0.2516	1.0337	0.6658	0.6441	3.4%	0.0031	0.0020	-34.1%
ACS0614	B4	1617003-16	273.4	6/14/17 13:53	31	10007	10.25	2.94	974.75	0.3859	3730.12	0.2613	0.2486	1.0513	0.6772	0.6441	5.1%	0.0030	0.0020	-32.6%
ACS0614	C1	1617003-16	273.4	6/14/17 14:21	38	10007	10.34	3.58	966.20	0.3888	3730.11	0.2590	0.2486	1.0344	0.6662	0.6441	3.4%	0.0037	0.0020	-45.1%
ACS0614	C2	1617003-16	273.4	6/14/17 14:37	26	10001	10.23	2.43	976.07	0.3994	3730.11	0.2617	0.2566	1.0197	0.6568	0.6441	2.0%	0.0037	0.0020	-45.1%
ACS0614	C3	1617003-16	273.4	6/14/17 14:51	26	10009	10.29	2.41	971.03	0.3953	3730.11	0.2603	0.2546	1.0224	0.6585	0.6441	2.2%	0.0025	0.0020	-18.4%
ACS0614	D1	1617003-16	273.4	6/14/17 15:06	25	10006	10.32	2.33	967.93	0.3921	3730.10	0.2595	0.2526	1.0275	0.6618	0.6441	2.7%	0.0024	0.0020	-15.5%
ACS0614	D2	1617003-16	273.4	6/14/17 15:20	33	10009	10.32	3.06	966.97	0.3769	3730.10	0.2592	0.2440	1.0622	0.6842	0.6441	6.2%	0.0032	0.0020	-35.7%
ACS0614	D3	1617003-16	273.4	6/14/17 15:43	38	10007	10.43	3.55	957.83	0.3923	3730.10	0.2568	0.2527	1.0162	0.6546	0.6441	1.6%	0.0037	0.0020	-45.2%
ACS0614	D4	1617003-16	273.4	6/14/17 15:58	64	10006	10.44	6.04	956.82	0.3833	3730.09	0.2565	0.2469	1.0390	0.6692	0.6441	3.9%	0.0063	0.0020	-67.8%
ACS0614	A1	1617003-17	273.4	6/14/17 16:14	32	10014	10.42	2.90	959.37	0.3931	3730.09	0.2572	0.2532	1.0158	0.6543	0.6441	1.6%	0.0030	0.0020	-32.8%
ACS0614	A2	1617003-17	273.4	6/14/17 11:28	17	10000	10.42	1.53	959.09	0.3920	3730.14	0.2568	0.2460	1.0439	0.6728	0.6441	4.4%	0.0016	0.0020	27.2%
ACS0614	A3	1617003-17	297.2	6/14/17 11:43	32	10002	10.30	3.03	969.63	0.4013	3730.14	0.2569	0.2498	1.0405	0.6474	0.6225	4.1%	0.0031	0.0021	-33.4%
ACS0614	A4	1617003-17	297.2	6/14/17 11:57	18	10005	10.27	1.66	972.86	0.3950	3730.13	0.2608	0.2459	1.0606	0.6603	0.6225	6.1%	0.0017	0.0021	22.0%
ACS0614	B1	1617003-17	297.2	6/14/17 12:13	31	10012	10.11	2.97	988.80	0.3978	3730.13	0.2651	0.2476	1.0704	0.6864	0.6225	7.0%	0.0030	0.0021	-30.7%
ACS0614	B2	1617003-17	297.2	6/14/17 12:26	29	10002	10.26	2.74	973.32	0.3938	3730.13	0.2609	0.2452	1.0644	0.6626	0.6225	6.4%	0.0028	0.0021	-26.2%
ACS0614	B3	1617003-17	297.2	6/14/17 12:41	35	10001	10.53	3.23	948.15	0.3934	3730.13	0.2542	0.2449	1.0379	0.6461	0.6225	3.8%	0.0034	0.0021	-39.0%
ACS0614	B4	1617003-17	297.2	6/14/17 12:54	34	10002	10.41	3.15	959.16	0.3907	3730.12	0.2571	0.2432	1.0572	0.6581	0.6225	5.7%	0.0033	0.0021	-36.6%
ACS0614	C1	1617003-17	297.2	6/14/17 13:11	36	10010	10.11	3.48	988.56	0.3859	3730.12	0.2650	0.2402	1.0322	0.6668	0.6225	10.3%	0.0035	0.0021	-40.8%
ACS0614	C2	1617003-17	297.2	6/14/17 13:37	34	10015	10.46	3.15	955.87	0.3888	3730.12	0.2563	0.2420	1.0587	0.6591	0.6225	5.9%	0.0033	0.0021	-36.9%
ACS0614	C3	1617003-17	297.2	6/14/17 13:54	35	10003	10.29	3.29	970.57	0.3944	3730.12	0.2602	0.2460	1.0491	0.6531	0.6225	4.9%	0.0034	0.0021	-38.6%
ACS0614	D1	1617003-17	297.2	6/14/17 14:21	37	10018	10.19	3.52	981.46	0.3953	3730.11	0.2631	0.2461	1.0692	0.6556	0.6225	6.8%	0.0036	0.0021	-42.0%
ACS0614	D2	1617003-17	297.2	6/14/17 14:37	30	10008	10.42	2.78	958.62	0.3921	3730.11	0.2570	0.2441	1.0531	0.6566	0.6225	5.3%	0.0029	0.0021	-28.3%
ACS0614	D3	1617003-17	297.2	6/14/17 14:51	43	10019	10.23	4.06	976.48	0.3789	3730.11	0.2618	0.2359	1.1098	0.6909	0.6225	11.0%	0.0042	0.0021	-50.0%
ACS0614	D4	1617003-17	297.2	6/14/17 15:06	43	10008	10.51	4.00	950.62	0.3923	3730.10	0.2549	0.2442	1.0435	0.6496	0.6225	4.4%	0.0042	0.0021	-50.5%
ACS0614	A1	1617003-18	299.7	6/14/17 15:20	47	10002	10.54	4.37	947.35	0.3833	3730.10	0.2540	0.2386	1.0644	0.6626	0.6225	6.4%	0.0046	0.0021	-54.9%
ACS0614	A2	1617003-18	299.7	6/14/17 15:43	47	10002	10.45	4.33	955.46	0.3931	3730.10	0.2561	0.2447	1.0467	0.6516	0.6225	4.7%	0.0045	0.0021	-54.0%
ACS0614	A3	1617003-18	299.7	6/14/17 15:58	49	10017	10.42	4.60	959.72	0.3920	3730.09	0.2573	0.2378	1.0819	0.6735	0.6225	8.2%	0.0048	0.0021	-56.6%
ACS0614	A4	1617003-18	299.7	6/14/17 11:57	36	10004	10.32	3.41	967.94	0.4013	3730.13	0.2595	0.2469	1.0424	0.6466	0.6203	4.2%	0.0035	0.0021	-40.8%
ACS0614	B1	1617003-18	299.7	6/14/17 12:13	24	10006	10.67	2.16	936.43	0.3950	3730.13	0.2510	0.2450	1.0246	0.6356	0.6203	2.5%	0.0023	0.0021	-9.4%
ACS0614	B2	1617003-18	299.7	6/14/17 12:26	33	10006	10.31	3.10	969.00	0.3978	3730.13	0.2598	0.2468	1.0528	0.6530	0.6203	5.3%	0.0032	0.0021	-34.9%
ACS0614	B3	1617003-18	299.7	6/14/17 12:40	38	10008	10.22	3.64	977.72	0.3938	3730.13	0.2621	0.2443	1.0730	0.6656	0.6203	7.3%	0.0037	0.0021	-43.9%
ACS0614	B4	1617003-18	299.7	6/14/17 12:55	40	10010	10.75	3.63	929.55	0.3934	3730.12	0.2492	0.2440	1.0212	0.6335	0.6203	2.1%	0.0039	0.0021	-46.6%
ACS0614	C1	1617003-18	299.7	6/14/17 13:11	34	10004	10.46	3.13	954.76	0.3907	3730.12	0.2560	0.2424	1.0561	0.6551	0.6203	5.6%	0.0033	0.0021	-36.4%
ACS0614	C2	1617003-18	299.7	6/14/17 13:37	33	9999	10.71	3.00	932.07	0.3859	3730.12	0.2499	0.2394	1.0439	0.6475	0.6203	4.4%	0.0032	0.0021	-35.1%
ACS0614	C3	1617003-18	299.7	6/14/17 13:54	39	10004	10.64	3.57	938.63	0.3888	3730.12	0.2516	0.2412	1.0434	0.6472	0.6203	4.3%	0.0038	0.0021	-45.1%
ACS0614	D1	1617003-18	299.7	6/14/17 14:22	33	10007	10.48	3.04	953.33	0.3984	3730.11	0.2556	0.2471	1.0342	0.6415	0.6203	3.4%	0.0032	0.0021	-34.6%
ACS0614	D2	1617003-18	299.7	6/14/17 14:37	28	10005	10.38	2.59	962.21	0.3953	3730.11	0.2580	0.2452	1.0520	0.6526	0.6203	5.2%	0.0027	0.0021	-22.4%
ACS0614	D3	1617003-18	299.7	6/14/17 14:52	28	10001	10.58	2.55	943.63	0.3921	3730.11	0.2530	0.2432	1.0401	0.6452	0.6203	4.0%	0.0027	0.0021	-22.8%
ACS0614	D4	1617003-18	299.7	6/14/17 15:06	35	10008	10.38	3.23	915.26	0.3789	3730.10	0.2577	0.2350	1.0965	0.6801	0.6203	9.6%	0.0034	0.0021	-37.9%
ACS0614	D1	1617003-18	299.7	6/14/17 15:21	33	10001	10.91	2.93	961.07	0.3823	3730.10	0.2453	0.2433	1.0081	0.6253	0.6203	0.8%	0.0032	0.0021	-37.9%
ACS0614	D2	1617003-18	299.7	6/14/17 15:44	54	10003	10.59	5.01	942.96	0.3833	3730.10	0.2528	0.2378	1.0632	0.6595	0.6203	6.3%	0.0053	0.0021	-60.8%
ACS0614	D3	1617003-18	299.7	6/14/17 15:58	30	10004	10.58	2.66	943.89	0.3931	3730.09	0.2530	0.2438	1.0378	0.6437	0.6203	3.8%	0.0028	0.0021	-26.1%
ACS0614	D4	1617003-18	299.7	6/14/17 16:14	56	10011	10.66	5.15	937.51	0.3920	3730.09	0.2513	0.2370	1.0607	0.6580	0.6203	6.1%	0.0055	0.0021	-62.0%







Date 6/12/17SOP 724r 2

ALS
Low Background Gas Flow Proportional Counter Log
Instrument: LB4100C

Instrument Daily Response and Background Checks

Det.	Daily Response Check				Background Check				Det. Status
	Start 1	Status	Start 2	Status	Start 1	Status	Start 2	Status	
1	✓	P			✓	P			P
2									
3									
4									
5									
6									
7						Hα	JCB	P	
8						P			
9						Hβ	JCB	P	
10						P			
11									
12									
13									
14						Hα	JCB	P	
15						Hβ	JCB	Hβ	Hβ
16									

Det = Detector; α = Alpha; β = Beta; P = Pass; H = High; L = Low; OL = Offline; R = Recount; W = Weekly; NP = Not Processed

Weekly Background Calibration

	Current Calib. File ID	Weekly Calib. Started	Status	File ID
Dr A	BK0607W			
Dr B				
Dr C				
Dr D				

Dr = Drawer

Gas Supply

P-10 Supply		P-10 Flow	
Tank 1	1900	Dr A	10
		Dr B	
Tank 2	1900	Dr C	
		Dr D	

Comments:

Date 6/12/12SOP 724r 12ALS
Low Background Gas Flow Proportional Counter Log
Instrument: LB4100C

Det.	Sample ID	Batch	Test	Count Dur. (min)	Start Time	Analyst Initials	File ID	Output Initials
12	SR170606-1 US	SR170606-1	9.90	90	1457	JCB	SR0612	JP
13	1705439-6	↓	↓	↓	↓	↓	↓	↓
14	↓ 7	↓	↓	↓	↓	↓	↓	↓
15	↓ 6	↓	Th-230	↓	↓	↓	↓	↓
1-16	1515004-1 216	AB150603-6	8.97	30	1109	JCB	ATH0612	JP
↓	↓	↓	Mass Attn	↓	↓	↓	↓	↓
1	1705441-1	SR170525-1	9.90	800	1636	JCB	SR0612A	JP
2	↓ 2	↓	↓	↓	↓	↓	↓	↓
3	↓ 3	↓	↓	↓	↓	↓	↓	↓
4	GR170525-1 MB	↓	↓	↓	↓	↓	↓	↓
9	1706189-1	AB170611-12	αβ	10	1637	JCB	AB0612C	↓
10	↓ -5	↓	↓	↓	↓	↓	↓	↓
11	↓ -15	↓	↓	↓	↓	↓	↓	↓
12	↓ -18	↓	↓	↓	↓	↓	↓	↓
5	SR170525-1 US	SR170525-1	9.90	90	1652	JCB	SR0612B	↓
6	↓ USD	↓	↓	↓	↓	↓	↓	↓
7	1705057-3	SR170516-2	↓	↓	↓	↓	↓	↓
8	SR170516-2 MB	↓	↓	↓	↓	↓	↓	↓
9	↓ US	↓	↓	↓	↓	↓	↓	↓
10	↓ USD	↓	↓	↓	↓	↓	↓	↓
11	1705439-9	SR170606-1	↓	↓	↓	↓	↓	↓
12	1705439-1	AB170529-3	αβ	240	1654	JCB	AB0612D	↓
13	↓ -8	↓	↓	↓	↓	↓	↓	↓
14	↓ -8D	↓	↓	↓	↓	↓	↓	↓
15	AB170529-3 MB	↓	↓	↓	↓	↓	↓	↓
JP 6/13/12								

Comments:

Date 6/13/17SOP 724r 12

ALS
Low Background Gas Flow Proportional Counter Log
Instrument: LB4100C

Instrument Daily Response and Background Checks

Det.	Daily Response Check				Background Check				Det. Status
	Start 1	Status	Start 2	Status	Start 1	Status	Start 2	Status	
1	JP	P			JP	P			P
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16						(HFB)			OLB

Det = Detector; α = Alpha; β = Beta; P = Pass; H = High; L = Low; OL = Offline; R = Recount; W = Weekly; NP = Not Processed

Weekly Background Calibration

	Current Calib. File ID	Weekly Calib. Started	Status	File ID
Dr A	BK0607W			
Dr B				
Dr C				
Dr D				

Dr = Drawer

Gas Supply

P-10 Supply		P-10 Flow	
Tank 1	1600	Dr A	10
		Dr B	
Tank 2	1800	Dr C	
		Dr D	

Comments:

Date

6/13/17

SOP 724r

12

ALS

Low Background Gas Flow Proportional Counter Log

Instrument: LB4100C

Det.	Sample ID	Batch	Test	Count Dur. (min)	Start Time	Analyst Initials	File ID	Output Initials
1-16	Daib EID	—	—	30	6:24	JP	EFC0613	JP
1-16	Daib Bkg	—	—	60	6:32	JP	BKC0613	JP
1-16	1518004-1-16	AB1506036	1720 Atm	30	7:40	JP	ATH0613	JP
1	1705464-1	AB170604-1	2.5	120	11:21	JP	AB170613	JP
2	1705491-1							
3	1705492-1							
4	1705528-1							
5	—10							
6	1705552-1							
7	1705583-1							
8	1705619-2							
9	—20							
10	—1							
11	17055192MS			30 min	11:24		AB170613A	
12	AB170604-148							
13	1705614-148	AB170530-4						
14	AB170530-4-148							
1	1705400-1	AB170530-4	αp	1000	13:31		AB170613B	
2	3							
3	4							
4	7							
5	8							
6	9							
7	10							
8	11							
9	13							
10	130							
11	14							
12	1705614-1							
13	AB170530-4-148							
14	1705400-34	AB170604-1						
15	AB170604-148							

Comments:

Page No.: 471496

B

(cont. from page 17)

B)

Form 780r8.doc (6/23/06)

Reviewed By / Date

JP 6/15/17

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Date 6/14/17SOP 724r 12

ALS
Low Background Gas Flow Proportional Counter Log
Instrument: LB4100C

Instrument Daily Response and Background Checks

Det.	Daily Response Check				Background Check				Det. Status
	Start 1	Status	Start 2	Status	Start 1	Status	Start 2	Status	
1	JCB	P			JCB	P			P
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16	✓	✓			✓	HB	JCB		OLB

Det = Detector; α = Alpha; β = Beta; P = Pass; H = High; L = Low; OL = Offline; R = Recount; W = Weekly; NP = Not Processed

Weekly Background Calibration

	Current Calib. File ID	Weekly Calib. Started	Status	File ID
Dr A	BK0607W			
Dr B				
Dr C				
Dr D				

Dr = Drawer

Gas Supply

P-10 Supply		P-10 Flow	
Tank 1	1100	Dr A	10
	↓	Dr B	
Tank 2	1800	Dr C	
	↓	Dr D	↓

Comments:

6/12/17

Th-230 (Gross Alpha) Mass Attenuation Curve

Filename:

ATH0612

ATH0613

Worksheet: ARS0603-G

Sources: 1518004-1*

Calibration

Range

12.4 → 100 mg

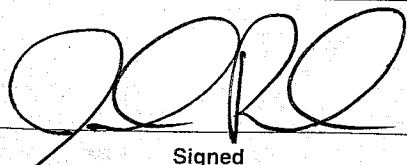
Det	11:09	11:39	12:09	12:39	13:01	13:26	13:55	14:23	7:40	8:08	8:35	9:00	9:26	9:51	10:18	10:40
A1	1	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2
A2	2	1	16	15	14	13	12	11	10	9	8	7	6	5	4	3
A3	3	2	1	16	15	14	13	12	11	10	9	8	7	6	5	4
A4	4	3	2	1	16	15	14	13	12	11	10	9	8	7	6	5
B1	5	4	3	2	1	16	15	14	13	12	11	10	9	8	7	6
B2	6	5	4	3	2	1	16	15	14	13	12	11	10	9	8	7
B3	7	6	5	4	3	2	1	16	15	14	13	12	11	10	9	8
B4	8	7	6	5	4	3	2	1	16	15	14	13	12	11	10	9
B5	9	8	7	6	5	4	3	2	1	16	15	14	13	12	11	10
C2	10	9	8	7	6	5	4	3	2	1	16	15	14	13	12	11
C3	11	10	9	8	7	6	5	4	3	2	1	16	15	14	13	12
C4	12	11	10	9	8	7	6	5	4	3	2	1	16	15	14	13
D1	13	12	11	10	9	8	7	6	5	4	3	2	1	16	15	14
D2	14	13	12	11	10	9	8	7	6	5	4	3	2	1	16	15
D3	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	16
D4	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1

6/12/17

6/13/17

JP 6/19/17

Continued on Page _____



Signed

6/19/17

Date

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Signed

6/20/17

Date
234 of 274

6/14/17 Cs 137 (gross Beta) Mass Attenuation Curve

Bench sheets: AB160510-2 Source: 1617003-1-18

Det	1117	1133	1146	1202	1216	1229	1273	1300	1326	1342	1400	1426	1440	1454	1509	1532	1547	1602
A1	1	17	18	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2
A2	2	1	17	18	16	15	14	13	12	11	10	9	8	7	6	5	4	3
A3	3	2	1	17	18	16	15	14	13	12	11	10	9	8	7	6	5	4
A4	4	3	2	1	17	18	16	15	14	13	12	11	10	9	8	7	6	5
B1	5	4	3	2	1	17	18	16	15	14	13	12	11	10	9	8	7	6
B2	6	5	4	3	2	1	17	18	16	15	14	13	12	11	10	9	8	7
B3	7	6	5	4	3	2	1	17	18	16	15	14	13	12	11	10	9	8
B4	8	7	6	5	4	3	2	1	17	18	16	15	14	13	12	11	10	9
C1	9	8	7	6	5	4	3	2	1	17	18	16	15	14	13	12	11	10
C2	10	9	8	7	6	5	4	3	2	1	17	18	16	15	14	13	12	11
C3	11	10	9	8	7	6	5	4	3	2	1	17	18	16	15	14	13	12
C4	12	11	10	9	8	7	6	5	4	3	2	1	17	18	16	15	14	13
D1	13	12	11	10	9	8	7	6	5	4	3	2	1	17	18	16	15	14
D2	14	13	12	11	10	9	8	7	6	5	4	3	2	1	17	18	16	15
D3	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	17	18	16
D4	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	17	18

Filename
ACS0614

6/19/17 → Ra228 Efficiency Calibration

Bench sheet: RA170615-1

Source ID: 1080

Log file: Ra228-06/17

Sources

1718016-

-3

-4

-5

Detectors

A1 B1 C1 D1

A2 B2 C2 D2

A3 B3 C3 D3

A4 B4 C4 D4

File names

ERA0619A

B

C

D

Continued on Page

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Signed

6/19/17

Date

Signed

6/20/17

Date

Radiochemistry Instrument Worksheet

Prep Batch: AB150603-6

ALS Environmental -- FC

Prep Procedure: GROSS_ALPH

Mass Attenuation Curve

Analytical QASS / NCR? Y

Notes

Prep Num	LabID	QC Type	Init Aliq	Fin Aliq	Units	Report Units	Residual Mass (mg)	Cnt 1 File	Cnt 1 Inst/Det	Cnt 1 Pos Chk By	Cnt 2 File	Cnt 2 Inst/Det	Cnt 2 Pos Chk By	Cnt 3 File	Cnt 3 Inst/Det	Cnt 3 Pos Chk By	Notes
1	1518004-1	SMP	200	200	ml	pCi/l	13.2	See Maintenance Log 3710 pg 87									
1	1518004-2	SMP	200	200	ml	pCi/l	12.4										
1	1518004-3	SMP	200	200	ml	pCi/l	25.8										
1	1518004-4	SMP	200	200	ml	pCi/l	28.1										
1	1518004-5	SMP	200	200	ml	pCi/l	43.9										
1	1518004-6	SMP	200	200	ml	pCi/l	36.8										
1	1518004-7	SMP	200	200	ml	pCi/l	49.9										
1	1518004-8	SMP	200	200	ml	pCi/l	49.5										
1	1518004-9	SMP	200	200	ml	pCi/l	67.8										
1	1518004-10	SMP	200	200	ml	pCi/l	70										
1	1518004-11	SMP	200	200	ml	pCi/l	79.3										
1	1518004-12	SMP	200	200	ml	pCi/l	77.3										
1	1518004-13	SMP	200	200	ml	pCi/l	83.5										
1	1518004-14	SMP	200	200	ml	pCi/l	89.8										
1	1518004-15	SMP	200	200	ml	pCi/l	100.4										
1	1518004-16	SMP	200	200	ml	pCi/l	100										

JP 6/16/17

Spike Solution Information

Soln #	Nuclide	SolnID	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
S1	Th-230	853.3020.89	1,166.300	DPM/ml	06/03/15	5	ml	RS-027

Sample Barcodes

1518004-1 AB150603-6PS1		1518004-2 AB150603-6PS2		1518004-3 AB150603-6PS3	
1518004-4 AB150603-6PS4		1518004-5 AB150603-6PS5		1518004-6 AB150603-6PS6	
1518004-7 AB150603-6PS7		1518004-8 AB150603-6PS8		1518004-9 AB150603-6PS9	
1518004-10 AB150603-6PS10		1518004-11 AB150603-6PS11		1518004-12 AB150603-6PS12	

Radiochemistry Instrument Worksheet

ALS Environmental -- FC

Prep Batch: AB150603-6

Prep Procedure: GROSS_ALPH

Analytical QASS / NCR? Y / N

Prep Num	LabID	QC Type	Init Aliq	Fin Aliq	Units	Report Units	Residual Mass (mg)	Cnt 1 File	Cnt 1 Inst/Det	Cnt 1 Pos Chk By	Cnt 2 File	Cnt 2 Inst/Det	Cnt 2 Pos Chk By	Cnt 3 File	Cnt 3 Inst/Det	Cnt 3 Pos Chk By	Notes
1518004-13	AB150603-6PS13							1518004-14	AB150603-6PS14					1518004-15	AB150603-6PS15		

1518004-16
AB150603-6PS16

Reporting Units

LabID	1stGrpName	RptUnits
1518004-1	GrossAlpha_DW	pCi/l
1518004-2	GrossAlpha_DW	pCi/l
1518004-3	GrossAlpha_DW	pCi/l
1518004-4	GrossAlpha_DW	pCi/l
1518004-5	GrossAlpha_DW	pCi/l
1518004-6	GrossAlpha_DW	pCi/l
1518004-7	GrossAlpha_DW	pCi/l
1518004-8	GrossAlpha_DW	pCi/l
1518004-9	GrossAlpha_DW	pCi/l
1518004-10	GrossAlpha_DW	pCi/l
1518004-11	GrossAlpha_DW	pCi/l
1518004-12	GrossAlpha_DW	pCi/l
1518004-13	GrossAlpha_DW	pCi/l
1518004-14	GrossAlpha_DW	pCi/l
1518004-15	GrossAlpha_DW	pCi/l
1518004-16	GrossAlpha_DW	pCi/l

Radiochemistry Prep Worksheet

ALS Environmental -- FC

Prep Batch: AB150603-6

Prep Procedure: GROSS_ALPHA

Reviewed By: jkb *JKB* Review Date: 6/8/2015

Non-Routine Pre-Treatment? Y / ☒ Batch: *NA*

Prep QASS / NCR? Y / ☒

Prep SOP: PAI 702 Rev: 20
Prep SOP: NONE
Matrix Class: liquid

Prep Analyst: Jennie Kill-Bowden
Prep Date: 6/3/2015
Prep Dept: RS

Balance:
Balance:

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Aliq ml	Fin Aliq ml	Prep Basis	Standards	Prep Notes
1	1	1518004-1	SMP		200	200		S1	Salt added based on 51mg/mL --> 0.23ml
2	1	1518004-2	SMP		200	200		S1	0.23 mL salt
3	1	1518004-3	SMP		200	200		S1	0.5 mL salt
4	1	1518004-4	SMP		200	200		S1	0.5 mL salt
5	1	1518004-5	SMP		200	200		S1	0.78 mL salt
6	1	1518004-6	SMP		200	200		S1	0.78 mL salt
7	1	1518004-7	SMP		200	200		S1	1.08 mL salt
8	1	1518004-8	SMP		200	200		S1	1.08 mL salt
9	1	1518004-9	SMP		200	200		S1	1.37 mL salt
10	1	1518004-10	SMP		200	200		S1	1.37 mL salt
11	1	1518004-11	SMP		200	200		S1	1.57 mL salt
12	1	1518004-12	SMP		200	200		S1	1.57 mL salt
13	1	1518004-13	SMP		200	200		S1	1.76 mL salt
14	1	1518004-14	SMP		200	200		S1	1.76 mL salt
15	1	1518004-15	SMP		200	200		S1	2.02 mL salt
16	1	1518004-16	SMP		200	200		S1	2.02 mL salt

Comments

Th-230 mass attenuation curve USGS method (approximately 200 mL DI H2O + 20 mL conc HNO3 cooked down in a glass beaker and transferred to a planchet) Salt added based on weight per mL of salt solution, additional salt added as needed.

Spiked By: Jennie Kill-Bowden Date: 6/3/2015

Witnessed By: Peter Workman Date: 6/3/2015

Spike Solution Information					
Soln #	Nuclide	SolnID	Prep Conc	Units	Pipet ID
S1	Th-230	853.3020.89	1,166.300	DPM/ml	06/03/15
				5	ml
					RS-027

Radiochemistry Prep Worksheet

Prep Batch: AB150603-6

ALS Environmental -- FC

Prep Procedure: GROSS_ALPHA

Prep Batch Not Validated!!!

Review Date:

Reviewed By:

Prep QASS / NCR? Y / N

Re-Prep? Y / N Batch:

Prep SOP: PAI 702 Rev: 20

Prep SOP: NONE

Matrix Class: liquid

Prep Analyst: Jennie Kill-Bowden

Prep Date: 6/3/2015

Prep Dept: RS

Balance:

Balance:

Sample Num	Prep Num	LabID	QC Type	Dish No.	Init Aliq ml	Fin Aliq ml	Prep Basis	Standards	Prep Notes
1	1	1518004-1	SMP		200	200		S1	
2	1	1518004-2	SMP		200	200		S1	
3	1	1518004-3	SMP		200	200		S1	
4	1	1518004-4	SMP		200	200		S1	
5	1	1518004-5	SMP		200	200		S1	
6	1	1518004-6	SMP		200	200		S1	
7	1	1518004-7	SMP		200	200		S1	
8	1	1518004-8	SMP		200	200		S1	
9	1	1518004-9	SMP		200	200		S1	
10	1	1518004-10	SMP		200	200		S1	
11	1	1518004-11	SMP		200	200		S1	
12	1	1518004-12	SMP		200	200		S1	
13	1	1518004-13	SMP		200	200		S1	
14	1	1518004-14	SMP		200	200		S1	
15	1	1518004-15	SMP		200	200		S1	
16	1	1518004-16	SMP		200	200		S1	

Comments

Th-230 mass attenuation curve USGS method

Spiked By: JKB Date: 6/3/15
 Witnessed By: [Signature] Date: 6/3/15

Spike Solution Information					
Soln #	Nuclide	SolnID	Prep Conc	Units	Pipet ID
S1	Th-230	853.3020.89	1,166.300	DPM/ml	06/03/15
				5	ml
					RS-027

Radiochemistry Gravimetric Worksheet

ALS Environmental -- FC

Prep Batch: AB150603-6

Prep Procedure: GROSS_ALPHA

Reviewed By: jkb *jk* Review Date: 6/8/2015

Prep Num	Planc. Num	LabID	QC Type	Test Alq (ml)	Tare Mass (g)	Initial Gross Mass (g)	Initial Net Mass (mg)	Suggested Alq (ml)	Samp Vol Available (ml)	Samp Vol Taken (ml)	Fin Gross Mass (g)	Final Net Mass (mg)	Salt Sol. Added (ml)	Flag
1	1	1518004-1	SMP	10	9.1569	0.0000	0	0	0	200	9.1701	13.2	0.23	
1	2	1518004-2	SMP	10	9.1115	0.0000	0	0	0	200	9.1239	12.4	0.23	
1	3	1518004-3	SMP	10	9.1509	0.0000	0	0	0	200	9.1767	25.8	0.5	
1	4	1518004-4	SMP	10	9.1834	0.0000	0	0	0	200	9.2115	28.1	0.5	
1	5	1518004-5	SMP	10	9.1505	0.0000	0	0	0	200	9.1944	43.9	0.78	
1	6	1518004-6	SMP	10	9.1176	0.0000	0	0	0	200	9.1544	36.8	0.78	
1	7	1518004-7	SMP	10	9.1596	0.0000	0	0	0	200	9.2095	49.9	1.08	
1	8	1518004-8	SMP	10	9.1459	0.0000	0	0	0	200	9.1954	49.5	1.08	
1	9	1518004-9	SMP	10	9.1503	0.0000	0	0	0	200	9.2181	67.8	1.37	
1	10	1518004-10	SMP	10	9.0442	0.0000	0	0	0	200	9.1142	70	1.37	
1	11	1518004-11	SMP	10	9.0531	0.0000	0	0	0	200	9.1324	79.3	1.57	
1	12	1518004-12	SMP	10	9.0094	0.0000	0	0	0	200	9.0867	77.3	1.57	
1	13	1518004-13	SMP	10	9.0334	0.0000	0	0	0	200	9.1169	83.5	1.76	
1	14	1518004-14	SMP	10	9.4305	0.0000	0	0	0	200	9.5203	89.8	1.76	
1	15	1518004-15	SMP	10	9.3886	0.0000	0	0	0	200	9.4890	100.4	2.02	
1	16	1518004-16	SMP	10	9.3856	0.0000	0	0	0	200	9.4856	100	2.02	

Prepare an intermediate dilution of Th-230 RSO# 853 of approximately 1200 dpm/ml

1) Prepare 0.5 M HNO_3 , 3 ml HNO_3 and 969 ml DI water, lot # 073602

2) Determine density of 0.5 M HNO_3 .

Mass of 100 ml vol. flask:

Bal. 12

68.2999 g

Mass of flask + 100 ml 0.5 M HNO_3 :

169.4529 g

Net mass of 0.5 M HNO_3 :

101.153 g

$$\rho = 1.0115 \text{ g/ml}$$

3) Transfer contents of vial to 1000 ml Nalgene.

Bal. 12

Mass of full standard vial:

8.2827

Mass of empty standard vial:

3.2327

Net mass of standard transferred:

5.05 g

4) Dilute with 0.5 M HNO_3

PRC 1000

Bal. 36

Mass of Nalgene w/o lid (empty):

73.66 g

73.70 g

Mass of Nalgene with standard:

78.71 g

Mass of Nalgene, standard, and diluent:

1085.2

Net mass of standard:

1011.54 g

5) Final activity calculation

$$(1.983 \times 10^4 \text{ Bq}) (5.15119 \text{ g}) = 3849.60 \text{ Bq/g} \times \left(\frac{60 \text{ s}}{1 \text{ min}} \right) = 230,975.755 \text{ dpm}$$

$$(3849.60 \text{ Bq/g}) \cdot \left(\frac{5.05 \text{ g}}{1011.54 \text{ g}} \right) \cdot (1.0115 \text{ g/ml}) = 1,166.38 \text{ dpm/ml}$$

Std ID: 853.3020.89

Description: Th-230

Expiration: 2/5/2009

Activity: 1166.38 dpm/mL

2s Uncertainty: 23.33 dpm/mL

Ref. Date: 11/6/2007

Ref Time: N/A

Prep Date: 12/12/2007 Prep by: DC

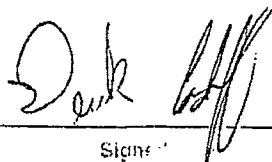
Matrix/Comp. 0.5 M HNO_3

Half Life (y): 7.70E+04

Reverification Log

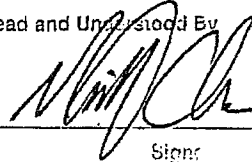
Analysis Date	Initials	Expiration Date
5/5/09	RG	5/5/2010
11/19/10	RG	11/19/2011
12/13/14	JP	12/13/2015

Continued on Page

Signature: 

Date: 12/12/07

Read and Understood By

Signature: 

Date: 2/13/08



Eckert & Ziegler

Analytics

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

CERTIFICATE OF CALIBRATION
Standard Radionuclide Source

76253-307

Th-230 5 mL Liquid in Flame Sealed Vial

Customer: Paragon Analytics / Fort Collins, CO
P.O. No.: 72909-REL 10-30-07, 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.

ANALYTICS maintains traceability to the National Institute of Standards and Technology through Measurements Assurance Programs as described in USNRC Reg. Guide 4.15, Revision 1.

Isotope:	Th-230
Activity (Bq):	1.983 E4
Half-Life:	7.538 E4 years
Calibration Date:	November 8, 2007 12:00 EST
Relative Expanded Uncertainty (k=2):	2.0%

Comments:

Impurities: γ -impurities <0.1%, α -impurities <0.01%,
5.15119 grams 0.5M HNO₃ solution.

Source Prepared By: N. E. Klesman
N. E. Klesman, Radiochemist

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

Date: 11-19-07

End of Certificate

Corporate Office
24937 Avenue Tibbitts Valencia, California 91355

Laboratory
1380 Seaboard Industrial Blvd. Atlanta, Georgia, 30318

Radiochemistry Instrument Worksheet

Prep Batch: AB160510-2

ALS Environmental -- FC

Prep Procedure: GAB

Analytical QASS / NCR? Y

NA

Gross Beta (Sb-137) Attenuation

Prep Num	LabID	QC Type	Init Aliq	Fin Aliq	Units	Report Units	Residual Mass (mg)	Cnt 1 File	Cnt 1 Inst/Det	Cnt 1 Pos Chk By	Cnt 2 File	Cnt 2 Inst/Det	Cnt 2 Pos Chk By	Cnt 3 File	Cnt 3 Inst/Det	Cnt 3 Pos Chk By	Notes
1	1617003-1	SMP	200	200	ml	pCi/l	0										
1	1617003-2	SMP	200	200	ml	pCi/l	16.3										
1	1617003-3	SMP	200	200	ml	pCi/l	30.4										
1	1617003-4	SMP	200	200	ml	pCi/l	49.6										
1	1617003-5	SMP	200	200	ml	pCi/l	63.4										
1	1617003-6	SMP	200	200	ml	pCi/l	75.3										
1	1617003-7	SMP	200	200	ml	pCi/l	95.8										
1	1617003-8	SMP	200	200	ml	pCi/l	102.6										
1	1617003-9	SMP	200	200	ml	pCi/l	129.6										
1	1617003-10	SMP	200	200	ml	pCi/l	139										
1	1617003-11	SMP	200	200	ml	pCi/l	164.4										
1	1617003-12	SMP	200	200	ml	pCi/l	181										
1	1617003-13	SMP	200	200	ml	pCi/l	195.7										
1	1617003-14	SMP	200	200	ml	pCi/l	239.1										
1	1617003-15	SMP	200	200	ml	pCi/l	252.6										
1	1617003-16	SMP	200	200	ml	pCi/l	273.4										
1	1617003-17	SMP	200	200	ml	pCi/l	297.2										
1	1617003-18	SMP	200	200	ml	pCi/l	299.7										

See Maintenance Log 3710 ps 89

7/6/16/17

Spike Solution Information							
Soln #	Nuclide	SolnID	Prep Conc	Units	Prep Date	Aliquot	Pipet ID
S1	Cs-137	1019.4096.83	3.825.389	DPM/ml	05/10/16	1	ml RS-019

Sample Barcodes

1617003-1 AB160510-2PS1	1617003-2 AB160510-2PS2	1617003-3 AB160510-2PS3
1617003-4 AB160510-2PS4	1617003-5 AB160510-2PS5	1617003-6 AB160510-2PS6
1617003-7 AB160510-2PS7	1617003-8 AB160510-2PS8	1617003-9 AB160510-2PS9

Radiochemistry Instrument Worksheet

ALS Environmental -- FC

Prep Batch: AB160510-2

Prep Procedure: GAB

Analytical QASS / NCR? Y / N

Prep Num	LabID	QC Type	Init Aliq	Fin Aliq	Units	Report Units	Residual Mass (mg)	Cnt 1 File	Cnt 1 Inst/Det	Cnt 1 Pos Chk By	Cnt 2 File	Cnt 2 Inst/Det	Cnt 2 Pos Chk By	Cnt 3 File	Cnt 3 Inst/Det	Cnt 3 Pos Chk By	Notes
1617003-10	AB160510-2PS10							1617003-11	AB160510-2PS11						1617003-12	AB160510-2PS12	
1617003-13	AB160510-2PS13							1617003-14	AB160510-2PS14						1617003-15	AB160510-2PS15	
1617003-16	AB160510-2PS16							1617003-17	AB160510-2PS17						1617003-18	AB160510-2PS18	

Reporting Units

LabID	InstGrpName	RptUnits
1617003-1	GrossAlpha/Beta_DW	pCi/l
1617003-2	GrossAlpha/Beta_DW	pCi/l
1617003-3	GrossAlpha/Beta_DW	pCi/l
1617003-4	GrossAlpha/Beta_DW	pCi/l
1617003-5	GrossAlpha/Beta_DW	pCi/l
1617003-6	GrossAlpha/Beta_DW	pCi/l
1617003-7	GrossAlpha/Beta_DW	pCi/l
1617003-8	GrossAlpha/Beta_DW	pCi/l
1617003-9	GrossAlpha/Beta_DW	pCi/l
1617003-10	GrossAlpha/Beta_DW	pCi/l
1617003-11	GrossAlpha/Beta_DW	pCi/l
1617003-12	GrossAlpha/Beta_DW	pCi/l
1617003-13	GrossAlpha/Beta_DW	pCi/l
1617003-14	GrossAlpha/Beta_DW	pCi/l
1617003-15	GrossAlpha/Beta_DW	pCi/l
1617003-16	GrossAlpha/Beta_DW	pCi/l
1617003-17	GrossAlpha/Beta_DW	pCi/l
1617003-18	GrossAlpha/Beta_DW	pCi/l

AS

Radiochemistry Prep Worksheet

ALS Environmental -- FC

Prep Batch: AB160510-2

Prep Procedure: GAB

Reviewed By: jkb

Review Date: 5/18/2016

Prep QASS / NCR? Y / N

Batch:

Re-Prep? Y / N

Prep Analyst: Jennie Kill-Bowden
Prep Date: 5/10/2016
Prep Dept: RS
Balance: 13
Balance:

Batch:

Prep SOP: PAI 702 Rev: 20
Prep SOP: NONE
Matrix Class: liquid

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Alq ml	Fin Alq ml	Prep Basis	Standards	Prep Notes
1	1	1617003-1	SMP		200	200	Unfiltered	S1	
2	1	1617003-2	SMP		200	200	Unfiltered	S1	
3	1	1617003-3	SMP		200	200	Unfiltered	S1	
4	1	1617003-4	SMP		200	200	Unfiltered	S1	
5	1	1617003-5	SMP		200	200	Unfiltered	S1	
6	1	1617003-6	SMP		200	200	Unfiltered	S1	
7	1	1617003-7	SMP		200	200	Unfiltered	S1	
8	1	1617003-8	SMP		200	200	Unfiltered	S1	
9	1	1617003-9	SMP		200	200	Unfiltered	S1	
10	1	1617003-10	SMP		200	200	Unfiltered	S1	
11	1	1617003-11	SMP		200	200	Unfiltered	S1	
12	1	1617003-12	SMP		200	200	Unfiltered	S1	
13	1	1617003-13	SMP		200	200	Unfiltered	S1	
14	1	1617003-14	SMP		200	200	Unfiltered	S1	
15	1	1617003-15	SMP		200	200	Unfiltered	S1	
16	1	1617003-16	SMP		200	200	Unfiltered	S1	
17	1	1617003-17	SMP		200	200	Unfiltered	S1	
18	1	1617003-18	SMP		200	200	Unfiltered	S1	

Comments

Cs-137 calibration planchets

Spiked By: Jennie Kill-Bowden Date: 5/17/2016

Witnessed By: Clayton D. Jacobs Date: 5/14/2016

Spike Solution Information					
Soln #	Nuclide	SolnID	Prep Conc.	Units	Prep Date
S1	Cs-137	1019.4095.83	3,825.389	DPM/ml	05/10/16
				ml	1
				Units	RS-019

Radiochemistry Prep Worksheet

ALS Environmental -- FC

Prep Batch: AB160510-2

Prep Procedure: GAB

Prep Batch Not Validated!!!

Review Date:

Reviewed By:

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

Prep SOP: PAI 702 Rev: 20
Prep SOP: NONE
Matrix Class: liquid

Prep Analyst: Jennie Kill-Bowden
Prep Date: 5/10/2016
Prep Dept: RS
Balance:
Balance:

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Alq ml	Fin Alq ml	Prep Basis	Standards	Prep Notes
1	1	1617003-1	SMP	200	200	200	Unfiltered	S1	
2	1	1617003-2	SMP	200	200	200	Unfiltered	S1	
3	1	1617003-3	SMP	200	200	200	Unfiltered	S1	
4	1	1617003-4	SMP	200	200	200	Unfiltered	S1	
5	1	1617003-5	SMP	200	200	200	Unfiltered	S1	
6	1	1617003-6	SMP	200	200	200	Unfiltered	S1	
7	1	1617003-7	SMP	200	200	200	Unfiltered	S1	
8	1	1617003-8	SMP	200	200	200	Unfiltered	S1	
9	1	1617003-9	SMP	200	200	200	Unfiltered	S1	
10	1	1617003-10	SMP	200	200	200	Unfiltered	S1	
11	1	1617003-11	SMP	200	200	200	Unfiltered	S1	
12	1	1617003-12	SMP	200	200	200	Unfiltered	S1	
13	1	1617003-13	SMP	200	200	200	Unfiltered	S1	
14	1	1617003-14	SMP	200	200	200	Unfiltered	S1	
15	1	1617003-15	SMP	200	200	200	Unfiltered	S1	
16	1	1617003-16	SMP	200	200	200	Unfiltered	S1	
17	1	1617003-17	SMP	200	200	200	Unfiltered	S1	
18	1	1617003-18	SMP	200	200	200	Unfiltered	S1	

Comments

Spiked By: 7615 Date: 5/17/16
Witnessed By: COS Date: 5/17/2016

Spike Solution Information						
Soln #	Nuclide	SolnID	Prep Conc	Units	Prep Date	Pipet ID
S1	Cs-137	1019.4095.83	3,825.389	DPM/ml	05/10/16	RS-019

4/11/2017

Radiochemistry Gravimetric Worksheet

ALS Environmental -- FC

Prep Batch: AB160510-2

Prep Procedure: GAB

Reviewed By: jkb JGJ

Review Date: 5/18/2016

Prep Num	Planc. Num	LabID	QC Type	Test Alq (ml)	Tare Mass (g)	Initial Gross Mass (g)	Initial Net Mass (mg)	Suggested Alq (ml)	Samp Vol Available (ml)	Samp Vol Taken (ml)	Fin Mass (g)	Final Net Mass (mg)	Salt Sol. Added (ml)	Flag
1	1	1617003-1	SMP	10	9.4100	0.0000	0	0	0	0	0.0000	0	0	
1	2	1617003-2	SMP	10	9.4242	9.4391	14.9	0	0	0	9.4405	16.3	0	
1	3	1617003-3	SMP	10	9.4391	9.4711	32	0	0	0	9.4695	30.4	0	
1	4	1617003-4	SMP	10	9.3826	9.4298	47.2	0	0	0	9.4322	49.6	0	
1	5	1617003-5	SMP	10	9.3332	9.3942	61	0	0	0	9.3966	63.4	0	
1	6	1617003-6	SMP	10	9.3931	9.4638	70.7	0	0	0	9.4684	75.3	0	
1	7	1617003-7	SMP	10	9.4174	9.5130	95.6	0	0	0	9.5132	95.8	0	
1	8	1617003-8	SMP	10	9.4186	9.5263	107.7	0	0	0	9.5212	102.6	0	
1	9	1617003-9	SMP	10	9.4485	9.5765	128	0	0	0	9.5781	129.6	0	
1	10	1617003-10	SMP	10	9.4189	9.5572	138.3	0	0	0	9.5579	139	0	
1	11	1617003-11	SMP	10	9.4339	9.5938	159.9	0	0	0	9.5983	164.4	0	
1	12	1617003-12	SMP	10	9.4347	9.6170	182.3	0	0	0	9.6157	181	0	
1	13	1617003-13	SMP	10	9.4474	9.6500	202.6	0	0	0	9.6431	195.7	0	
1	14	1617003-14	SMP	10	9.4350	9.6593	224.3	0	0	0	9.6741	239.1	0	
1	15	1617003-15	SMP	10	9.4210	9.6725	251.5	0	0	0	9.6736	252.6	0	
1	16	1617003-16	SMP	10	9.3651	9.6307	265.6	0	0	0	9.6385	273.4	0	
1	17	1617003-17	SMP	10	9.3731	9.6609	287.8	0	0	0	9.6703	297.2	0	
1	18	1617003-18	SMP	10	9.3909	9.6913	300.4	0	0	0	9.6906	299.7	0	

Prepare a working dilution of RSO #1019

12/31/15

1. Density of 0.1M HCl, lot # 0000094396

Mass of 100mL vol. flask:

56.4421 g

Balance # 12

Mass of flask & 100mL acid:

156.2152g

Balance# 12

Net Mass:

99.7731g

Density:

0.9977g/mL

2. Mass of RSO #1019 transferred:

Mass of empty nalgene:

74.1899g

Balance# 12

Mass of nalgene & standard

79.0859g

Balance# 12

Net mass of standard transferred:

4.8960g

3. Dilute to final volume:

Mass of nalgene, standard, & diluent:

629.3g

Balance# 26

Mass of empty nalgene:

74.1899g

Balance# 12

Net mass of new dilution:

555.1101g

4. Final activity calculation:

$$\frac{3,727,032 \text{ Bq} (60 \text{ dpm})}{(1 \text{ Bq})} \times \frac{(4.8960 \text{ g})}{(4.99800 \text{ g})} \times \frac{(0.9977 \text{ g/mL})}{(555.1101 \text{ g})} = 3,937.10 \text{ dpm/mL}$$

Std ID: 1019.4095.83

Description: Cs-137

Expiration: 3/6/2016

Activity: 3937.10 dpm/mL

2s Uncertainty: 70.87 dpm/mL

Ref. Date: 2/9/2015

Ref Time: N/A

Prep Date: 3/5/2015 Prep by: TE

Matrix/Comp. 0.1 MHC1

Half Life (y): 3.01E+01

Reverification Log		
Analysis Date	Initials	Expiration Date
12/29/16	JP	12/29/2017

Continued on Page

Signed

Date

Read and Understood By

Signed

Date



Eckert & Ziegler

Analytics

RSO#
1019

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Fax 404-352-2837
www.ezag.com

CERTIFICATE OF CALIBRATION

Standard Reference Source

99575

Cs-137 5 mL Liquid in Flame Sealed Vial

Customer: ALS Laboratory Group

P.O. No.: FC000610, Item 3 Product Code: 8137

This standard radionuclide source was prepared gravimetrically from a master solution calibrated with an ionization chamber. The ionization chamber was calibrated by the National Physical Laboratory, Teddington, U.K., and is traceable to national standards. Radionuclide calibration and purity were checked by germanium gamma-ray spectrometry, liquid scintillation counting, and/or alpha spectrometry, as applicable. The nuclear decay rate and reference date for this source are given below. 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 2, July 2007, and compliance with ANSI N42.22-1995, "Traceability of Radioactive Sources to NIST."

Isotope	Half-Life, Days	Activity (Bq)	Uncertainty*, %			Reference Date (12:00 PM EST)
			u_A	u_B	U	
Cs-137	1.099E+04	3.727E+04	0.1	0.9	1.8	02/09/2015

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

Comments:

Impurities: γ -impurities < 0.1%.

4.99800 g 0.1M HCl solution with approximately 30 μ g/g Cs carrier.

Source Prepared by:

K. Eardley, Radiochemist

QC Approved:

A. Chen, Spectroscopist

Date: 7 Feb 15

Internal Calculation Verifications

ICBs

&

ICVs

Gross Alpha/Beta LB4100C ICV's/ICB's Th-230/CS137

Atten. Constants	b	m	a	x0
Alpha	0.9050	0.9875	0.8948	0
Beta	0.9526	0.9985	0.9766	0.0

X-Talk Constants	m	b
$\alpha > \beta$	0.9983	0.2523
$\beta > \alpha$	0.0015	2.060E-06

Detector	Sample ID	Initial Aliquot	Final Sam. Size	Alpha				Beta										
				Count Dur.	Residual Mass (mg)	Gross CPM	Bkg CPM	$\beta > \alpha$ X-Talk	Net CPM	Atten.	Efficiency	Gross CPM	Bkg CPM	$\alpha > \beta$ X-Talk	Net CPM	Atten.	Efficiency	
A1	1624002-1	0.200	0.200	6/9/2016	240	52.1	12.542	0.078	0.068	12.396	0.503	0.2305	43.617	1.436	3.4361	38.7449	0.6826	0.4013
B1	1624002-2	0.200	0.200	6/9/2016	240	51.2	12.563	0.091	0.064	12.408	0.509	0.2316	41.683	1.613	3.4330	36.6370	0.8837	0.3934
C1	1624002-3	0.200	0.200	6/9/2016	240	51.7	12.471	0.110	0.067	12.294	0.506	0.2301	43.467	1.540	3.4054	38.5216	0.8831	0.3984
D1	1624002-4	0.200	0.200	6/9/2016	240	52.1	12.496	0.095	0.063	12.338	0.503	0.2239	40.513	1.614	3.4187	35.4803	0.8826	0.3923
A2	AB161708-2AMB	0.200	0.200	6/9/2016	240	51.2	0.168	0.084	0.000	0.064	0.509	0.2232	1.392	1.336	0.0177	0.0383	0.8837	0.3950
B3	AB161208-2BMB	0.200	0.200	6/9/2016	240	49.7	0.175	0.084	0.000	0.091	0.517	0.2221	1.504	1.545	0.0250	-0.0660	0.8857	0.3859
C2	AB161208-2CMB	0.200	0.200	6/9/2016	240	50.7	0.167	0.112	0.000	0.055	0.511	0.2306	1.667	1.676	0.0150	-0.0070	0.8844	0.3953
D2	AB161708-2EMB	0.200	0.200	6/9/2016	240	50.4	0.108	0.087	0.000	0.021	0.513	0.2229	1.604	1.607	0.0059	-0.0089	0.8848	0.3833

Spike Information				Decay Corr.	
Alpha	Ref.	Act	Spike	Spike	
Std		(dpm/ml)	Vol (mL)	Act. Added	
ID	Date				
760.4095.67	7/13/2004	96.660	1.0	94.831	

Spike Information					Decay Corr.	
Beta	Std	Ref.	Act	Spike	Spike	
ID		Date	(dpm/ml)	Vol (mL)	Act. Added	
1013.4095.77		9/30/2005	131.750	1.0	102.998	

Acceptance criteria for LCS's --> 80-120%

Sample ID	Acceptance criteria for ECOS-200-120/78					
	Alpha			Beta		
	Act (pCi/L)	TPU (2 sig)	MDC	% Recov.	Act<MDCa	Act-MDCa
1624002-1	240.58	39.3	2.44	112.6%	NA	NA
1624002-2	237.25	38.8	2.48	111.1%	NA	NA
1624002-3	237.94	38.9	2.66	111.4%	NA	NA
1624002-4	246.51	40.3	2.61	115.4%	NA	NA
AB161208-2AMB	1.27	1.11	2.05	2.05	PASS	PASS
AD161208-2BMS	1.78	1.15	1.93	NA	PASS	PASS
AB161208-2CMB	1.05	1.10	2.13	NA	PASS	PASS
AB161208-2FMB	0.41	0.91	1.97	NA	PASS	PASS
AB161208-2GMB	0.41	0.91	1.97	NA	PASS	PASS

OK TR 6/16/17

Alpha Attenuation Calibration	Beta Attenuation Calibration
$y = b^*m^a(m^{*}mass*x0)$	$y = b^*m^a(m^{*}mass*x0)$
Alpha b = 0.90500	Beta b = 0.9526
m = 0.99750	m = 0.9945
a = 0.89448	a = 0.9766
x0 = 0.0000	x0 = 0.0000
Beta to Alpha Xrel	Alpha to Alpha Xrel
$y = b^*m^a*mass$	$y = b^*mass + m$
a -> a statk b = 0.2523	b -> a statk b = 2.06E-06
a -> a statk m = 0.9983	b -> a statk m = 0.0015

Background logfile: BKGABW
Date of Bkg. Cal: 6/8/2017
Alpha efficiency logfile: Th230-06/
Alpha attenuation calibration: ATH0612,
Beta efficiency logfile: Cs-137-06,
Beta attenuation calibration: ACS0614

Det. ID	Sample ID	Count End Date & Time	Count Dur. (min)	Resid. Mass (mg)	Alpha Activity					Beta Activity						
					Gross CPM	Bkg. CPM	b>a xtlk CPM	Base Cor.Fact.	Progeny Eff	Gross CPM	Bkg. CPM	a>b xtlk CPM	Base Cor.Fact.	Progeny Eff	Progeny Cor.Fact.	
A1	1624002-1	6/15/2017 13:05	240.00	52.1	12,542	0.078	0.088	0.2305	0.503	n/a	43,617	1,436	3,4361	0.4013	n/a	n/a
A2	1616208-2AMB	6/15/2017 13:05	240.00	51.2	0.158	0.094	0.089	0.2232	0.509	n/a	1,392	1,392	0.0177	0.3950	0.884	n/a
C1	1624002-3	6/15/2017 13:05	240.00	51.7	12,471	0.110	0.067	0.2301	0.506	n/a	43,467	3,405	3,4054	0.3984	n/a	n/a
C2	AB161208-2CMB	6/15/2017 13:05	240.00	50.7	0.167	0.112	0.000	0.2306	0.511	n/a	1,667	1,659	0.0150	0.3953	n/a	n/a
B1	1624002-2	6/15/2017 13:05	240.00	51.2	12,563	0.091	0.064	0.2316	0.509	n/a	41,583	1,613	3,4330	0.3934	n/a	n/a
B3	AB161208-2BMB	6/15/2017 13:05	240.00	49.7	0.175	0.084	0.000	0.2221	0.517	n/a	1,504	1,545	0.0250	0.3859	n/a	n/a
D1	1624002-4	6/15/2017 13:05	240.00	52.1	12,496	0.095	0.063	0.2239	0.503	n/a	40,513	1,614	3,4187	0.3923	n/a	n/a
D2	AB161208-2EMB	6/15/2017 13:05	240.00	50.4	0.108	0.087	0.000	0.2229	0.513	n/a	1,604	1,607	0.0059	0.3833	0.885	n/a

TP 6/6/17

Date 6/15/17SOP 724r 12

ALS
Low Background Gas Flow Proportional Counter Log
Instrument: LB4100C

Instrument Daily Response and Background Checks

Det.	Daily Response Check				Background Check				Det. Status
	Start 1	Status	Start 2	Status	Start 1	Status	Start 2	Status	
1	JP	P			JP	P			P
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16						CHB			αβ

Det = Detector; α = Alpha; β = Beta; P = Pass; H = High; L = Low; OL = Offline; R = Recount; W = Weekly; NP = Not Processed

Weekly Background Calibration

	Current Calib. File ID	Weekly Calib. Started	Status	File ID
Dr A	BUC0607W			
Dr B				
Dr C				
Dr D				

Dr = Drawer

Gas Supply

P-10 Supply		P-10 Flow	
Tank 1	900	Dr A	10
		Dr B	
Tank 2	1500	Dr C	
		Dr D	

Comments:

Date

6/15/17

SOP 724r 12

ALS

Low Background Gas Flow Proportional Counter Log

Instrument: LB4100C

Det.	Sample ID	Batch	Test	Count Dur. (min)	Start Time	Analyst Initials	File ID	Output Initials
1-16	Daily EFP	—	—	30	6:52	JP	EFC0615	JP
1-16	Daily BKG	—	—	60	7:02	JP	BKC0615	JP
5	1718016-1	RA170612-12	Ru225	10	8:16	JP	RAC0615	JP
5	-2		Other				A	
5	-3						B	
6	-4						C	
5	-5						D	
1	1624002-1	AB16206-2	US65 JCV	240	904	JLB	AB160615	JP
3	2							
9	3							
13	4							
2	Am161205-2 AMB							
2	AMB							
10	AMB							
14	AMB							
3	1705423-1	AB170604-1	DP	240	908	JLB	AB170615A	
4	1705424-1	AB170604-3						
6	3							
8	1705611-5							
11	1705611-7							
12	1705625-5							
15	1706003-3							
1	1706306-6	AB170614-2		1000	1320		AB170615B	
2	-11							
3	-10							
4	-12							
5	AB170614-2 MB							
6	1706278-5	AB170613-3						
7	AB170613 MB							
8	1706278-9	AB170613		180	1327		AB170615C	
9	1706306-8	AB170614-9D						
10	1706306-3							
11	1706193-1				1328		AB170615D	
12	1705465-1 MS	AB170612-1	DP	90	1435		AB170615E	
13	1706130-2							
14	AB170617165							

Comments:

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B

cont from page

NA

B)

Form 780r8.doc (6/23/06)

Reviewed By / Date

JP 6/16/17

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Date 6/16/17SOP 724r 12

ALS
Low Background Gas Flow Proportional Counter Log
Instrument: LB4100C

Instrument Daily Response and Background Checks

Det.	Daily Response Check				Background Check				Det. Status
	Start 1	Status	Start 2	Status	Start 1	Status	Start 2	Status	
1	JP	P			JP	H α	200	P	P
2						H α	↓	↓	
3						P			
4						H α	200	P	
5						P			
6						↓			
7						H α	JKB	P	
8						P			
9						H β	JKB	P	
10						P			
11						↓			
12						↓			
13						↓			
14						↓			
15						↓			
16	↓	↓			↓	H β			OLB

Det = Detector; α = Alpha; β = Beta; P = Pass; H = High; L = Low; OL = Offline; R = Recount; W = Weekly; NP = Not Processed*Weekly Background Calibration*

	Current Calib. File ID	Weekly Calib. Started	Status	File ID
Dr A	BK00607W			
Dr B	↓			
Dr C				
Dr D	↓			

Dr = Drawer

Gas Supply

	P-10 Supply		P-10 Flow
Tank 1	550	Dr A	10
	↓	Dr B	↓
Tank 2	1800	Dr C	
	↓	Dr D	↓

Comments:

Radiochemistry Instrument Worksheet

ALS -- Fort Collins

Prep Batch: AB161208-2

Prep Procedure: GAB

ICVs / ICBs

Analytical QASS / NCR? Y **GM**

Prep Num	LabID	QC Type	Init Alq	Fin Alq	Units	Report Units	Residual Mass (mg)	Cnt 1 File	Cnt 1 Inst/Det	Cnt 1 Pos Chk By	Cnt 2 File	Cnt 2 Inst/Det	Cnt 2 Pos Chk By	Cnt 3 File	Cnt 3 Inst/Det	Cnt 3 Pos Chk By	Notes
1	1624002-1	SMP	200	200	ml	pCi/l	52.1	ABCOGS 1		265							
1	1624002-2	SMP	200	200	ml	pCi/l	51.2										
1	1624002-3	SMP	200	200	ml	pCi/l	51.7										
1	1624002-4	SMP	200	200	ml	pCi/l	52.1										
1	AB161208-2a	MB	200	200	ml	pCi/l	51.2										
1	AB161208-2b	MB	200	200	ml	pCi/l	49.7										
1	AB161208-2c	MB	200	200	ml	pCi/l	50.7										
1	AB161208-2e	MB	200	200	ml	pCi/l	50.4										

JP 6/16/17

Spike Solution Information									
Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
S1	Cs-137	1013.4095.77		101.810	DPM/ml	12/08/16	1	ml	RS-033
S2	Th-230	760.4095.67		96.653	DPM/ml	12/08/16	1	ml	RS-033

Sample Barcodes

1624002-1 AB161208-2PS1		1624002-2 AB161208-2PS2		1624002-3 AB161208-2PS3	
1624002-4 AB161208-2PS4		AB161208-2aMB AB161208-2PS5		AB161208-2bMB AB161208-2PS6	
AB161208-2cMB AB161208-2PS7		AB161208-2dMB AB161208-2PS8			

Reporting Units

LabID	TstGrpName	RptUnits
1624002-1	GrossAlpha/Beta_DW	pCi/l
1624002-2	GrossAlpha/Beta_DW	pCi/l
1624002-3	GrossAlpha/Beta_DW	pCi/l
1624002-4	GrossAlpha/Beta_DW	pCi/l

Radiochemistry Prep Worksheet

ALS -- Fort Collins

Prep Batch: AB161208-2

Prep Procedure: GAB

Reviewed By: bat347

Review Date: 12/12/2016

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

Prep SOP: PAI 702 Rev: 20

Prep SOP: NONE

Matrix Class: liquid

Prep Analyst: Bryan A. Terry bat

Prep Date: 12/8/2016

Prep Dept: RS

Balance: 13

Balance: N/A

Sampl Num	Prep Num	LabID	QC Type	Dish No.	Init Alq ml	Fin Alq ml	Prep Basis	Standards	Prep Notes
1	1	1624002-1	SMP	<u>MA</u>	200	200	Unfiltered	S1,S2	
2	1	1624002-2	SMP		200	200	Unfiltered	S1,S2	
3	1	1624002-3	SMP		200	200	Unfiltered	S1,S2	
4	1	1624002-4	SMP		200	200	Unfiltered	S1,S2	
5	1	AB161208-2a	MB		200	200	Unfiltered	<u>MA</u>	<u>BAT 12/8/2016</u>
6	1	AB161208-2b	MB		200	200	Unfiltered		
7	1	AB161208-2c	MB		200	200	Unfiltered		
8	1	AB161208-2e	MB		200	200	Unfiltered		

Comments

Spiked By: Bryan A. Terry Date: 12/8/2016

Witnessed By: Andrew R. Steger Date: 12/8/2016

Spike Solution Information							
Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Prep Date	Aliquot Units
S1	Cs-137	1013.4095.77		101.810	DPM/ml	12/08/16	1 ml
S2	Th-230	760.4095.67		96.653	DPM/ml	12/08/16	1 ml

Reagent Solution IDs*

0000046694

*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: AB161208-2

Prep Procedure: GAB

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 702 Rev: 20

Prep SOP: NONE

Matrix Class: liquid

Prep Analyst: Bryan A. Terry

Prep Date: 12/8/2016

Prep Dept: RS

Balance: 13

Balance: N/A

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Aliq ml	Fin Aliq ml	Prep Basis	Standards	Prep Notes
1	1	1624002-1	SMP		0	0		S1,S2	
2	1	1624002-2	SMP		0	0		S1,S2	
3	1	1624002-3	SMP		0	0		S1,S2	
4	1	1624002-4	SMP		0	0		S1,S2	
5	1	AB161208-2a	MB		0	0			
6	1	AB161208-2b	MB		0	0			
7	1	AB161208-2c	MB		0	0			
8	1	AB161208-2e	MB		0	0			

Comments

Spiked By: BA Date: 12/8/2016

Witnessed By: And R. Terry Date: 12/8/16

Spike Solution Information						
Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Pipet ID
S1	Cs-137	1013.4095.77	1/7/17	101.810	DPM/ml	12/08/16 1 ml RS-033
S2	Th-230	760.4095.67	4/7/17	96.653	DPM/ml	12/08/16 1 ml RS-033

Reagent Solution IDs*

0000046694

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

Radiochemistry Gravimetric Worksheet

ALS -- Fort Collins

Prep Batch: AB161208-2

Prep Procedure: GAB

Reviewed By: bat ~~341~~ Review Date: 12/12/2016

Prep Num	Planc. Num	LabID	QC Type	Test Alq (ml)	Tare Mass (g)	Initial Gross Mass (g)	Initial Net Mass (mg)	Suggested Alq (ml)	Samp Vol Available (ml)	Samp Vol Taken (ml)	Fin Gross Mass (g)	Final Net Mass (mg)	Salt Sol. Added (ml)	Flag
1	1	1624002-1	SMP	10	9.3802	9.4323	52.1	14	200	200	9.4323	52.1	1	
1	2	1624002-2	SMP	10	9.4308	9.4820	51.2	15	200	200	9.4820	51.2	1	
1	3	1624002-3	SMP	10	9.4130	9.4647	51.7	15	200	200	9.4647	51.7	1	
1	4	1624002-4	SMP	10	9.4013	9.4534	52.1	14	200	200	9.4534	52.1	1	
1	5	AB161208-2a	MB	10	9.4458	9.4970	51.2	15	200	200	9.4970	51.2	1	
1	6	AB161208-2b	MB	10	9.3486	9.3983	49.7	15	200	200	9.3983	49.7	1	
1	7	AB161208-2c	MB	10	9.3869	9.4376	50.7	15	200	200	9.4376	50.7	1	
1	8	AB161208-2e	MB	10	9.4117	9.4621	50.4	15	200	200	9.4621	50.4	1	

[illegible]

DATA NOT USED

INTERNAL USE
ONLY

OTHER
SUPPORTING INFO
NOT TO BE
INCLUDED IN FINAL
DATA PACKAGE

Prep Batch: AB161208-2

Start Date: 12/8/2016

End Date: 12/8/2016

Start Time: 12:50

End Time: 12:50

Prep Analyst: Bryan A. Terry

Concentration Method: NONE

Extract Method: PAI 70220

Initial Volume Units: ml

Final Volume Units: ml

Batch Created By: bat

Date Created: 12/8/2016

Time Created: 12:51

Validated By: bat

Date Validated: 12/12/2016

Time Validated: 10:54

Comments:

QC Batch ID: AB161208-2-1

Prep Number	Lab ID	QC Type	Matrix	Date Collected	Test Nickname	Initial Wt/Vol	Final Wt/Vol	Cleanup Method	Cleanup DF	Misc. DF	Order Number	Leach Date	Standards	Notes
1	AB161208-2a	MB	Liquid		GrossAlpha/Beta_DW	200	200	NONE	1	1	1624002			
1	AB161208-2b	MB	Liquid		GrossAlpha/Beta_DW	200	200	NONE	1	1	1624002			
1	AB161208-2c	MB	Liquid		GrossAlpha/Beta_DW	200	200	NONE	1	1	1624002			
1	AB161208-2e	MB	Liquid		GrossAlpha/Beta_DW	200	200	NONE	1	1	1624002			
1	1624002-1	SMP	Liquid		GrossAlpha/Beta_DW	200	200	NONE	1	1	1624002		S1,S2	L
1	1624002-2	SMP	Liquid		GrossAlpha/Beta_DW	200	200	NONE	1	1	1624002		S1,S2	L
1	1624002-3	SMP	Liquid		GrossAlpha/Beta_DW	200	200	NONE	1	1	1624002		S1,S2	L
1	1624002-4	SMP	Liquid		GrossAlpha/Beta_DW	200	200	NONE	1	1	1624002		S1,S2	L

Prep Batch: AB161208-2

Start Date: 12/8/2016 End Date: 12/8/2016
 Start Time: 12:50 End Time: 12:50
 Prep Analyst: Bryan A. Terry

Concentration Method: NONE
 Extract Method: PAI 70220
 Initial Volume Units: ml
 Final Volume Units: ml

Batch Created By: bat
 Date Created: 12/8/2016
 Time Created: 12:51
 Validated By: bat
 Date Validated: 12/12/2016
 Time Validated: 10:54

** = Client designated matrix qc
 L = Original Nickname

Program Spec: PAI_Standard

Shared QC: PAI Protocol
 BatchQCReq: PAI Protocol
 LCS_LCSDReq: PAI Protocol
 DUPReq: PAI Protocol
 MS_MSReq: PAI Protocol

☐ Control on MS/MSD

1624002 ProjID: Calibr/Blank Ver. GrossAlpha/Beta_DW ievs icbs for th230 cs137 USGS

QC Types

CAR	Carrier reference sample
LCS	Laboratory Control Sample
MB	Method Blank
MSD	Laboratory Matrix Spike Duplicate
RVS	Reporting Level Verification Standar
SYS	Sample Yield Spike

DUP	Laboratory Duplicate
LCSD	Laboratory Control Sample Duplicate
MS	Laboratory Matrix Spike
REP	Sample replicate
SMP	Field Sample

Spike Solution Information				
Soln #	SolnID	Aliquot	Units	PipetID
S1	1013.4095.77	1	ml	RS-033
S2	760.4095.67	1	ml	RS-033

Reagent Solution IDs*

0000046694

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

Prepare a working dilution of 760.3020.08

1. Density of 0.5M HNO₃ lot # 0000084176

Mass of 100mL vol. flask: 68.5632g

Mass of flask & 100mL acid: 169.6732g

Net Mass: 101.1100g

Density: 1.011g/mL

Balance # 12

Balance # 12

2. Mass of 760.3020.08 transferred:

Mass of open empty nalgene: 74.1983g

Mass of nalgene & standard: 77.2060g

Net mass of standard transferred: 3.0077g

Balance # 12

Balance # 12

Balance # N/A

3. Dilute to final volume:

Mass of nalgene, standard, & diluent: 908.9g

Mass of empty nalgene (from above): 74.1983g

Net mass of new dilution: 834.7017g

Balance # 26

Balance # 12

Balance # N/A

4. Final activity calculation:

$$26,534.43 \text{ dpm/g} (1.011 \text{ g/mL}) \frac{(3.0077 \text{ g})}{(834.7017 \text{ g})} = 96.66 \text{ dpm/mL}$$

Std ID: 760.4095.67

Description: Th-230

Expiration: 4/12/2016

Activity: 96.66 dpm/mL

2s Uncertainty: 3.19 dpm/mL

Ref. Date: 7/13/2004

Ref Time: N/A

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

Matrix/Comp. 0.5 M HNO₃

Half Life (y): 7.54E+04

Verification Log		
Analysis Date	Initials	Expiration Date
4/07/16	JP	04/07/2017

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Date

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Date

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Prepare a primary dilution of R50 #760 (Analyte # 68750-307) in 0.5 M HNO₃ to a concentration of approx 30,000 dpm/mL.

1) Prepare 0.5M HNO₃ by diluting 5 mL of conc. (16M) HNO₃ (EMD lot # 44251) to a final volume of 1000 mL.

2) Determine density of 0.5M HNO₃

Mass of 100mL volumetric flask =	66.4289 g (Bal 12)
Mass of flask + 0.5M HNO ₃ =	167.5792 g
Net mass of solution =	101.1503 g
÷ 100 mL = density =	1.0115 g/mL

3) Transfer # 760 to a 40 mL VOA vial.

Mass of bottle without lid =	21.5801 g (Bal 12)
Mass of bottle + lid =	21.5278 g
Net mass of std transferred	4.9477 g

4) Dilute to volume w/ 0.5M HNO₃

Mass of bottle + std + soln =	61.8912 g (Bal 12)
Mass of bottle (from above) =	21.5801 g
Net mass of std	40.3111 g

5) Final activity calc

$$\frac{(1.830 \times 10^4 \text{ dpm/g}) (4.9477 \text{ g})}{(5.08447) (40.3111 \text{ g})} \left(\frac{1.0115 \text{ g/mL}}{1.0115 \text{ g/mL}} \right) = 26,534.43 \text{ dpm/g}$$

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Heather Barker
Signed

1/24/06
Date

[Signature]
Signed

1/27/06
Date



ANALYTICS

RSO# 760 Rec'd 7/14/04 JCB

1380 Seaboard Industrial Blvd.
Atlanta, Georgia 30318 - U.S.A.

Phone (404) 352-8577
Fax (404) 352-2397

CERTIFICATE OF CALIBRATION Standard Radionuclide Source

68750-307

Th-230 5 mL Liquid in Flame Sealed Vial

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.

ANALYTICS maintains traceability to the National Institute of Standards and Technology through Measurements Assurance Programs as described in USNRC Reg. Guide 4.15, Revision 1.

ISOTOPE:	Th-230
ACTIVITY (dps):	1.832 E4
HALF-LIFE:	7.538 E4 years
CALIBRATION DATE:	July 13, 2004 12:00 EST
RELATIVE EXPANDED UNCERTAINTY (k=2):	3.3%

Impurities: γ -impurities $<0.1\%$, α -impurities $<0.01\%$

5.08447 grams 0.5M HNO₃ solution.

P O NUMBER 70635, Item 1.

SOURCE PREPARED BY:

M. D. Currie
M. D. Currie, Radiochemist

Q A APPROVED:

A. Currie 7/13/04

Prepare a working dilution of 1013.4095.76

1. Density of 4% HCl, lot # 0000094396
Mass of 100mL vol. flask: 68.5652g
Mass of flask & 100mL acid: 169.0154g
Net Mass: 100.4502g
Density: 1.0045g/mL

Balance # 12
Balance # 12

2. Mass of 1013.4095.76 transferred:
Mass of empty nalgene: 74.1532g
Mass of nalgene & standard: 75.4532g
Net mass of standard transferred: 1.3000g

Balance # 12
Balance # 12

3. Dilute to final volume:
Mass of nalgene, standard, & diluent: 1069.7g
Mass of empty nalgene: 74.1532g
Net mass of new dilution: 995.5468g

Balance # 26
Balance # 12

4. Final activity calculation:

$$100,443.61 \text{ dpm/g} (1.0045 \text{ g/mL}) \left(\frac{1.3000 \text{ g}}{995.5468 \text{ g}} \right) = 131.75 \text{ dpm/mL}$$

Std ID: 1013.4095.77

Description: **Cs-137**
Expiration: **1/20/2016**
Activity: **131.75 dpm/mL**

2s Uncertainty: **0.92 dpm/mL**
Ref. Date: **9/30/2005**
Ref Time: **N/A**
Prep Date: **1/16/2015** Prep by: **TE**
Matrix/Comp. **4% HCl**
Half Life (y): **3.01E+01**

Reverification Log		
Analysis Date	Initials	Expiration Date
12/29/16	JP	12/29/2017

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Signed Date

Read and Understood By [Signature] 02/09/15
Signed Date

10/16/15
Prepare an intermediate dilution of RSO#1013

1. Density of 4% HCl, lot # 0000094396

Mass of 100mL vol. flask: 68.5652g

Balance # 12

Mass of flask & 100mL acid: 169.0154g

Balance# 12

Net Mass: 100.4502g

Density: 1.0045 g/mL

2. Mass of RSO#1013 -transferred:

Mass of open empty bottle: 398.34g

Balance# 26

Mass of bottle and standard: 403.33g

Balance# 26

Net mass of standard transferred: 4.99g

3. Dilute to final volume:

Mass of open empty bottle: 398.34g

Balance# 26

Mass of bottle, standard, & diluent: 1288.4g

Balance# 26

Net mass of new dilution: 890.06g

4. Final activity calculation:

298.6 kBq/g $\left(\frac{1000 \text{ Bq}}{1 \text{ kBq}} \right) \left(\frac{60 \text{ dpm}}{1 \text{ Bq}} \right) \left(\frac{4.99 \text{ g}}{890.06 \text{ g}} \right) = 100,443.61 \text{ dpm/g}$

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Date



RSOP
1013

National Institute of Standards & Technology Certificate

Standard Reference Material 4233E Cesium-137 Radioactivity Standard

This Standard Reference Material (SRM) consists of radioactive cesium-137 chloride, non-radioactive cesium chloride, and hydrochloric acid dissolved in 5 mL of distilled water. The solution is contained in a flame-sealed NIST borosilicate-glass ampoule. The SRM is intended for the calibration of ionization chambers and solid-state gamma-ray spectrometry systems.

Radiological Hazard: The SRM ampoule contains cesium-137 with a total activity of approximately 1.5MBq. Cesium-137 decays by beta-particle emission to barium-137m, which decays by internal conversion. During the decay process X-rays and gamma rays with energies from approximately 3 keV to 662 keV are emitted. Most of these photons escape from the SRM ampoule and can represent a radiation hazard. Approximate unshielded dose rates at several distances (as of the reference time) are given in note [a]*. Appropriate shielding and/or distance should be used to minimize personnel exposure. The SRM should be used only by persons qualified to handle radioactive material.

Chemical Hazard: The SRM ampoule contains hydrochloric acid with a concentration of 1 mole per liter of water. The solution is corrosive and represents a health hazard if it comes in contact with eyes or skin. If the ampoule is to be opened to transfer the solution, the recommended procedure is given on page 2. The ampoule should be opened only by persons qualified to handle both radioactive material and strong acid solution.

Storage and Handling: The SRM should be stored and used at a temperature between 5 and 65 °C. The solution in an unopened ampoule should remain stable and homogeneous until at least September 2015. The ampoule (or any subsequent container) should always be clearly marked as containing radioactive material. If the ampoule is transported, it should be packed, marked, labeled, and shipped in accordance with the applicable national, international, and carrier regulations. The solution in the ampoule is a dangerous good (hazardous material) because of both the radioactivity and the strong acid.

Preparation: This Standard Reference Material was prepared in the Physics Laboratory, Ionizing Radiation Division, Radioactivity Group, M.P. Unterweger, Acting Group Leader. The overall technical direction and physical measurements leading to certification were provided by L.L. Lucas, R. Collé and L. Laureano-Pérez 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

Gaithersburg, Maryland 20899
October 2005

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

Recommended Procedure for Opening the SRM Ampoule

- 1) If the SRM solution is to be diluted, it is recommended that the diluting solution have a composition comparable to that of the SRM solution.
- 2) Wear eye protection, gloves, and protective clothing and work over a tray with absorbent paper in it. Work in a fume hood. In addition to the radioactive material, the solution contains strong acid and is corrosive.
- 3) Shake the ampoule to wet all of the inside surface of the ampoule. Return the ampoule to the upright position.
- 4) Check that all of the liquid has drained out of the neck of the ampoule. If necessary, gently tap the neck to speed the process.
- 5) Holding the ampoule upright, score the narrowest part of the neck with a scribe or diamond pencil.
- 6) Lightly wet the scored line. This reduces the crack propagation velocity and makes for a cleaner break.
- 7) Hold the ampoule upright with a paper towel, a wiper, or a support jig. Position the scored line away from you. Using a paper towel or wiper to avoid contamination, snap off the top of the ampoule by pressing the narrowest part of the neck away from you while pulling the tip of the ampoule towards you.
- 8) Transfer the solution from the ampoule using a pycnometer or a pipet with dispenser handle. NEVER PIPETTE BY MOUTH.
- 9) Seal any unused SRM solution in a flame-sealed glass ampoule, if possible, to minimize the evaporation loss.

See also reference [4]*.

PROPERTIES OF SRM 4233E

Certified values

Radionuclide	Cesium-137
Reference time	1200 EST, 30 September 2005
Massic activity of the solution [c]*	298.6 kBq·g ⁻¹
Relative expanded uncertainty (k=2)	0.70% [d] [e]
Solution mass	(5.0668 ± 0.0009) g [b]
Solution density	(1.015 ± 0.002) g·mL ⁻¹ at 20 °C [b]

Uncertified values

Uncertained values

Physical Properties:			
Source description	Liquid in flame-sealed NIST borosilicate-glass ampoule		
Ampoule specifications	Body outside diameter	(16.5 ± 0.5) mm	
	Wall thickness	(0.60 ± 0.04) mm	
	Barium content	Less than 2.5%	
	Lead-oxide content	Less than 0.02%	
	Other heavy elements	Trace quantities	
Chemical Properties:			
Solution composition	Chemical Formula	Concentration (mol·L ⁻¹)	Mass Fraction (g·g ⁻¹)
	H ₂ O	54	0.96
	HCl	1.0	0.04
	CsCl	1.6 × 10 ⁻⁴	2.7 × 10 ⁻⁵
	¹³⁷ CsCl	6.9 × 10 ⁻⁷	1.2 × 10 ⁻⁷
Radiological Properties:			
Photon-emitting impurities	None detected [f]		
Half lives used	Cesium-137: (10983 ± 11) d [g] [5] Radium-226: (1600 ± 7) a [g] [5]		
Calibration method and measuring instrument(s)	Pressurized "4π"γ ionization chamber A calibrated using an cesium-137 solution whose activity was determined by the 4π(e+X)-γ-coincidence efficiency-extrapolation technique.		

EVALUATION OF THE UNCERTAINTY OF THE MASSIC ACTIVITY [d]*

Input Quantity x_i , the source of uncertainty (and individual uncertainty components where appropriate)	Method Used To Evaluate $u(x_i)$, the standard uncertainty of x_i (A) denotes evaluation by statistical methods (B) denotes evaluation by other methods	Relative Uncertainty Of Input Quantity, $u(x_i)/x_i$, (%) [h]	Relative Sensitivity Factor, $ \partial y/\partial x_i \cdot$ (x_i/y) [i]	Relative Uncertainty Of Output Quantity, $u(y)/y$, (%) [j]
PIC A net response per gram of SRM 4233E, measured relative to RRS20 [k]	Standard deviation of the mean (within-measurement precision) for 20 to 100 repeated measurements (A)	0.02	1.0	0.02
	Standard deviation (between- measurement precision) for 4 sets of measurement (A)	0.13	1.0	0.13
PIC A net response per Bq of cesium-137 in solution, measured relative to RRS20.	Standard deviation of the mean (for both between- and within- measurement precision) for >100 repeated measurements (A)	0.01	1.0	0.01
Activity used to calibrate PIC A net response per Bq of cesium-137 in solution	Standard uncertainty of the activity determined by the $4\pi(e+X)$ - γ -coincidence efficiency-extrapolation technique. (B)	0.31	1.0	0.31
Half life of cesium-137 Half life of radium-226	Standard uncertainty of the half life (A)	0.10 [m] 0.44 [m]	0.0001 [n] 0.010 [n]	0.00001 0.004
Gravimetric measurements	Estimated (B)	0.03	1.0	0.03
PIC A charge collection	Estimated (B)	0.05	1.0	0.05
Charge collection measurement time [p]	Estimated (B)	0.05	1.0	0.05
Long-term RRS positioning	Estimated (B)	0.05	1.0	0.05
Photon-emitting impurities	Limit of detection (B) [q]	100.	0.0001	0.01
Relative Combined Standard Uncertainty of the Output Quantity, $u_c(y)/y$, (%)				0.35
Coverage Factor, k				<u>x 2</u>
Relative Expanded Uncertainty of the Output Quantity, U/y , (%)				0.70

NOTES

- [a] The Sievert is the SI unit for dose equivalent. See reference [1]. One μSv is equal to 0.1 mrem.
 Distance from Ampoule (cm): 1 30 100
 Approximate Dose Rate ($\mu\text{Sv/h}$): 300 4 0.3
- [b] The stated uncertainty is two times the standard uncertainty.
- [c] **Massic activity** is the preferred name for the quantity activity divided by the total mass of the sample. See reference [1].
- [d] The reported value, y , of massic activity (activity per unit mass) at the reference time was not measured directly but was derived from measurements and calculations of other quantities. This can be expressed as $y = f(x_1, x_2, x_3, \dots, x_n)$, where f is a mathematical function derived from the assumed model of the measurement process. The value, x_i , used for each input quantity i has a **standard uncertainty**, $u(x_i)$, that generates a corresponding uncertainty in y , $u_i(y) = |\partial y / \partial x_i| \cdot u(x_i)$, called a **component of combined standard uncertainty** of y . The **combined standard uncertainty** of y , $u_c(y)$, is the positive square root of the sum of the squares of the components of combined standard uncertainty. The combined standard uncertainty is multiplied by a **coverage factor** of $k = 2$ to obtain U , the **expanded uncertainty** of y .
- Since it can be assumed that the possible estimated values of the massic activity are approximately normally distributed with approximate standard deviation $u_c(y)$, the unknown value of the massic activity is believed to lie in the interval $y \pm U$ with a level of confidence of approximately 95 percent.
- For further information on the expression of uncertainties, see references [2] and [3].
- [e] The value of each component of combined standard uncertainty, and hence the value of the expanded uncertainty itself, is a best estimate based upon all available information, but is only approximately known. That is to say, the "uncertainty of the uncertainty" is large and not well known. This is true for uncertainties evaluated by statistical methods (e.g., the relative standard deviation of the standard deviation of the mean for the massic response is approximately 50%) and for uncertainties evaluated by other methods (which could easily be over estimated or under estimated by substantial amounts). The unknown value of the expanded uncertainty is believed to lie in the interval $U/2$ to $2U$ (i.e., within a factor of 2 of the estimated value).
- [f] Estimated limits of detection for photon-emitting impurities, as of 3 October 2005 (3 days after the reference time), expressed as massic photon emission rates, are:
 $< 40 \text{ } \gamma \cdot \text{s}^{-1} \cdot \text{g}^{-1}$ for energies between 40 keV and 1350 keV, and
 $< 4 \text{ } \gamma \cdot \text{s}^{-1} \cdot \text{g}^{-1}$ for energies between 1350 keV and 3600 keV,
- [g] The stated uncertainty is the standard uncertainty.
- [h] Relative standard uncertainty of the input quantity x_i .
- [i] The relative change in the output quantity y divided by the relative change in the input quantity x_i . If $|\partial y / \partial x_i| \cdot (x_i/y) = 1.0$, then a 1% change in x_i results in a 1% change in y . If $|\partial y / \partial x_i| \cdot (x_i/y) = 0.05$, then a 1% change in x_i results in a 0.05% change in y .

- [j] Relative component of combined standard uncertainty of output quantity y , rounded to two significant figures or less. The relative component of combined standard uncertainty of y is given by $u_i(y)/y \approx |\partial y/\partial x_i| \cdot u(x_i)/y = |\partial y/\partial x_i| \cdot (x_i/y) \cdot u(x_i)/x_i$. The numerical values of $u(x_i)/x_i$, $|\partial y/\partial x_i| \cdot (x_i/y)$, and $u_i(y)/y$, all dimensionless quantities, are listed in columns 3, 4, and 5, respectively. Thus, the value in column 5 is equal to the value in column 4 multiplied by the value in column 3. The input quantities are independent, or very nearly so. Hence the covariances are zero or negligible.
- [k] The response of pressurized ionization chamber A (PIC A) is determined from measurement of the time required to collect a given amount of charge on a stable fixed capacitor. All of the response measurements in the NIST pressurized ionization chambers are made relative to the response of one or more artifact standards. These artifact standards consist of microgram quantities of aged radium-226 in small welded stainless-steel capsules. These capsules are encapsulated in plastic rods whose dimensions are similar to those of the standard NIST ampoule. The artifact standards are called **Radium Reference Sources** and are designated as RRSx, where x is the nominal mass (in micrograms) of radium-226 in the capsule.
- [m] The relative standard uncertainty of $\lambda \cdot t$ is determined by the relative standard uncertainty of λ (i.e., of the half life). The relative standard uncertainty of t is negligible.
- [n] $|\partial y/\partial x_i| \cdot (x_i/y) = |\lambda \cdot t|$
- [p] The charge collection measurement time is determined by counting the pulses from a gated crystal-controlled oscillator.
- [q] The standard uncertainty for each undetected impurity that might reasonably be expected to be present is estimated to be equal to the estimated limit of detection for that impurity, i.e. $u(x_i)/x_i = 100\%$. $|\partial y/\partial x_i| \cdot (x_i/y) = \{(\text{response per Bq of impurity})/(\text{response per Bq of cesium-137})\} \cdot \{(\text{Bq of impurity})/(\text{Bq of cesium-137})\}$. Thus $u_i(y)/y$ is the relative change in y if the impurity were present with a mass activity equal to the estimated limit of detection.

REFERENCES

- [1] International Organization for Standardization (ISO), *ISO Standards Handbook - Quantities and Units*, 1993. Available from Global Engineering Documents, 12 Inverness Way East, Englewood, CO 80112, U.S.A. Telephone 1-800-854-7179.
- [2] International Organization for Standardization (ISO), *Guide to the Expression of Uncertainty in Measurement*, 1993 (corrected and reprinted, 1995). Available from Global Engineering Documents, 12 Inverness Way East, Englewood, CO 80112, U.S.A. Telephone 1-800-854-7179.
- [3] B. N. Taylor and C. E. Kuyatt, *Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results*, NIST Technical Note 1297, 1994. Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20407, U.S.A.
- [4] National Council on Radiation Protection and Measurements Report No. 58, *A Handbook of Radioactivity Measurements Procedures*, Second Edition, 1985. Available from the National Council on Radiation Protection and Measurements, 7910 Woodmont Avenue, Bethesda, MD 20814 U.S.A.
- [5] Evaluated Nuclear Structure Data File (ENSDF), September 2005.