Lindsay Light Field Report
Gamma Survey and Sample Collection
U.S. EPA Region 5 Emergency Response

Site Name:	161 E Grand Ave
Operable Unit:	Lindsay Light II Site OU17
Date of Field Work:	June 14, 2021
EPA/START Personnel:	Adam Peterca (START / Tetra Tech) Kirsten Myles (START / Tetra Tech) Verneta Simon (USEPA) Eugene Jablonowski (USEPA)

Summary of Environmental Conditions

- During historical construction/excavation activities at the 161 E Grand Ave property radioactive contamination in soil/fill has been identified. Current utility installation plans required excavation of soil/fill in areas where radioactive contamination was suspected to be present, but had not been remediated during previous clean-up efforts. Due to the history of contaminated material in the vicinity of the utility excavation and the relatively small size of the excavation EPA and START were present during all excavation activities.
- Excavation was conducted by Electric Conduit Construction (ECC). Radiation monitoring during excavation was conducted by Stan A. Huber Consultants, Inc. (SAHCI).
- Elevated levels of gamma radiation were observed by SAHCI within the excavation. Material with elevated levels of gamma radiation was segregated from other material and placed in designated containers for future disposal.
- Excavation activities terminated at the planned excavation extent based on the requirements for utility installation. When excavation was completed, an area of material with elevated gamma radiation remained in place along the northern wall of the excavated trench.

Description of EPA/START Activities

- Verneta Simon (USEPA), Adam Peterca (START / Tetra Tech), and Kirsten Myles (START / Tetra Tech) arrived at the excavation site at approximately 08:35 on June 14, 2021. Kirsten Myles left the site at approximately 09:40 to respond to an unrelated emergency response. Gene Jablonowski (USEPA) arrived at the excavation site at approximately 10:00.
- The instrument used by Tetra Tech for gamma surveying was a Ludlum Model 2221 scaler/ratemeter (Serial Number 106678) with a Ludlum 44-10 sodium iodide detector (Serial Number PR292700) with a 6-inch lead shield, calibrated on April 21, 2021 with a 7.1 picocurie per gram (pCi/g) cutoff of 5,828 counts per minute (cpm).

- Tetra Tech completed a post-excavation walkover gamma survey of the excavated area at approximately 12:00. The excavated area was considered one survey unit.
    - Gamma readings of the floor of the survey unit ranged from 2,009 to 5,256 cpm. Gamma readings of the walls of the survey unit ranged from 1,612 to 12,000 cpm. The area of the excavation wall with elevated gamma readings above the instrument-specific cutoff level was a known area of contamination that was intentionally left in place. A soil sample was collected from this portion of the excavation wall to document the gamma radiation levels left in place.
- Tetra Tech collected the following samples from the excavation:
    - A 5-point composite soil sample from the floor of the survey unit for gamma spectroscopy analysis (sample field ID LL-210614-F) and a corresponding soil sample for dry weight moisture analysis.
    - A 5-point composite soil sample from the area of the excavation wall that exceeded the instrument-specific cutoff level for gamma spectroscopy analysis (sample field ID LL-210614-W) and a corresponding soil sample for dry weight moisture analysis.

Summary of Sample Results

Samples were sent to ALS Environmental (ALS) in Fort Collins, Colorado for gamma spectroscopy analysis. The results are summarized in the table below.

Table 1: Verification Sampling Analytical Results

Sample Field ID	Sample Lab ID	Sample Ra-228 (pCi/g)	Sample Ra-226 (pCi/g)	Ra-228 plus Ra-226 (pCi/g)
LL-210614-F	2106442-1	0.950	0.518	1.468
LL-210614-W	2106442-2	21.000	2.240	23.240

Notes:
DUP – Duplicate
ID – Identification
pCi/g – Picocuries per gram
Ra – Radium

Attachments

1. ALS report of gamma spectroscopy results for the samples collected by EPA.

Prepared by:

Name: Adam Peterca, START / Tetra Tech

Signature: 

Date: February 3, 2022

Reviewed by:

Name: Eugene Jablonowski, Health Physicist, U.S. EPA Region 5

Signature: EUGENE JABLONOWSKI Digitally signed by EUGENE JABLONOWSKI Date: 2022.02.24 08:39:57 -06'00'

Date: February 24, 2022

Gamma Spectroscopy

Case Narrative

Tetra Tech, Inc.

Lindsay Light - 161 E Grand Alley

Work Order Number: 2106442

1. This report consists of analytical results and supporting documentation for two solid samples received by ALS on 06/16/2021.

2. These samples were prepared according to the current revision of SOP 739. The samples were sealed in steel cans on 06/19/2029 and stored for at least 21 days to allow ^{222}Rn to approach secular equilibrium with its parent, ^{226}Ra. The degree of ingrowth achieved prior to analysis on 07/11/2021 is at least 97.8%. Conservatively assuming a radon emanation efficiency of approximately 50%, the effective radon progeny ingrowth for these samples would be greater than 98.9%.

3. The samples were analyzed for the presence of gamma emitting radionuclides according to the current revision of SOP 713. The analyses were completed on 07/11/2021.

4. The results for these samples are reported on a “Dry Weight” basis in units of pCi/gram.

5. Sample volumes were insufficient to allow preparation of a duplicate. A duplicate analysis of sample 2106442-1 was performed in lieu of a prepared duplicate.

6. Activity concentrations above the calculated MDC are reported in some instances where minimum nuclide identification criteria are not met. Such tentative identifications result when the software attempts to calculate net activity concentrations for analytes where either one or both of the following criteria are not satisfied: the ‘diagnostic’ peak for a nuclide must be identified above the critical level, or the minimum library peak abundance must be attained. Nuclides not meeting these requirements have been flagged with a “TI” qualifier.

7. In cases where there are no peaks found in the peak search routine, the software performs a net quantification. This indicates that nuclides are not detected or supported at any level above the reported MDC. Consequently, these nuclides are flagged with an "NQ" qualifier on the final reports. Please refer to the Technical Bulletin Addendum in section 5 of this report.

8. The volume of these samples was not within 0.5 cm of the associated calibration volume as required per the current revision of SOP 739. Therefore, any reported results for these samples are identified with a "J" qualifier, indicating the activity values to be an estimated value. Results are reported without further qualification.

9. Technical considerations made in the creation of the gamma spectroscopy library used in this analysis are detailed in the document "Technical Comments Regarding Gamma Spectroscopy Libraries" found in Section 5.

10. ALS uses the following convention for reporting significant digits in the TPU and MDC results. The TPU value is rounded to two significant digits. The MDC value is rounded to the same decimal place as the TPU value. In practice, this could result in an MDC reported value of zero for samples with significant activity, including the batch laboratory control sample.

11. No further problems were encountered with either the client's samples or the associated quality control 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.

Joan Anderson — 7/15/21
Joan Anderson — Date
Radiochemistry Primary Data Reviewer

7/22/21
Radiochemistry Final Data Reviewer — Date

1

Section 1

CHAIN OF CUSTODY

ALS -- Fort Collins

Sample Number(s) Cross-Reference Table

OrderNum: 2106442
Client Name: Tetra Tech, Inc.
Client Project Name: Lindsay Light - 161 E Grand Alley
Client Project Number:
Client PO Number:

Client Sample Number	Lab Sample Number	COC Number	Matrix	Date Collected	Time Collected
LL-210614-F	2106442-1		SOLID	14-Jun-21	12:03
LL-210614-W	2106442-2		SOLID	14-Jun-21	12:14

ENVIRONMENTAL PROTECTION AGENCY
Office of Enforcement

2106442

REGION 5
77 West Jackson Boulevard
Chicago, Illinois 60604

CHAIN OF CUSTODY RECORD

PROJ. NO.	PROJECT NAME	NO. OF CONTAINERS	Analyte: HPGe Gamma Spec (3-DAY)	Gamma Spec (21-DAY INGROWTH)	Soil Moisture				Activity Code:
	LINDSAY LIGHT - 161 E. GRAND								

SAMPLERS: *(Print Name and Sign)*
ADAM PETERCA / Adam J. Peterca

STA. NO.	DATE	TIME	COMP.	GRAB	STATION LOCATION	TAG NUMBERS
1	6/14/21	1203	X		LL-210614-F	2
2	6/14/21	1214		X	LL-210614-W	2

Relinquished by: *(Signature)*	Date / Time	Received by: *(Signature)*	Ship To:
Adam J. Peterca	6/14/21 1500	[signature] 6/16/21 0945	ALS FORT COLLINS 225 COMMERCE DRIVE FORT COLLINS, CO 80524
Relinquished by: *(Signature)*	Date / Time	Received by: *(Signature)*	ATTN:
Relinquished by: *(Signature)*	Date / Time	Received for Laboratory by: *(Signature)* / Date / Time	Airbill Number
			Chain of Custody Seal Numbers: 57822; 57823

5 of 173

Distribution: White - Accompanies Shipment; Pink - Coordinator Field Files; Yellow - Laboratory File

5-63733

ALS Environmental - Fort Collins
CONDITION OF SAMPLE UPON RECEIPT FORM

Client: TETRA TECH Workorder No: 2106442

Project Manager: JME Initials: JPE Date: 06/16/2021

		N/A	YES	NO
1.	Are airbills / shipping documents present and/or removable?		X	
	Tracking number: 2804 3373 9428			
2.	Are custody seals on **shipping** containers intact?	X		
3.	Are custody seals on **sample** containers intact?	X		
4.	Is there a COC (chain-of-custody) present?		X	
5.	Is the COC in agreement with samples received? (IDs, dates, times, # of samples, # of containers, matrix, requested analyses, etc.)		X	
6.	Are short-hold samples present?			X
7.	Are all samples within holding times for the requested analyses?		X	
8.	Were all sample containers received intact? (not broken or leaking)		X	
9.	Is there sufficient sample for the requested analyses?		X	
10.	Are samples in proper containers for requested analyses? (form 250, *Sample Handling Guidelines*)		X	
11.	Are all aqueous samples preserved correctly, if required? (excluding volatiles)	X		
12.	Are all samples requiring no headspace (VOC, GRO, RSK/MEE, radon) free of bubbles > 6 mm (1/4 inch) diameter? (i.e. size of green pea)	X		
13.	Were the samples shipped on ice?			X
14.	Were cooler temperatures measured at 0.1-6.0°C? IR gun used*: #5	RAD ONLY		X

Cooler #:	1						
Temperature (°C):	AMB						
# of custody seals on cooler:	0						
External µR/hr reading:	11						
Background µR/hr reading:	12						

Were external µR/hr readings ≤ two times background and within DOT acceptance criteria? **YES**

*** Please provide details here for NO responses to boxes above - for 2 thru 5 & 7 thru 12, notify PM & continue w/ login.**

Were unpreserved bottles pH checked? NA All client bottle ID's vs ALS lab ID's double-checked by: JE

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

Project Manager Signature / Date: Julie Ellyson

Form 201r30.xls
03/18/2021

*IR Gun #5, VWR SN 192272629

Section 2

SAMPLE RESULTS SUMMARY

Due to the nature of gamma spectroscopy data, a summary report is not provided.

Please refer to the individual sample results in Section 4.

Section 3

QC RESULTS SUMMARY 3

Gamma Spectroscopy Results

PAI 713 Rev 15

Method Blank Results

Lab Name: ALS -- Fort Collins
Work Order Number: 2106442
Client Name: Tetra Tech, Inc.
ClientProject ID: Lindsay Light - 161 E Grand Alley

Lab ID: GS210619-1MB
Library: NATURAL(SUB

Sample Matrix: SOLID
Prep SOP: PAI 739 Rev 13
Date Collected: 19-Jun-21
Date Prepared: 19-Jun-21
Date Analyzed: 11-Jul-21

Prep Batch: GS210619-1
QCBatchID: GS210619-1-1
Run ID: GS210619-1A
Count Time: 1000 minutes

Final Aliquot: 500 g
Result Units: pCi/g
File Name: 210799d01

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14331-83-0	Ac-228	0.009 +/- 0.052	0.087	1	NA	U
14913-49-6	Bi-212	0.130 +/- 0.094	0.149	1	NA	U
14733-03-0	Bi-214	0.004 +/- 0.035	0.058	1	NA	U
13966-00-2	K-40	0.05 +/- 0.27	0.45	2	NA	U
378783-76-7	Pa-234m	0.9 +/- 1.2	1.9	35	NA	U
15092-94-1	Pb-212	0.011 +/- 0.019	0.032	1	NA	U
15067-28-4	Pb-214	0.013 +/- 0.022	0.037	1	NA	U
15262-20-1	Ra-228	0.009 +/- 0.052	0.087	1	NA	U
14274-82-9	Th-228	0.009 +/- 0.052	0.087	1	NA	U
15065-10-8	Th-234	0.03 +/- 0.23	0.38	2	NA	U
14913-50-9	Tl-208	0.006 +/- 0.018	0.030	1	NA	U

Comments:

Qualifiers/Flags:

U - Result is less than the sample specific MDC or less than the associated TP
U
Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

SQ - Spectral quality prevents accurate quantitation.

SI - Nuclide identification and/or quantitation is tentative.

TI - Nuclide identification is tentative.

R - Nuclide has exceeded 8 halflives.

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

Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

Data Package ID: *GSS2106442-1*

Gamma Spectroscopy Results

PAI 713 Rev 15

Method Blank Results

Lab Name: ALS -- Fort Collins
Work Order Number: 2106442
Client Name: Tetra Tech, Inc.
ClientProject ID: Lindsay Light - 161 E Grand Alley

Lab ID: GS210619-1MB
Library: RA226.LIB

Sample Matrix: SOLID
Prep SOP: PAI 739 Rev 13
Date Collected: 19-Jun-21
Date Prepared: 19-Jun-21
Date Analyzed: 11-Jul-21

Prep Batch: GS210619-1
QCBatchID: GS210619-1-1
Run ID: GS210619-1A
Count Time: 1000 minutes

Final Aliquot: 500 g
Result Units: pCi/g
File Name: 210799d01A

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13982-63-3	Ra-226	0.031 +/- 0.014	0.022	1	NA	NQ

Comments:

Qualifiers/Flags:

U - Result is less than the sample specific MDC or less than the associated TP
U
Y1 - Chemical Yield is in control at 100-110%. Quantitative Yield is assumed.

Y2 - Chemical Yield outside default limits.

SQ - Spectral quality prevents accurate quantitation.

SI - Nuclide identification and/or quantitation is tentative.

TI - Nuclide identification is tentative.

R - Nuclide has exceeded 8 halflives.

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

Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

Data Package ID: *GSS2106442-1*

Gamma Spectroscopy Results

PAI 713 Rev 15

Laboratory Control Sample(s)

Lab Name: ALS -- Fort Collins
Work Order Number: 2106442
Client Name: Tetra Tech, Inc.
ClientProject ID: Lindsay Light - 161 E Grand Alley

Lab ID: GS210619-1LCS

Library: ANALYTICAL.LI

Sample Matrix: SOLID
Prep SOP: PAI 739 Rev 13
Date Collected: 19-Jun-21
Date Prepared: 19-Jun-21
Date Analyzed: 11-Jul-21

Prep Batch: GS210619-1
QCBatchID: GS210619-1-1
Run ID: GS210619-1A
Count Time: 30 minutes

Final Aliquot: 500 g
Result Units: pCi/g
File Name: 210798d01

CASNO	Target Nuclide	Results +/- 2s TPU	MDC	Spike Added	% Rec	Control Limits	Lab Qualifier
14596-10-2	Am-241	204 +/- 25	8	200.2	102	85 - 115	P
10198-40-0	Co-60	86 +/- 10	0	85.67	101	85 - 115	P
10045-97-3	Cs-137	78.6 +/- 9.3	0.6	76.29	103	85 - 115	P

Comments:

Qualifiers/Flags:

U - Result is less than the sample specific MDC or less than the associated TP
I I
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

SQ - Spectral quality prevents accurate quantitation.

SI - Nuclide identification and/or quantitation is tentative.

TI - Nuclide identification is tentative.

R - Nuclide has exceeded 8 halflives.

Data Package ID: *GSS2106442-1*

Gamma Spectroscopy Results

PAI 713 Rev 15

Duplicate Sample Results (DER)

Lab Name: ALS -- Fort Collins
Work Order Number: 2106442
Client Name: Tetra Tech, Inc.
ClientProject ID: Lindsay Light - 161 E Grand Alley

Field ID: LL-210614-F
Lab ID: 2106442-1DUP

Library: NATURAL(SUB

Sample Matrix: SOLID
Prep SOP: PAI 739 Rev 13
Date Collected: 14-Jun-21
Date Prepared: 19-Jun-21
Date Analyzed: 11-Jul-21

Prep Batch: GS210619-1
QCBatchID: GS210619-1-1
Run ID: GS210619-1A
Count Time: 1000 minutes
Report Basis: Dry Weight

Final Aliquot: 426 g
Prep Basis: As Received
Moisture(%): 11.293
Result Units: pCi/g
File Name: 210805d02

CASNO	Analyte	Sample			Duplicate			DER	DER Lim
		Result +/- 2 s TPU	MDC	Flags	Result +/- 2 s TPU	MDC	Flags		
14331-83-0	Ac-228	0.95 +/- 0.13	0.12	J	1.01 +/- 0.13	0.08	J	0.315	2.13
14913-49-6	Bi-212	1.02 +/- 0.24	0.30	J	1.09 +/- 0.19	0.18	J	0.205	2.13
14733-03-0	Bi-214	0.507 +/- 0.078	0.082	J	0.50 +/- 0.10	0.14	J	0.0854	2.13
13966-00-2	K-40	6.75 +/- 0.91	0.61	J	7.21 +/- 0.89	0.29	J	0.362	2.13
378783-76-7	Pa-234m	1.6 +/- 1.8	3.0	U,J	2.9 +/- 1.8	2.8	J	0.516	2.13
15092-94-1	Pb-212	0.97 +/- 0.12	0.05	J	1.08 +/- 0.13	0.04	J	0.613	2.13
15067-28-4	Pb-214	0.523 +/- 0.070	0.053	J	0.574 +/- 0.074	0.053	J	0.497	2.13
15262-20-1	Ra-228	0.95 +/- 0.13	0.12	J	1.01 +/- 0.13	0.08	J	0.315	2.13
14274-82-9	Th-228	0.95 +/- 0.13	0.12	J	1.01 +/- 0.13	0.08	J	0.315	2.13
15065-10-8	Th-234	1.36 +/- 0.43	0.63	J,TI	1.31 +/- 0.30	0.41	J,TI	0.0919	2.13
14913-50-9	Tl-208	0.322 +/- 0.045	0.037	J	0.319 +/- 0.041	0.022	J	0.049	2.13

Comments:

Duplicate Qualifiers/Flags:

U - Result is less than the sample specific MDC.
Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.
Y2 - Chemical Yield outside default limits.
W - DER is greater than Warning Limit of 1.42
D - DER is greater than Control Limit of 2.13
LT - Result is less than Request MDC, greater than sample specific MDC
M - Requested MDC not met.
M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.
L - LCS Recovery below lower control limit.
H - LCS Recovery above upper control limit.
P - LCS, Matrix Spike Recovery within control limits.
N - Matrix Spike Recovery outside control limits
SQ - Spectral quality prevents accurate quantitation.
SI - Nuclide identification and/or quantitation is tentative.
TI - Nuclide identification is tentative.
R - Nuclide has exceeded 8 halflives.
G - Sample density differs by more than 15% of LCS density.

Abbreviations:
TPU - Total Propagated Uncertainty
DER - Duplicate Error Ratio
BDL - Below Detection Limit
NR - Not Reported

Data Package ID: *GSS2106442-1*

Gamma Spectroscopy Results

PAI 713 Rev 15

Duplicate Sample Results (DER)

Lab Name: ALS -- Fort Collins
Work Order Number: 2106442
Client Name: Tetra Tech, Inc.
ClientProject ID: Lindsay Light - 161 E Grand Alley

Field ID: LL-210614-F
Lab ID: 2106442-1DUP

Library: RA226.LIB

Sample Matrix: SOLID
Prep SOP: PAI 739 Rev 13
Date Collected: 14-Jun-21
Date Prepared: 19-Jun-21
Date Analyzed: 11-Jul-21

Prep Batch: GS210619-1
QCBatchID: GS210619-1-1
Run ID: GS210619-1A
Count Time: 1000 minutes
Report Basis: Dry Weight

Final Aliquot: 426 g
Prep Basis: As Received
Moisture(%): 11.293
Result Units: pCi/g
File Name: 210805d02A

CASNO	Analyte	Sample			Duplicate			DER	DER Lim
		Result +/- 2 s TPU	MDC	Flags	Result +/- 2 s TPU	MDC	Flags		
13982-63-3	Ra-226	0.518 +/- 0.067	0.053	J	0.566 +/- 0.070	0.053	J	0.492	2.13

Comments:

Duplicate Qualifiers/Flags:

U - Result is less than the sample specific MDC.
Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.
Y2 - Chemical Yield outside default limits.
W - DER is greater than Warning Limit of 1.42
D - DER is greater than Control Limit of 2.13
LT - Result is less than Request MDC, greater than sample specific MDC
M - Requested MDC not met.
M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.
L - LCS Recovery below lower control limit.
H - LCS Recovery above upper control limit.
P - LCS, Matrix Spike Recovery within control limits.
N - Matrix Spike Recovery outside control limits
SQ - Spectral quality prevents accurate quantitation.
SI - Nuclide identification and/or quantitation is tentative.
TI - Nuclide identification is tentative.
R - Nuclide has exceeded 8 halflives.
G - Sample density differs by more than 15% of LCS density.

Abbreviations:
TPU - Total Propagated Uncertainty
DER - Duplicate Error Ratio
BDL - Below Detection Limit
NR - Not Reported

Data Package ID: *GSS2106442-1*

Section 4

INDIVIDUAL SAMPLE RESULTS

Gamma Spectroscopy Results

PAI 713 Rev 15

Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 2106442
Client Name: Tetra Tech, Inc.
ClientProject ID: Lindsay Light - 161 E Grand Alley

Field ID: LL-210614-F
Lab ID: 2106442-1
Library: NATURAL(SUB

Sample Matrix: SOLID
Prep SOP: PAI 739 Rev 13
Date Collected: 14-Jun-21
Date Prepared: 19-Jun-21
Date Analyzed: 10-Jul-21

Prep Batch: GS210619-1
QCBatchID: GS210619-1-1
Run ID: GS210619-1A
Count Time: 1000 minutes
Report Basis: Dry Weight

Final Aliquot: 426 g
Prep Basis: As Received
Moisture(%): 11.293
Result Units: pCi/g
File Name: 210796d01

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14331-83-0	Ac-228	0.95 +/- 0.13	0.12	1	NA	J
14913-49-6	Bi-212	1.02 +/- 0.24	0.30	1	NA	J
14733-03-0	Bi-214	0.507 +/- 0.078	0.082	1	NA	J
13966-00-2	K-40	6.75 +/- 0.91	0.61	2	NA	J
378783-76-7	Pa-234m	1.6 +/- 1.8	3.0	35	NA	U,J
15092-94-1	Pb-212	0.97 +/- 0.12	0.05	1	NA	J
15067-28-4	Pb-214	0.523 +/- 0.070	0.053	1	NA	J
15262-20-1	Ra-228	0.95 +/- 0.13	0.12	1	NA	J
14274-82-9	Th-228	0.95 +/- 0.13	0.12	1	NA	J
15065-10-8	Th-234	1.36 +/- 0.43	0.63	2	NA	J,TI
14913-50-9	Tl-208	0.322 +/- 0.045	0.037	1	NA	J

Comments:

Qualifiers/Flags:

U - Result is less than the sample specific MDC or less than the associated TP

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

Y2 - Chemical Yield outside default limits.

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

SQ - Spectral quality prevents accurate quantitation.

SI - Nuclide identification and/or quantitation is tentative.

TI - Nuclide identification is tentative.

R - Nuclide has exceeded 8 halflives.

G - Sample density differs by more than 15% of LCS density.

Data Package ID: *GSS2106442-1*

Gamma Spectroscopy Results

PAI 713 Rev 15

Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 2106442
Client Name: Tetra Tech, Inc.
ClientProject ID: Lindsay Light - 161 E Grand Alley

Field ID: LL-210614-F
Lab ID: 2106442-1
Library: RA226.LIB

Sample Matrix: SOLID
Prep SOP: PAI 739 Rev 13
Date Collected: 14-Jun-21
Date Prepared: 19-Jun-21
Date Analyzed: 10-Jul-21

Prep Batch: GS210619-1
QCBatchID: GS210619-1-1
Run ID: GS210619-1A
Count Time: 1000 minutes
Report Basis: Dry Weight

Final Aliquot: 426 g
Prep Basis: As Received
Moisture(%): 11.293
Result Units: pCi/g
File Name: 210796d01A

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13982-63-3	Ra-226	0.518 +/- 0.067	0.053	1	NA	J

Comments:

Qualifiers/Flags:

U - Result is less than the sample specific MDC or less than the associated TPU

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

Y2 - Chemical Yield outside default limits.

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

M - The requested MDC was not met.

SQ - Spectral quality prevents accurate quantitation.

SI - Nuclide identification and/or quantitation is tentative.

TI - Nuclide identification is tentative.

R - Nuclide has exceeded 8 halflives.

G - Sample density differs by more than 15% of LCS density.

Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *GSS2106442-1*

Gamma Spectroscopy Results

PAI 713 Rev 15

Sample Duplicate Results

Lab Name: ALS -- Fort Collins
Work Order Number: 2106442
Client Name: Tetra Tech, Inc.
ClientProject ID: Lindsay Light - 161 E Grand Alley

Field ID: LL-210614-F
Lab ID: 2106442-1DUP
Library: NATURAL(SUB

Sample Matrix: SOLID
Prep SOP: PAI 739 Rev 13
Date Collected: 14-Jun-21
Date Prepared: 19-Jun-21
Date Analyzed: 11-Jul-21

Prep Batch: GS210619-1
QCBatchID: GS210619-1-1
Run ID: GS210619-1A
Count Time: 1000 minutes
Report Basis: Dry Weight

Final Aliquot: 426 g
Prep Basis: As Received
Moisture(%): 11.293
Result Units: pCi/g
File Name: 210805d02

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14331-83-0	Ac-228	1.01 +/- 0.13	0.08	1	NA	J
14913-49-6	Bi-212	1.09 +/- 0.19	0.18	1	NA	J
14733-03-0	Bi-214	0.50 +/- 0.10	0.14	1	NA	J
13966-00-2	K-40	7.21 +/- 0.89	0.29	2	NA	J
378783-76-7	Pa-234m	2.9 +/- 1.8	2.8	35	NA	J
15092-94-1	Pb-212	1.08 +/- 0.13	0.04	1	NA	J
15067-28-4	Pb-214	0.574 +/- 0.074	0.053	1	NA	J
15262-20-1	Ra-228	1.01 +/- 0.13	0.08	1	NA	J
14274-82-9	Th-228	1.01 +/- 0.13	0.08	1	NA	J
15065-10-8	Th-234	1.31 +/- 0.30	0.41	2	NA	J,TI
14913-50-9	Tl-208	0.319 +/- 0.041	0.022	1	NA	J

Comments:

Qualifiers/Flags:

U - Result is less than the sample specific MDC or less than the associated TPU.
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 thereported activity is greater than the reported MDC.
W - DER is greater than Warning Limit of 1.42
D - DER is greater than Control Limit of 2.13

SQ - Spectral quality prevents accurate quantitation.
SI - Nuclide identification and/or quantitation is tentative.
TI - Nuclide identification is tentative.
R - Nuclide has exceeded 8 halflives.
G - Sample density differs by more than 15% of LCS density.

Abbreviations:
TPU - Total Propagated Uncertainty
MDC - Sample specific Minimum Detectable Concentration
BDL - Below Detection Limit
DL - Decision Level

Data Package ID: *GSS2106442-1*

Gamma Spectroscopy Results

PAI 713 Rev 15

Sample Duplicate Results

Lab Name: ALS -- Fort Collins
Work Order Number: 2106442
Client Name: Tetra Tech, Inc.
ClientProject ID: Lindsay Light - 161 E Grand Alley

Field ID: LL-210614-F
Lab ID: 2106442-1DUP
Library: RA226.LIB

Sample Matrix: SOLID
Prep SOP: PAI 739 Rev 13
Date Collected: 14-Jun-21
Date Prepared: 19-Jun-21
Date Analyzed: 11-Jul-21

Prep Batch: GS210619-1
QCBatchID: GS210619-1-1
Run ID: GS210619-1A
Count Time: 1000 minutes
Report Basis: Dry Weight

Final Aliquot: 426 g
Prep Basis: As Received
Moisture(%): 11.293
Result Units: pCi/g
File Name: 210805d02A

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13982-63-3	Ra-226	0.566 +/- 0.070	0.053	1	NA	J

Comments:

Qualifiers/Flags:

U - Result is less than the sample specific MDC or less than the associated TPU.
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 thereported activity is greater than the reported MDC.
W - DER is greater than Warning Limit of 1.42

D - DER is greater than Control Limit of 2.13

SQ - Spectral quality prevents accurate quantitation.
SI - Nuclide identification and/or quantitation is tentative.
TI - Nuclide identification is tentative.
R - Nuclide has exceeded 8 halflives.
G - Sample density differs by more than 15% of LCS density.

Abbreviations:
TPU - Total Propagated Uncertainty
MDC - Sample specific Minimum Detectable Concentration
BDL - Below Detection Limit
DL - Decision Level

Data Package ID: *GSS2106442-1*

Gamma Spectroscopy Results

PAI 713 Rev 15

Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 2106442
Client Name: Tetra Tech, Inc.
ClientProject ID: Lindsay Light - 161 E Grand Alley

Field ID: LL-210614-W
Lab ID: 2106442-2
Library: NATURAL(SUB

Sample Matrix: SOLID
Prep SOP: PAI 739 Rev 13
Date Collected: 14-Jun-21
Date Prepared: 19-Jun-21
Date Analyzed: 10-Jul-21

Prep Batch: GS210619-1
QCBatchID: GS210619-1-1
Run ID: GS210619-1A
Count Time: 1000 minutes
Report Basis: Dry Weight

Final Aliquot: 444 g
Prep Basis: As Received
Moisture(%): 8.752
Result Units: pCi/g
File Name: 210802d02

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
14331-83-0	Ac-228	21.0 +/- 2.5	0.1	1	NA	J
14913-49-6	Bi-212	21.9 +/- 2.6	0.5	1	NA	J
14733-03-0	Bi-214	2.28 +/- 0.27	0.08	1	NA	J
13966-00-2	K-40	11.9 +/- 1.4	0.3	2	NA	J
378783-76-7	Pa-234m	2.4 +/- 1.7	2.7	35	NA	U,J
15092-94-1	Pb-212	21.7 +/- 2.5	0.1	1	NA	J
15067-28-4	Pb-214	2.20 +/- 0.27	0.13	1	NA	J
15262-20-1	Ra-228	21.0 +/- 2.5	0.1	1	NA	J
14274-82-9	Th-228	21.0 +/- 2.5	0.1	1	NA	J
15065-10-8	Th-234	12.8 +/- 1.6	0.8	2	NA	J
14913-50-9	Tl-208	6.71 +/- 0.79	0.04	1	NA	J

Comments:

Qualifiers/Flags:

U - Result is less than the sample specific MDC or less than the associated TP

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

Y2 - Chemical Yield outside default limits.

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

M - The requested MDC was not met.

SQ - Spectral quality prevents accurate quantitation.

SI - Nuclide identification and/or quantitation is tentative.

TI - Nuclide identification is tentative.

R - Nuclide has exceeded 8 halflives.

G - Sample density differs by more than 15% of LCS density.

Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *GSS2106442-1*

Gamma Spectroscopy Results

PAI 713 Rev 15

Sample Results

Lab Name: ALS -- Fort Collins
Work Order Number: 2106442
Client Name: Tetra Tech, Inc.
ClientProject ID: Lindsay Light - 161 E Grand Alley

Field ID: LL-210614-W
Lab ID: 2106442-2
Library: RA226.LIB

Sample Matrix: SOLID
Prep SOP: PAI 739 Rev 13
Date Collected: 14-Jun-21
Date Prepared: 19-Jun-21
Date Analyzed: 10-Jul-21

Prep Batch: GS210619-1
QCBatchID: GS210619-1-1
Run ID: GS210619-1A
Count Time: 1000 minutes
Report Basis: Dry Weight

Final Aliquot: 444 g
Prep Basis: As Received
Moisture(%): 8.752
Result Units: pCi/g
File Name: 210802d02A

CASNO	Target Nuclide	Result +/- 2 s TPU	MDC	Requested MDC	DL	Lab Qualifier
13982-63-3	Ra-226	2.24 +/- 0.27	0.08	1	NA	J

Comments:

Qualifiers/Flags:

U - Result is less than the sample specific MDC or less than the associated TPU

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

Y2 - Chemical Yield outside default limits.

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

M - The requested MDC was not met.

SQ - Spectral quality prevents accurate quantitation.

SI - Nuclide identification and/or quantitation is tentative.

TI - Nuclide identification is tentative.

R - Nuclide has exceeded 8 halflives.

G - Sample density differs by more than 15% of LCS density.

Abbreviations:

TPU - Total Propagated Uncertainty

MDC - Sample specific Minimum Detectable Concentration

BDL - Below Detection Limit

DL - Decision Level

Data Package ID: *GSS2106442-1*

Section 5

RAW DATA

210796D01.SPC Analyzed by JH

SEEKER G A M M A A N A L Y S I S R E S U L T S PS Version 1.8.4

ALS Laboratory Group - Fort Collins
GammaScan

Geo 13 / Solid

Sample ID: 2106442-1 GS210619-1

Sampling Start: 06/14/2021 12:00:00	Counting Start: 07/10/2021 14:00:48
Sampling Stop: 06/14/2021 12:00:00	Decay Time. . . . . 6.26E+002 Hrs
Buildup Time. . . . . 0.00E+000 Hrs	Live Time . . . . . 60000 Sec
Sample Size . . . . . 3.78E+002 g	Real Time . . . . . 60274 Sec
Collection Efficiency 1.0000	Spc. File 210796D01.SPC

Detector #: 1 (Detector 1)

Energy(keV)= -2.02 + 0.501*Ch + 0.00E+00*Ch^2 + 0.00E+00*Ch^3 07/10/2021
FWHM(keV) = 0.74 + 0.020*En + 4.70E-04*En^2 + 0.00E+00*En^3 08/22/2020
Where En = Sqrt(Energy in keV)

Search Sensitivity: 1.00 | Sigma Multiplier: 2.00 | Search Start/End: 80/4000

PEAK SEARCH RESULTS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET/MDA COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)		FLAG
1	63.46	130.67	66	110	90	1618	0.83	a	NET< CL Wide Pk
2	66.55	136.85	215	113	90	1618	0.85	b	
3	70.97	145.66	423	293	239	5502	2.80	c	
4	74.80	153.32	1117	155	115	2266	1.13	d	
5	77.03	157.75	1523	147	103	1942	1.04	e	
6	84.32	172.30	338	157	125	2485	1.36	a	
7	87.26	178.17	743	134	100	1864	0.99	b	
8	89.80	183.25	458	129	100	1864	0.98	c	
9	92.96	189.55	949	178	138	2796	1.40	d	
10	99.30	202.21	143	136	110	2080	1.10	a	
11	105.40	214.38	158	171	139	2862	1.53	a	
12	114.93	233.40	67	77	62	939	0.50	a	
13	129.18	261.84	288	114	89	1606	0.75	a	
14	139.91	283.25	139	110	88	1572	0.79	a	
15	143.84	291.09	100	124	101	1886	0.95	b	NET< CL
16	154.21	311.77	153	109	88	1547	0.74	a	
17	185.96	375.15	788	142	107	1966	1.18	a	
18	198.70	400.56	194	133	107	1955	1.15	a	
19	209.21	421.54	574	122	92	1574	0.94	a	
20	238.66	480.31	6180	194	93	1483	1.12	a	

210796D01.SPC Analyzed by

PEAK SEARCH RESULTS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET/MDA COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)		FLAG
21	241.50	485.98	1198	177	134	2330	1.83	b	
22	257.03	516.98	75	80	64	944	0.83	a	
23	270.24	543.33	409	105	80	1258	1.14	a	
24	277.60	558.02	176	121	97	1631	1.42	a	
25	283.49	569.78	53	78	63	906	0.76	b	NET< CL
26	295.26	593.27	1382	125	83	1276	1.24	a	
27	300.15	603.03	410	100	75	1117	1.18	b	
28	328.13	658.87	294	104	81	1207	1.25	a	
29	338.39	679.35	1267	120	79	1161	1.25	a	
30	351.92	706.34	2385	131	72	957	1.32	a	
31	409.55	821.36	133	80	63	781	1.23	a	
32	463.07	928.15	341	78	57	636	1.22	a	
33	511.09	1023.98	1801	145	97	1265	2.23	a	Wide Pk
34	558.46	1118.51	95	66	52	529	1.15	a	
35	570.47	1142.48	51	65	52	531	1.20	a	NET< CL
36	583.28	1168.05	2098	121	65	685	1.61	a	
37	609.43	1220.23	1761	115	64	766	1.64	a	
38	666.15	1333.43	94	66	52	518	1.41	a	
39	727.44	1455.74	410	82	59	605	1.72	a	
40	768.90	1538.47	94	56	43	399	1.15	a	
41	785.96	1572.53	49	44	34	273	1.05	a	
42	795.14	1590.84	217	70	53	487	1.80	a	
43	803.80	1608.12	124	72	56	532	1.89	b	
44	835.90	1672.18	56	61	48	457	1.44	a	
45	860.60	1721.48	237	74	55	494	2.15	a	
46	911.52	1823.09	1251	91	48	399	1.84	a	
47	934.41	1868.77	87	56	43	346	1.65	a	
48	964.96	1929.74	281	83	63	558	2.58	a	
49	969.16	1938.13	771	77	43	349	1.68	b	
50	1000.70	2001.06	44	50	40	293	1.61	a	
51	1014.80	2029.20	36	62	50	409	2.51	a	NET< CL
52	1120.62	2240.39	367	67	45	381	1.93	a	
53	1238.28	2475.20	136	56	42	344	1.85	a	
54	1378.14	2754.29	80	47	36	212	2.48	a	
55	1408.81	2815.51	46	39	30	178	1.86	a	
56	1461.25	2920.16	3165	120	34	184	2.65	a	HiResid
57	1589.24	3175.57	104	31	20	85	1.32	a	
58	1592.63	3182.35	104	53	41	222	3.36	b	
59	1622.24	3241.44	57	32	23	101	1.74	a	
60	1631.13	3259.17	28	31	24	110	2.00	b	
61	1730.07	3456.62	53	27	18	68	1.64	a	
62	1764.97	3526.28	338	51	29	129	2.82	a	
63	1848.96	3693.88	23	21	15	56	1.23	a	

210796D01.SPC Analyzed by

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SEEKER B A C K G R O U N D S U B T R A C T R E S U L T S Vers. 2.2.1

ALS Laboratory Group - Fort Collins

GammaScan

****

Background File:. . . . . DET010707.BKG (210707-1 LONGBKGCAL)

Bkg.File Detector #: 1

==========

BACKGROUND SUBTRACT RESULTS

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PK#	ENERGY (keV)	OLD NET COUNTS	OLD UN-CERTAINTY	OLD CR.LEVEL	NEW NET COUNTS	NEW UN-CERTAINTY	NEW CR.LEVEL	FLAG
2	66.55	215	113	90	80	164	134	NET<CL
4	74.80	1117	155	115	994	209	164	
5	77.03	1523	147	103	1478	232	180	
9	92.96	949	178	138	802	232	185	
14	139.91	139	110	88	58	153	126	NET<CL
16	154.21	153	109	88	111	149	121	NET<CL
17	185.96	788	142	107	691	218	174	
18	198.70	194	133	107	21	211	173	NET<CL
20	238.66	6180	194	93	6087	237	147	
26	295.26	1382	125	83	1338	194	148	
30	351.92	2385	131	72	2283	163	108	
33	511.09	1801	145	97	809	268	216	
34	558.46	95	66	52	-88	135	112	NET<CL
36	583.28	2098	121	65	2017	164	113	
37	609.43	1761	115	64	1636	180	132	
43	803.80	124	72	56	6	109	90	NET<CL
46	911.52	1251	91	48	1182	121	81	
49	969.16	771	77	43	729	122	90	
52	1120.62	367	67	45	340	87	65	
53	1238.28	136	56	42	97	97	78	
56	1461.25	3165	120	34	2519	169	112	
62	1764.97	338	51	29	273	91	70	

210796D01.SPC Analyzed by

SEEKER F I N A L A C T I V I T Y R E P O R T Version 2.2.1

ALS Laboratory Group - Fort Collins
GammaScan

Geo 13 / Solid

Sample ID: 2106442-1 GS210619-1

Sampling Start: 06/14/2021 12:00:00	Counting Start: 07/10/2021 14:00:48
Sampling Stop: 06/14/2021 12:00:00	Decay Time. . . . . 6.26e+002 Hrs
Buildup Time. . . . . 0.00e+000 Hrs	Live Time . . . . . 60000 Sec
Sample Size . . . . . 3.78e+002 g	Real Time . . . . . 60274 Sec
Collection Efficiency 1.0000	Spectrum File 210796D01.SPC
Cr. Level Confidence Interval: 95 %	Det. Limit Confidence Interval: 95 %

Detector #: 1 (Detector 1)

Efficiency File: (D01)(Sh13).EFF (Geo 13 Eff Cal)
Eff=10^[-1.10E+02 +1.44E+02*L +-6.36E+01*L^2 +9.33E+00*L^3] 06/25/2021
Eff.= EXP[5.97E-01 + -8.38E-01 * En + 0.00E+00 * En^2] Above 300.00 keV

Library File: NATURAL(SUB RA228).LI (Natural.LIB)

MEASURED or MDA CONCENTRATIONS

Nuclide	ENERGY (keV)	N E T	Concentration (pCi/g)	MDA	Critical Level	Halflife (hrs)
Th-234	92.50		1.36E+00 +- 3.95E-01	6.35E-01	3.15E-01	3.92E+13
Pb-212	Average:x		9.68E-01 +- 3.72E-02	. . . .	. . . .	1.27E+14
	115.18		7.56E-01 +- 8.73E-01	1.43E+00	7.02E-01	1.27E+14
	238.63		9.68E-01 +- 3.77E-02	4.71E-02	2.33E-02	1.27E+14
	300.09		9.80E-01 +- 2.39E-01	3.67E-01	1.80E-01	1.27E+14
U-235	143.76	N	6.47E-02 +- 6.90E-02	1.13E-01	5.59E-02	6.17E+12
	185.72		I.D.	. . . .	. . . .	6.17E+12
Tl-208	Average:x		3.22E-01 +- 2.53E-02	. . . .	. . . .	1.27E+14
	277.36		1.86E-01 +- 1.28E-01	2.08E-01	1.03E-01	1.27E+14
	583.14		3.26E-01 +- 2.65E-02	3.69E-02	1.82E-02	1.27E+14
	860.47		3.61E-01 +- 1.13E-01	1.73E-01	8.45E-02	1.27E+14
Pb-214	Average:x		5.23E-01 +- 3.36E-02	. . . .	. . . .	1.40E+07
	295.22		4.48E-01 +- 6.51E-02	1.00E-01	4.96E-02	1.40E+07
	351.99		5.50E-01 +- 3.92E-02	5.29E-02	2.61E-02	1.40E+07
Ra-228	Average:x		9.53E-01 +- 6.10E-02	. . . .	. . . .	5.04E+04
	338.40		9.81E-01 +- 9.28E-02	1.25E-01	6.14E-02	5.04E+04
	911.07		9.17E-01 +- 9.35E-02	1.28E-01	6.32E-02	5.04E+04
	968.90		9.73E-01 +- 1.63E-01	2.43E-01	1.20E-01	5.04E+04
Bi-214	Average:x		5.07E-01 +- 5.12E-02	. . . .	. . . .	1.40E+07
	609.32		5.03E-01 +- 5.53E-02	8.21E-02	4.06E-02	1.40E+07
	1120.28		5.31E-01 +- 1.36E-01	2.06E-01	1.01E-01	1.40E+07

210796D01.SPC Analyzed by

MEASURED or MDA CONCENTRATIONS

Nuclide	ENERGY (keV)	N E T	Concentration (pCi/g)	MDA	Critical Level	Halflife (hrs)
Bi-212	727.17		1.02E+00 +- 2.05E-01	3.00E-01	1.46E-01	1.27E+14
Pa-234m	1001.03		1.62E+00 +- 1.83E+00	3.00E+00	1.45E+00	3.92E+13
K-40	1460.75		6.75E+00 +- 4.54E-01	6.08E-01	3.01E-01	1.12E+13
Pb-210	46.50	N	8.73E-01 +- 1.23E+01	2.05E+01	1.01E+01	1.95E+05
Th-227	236.00	N	1.08E-01 +- 1.63E+00	2.69E+00P	1.34E+00	1.90E+05
Cs-137	661.62	N	2.86E-03 +- 1.21E-02	2.03E-02B	9.92E-03	2.64E+05

MEASURED TOTAL: 1.51E+01 +- 1.71E+01 pCi/g

UNKNOWN,SUM or ESCAPE PEAKS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)	FLAG
1	63.46	130.67	66	110	90	1618	0.83	Deleted
2	66.55	136.85	80	164	134	1618	0.85	Deleted
3	70.97	145.66	423	293	239	5502	2.80	Unknown
4	74.80	153.32	994	209	164	2266	1.13	Unknown
5	77.03	157.75	1478	232	180	1942	1.04	Unknown
6	84.32	172.30	338	157	125	2485	1.36	Unknown
7	87.26	178.17	743	134	100	1864	0.99	Unknown
8	89.80	183.25	458	129	100	1864	0.98	Unknown
10	99.30	202.21	143	136	110	2080	1.10	1121DEsc
11	105.40	214.38	158	171	139	2862	1.53	Unknown
13	129.18	261.84	288	114	89	1606	0.75	Unknown
14	139.91	283.25	58	153	126	1572	0.79	Deleted
15	143.84	291.09	100	124	101	1886	0.95	Deleted
16	154.21	311.77	111	149	121	1547	0.74	Deleted
18	198.70	400.56	21	211	173	1955	1.15	Deleted
19	209.21	421.54	574	122	92	1574	0.94	Unknown
21	241.50	485.98	1198	177	134	2330	1.83	Unknown
22	257.03	516.98	75	80	64	944	0.83	Unknown
23	270.24	543.33	409	105	80	1258	1.14	Unknown
25	283.49	569.78	53	78	63	906	0.76	Deleted
28	328.13	658.87	294	104	81	1207	1.25	Unknown
31	409.55	821.36	133	80	63	781	1.23	Unknown
32	463.07	928.15	341	78	57	636	1.22	Unknown
33	511.09	1023.98	809	268	216	1265	2.23	Unknown
34	558.46	1118.51	-88	135	112	529	1.15	Deleted
35	570.47	1142.48	52	65	52	531	1.20	Deleted
38	666.15	1333.43	94	66	52	518	1.41	Unknown
40	768.90	1538.47	94	56	43	399	1.15	Unknown
41	785.96	1572.53	49	44	34	273	1.05	Unknown
42	795.14	1590.84	217	70	53	487	1.80	Unknown
43	803.80	1608.12	6	109	90	532	1.89	Deleted

210796D01.SPC Analyzed by

UNKNOWN,SUM or ESCAPE PEAKS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)	FLAG
44	835.90	1672.18	56	61	48	457	1.44	Unknown
47	934.41	1868.77	87	56	43	346	1.65	Unknown
48	964.96	1929.74	281	83	63	558	2.58	Unknown
51	1014.80	2029.20	36	62	50	409	2.51	Deleted
53	1238.28	2475.20	97	97	78	344	1.85	Unknown
54	1378.14	2754.29	80	47	36	213	2.48	Unknown
55	1408.81	2815.51	46	39	30	178	1.86	Unknown
57	1589.24	3175.57	104	31	20	85	1.32	Unknown
58	1592.63	3182.35	104	53	41	222	3.36	Unknown
59	1622.24	3241.44	57	32	23	101	1.74	Unknown
60	1631.13	3259.17	28	32	24	110	2.00	Unknown
61	1730.07	3456.62	53	27	18	68	1.64	Unknown
62	1764.97	3526.28	273	91	70	129	2.82	Unknown
63	1848.96	3693.88	23	21	15	56	1.23	Unknown

c:\SEEKER\BIN\210796d01.res Analysis Results Saved.

210796D01.SPC Analyzed by JH

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SEEKER G A M M A A N A L Y S I S R E S U L T S PS Version 1.8.4

ALS Laboratory Group - Fort Collins
GammaScan

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Geo 13 / Solid

Sample ID: 2106442-1 GS210619-1

Sampling Start:	06/14/2021 12:00:00	Counting Start:	07/10/2021 14:00:48
Sampling Stop:	06/14/2021 12:00:00	Decay Time.	6.26E+002 Hrs
Buildup Time.	0.00E+000 Hrs	Live Time	60000 Sec
Sample Size	3.78E+002 g	Real Time	60274 Sec
Collection Efficiency	1.0000	Spc. File	.210796D01.SPC

Detector #: 1 (Detector 1)

Energy(keV)= -2.02 + 0.501*Ch + 0.00E+00*Ch^2 + 0.00E+00*Ch^3 07/10/2021
FWHM(keV) = 0.74 + 0.020*En + 4.70E-04*En^2 + 0.00E+00*En^3 08/22/2020
Where En = Sqrt(Energy in keV)

Search Sensitivity: 1.00 | Sigma Multiplier: 2.00 | Search Start/End: 80/4000

PEAK SEARCH RESULTS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET/MDA COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)		FLAG
1	63.46	130.67	66	110	90	1618	0.83	a	NET< CL Wide Pk
2	66.55	136.85	215	113	90	1618	0.85	b	
3	70.97	145.66	423	293	239	5502	2.80	c	
4	74.80	153.32	1117	155	115	2266	1.13	d	
5	77.03	157.75	1523	147	103	1942	1.04	e	
6	84.32	172.30	338	157	125	2485	1.36	a	
7	87.26	178.17	743	134	100	1864	0.99	b	
8	89.80	183.25	458	129	100	1864	0.98	c	
9	92.96	189.55	949	178	138	2796	1.40	d	
10	99.30	202.21	143	136	110	2080	1.10	a	
11	105.40	214.38	158	171	139	2862	1.53	a	
12	114.93	233.40	67	77	62	939	0.50	a	
13	129.18	261.84	288	114	89	1606	0.75	a	
14	139.91	283.25	139	110	88	1572	0.79	a	
15	143.84	291.09	100	124	101	1886	0.95	b	NET< CL
16	154.21	311.77	153	109	88	1547	0.74	a	
17	185.96	375.15	788	142	107	1966	1.18	a	
18	198.70	400.56	194	133	107	1955	1.15	a	
19	209.21	421.54	574	122	92	1574	0.94	a	
20	238.66	480.31	6180	194	93	1483	1.12	a	

PEAK SEARCH RESULTS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET/MDA COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)		FLAG
21	241.50	485.98	1198	177	134	2330	1.83	b	
22	257.03	516.98	75	80	64	944	0.83	a	
23	270.24	543.33	409	105	80	1258	1.14	a	
24	277.60	558.02	176	121	97	1631	1.42	a	
25	283.49	569.78	53	78	63	906	0.76	b	NET< CL
26	295.26	593.27	1382	125	83	1276	1.24	a	
27	300.15	603.03	410	100	75	1117	1.18	b	
28	328.13	658.87	294	104	81	1207	1.25	a	
29	338.39	679.35	1267	120	79	1161	1.25	a	
30	351.92	706.34	2385	131	72	957	1.32	a	
31	409.55	821.36	133	80	63	781	1.23	a	
32	463.07	928.15	341	78	57	636	1.22	a	
33	511.09	1023.98	1801	145	97	1265	2.23	a	Wide Pk
34	558.46	1118.51	95	66	52	529	1.15	a	
35	570.47	1142.48	51	65	52	531	1.20	a	NET< CL
36	583.28	1168.05	2098	121	65	685	1.61	a	
37	609.43	1220.23	1761	115	64	766	1.64	a	
38	666.15	1333.43	94	66	52	518	1.41	a	
39	727.44	1455.74	410	82	59	605	1.72	a	
40	768.90	1538.47	94	56	43	399	1.15	a	
41	785.96	1572.53	49	44	34	273	1.05	a	
42	795.14	1590.84	217	70	53	487	1.80	a	
43	803.80	1608.12	124	72	56	532	1.89	b	
44	835.90	1672.18	56	61	48	457	1.44	a	
45	860.60	1721.48	237	74	55	494	2.15	a	
46	911.52	1823.09	1251	91	48	399	1.84	a	
47	934.41	1868.77	87	56	43	346	1.65	a	
48	964.96	1929.74	281	83	63	558	2.58	a	
49	969.16	1938.13	771	77	43	349	1.68	b	
50	1000.70	2001.06	44	50	40	293	1.61	a	
51	1014.80	2029.20	36	62	50	409	2.51	a	NET< CL
52	1120.62	2240.39	367	67	45	381	1.93	a	
53	1238.28	2475.20	136	56	42	344	1.85	a	
54	1378.14	2754.29	80	47	36	212	2.48	a	
55	1408.81	2815.51	46	39	30	178	1.86	a	
56	1461.25	2920.16	3165	120	34	184	2.65	a	HiResid
57	1589.24	3175.57	104	31	20	85	1.32	a	
58	1592.63	3182.35	104	53	41	222	3.36	b	
59	1622.24	3241.44	57	32	23	101	1.74	a	
60	1631.13	3259.17	28	31	24	110	2.00	b	
61	1730.07	3456.62	53	27	18	68	1.64	a	
62	1764.97	3526.28	338	51	29	129	2.82	a	
63	1848.96	3693.88	23	21	15	56	1.23	a	

210796D01.SPC Analyzed by

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SEEKER B A C K G R O U N D S U B T R A C T R E S U L T S Vers. 2.2.1

ALS Laboratory Group - Fort Collins

GammaScan

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Background File:. . . . . DET010707.BKG (210707-1 LONGBKGCAL)

Bkg.File Detector #: 1

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BACKGROUND SUBTRACT RESULTS

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PK#	ENERGY (keV)	OLD NET COUNTS	OLD UN-CERTAINTY	OLD CR.LEVEL	NEW NET COUNTS	NEW UN-CERTAINTY	NEW CR.LEVEL	FLAG
2	66.55	215	113	90	80	164	134	NET<CL
4	74.80	1117	155	115	994	209	164	
5	77.03	1523	147	103	1478	232	180	
9	92.96	949	178	138	802	232	185	
14	139.91	139	110	88	58	153	126	NET<CL
16	154.21	153	109	88	111	149	121	NET<CL
17	185.96	788	142	107	691	218	174	
18	198.70	194	133	107	21	211	173	NET<CL
20	238.66	6180	194	93	6087	237	147	
26	295.26	1382	125	83	1338	194	148	
30	351.92	2385	131	72	2283	163	108	
33	511.09	1801	145	97	809	268	216	
34	558.46	95	66	52	-88	135	112	NET<CL
36	583.28	2098	121	65	2017	164	113	
37	609.43	1761	115	64	1636	180	132	
43	803.80	124	72	56	6	109	90	NET<CL
46	911.52	1251	91	48	1182	121	81	
49	969.16	771	77	43	729	122	90	
52	1120.62	367	67	45	340	87	65	
53	1238.28	136	56	42	97	97	78	
56	1461.25	3165	120	34	2519	169	112	
62	1764.97	338	51	29	273	91	70	

210796D01.SPC Analyzed by

SEEKER F I N A L A C T I V I T Y R E P O R T Version 2.2.1

ALS Laboratory Group - Fort Collins
GammaScan

Geo 13 / Solid

Sample ID: 2106442-1 GS210619-1

Sampling Start: 06/14/2021 12:00:00	Counting Start: 07/10/2021 14:00:48
Sampling Stop: 06/14/2021 12:00:00	Decay Time. . . . . 6.26e+002 Hrs
Buildup Time. . . . . 0.00e+000 Hrs	Live Time . . . . . 60000 Sec
Sample Size . . . . . 3.78e+002 g	Real Time . . . . . 60274 Sec
Collection Efficiency 1.0000	Spectrum File 210796D01.SPC
Cr. Level Confidence Interval: 95 %	Det. Limit Confidence Interval: 95 %

Detector #: 1 (Detector 1)
Efficiency File: (D01)(Sh13).EFF (Geo 13 Eff Cal)
Eff=10^[-1.10E+02 +1.44E+02*L +-6.36E+01*L^2 +9.33E+00*L^3] 06/25/2021
Eff.= EXP[5.97E-01 + -8.38E-01 * En + 0.00E+00 * En^2] Above 300.00 keV

Library File: . . . . . RA226.LIB (Ra-226 (215g steel can))

MEASURED or MDA CONCENTRATIONS

Nuclide	ENERGY (keV)	NET	Concentration (pCi/g)	MDA	Critical Level	Halflife (hrs)
Ra-226	Average:x		5.18E-01 +- 2.81E-02	. . . .	. . . .	1.40E+07
	295.21		4.48E-01 +- 6.51E-02	1.00E-01	4.96E-02	1.40E+07
	351.92		5.50E-01 +- 3.92E-02	5.29E-02	2.61E-02	1.40E+07
	609.31		5.03E-01 +- 5.53E-02	8.21E-02	4.06E-02	1.40E+07
	1120.29		5.31E-01 +- 1.36E-01	2.06E-01	1.01E-01	1.40E+07

MEASURED TOTAL: 5.18E-01 +- 2.81E-02 pCi/g

UNKNOWN,SUM or ESCAPE PEAKS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)	FLAG
1	70.97	145.66	423	293	239	5502	2.80	Unknown
2	74.80	153.32	994	209	164	2266	1.13	Unknown
3	77.03	157.75	1478	232	180	1942	1.04	Unknown
4	84.32	172.30	338	157	125	2485	1.36	Unknown
5	87.26	178.17	743	134	100	1864	0.99	Unknown
6	89.80	183.25	458	129	100	1864	0.98	Unknown
7	92.96	189.55	802	232	185	2796	1.40	Unknown

210796D01.SPC Analyzed by

UNKNOWN,SUM or ESCAPE PEAKS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)	FLAG
8	99.30	202.21	143	136	110	2080	1.10	1121DEsc
9	105.40	214.38	158	171	139	2862	1.53	Unknown
10	114.93	233.40	67	77	62	939	0.50	Unknown
11	129.18	261.84	288	114	89	1606	0.75	Unknown
12	185.96	375.15	691	218	174	1966	1.18	Unknown
13	209.21	421.54	574	122	92	1574	0.94	Unknown
14	238.66	480.31	6087	237	147	1483	1.12	Unknown
15	241.50	485.98	1198	177	134	2330	1.83	Unknown
16	257.03	516.98	75	80	64	944	0.83	Unknown
17	270.24	543.33	409	105	80	1258	1.14	Unknown
18	277.60	558.02	176	121	97	1631	1.42	Unknown
20	300.15	603.03	410	100	75	1117	1.18	Unknown
21	328.13	658.87	294	104	81	1207	1.25	Unknown
22	338.39	679.35	1267	120	79	1161	1.25	Unknown
24	409.55	821.36	133	80	63	781	1.23	Unknown
25	463.07	928.15	341	78	57	636	1.22	Unknown
26	511.09	1023.98	809	268	216	1265	2.23	Unknown
27	583.28	1168.05	2017	164	113	685	1.61	Unknown
29	666.15	1333.43	94	66	52	518	1.41	Unknown
30	727.44	1455.74	410	82	59	605	1.72	Unknown
31	768.90	1538.47	94	56	43	399	1.15	Unknown
32	785.96	1572.53	49	44	34	273	1.05	Unknown
33	795.14	1590.84	217	70	53	487	1.80	Unknown
34	835.90	1672.18	56	61	48	457	1.44	Unknown
35	860.60	1721.48	237	74	55	494	2.15	Unknown
36	911.52	1823.09	1182	121	81	399	1.84	Unknown
37	934.41	1868.77	87	56	43	346	1.65	Unknown
38	964.96	1929.74	281	83	63	558	2.58	Unknown
39	969.16	1938.13	729	122	90	349	1.68	Unknown
40	1000.70	2001.06	44	50	40	293	1.61	Unknown
42	1238.28	2475.20	97	97	78	344	1.85	Unknown
43	1378.14	2754.29	80	47	36	213	2.48	Unknown
44	1408.81	2815.51	46	39	30	178	1.86	Unknown
45	1461.25	2920.16	2519	169	112	184	2.65	Unknown
46	1589.24	3175.57	104	31	20	85	1.32	Unknown
47	1592.63	3182.35	104	53	41	222	3.36	Unknown
48	1622.24	3241.44	57	32	23	101	1.74	Unknown
49	1631.13	3259.17	28	32	24	110	2.00	Unknown
50	1730.07	3456.62	53	27	18	68	1.64	Unknown
51	1764.97	3526.28	273	91	70	129	2.82	Unknown
52	1848.96	3693.88	23	21	15	56	1.23	Unknown

c:\SEEKER\BIN\210796d01A.res Analysis Results Saved.

210805D02.SPC Analyzed by JH

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SEEKER G A M M A A N A L Y S I S R E S U L T S PS Version 1.8.4

ALS Laboratory Group - Fort Collins
GammaScan

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Geo 13 / Solid

Sample ID: 2106442-1D GS210619-1

Sampling Start:	06/14/2021 12:00:00	Counting Start:	07/11/2021 13:16:20
Sampling Stop:	06/14/2021 12:00:00	Decay Time.	6.49E+002 Hrs
Buildup Time.	0.00E+000 Hrs	Live Time	60000 Sec
Sample Size	3.78E+002 g	Real Time	60110 Sec
Collection Efficiency	1.0000	Spc. File	.210805D02.SPC

Detector #: 2 (Detector 2)

Energy(keV)= -1.46 + 0.501*Ch + 0.00E+00*Ch^2 + 0.00E+00*Ch^3 07/11/2021
FWHM(keV) = 0.59 + 0.019*En + 4.08E-04*En^2 + 0.00E+00*En^3 07/29/2020
Where En = Sqrt(Energy in keV)

Search Sensitivity: 1.00 | Sigma Multiplier: 2.00 | Search Start/End: 80/4000

PEAK SEARCH RESULTS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET/MDA COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)		FLAG
1	46.34	95.44	138	100	80	1423	0.59	a	
2	53.39	109.50	101	63	49	677	0.41	a	
3	63.28	129.26	351	110	85	1613	0.66	a	
4	66.23	135.16	252	143	114	2419	0.97	b	
5	72.89	148.45	210	94	74	1335	0.50	a	
6	74.77	152.20	1743	153	105	2225	0.88	b	
7	77.03	156.72	2671	164	105	2225	0.80	c	
8	84.13	170.90	503	156	123	2588	1.15	a	
9	87.12	176.86	1308	152	110	2218	1.03	b	
10	89.92	182.45	817	145	110	2218	0.92	c	
11	92.87	188.35	1702	185	137	2957	1.33	d	
12	99.52	201.62	228	162	131	2721	1.37	a	
13	105.58	213.72	193	131	105	2033	0.99	a	
14	108.71	219.96	86	129	105	2033	0.97	b	NET< CL
15	115.41	233.34	59	80	64	1018	0.42	a	NET< CL
16	129.15	260.77	443	104	78	1354	0.71	a	
17	139.87	282.19	251	115	91	1674	0.79	a	Wide Pk
18	143.07	288.58	229	191	155	3348	1.69	b	
19	154.09	310.58	130	81	64	996	0.45	a	
20	185.95	374.19	1164	140	101	1885	1.04	a	
21	198.40	399.04	251	153	123	2388	1.25	a	

210805D02.SPC Analyzed by

PEAK SEARCH RESULTS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET/MDA COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)		FLAG
22	209.19	420.59	733	115	83	1404	0.90	a	
23	238.60	479.33	8709	216	89	1479	0.92	a	HiResid
24	241.44	484.99	1259	141	101	1726	1.22	b	HiResid
25	248.91	499.91	47	76	62	844	0.74	a	NET< CL
26	270.30	542.62	652	133	101	1603	1.26	a	
27	277.40	556.79	251	88	68	928	0.74	a	
28	295.25	592.43	1936	127	76	1054	0.98	a	
29	300.11	602.13	573	104	76	1054	1.05	b	
30	328.04	657.90	359	87	65	841	0.78	a	HiResid
31	338.31	678.41	1574	118	72	966	0.91	a	HiResid
32	351.86	705.46	3410	148	75	949	1.09	a	
33	409.51	820.57	248	81	62	706	1.03	a	
34	427.93	857.34	78	81	65	729	1.17	a	
35	462.98	927.34	558	96	68	812	1.54	a	
36	510.98	1023.18	2894	156	93	1220	2.20	a	Wide Pk
37	558.51	1118.07	205	67	50	519	0.94	a	
38	562.50	1126.04	81	56	44	433	0.88	b	
39	569.95	1140.92	87	57	44	448	0.81	a	
40	583.22	1167.42	2891	129	59	647	1.29	a	
41	597.64	1196.21	89	137	112	1540	2.57	a	NET< CL Wide Pk
42	609.34	1219.57	2774	130	63	738	1.29	a	
43	665.33	1331.36	70	62	49	478	1.12	a	
44	692.24	1385.10	34	44	35	302	0.70	a	NET< CL Wide Pk
45	694.96	1390.52	176	117	94	1131	2.51	b	
46	705.45	1411.47	31	47	37	344	0.70	a	NET< CL
47	727.35	1455.20	628	80	52	494	1.37	a	
48	755.51	1511.42	114	78	62	598	1.75	a	
49	768.46	1537.29	200	62	45	400	1.08	a	
50	772.48	1545.32	84	52	40	343	0.94	b	
51	782.10	1564.51	71	53	41	339	1.15	a	
52	785.73	1571.76	177	71	54	484	1.69	b	
53	795.00	1590.27	346	76	54	483	1.57	a	
54	803.19	1606.62	127	59	45	396	1.08	a	
55	830.94	1662.04	17	45	37	303	0.87	a	NET< CL
56	835.66	1671.46	86	65	51	485	1.26	b	
57	860.58	1721.22	365	66	45	389	1.51	a	
58	904.78	1809.48	45	47	37	297	1.21	a	
59	911.37	1822.63	2064	105	43	356	1.50	a	
60	934.07	1867.96	128	74	58	511	2.36	a	
61	964.85	1929.41	392	62	39	310	1.36	a	
62	969.05	1937.79	1217	89	46	387	1.56	b	
63	1001.10	2001.79	120	71	55	470	2.31	a	
64	1014.08	2027.72	59	62	49	409	1.92	a	
65	1120.43	2240.05	522	70	44	356	1.60	a	

210805D02.SPC Analyzed by

PEAK SEARCH RESULTS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET/MDA COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)		FLAG
66	1238.15	2475.10	203	56	40	305	1.51	a	
67	1303.51	2605.61	54	36	27	158	1.13	a	
68	1327.27	2653.05	34	38	30	179	1.27	a	
69	1377.69	2753.71	138	49	35	228	1.94	a	
70	1401.41	2801.09	48	44	35	224	2.02	a	
71	1408.28	2814.79	81	36	26	149	1.37	b	
72	1460.96	2919.98	4416	138	31	179	1.95	a	HiResid
73	1510.12	3018.14	78	46	35	203	2.43	a	
74	1588.21	3174.06	164	45	31	180	1.74	a	
75	1592.23	3182.09	90	44	33	196	1.89	b	
76	1620.96	3239.45	57	32	23	115	1.47	a	
77	1630.69	3258.89	54	34	25	129	1.60	a	
78	1729.80	3456.78	87	31	20	86	1.46	a	
79	1764.58	3526.22	475	55	27	129	2.17	a	
80	1847.91	3692.61	56	33	24	106	1.92	a	

210805D02.SPC Analyzed by

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SEEKER B A C K G R O U N D S U B T R A C T R E S U L T S Vers. 2.2.1

ALS Laboratory Group - Fort Collins

GammaScan

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Background File:. . . . . DET020707.BKG (210707-2 LONGBKGCAL)

Bkg.File Detector #: 2

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BACKGROUND SUBTRACT RESULTS

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PK#	ENERGY (keV)	OLD NET COUNTS	OLD UN-CERTAINTY	OLD CR.LEVEL	NEW NET COUNTS	NEW UN-CERTAINTY	NEW CR.LEVEL	FLAG
1	46.34	138	100	80	48	152	125	NET<CL
3	63.28	351	110	85	172	214	175	NET<CL
4	66.23	252	143	114	-10	236	194	NET<CL
6	74.77	1743	153	105	1620	207	157	
7	77.03	2671	164	105	2546	231	171	
8	84.13	503	156	123	411	227	184	
9	87.12	1308	152	110	1270	208	160	
11	92.87	1702	186	137	1282	254	200	
12	99.52	228	162	131	189	252	206	NET<CL
17	139.87	251	115	91	70	186	153	NET<CL
18	143.07	229	191	155	174	216	176	NET<CL
20	185.95	1164	140	101	892	204	160	
21	198.40	251	153	123	-66	212	175	NET<CL
23	238.60	8709	216	89	8456	249	138	
24	241.44	1259	141	101	1162	181	138	
28	295.25	1936	127	76	1872	176	126	
32	351.86	3410	148	75	3215	208	143	
36	510.98	2894	156	93	789	316	256	
37	558.51	205	67	50	-115	135	113	NET<CL
39	569.95	87	57	44	13	105	86	NET<CL
40	583.22	2891	129	59	2790	157	95	
41	597.64	89	137	112	-39	206	170	NET<CL
42	609.34	2774	130	63	2606	192	133	
54	803.19	127	59	45	-36	125	103	NET<CL
59	911.37	2064	105	43	1977	152	101	
65	1120.43	522	70	44	480	90	65	
69	1377.69	138	49	35	108	74	58	
72	1460.96	4416	138	31	4174	163	81	
79	1764.58	475	55	27	426	78	55	

210805D02.SPC Analyzed by

SEEKER F I N A L A C T I V I T Y R E P O R T Version 2.2.1

ALS Laboratory Group - Fort Collins
GammaScan

Geo 13 / Solid

Sample ID: 2106442-1D GS210619-1

Sampling Start: 06/14/2021 12:00:00	Counting Start: 07/11/2021 13:16:20
Sampling Stop: 06/14/2021 12:00:00	Decay Time. . . . . 6.49e+002 Hrs
Buildup Time. . . . . 0.00e+000 Hrs	Live Time . . . . . 60000 Sec
Sample Size . . . . . 3.78e+002 g	Real Time . . . . . 60110 Sec
Collection Efficiency 1.0000	Spectrum File 210805D02.SPC
Cr. Level Confidence Interval: 95 %	Det. Limit Confidence Interval: 95 %

Detector #: 2 (Detector 2)

Efficiency File: (D02)(Sh13).EFF (Geo 13 Eff Cal)
Eff=10^[-8.02E+01 +1.04E+02*L +-4.58E+01*L^2 +6.67E+00*L^3] 10/10/2020
Eff.= EXP[-2.35E-01 + -5.84E-01 * En + -1.09E-02 * En^2] Above 300.00 keV

Library File: NATURAL(SUB RA228).LI (Natural.LIB)

MEASURED or MDA CONCENTRATIONS

Nuclide	ENERGY (keV)	N E T	Concentration (pCi/g)	MDA	Critical Level	Halflife (hrs)
Pb-210	46.50	N	1.10E+00 +- 3.47E+00	5.74E+00	2.84E+00	1.95E+05
Th-234	92.50		1.31E+00 +- 2.60E-01	4.14E-01	2.05E-01	3.92E+13
U-235	143.76	N	7.04E-02 +- 8.74E-02	1.44E-01	7.13E-02	6.17E+12
	185.72		I.D.	. . . .	. . . .	6.17E+12
Pb-212	Average:x		1.08E+00 +- 3.13E-02	. . . .	. . . .	1.27E+14
	238.63		1.08E+00 +- 3.17E-02	3.55E-02	1.76E-02	1.27E+14
	300.09		1.06E+00 +- 1.91E-01	2.83E-01	1.39E-01	1.27E+14
Tl-208	Average:x		3.19E-01 +- 1.70E-02	. . . .	. . . .	1.27E+14
	277.36		2.26E-01 +- 7.96E-02	1.25E-01	6.11E-02	1.27E+14
	583.14		3.20E-01 +- 1.80E-02	2.22E-02	1.09E-02	1.27E+14
	860.47		3.78E-01 +- 6.88E-02	9.54E-02	4.63E-02	1.27E+14
Pb-214	Average:x		5.73E-01 +- 3.05E-02	. . . .	. . . .	1.40E+07
	295.22		5.52E-01 +- 5.19E-02	7.52E-02	3.72E-02	1.40E+07
	351.99		5.85E-01 +- 3.78E-02	5.26E-02	2.60E-02	1.40E+07
Ra-228	Average:x		1.01E+00 +- 4.38E-02	. . . .	. . . .	5.04E+04
	338.40		9.25E-01 +- 6.96E-02	8.66E-02	4.25E-02	5.04E+04
	911.07		1.04E+00 +- 7.97E-02	1.08E-01	5.32E-02	5.04E+04
	968.90		1.09E+00 +- 8.00E-02	8.45E-02	4.10E-02	5.04E+04
Bi-212	727.17		1.09E+00 +- 1.39E-01	1.83E-01	8.94E-02	1.27E+14
Pa-234m	1001.03		2.93E+00 +- 1.72E+00	2.76E+00	1.35E+00	3.92E+13
Bi-214	Average:x		4.96E-01 +- 8.61E-02	. . . .	. . . .	1.40E+07

210805D02.SPC Analyzed by

MEASURED or MDA CONCENTRATIONS

Nuclide	ENERGY (keV)	N E T	Concentration (pCi/g)	MDA	Critical Level	Halflife (hrs)
	1120.28		4.96E-01 +- 9.35E-02	1.37E-01	6.73E-02	1.40E+07
	609.32		4.96E-01 +- 2.21E-01	3.44E-01	1.72E-01	1.40E+07
K-40	1460.75		7.21E+00 +- 2.81E-01	2.85E-01	1.40E-01	1.12E+13
Th-227	236.00	N	2.40E-01 +- 1.35E+00	2.22E+00P	1.11E+00	1.90E+05
Cs-137	661.62	N	2.75E-03 +- 8.15E-03	1.36E-02B	6.63E-03	2.64E+05

MEASURED TOTAL: 1.74E+01 +- 7.52E+00 pCi/g

UNKNOWN,SUM or ESCAPE PEAKS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)	FLAG
2	53.39	109.50	101	63	49	677	0.41	Unknown
3	63.28	129.26	172	214	175	1613	0.66	Deleted
4	66.23	135.16	-10	236	194	2419	0.97	Deleted
5	72.89	148.45	210	94	74	1335	0.50	Unknown
6	74.77	152.20	1620	207	157	2225	0.88	Unknown
7	77.03	156.72	2546	231	171	2225	0.80	Unknown
8	84.13	170.90	411	227	184	2588	1.15	Unknown
9	87.12	176.86	1270	208	160	2218	1.03	Unknown
10	89.92	182.45	817	145	110	2218	0.92	Unknown
12	99.52	201.62	189	252	206	2721	1.37	Deleted
13	105.58	213.72	193	131	105	2033	0.99	Unknown
14	108.71	219.96	86	129	105	2033	0.97	Deleted
15	115.41	233.34	59	80	64	1018	0.42	Deleted
16	129.15	260.77	443	104	78	1354	0.71	Unknown
17	139.87	282.19	70	186	153	1674	0.79	Deleted
19	154.09	310.58	130	81	64	996	0.45	Unknown
21	198.40	399.04	-66	212	175	2388	1.25	Deleted
22	209.19	420.59	733	115	83	1404	0.90	Unknown
24	241.44	484.99	1162	181	138	1726	1.22	Unknown
25	248.91	499.91	47	76	62	844	0.74	Deleted
26	270.30	542.62	652	133	101	1603	1.26	Unknown
30	328.04	657.90	359	87	65	841	0.78	Unknown
33	409.51	820.57	248	81	62	706	1.03	Unknown
34	427.93	857.34	78	81	65	729	1.17	Unknown
35	462.98	927.34	558	96	68	812	1.54	Unknown
36	510.98	1023.18	789	316	256	1220	2.20	Unknown
37	558.51	1118.07	-115	135	113	519	0.94	Deleted
38	562.50	1126.04	81	56	44	433	0.88	Unknown
39	569.95	1140.92	13	105	86	448	0.81	Deleted
41	597.64	1196.21	-39	206	170	1540	2.57	Deleted
42	609.34	1219.57	2606	192	133	738	1.29	SPLIT
43	665.33	1331.36	70	62	49	478	1.12	Unknown

210805D02.SPC Analyzed by

UNKNOWN,SUM or ESCAPE PEAKS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)	FLAG
44	692.24	1385.10	34	44	35	302	0.70	Deleted
45	694.96	1390.52	176	117	94	1131	2.51	Unknown
46	705.45	1411.47	31	47	37	344	0.70	Deleted
48	755.51	1511.42	114	78	62	598	1.75	Unknown
49	768.46	1537.29	200	62	45	400	1.08	Unknown
50	772.48	1545.32	84	52	40	343	0.94	Unknown
51	782.10	1564.51	71	53	41	339	1.15	Unknown
52	785.73	1571.76	177	71	54	484	1.69	Unknown
53	795.00	1590.27	346	76	54	483	1.57	Unknown
54	803.19	1606.62	-36	125	103	396	1.08	Deleted
55	830.94	1662.04	17	45	37	303	0.87	Deleted
56	835.66	1671.46	86	65	51	485	1.26	Unknown
58	904.78	1809.48	45	47	37	297	1.21	Unknown
60	934.07	1867.96	128	74	58	511	2.36	Unknown
61	964.85	1929.41	392	62	39	310	1.36	Unknown
64	1014.08	2027.72	59	62	49	409	1.92	Unknown
66	1238.15	2475.10	203	56	40	305	1.51	Unknown
67	1303.51	2605.61	54	36	27	158	1.13	Unknown
68	1327.27	2653.05	34	38	30	179	1.27	Unknown
69	1377.69	2753.71	108	74	58	228	1.94	Unknown
70	1401.41	2801.09	48	45	35	224	2.02	Unknown
71	1408.28	2814.79	81	36	26	149	1.37	Unknown
73	1510.12	3018.14	78	46	35	203	2.43	Unknown
74	1588.21	3174.06	164	45	31	180	1.74	Unknown
75	1592.23	3182.09	90	44	33	196	1.89	Unknown
76	1620.96	3239.45	57	32	23	115	1.47	Unknown
77	1630.69	3258.89	54	34	25	129	1.60	Unknown
78	1729.80	3456.78	87	31	20	86	1.46	Unknown
79	1764.58	3526.22	426	78	55	129	2.17	Unknown
80	1847.91	3692.61	56	33	24	106	1.92	Unknown
82	609.34	1219.57	322	2071	133	738	1.29	1120SEsc

c:\SEEKER\BIN\210805d02.res Analysis Results Saved.

210805D02.SPC Analyzed by JH

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SEEKER G A M M A A N A L Y S I S R E S U L T S PS Version 1.8.4

ALS Laboratory Group - Fort Collins
GammaScan

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Geo 13 / Solid

Sample ID: 2106442-1D GS210619-1

Sampling Start: 06/14/2021 12:00:00	Counting Start: 07/11/2021 13:16:20
Sampling Stop: 06/14/2021 12:00:00	Decay Time. . . . . 6.49E+002 Hrs
Buildup Time. . . . . 0.00E+000 Hrs	Live Time . . . . . 60000 Sec
Sample Size . . . . . 3.78E+002 g	Real Time . . . . . 60110 Sec
Collection Efficiency 1.0000	Spc. File 210805D02.SPC

Detector #: 2 (Detector 2)

Energy(keV)= -1.46 + 0.501*Ch + 0.00E+00*Ch^2 + 0.00E+00*Ch^3 07/11/2021
FWHM(keV) = 0.59 + 0.019*En + 4.08E-04*En^2 + 0.00E+00*En^3 07/29/2020
Where En = Sqrt(Energy in keV)

Search Sensitivity: 1.00 | Sigma Multiplier: 2.00 | Search Start/End: 80/4000

PEAK SEARCH RESULTS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET/MDA COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)	FLAG
1	46.34	95.44	138	100	80	1423	0.59 a	
2	53.39	109.50	101	63	49	677	0.41 a	
3	63.28	129.26	351	110	85	1613	0.66 a	
4	66.23	135.16	252	143	114	2419	0.97 b	
5	72.89	148.45	210	94	74	1335	0.50 a	
6	74.77	152.20	1743	153	105	2225	0.88 b	
7	77.03	156.72	2671	164	105	2225	0.80 c	
8	84.13	170.90	503	156	123	2588	1.15 a	
9	87.12	176.86	1308	152	110	2218	1.03 b	
10	89.92	182.45	817	145	110	2218	0.92 c	
11	92.87	188.35	1702	185	137	2957	1.33 d	
12	99.52	201.62	228	162	131	2721	1.37 a	
13	105.58	213.72	193	131	105	2033	0.99 a	
14	108.71	219.96	86	129	105	2033	0.97 b	NET< CL
15	115.41	233.34	59	80	64	1018	0.42 a	NET< CL
16	129.15	260.77	443	104	78	1354	0.71 a	
17	139.87	282.19	251	115	91	1674	0.79 a	Wide Pk
18	143.07	288.58	229	191	155	3348	1.69 b	
19	154.09	310.58	130	81	64	996	0.45 a	
20	185.95	374.19	1164	140	101	1885	1.04 a	
21	198.40	399.04	251	153	123	2388	1.25 a	

210805D02.SPC Analyzed by

PEAK SEARCH RESULTS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET/MDA COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)		FLAG
22	209.19	420.59	733	115	83	1404	0.90	a	
23	238.60	479.33	8709	216	89	1479	0.92	a	HiResid
24	241.44	484.99	1259	141	101	1726	1.22	b	HiResid
25	248.91	499.91	47	76	62	844	0.74	a	NET< CL
26	270.30	542.62	652	133	101	1603	1.26	a	
27	277.40	556.79	251	88	68	928	0.74	a	
28	295.25	592.43	1936	127	76	1054	0.98	a	
29	300.11	602.13	573	104	76	1054	1.05	b	
30	328.04	657.90	359	87	65	841	0.78	a	HiResid
31	338.31	678.41	1574	118	72	966	0.91	a	HiResid
32	351.86	705.46	3410	148	75	949	1.09	a	
33	409.51	820.57	248	81	62	706	1.03	a	
34	427.93	857.34	78	81	65	729	1.17	a	
35	462.98	927.34	558	96	68	812	1.54	a	
36	510.98	1023.18	2894	156	93	1220	2.20	a	Wide Pk
37	558.51	1118.07	205	67	50	519	0.94	a	
38	562.50	1126.04	81	56	44	433	0.88	b	
39	569.95	1140.92	87	57	44	448	0.81	a	
40	583.22	1167.42	2891	129	59	647	1.29	a	
41	597.64	1196.21	89	137	112	1540	2.57	a	NET< CL Wide Pk
42	609.34	1219.57	2774	130	63	738	1.29	a	
43	665.33	1331.36	70	62	49	478	1.12	a	
44	692.24	1385.10	34	44	35	302	0.70	a	NET< CL Wide Pk
45	694.96	1390.52	176	117	94	1131	2.51	b	
46	705.45	1411.47	31	47	37	344	0.70	a	NET< CL
47	727.35	1455.20	628	80	52	494	1.37	a	
48	755.51	1511.42	114	78	62	598	1.75	a	
49	768.46	1537.29	200	62	45	400	1.08	a	
50	772.48	1545.32	84	52	40	343	0.94	b	
51	782.10	1564.51	71	53	41	339	1.15	a	
52	785.73	1571.76	177	71	54	484	1.69	b	
53	795.00	1590.27	346	76	54	483	1.57	a	
54	803.19	1606.62	127	59	45	396	1.08	a	
55	830.94	1662.04	17	45	37	303	0.87	a	NET< CL
56	835.66	1671.46	86	65	51	485	1.26	b	
57	860.58	1721.22	365	66	45	389	1.51	a	
58	904.78	1809.48	45	47	37	297	1.21	a	
59	911.37	1822.63	2064	105	43	356	1.50	a	
60	934.07	1867.96	128	74	58	511	2.36	a	
61	964.85	1929.41	392	62	39	310	1.36	a	
62	969.05	1937.79	1217	89	46	387	1.56	b	
63	1001.10	2001.79	120	71	55	470	2.31	a	
64	1014.08	2027.72	59	62	49	409	1.92	a	
65	1120.43	2240.05	522	70	44	356	1.60	a	

PEAK SEARCH RESULTS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET/MDA COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)		FLAG
66	1238.15	2475.10	203	56	40	305	1.51	a	
67	1303.51	2605.61	54	36	27	158	1.13	a	
68	1327.27	2653.05	34	38	30	179	1.27	a	
69	1377.69	2753.71	138	49	35	228	1.94	a	
70	1401.41	2801.09	48	44	35	224	2.02	a	
71	1408.28	2814.79	81	36	26	149	1.37	b	
72	1460.96	2919.98	4416	138	31	179	1.95	a	HiResid
73	1510.12	3018.14	78	46	35	203	2.43	a	
74	1588.21	3174.06	164	45	31	180	1.74	a	
75	1592.23	3182.09	90	44	33	196	1.89	b	
76	1620.96	3239.45	57	32	23	115	1.47	a	
77	1630.69	3258.89	54	34	25	129	1.60	a	
78	1729.80	3456.78	87	31	20	86	1.46	a	
79	1764.58	3526.22	475	55	27	129	2.17	a	
80	1847.91	3692.61	56	33	24	106	1.92	a	

210805D02.SPC Analyzed by

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SEEKER B A C K G R O U N D S U B T R A C T R E S U L T S Vers. 2.2.1

ALS Laboratory Group - Fort Collins
GammaScan

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Background File:. . . . . DET020707.BKG (210707-2 LONGBKGCAL)

Bkg.File Detector #: 2

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BACKGROUND SUBTRACT RESULTS

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PK#	ENERGY (keV)	OLD NET COUNTS	OLD UN-CERTAINTY	OLD CR.LEVEL	NEW NET COUNTS	NEW UN-CERTAINTY	NEW CR.LEVEL	FLAG
1	46.34	138	100	80	48	152	125	NET<CL
3	63.28	351	110	85	172	214	175	NET<CL
4	66.23	252	143	114	-10	236	194	NET<CL
6	74.77	1743	153	105	1620	207	157	
7	77.03	2671	164	105	2546	231	171	
8	84.13	503	156	123	411	227	184	
9	87.12	1308	152	110	1270	208	160	
11	92.87	1702	186	137	1282	254	200	
12	99.52	228	162	131	189	252	206	NET<CL
17	139.87	251	115	91	70	186	153	NET<CL
18	143.07	229	191	155	174	216	176	NET<CL
20	185.95	1164	140	101	892	204	160	
21	198.40	251	153	123	-66	212	175	NET<CL
23	238.60	8709	216	89	8456	249	138	
24	241.44	1259	141	101	1162	181	138	
28	295.25	1936	127	76	1872	176	126	
32	351.86	3410	148	75	3215	208	143	
36	510.98	2894	156	93	789	316	256	
37	558.51	205	67	50	-115	135	113	NET<CL
39	569.95	87	57	44	13	105	86	NET<CL
40	583.22	2891	129	59	2790	157	95	
41	597.64	89	137	112	-39	206	170	NET<CL
42	609.34	2774	130	63	2606	192	133	
54	803.19	127	59	45	-36	125	103	NET<CL
59	911.37	2064	105	43	1977	152	101	
65	1120.43	522	70	44	480	90	65	
69	1377.69	138	49	35	108	74	58	
72	1460.96	4416	138	31	4174	163	81	
79	1764.58	475	55	27	426	78	55	

210805D02.SPC Analyzed by

SEEKER F I N A L A C T I V I T Y R E P O R T Version 2.2.1

ALS Laboratory Group - Fort Collins
GammaScan

Geo 13 / Solid

Sample ID: 2106442-1D GS210619-1

Sampling Start: 06/14/2021 12:00:00	Counting Start: 07/11/2021 13:16:20
Sampling Stop: 06/14/2021 12:00:00	Decay Time. . . . . 6.49e+002 Hrs
Buildup Time. . . . . 0.00e+000 Hrs	Live Time . . . . . 60000 Sec
Sample Size . . . . . 3.78e+002 g	Real Time . . . . . 60110 Sec
Collection Efficiency 1.0000	Spectrum File 210805D02.SPC
Cr. Level Confidence Interval: 95 %	Det. Limit Confidence Interval: 95 %

Detector #: 2 (Detector 2)
Efficiency File: (D02)(Sh13).EFF (Geo 13 Eff Cal)
Eff=10^[-8.02E+01 +1.04E+02*L +-4.58E+01*L^2 +6.67E+00*L^3] 10/10/2020
Eff.= EXP[-2.35E-01 + -5.84E-01 * En + -1.09E-02 * En^2] Above 300.00 keV

Library File: . . . . . RA226.LIB (Ra-226 (215g steel can))

MEASURED or MDA CONCENTRATIONS

Nuclide	ENERGY (keV)	N E T	Concentration (pCi/g)	MDA	Critical Level	Halflife (hrs)
Ra-226	Average:	x	5.66E-01 +- 2.38E-02	. . . .	. . . .	1.40E+07
	295.21		5.52E-01 +- 5.19E-02	7.52E-02	3.72E-02	1.40E+07
	351.92		5.85E-01 +- 3.78E-02	5.25E-02	2.60E-02	1.40E+07
	609.31		5.66E-01 +- 4.16E-02	5.85E-02	2.90E-02	1.40E+07
	1120.29		4.96E-01 +- 9.35E-02	1.37E-01	6.73E-02	1.40E+07

MEASURED TOTAL: 5.66E-01 +- 2.38E-02 pCi/g

UNKNOWN,SUM or ESCAPE PEAKS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)	FLAG
1	53.39	109.50	101	63	49	677	0.41	Unknown
2	72.89	148.45	210	94	74	1335	0.50	Unknown
3	74.77	152.20	1620	207	157	2225	0.88	Unknown
4	77.03	156.72	2546	231	171	2225	0.80	Unknown
5	84.13	170.90	411	227	184	2588	1.15	Unknown
6	87.12	176.86	1270	208	160	2218	1.03	Unknown
7	89.92	182.45	817	145	110	2218	0.92	Unknown

210805D02.SPC Analyzed by

UNKNOWN,SUM or ESCAPE PEAKS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)	FLAG
8	92.87	188.35	1282	254	200	2957	1.33	Unknown
9	105.58	213.72	193	131	105	2033	0.99	Unknown
10	129.15	260.77	443	104	78	1354	0.71	Unknown
11	154.09	310.58	130	81	64	996	0.45	Unknown
12	185.95	374.19	892	204	160	1885	1.04	Unknown
13	209.19	420.59	733	115	83	1404	0.90	Unknown
14	238.60	479.33	8456	249	138	1479	0.92	Unknown
15	241.44	484.99	1162	181	138	1726	1.22	Unknown
16	270.30	542.62	652	133	101	1603	1.26	Unknown
17	277.40	556.79	251	88	68	928	0.74	Unknown
19	300.11	602.13	573	104	76	1054	1.05	Unknown
20	328.04	657.90	359	87	65	841	0.78	Unknown
21	338.31	678.41	1574	118	72	966	0.91	Unknown
23	409.51	820.57	248	81	62	706	1.03	Unknown
24	427.93	857.34	78	81	65	729	1.17	Unknown
25	462.98	927.34	558	96	68	812	1.54	Unknown
26	510.98	1023.18	789	316	256	1220	2.20	Unknown
27	562.50	1126.04	81	56	44	433	0.88	Unknown
28	583.22	1167.42	2790	157	95	647	1.29	Unknown
30	609.34	1219.57	2284	1017	791	738	1.29	1120SEsc
31	609.34	1219.57	322	2071	133	738	1.29	Unknown
32	665.33	1331.36	70	62	49	478	1.12	Unknown
33	694.96	1390.52	176	117	94	1131	2.51	Unknown
34	727.35	1455.20	628	80	52	494	1.37	1238SEsc
35	755.51	1511.42	114	78	62	598	1.75	Unknown
36	768.46	1537.29	200	62	45	400	1.08	Unknown
37	772.48	1545.32	84	52	40	343	0.94	Unknown
38	782.10	1564.51	71	53	41	339	1.15	Unknown
39	785.73	1571.76	177	71	54	484	1.69	Unknown
40	795.00	1590.27	346	76	54	483	1.57	Unknown
41	835.66	1671.46	86	65	51	485	1.26	Unknown
42	860.58	1721.22	365	66	45	389	1.51	Unknown
43	904.78	1809.48	45	47	37	297	1.21	Unknown
44	911.37	1822.63	1977	152	101	356	1.50	Unknown
45	934.07	1867.96	128	74	58	511	2.36	Unknown
46	964.85	1929.41	392	62	39	310	1.36	Unknown
47	969.05	1937.79	1217	89	46	387	1.56	Unknown
48	1001.10	2001.79	120	71	55	470	2.31	Unknown
49	1014.08	2027.72	59	62	49	409	1.92	Unknown
51	1238.15	2475.10	203	56	40	305	1.51	Unknown
52	1303.51	2605.61	54	36	27	158	1.13	Unknown
53	1327.27	2653.05	34	38	30	179	1.27	Unknown
54	1377.69	2753.71	108	74	58	228	1.94	Unknown
55	1401.41	2801.09	48	45	35	224	2.02	Unknown
56	1408.28	2814.79	81	36	26	149	1.37	Unknown
57	1460.96	2919.98	4174	163	81	179	1.95	Unknown

210805D02.SPC Analyzed by

UNKNOWN,SUM or ESCAPE PEAKS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)	FLAG
58	1510.12	3018.14	78	46	35	203	2.43	Unknown
59	1588.21	3174.06	164	45	31	180	1.74	Unknown
60	1592.23	3182.09	90	44	33	196	1.89	Unknown
61	1620.96	3239.45	57	32	23	115	1.47	Unknown
62	1630.69	3258.89	54	34	25	129	1.60	Unknown
63	1729.80	3456.78	87	31	20	86	1.46	Unknown
64	1764.58	3526.22	426	78	55	129	2.17	Unknown
65	1847.91	3692.61	56	33	24	106	1.92	Unknown

c:\SEEKER\BIN\210805d02A.res Analysis Results Saved.

210802D02.SPC Analyzed by JH

SEEKER G A M M A A N A L Y S I S R E S U L T S PS Version 1.8.4

ALS Laboratory Group - Fort Collins
GammaScan

Geo 13 / Solid

Sample ID: 2106442-2 GS210619-1

Sampling Start: 06/14/2021 12:00:00	Counting Start: 07/10/2021 14:01:00
Sampling Stop: 06/14/2021 12:00:00	Decay Time. . . . . 6.26E+002 Hrs
Buildup Time. . . . . 0.00E+000 Hrs	Live Time . . . . . 60000 Sec
Sample Size . . . . . 4.05E+002 g	Real Time . . . . . 60274 Sec
Collection Efficiency 1.0000	Spc. File 210802D02.SPC

Detector #: 2 (Detector 2)

Energy(keV)= -1.45 + 0.501*Ch + 0.00E+00*Ch^2 + 0.00E+00*Ch^3 07/10/2021
FWHM(keV) = 0.59 + 0.019*En + 4.08E-04*En^2 + 0.00E+00*En^3 07/29/2020
Where En = Sqrt(Energy in keV)

Search Sensitivity: 1.00 | Sigma Multiplier: 2.00 | Search Start/End: 80/4000

PEAK SEARCH RESULTS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET/MDA COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)		FLAG
1	63.45	129.53	529	268	217	11617	0.51	a	
2	72.74	148.09	1202	434	352	25025	0.89		
3	74.83	152.25	22901	538	366	27012	0.84		
4	77.13	156.84	40971	658	427	31052	0.83		
5	79.42	161.41	526	315	257	14612	0.83		
6	81.26	165.08	-4692	506	431	31654	1.50		NET< CL
7	84.33	171.22	5766	514	404	27880	1.09		
8	87.20	176.94	-835	639	527	47451	0.07		NET< CL
9	89.94	182.41	-15205	645	568	54972	3.46		NET< CL
10	93.25	189.01	15893	527	381	24742	0.99		
11	99.60	201.70	3820	513	410	26579	1.10		
12	105.43	213.32	5679	474	370	23311	1.17	a	
13	108.93	220.32	1791	360	287	16651	0.89	b	
14	115.31	233.05	2287	360	286	16448	0.85	a	
15	129.19	260.76	8991	414	302	18433	0.74	a	
16	154.12	310.52	3222	358	280	15759	0.90	a	
17	166.50	335.23	405	284	231	11814	0.72	a	
18	186.03	374.21	3870	390	304	17084	0.99	a	
19	199.19	400.48	1091	370	299	16563	0.99	a	
20	203.95	409.97	410	321	262	13803	0.82	b	
21	209.21	420.46	15640	396	253	12871	0.80	a	HiResid

210802D02.SPC Analyzed by

PEAK SEARCH RESULTS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET/MDA COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)		FLAG
22	211.98	426.00	38	216	177	7723	0.48	b	NET< CL HiResid
23	216.05	434.12	1236	358	289	15445	1.02	c	HiResid
24	233.36	468.67	266	213	173	7394	0.49	a	
25	238.74	479.42	183421	917	269	13413	0.97	a	HiResid
26	241.25	484.42	19648	461	301	14378	1.27	b	HiResid
27	252.75	507.38	946	279	224	9261	0.96	a	
28	270.40	542.62	12559	371	243	10102	1.09	a	
29	277.55	556.88	7331	313	215	8563	0.94	a	
30	279.21	560.20	503	266	215	8563	1.06	b	
31	288.33	578.40	1264	295	235	9436	1.11	a	
32	295.36	592.44	8073	308	206	7816	0.95	a	
33	300.28	602.25	11465	329	206	7816	1.02	b	
34	321.64	644.88	503	216	174	6072	0.82	a	
35	328.10	657.77	9498	310	198	7257	1.05	a	
36	338.44	678.42	37015	450	191	6760	1.04	a	
37	341.09	683.71	1101	270	215	7887	1.10	b	
38	352.03	705.55	14177	343	203	7012	1.08	a	
39	409.72	820.69	5206	270	188	6007	1.12	a	
40	440.72	882.56	334	179	144	4365	0.97	a	
41	453.14	907.35	830	182	142	4262	0.93	a	
42	463.20	927.44	10635	281	157	4857	1.16	a	
43	478.50	957.97	278	154	123	3463	0.78	a	
44	503.98	1008.83	453	191	153	4624	1.13	a	
45	509.28	1019.42	1343	218	169	5284	1.27	b	
46	511.14	1023.12	19623	348	169	5284	1.38	c	
47	546.83	1094.36	514	199	159	4677	1.33	a	
48	550.17	1101.02	337	215	174	5262	1.40	b	
49	558.67	1117.99	247	141	113	2914	0.77	a	
50	562.80	1126.24	1874	195	144	4080	1.21	b	
51	571.27	1143.13	525	268	218	6993	1.96	a	
52	573.10	1146.79	245	141	113	2914	0.84	b	
53	583.49	1167.54	62580	536	157	4573	1.31	a	
54	609.62	1219.70	11335	281	151	4189	1.34	a	
55	616.24	1232.91	167	182	148	4071	1.35	a	
56	652.24	1304.76	132	180	147	3977	1.39	a	NET< CL
57	666.19	1332.59	303	165	133	3482	1.11	a	
58	702.66	1405.39	337	199	161	4501	1.42	a	
59	707.78	1415.62	422	216	175	5001	1.69	b	
60	727.64	1455.26	13599	294	147	3746	1.45	a	
61	742.78	1485.48	57	99	81	1609	0.71	a	NET< CL
62	755.68	1511.21	1737	188	139	3354	1.40	a	
63	763.92	1527.67	1092	175	133	3070	1.44	a	
64	768.80	1537.41	983	173	133	3070	1.53	b	
65	772.75	1545.30	2614	203	144	3411	1.56	c	
66	782.72	1565.19	831	151	115	2438	1.29	a	

PEAK SEARCH RESULTS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET/MDA COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)	FLAG
67	786.03	1571.81	1975	177	126	2743	1.42 b	
68	795.43	1590.57	7130	224	122	2567	1.50 a	
69	803.41	1606.49	259	144	115	2306	1.43 a	
70	806.55	1612.75	162	95	75	1281	0.85 b	
71	830.96	1661.48	831	135	101	1875	1.33 a	
72	836.14	1671.82	2915	181	119	2344	1.59 b	
73	840.72	1680.97	1626	166	119	2344	1.65 c	
74	860.99	1721.42	7633	215	103	1958	1.58 a	
75	894.08	1787.47	418	104	78	1332	1.16 a	
76	904.84	1808.95	1108	138	99	1827	1.65 a	
77	911.78	1822.79	43429	434	99	1827	1.59 b	
78	934.54	1868.22	487	119	91	1521	1.62 a	
79	944.79	1888.68	123	89	71	1092	1.09 a	
80	952.53	1904.13	184	97	77	1218	1.24 a	
81	959.15	1917.36	346	85	63	913	1.02 b	
82	965.27	1929.57	7850	209	91	1522	1.72 c	
83	969.48	1937.96	26078	341	91	1522	1.65 d	
84	976.72	1952.41	64	83	67	986	1.17 a	NET< CL
85	988.85	1976.62	240	98	77	1149	1.49 a	
86	1001.53	2001.94	104	75	59	804	0.96 a	
87	1034.01	2066.77	260	90	69	988	1.39 a	
88	1040.86	2080.44	108	79	63	865	1.21 b	
89	1065.66	2129.93	281	100	77	1158	1.41 a	
90	1079.31	2157.19	705	114	83	1264	1.59 a	
91	1094.91	2188.32	761	150	114	1861	2.54 a	
92	1111.12	2220.68	492	109	82	1238	1.66 a	
93	1120.90	2240.21	2490	149	91	1404	1.89 a	
94	1153.51	2305.29	112	70	55	697	0.97 a	
95	1154.64	2307.55	207	101	79	1162	1.59 b	
96	1156.09	2310.44	187	93	73	1046	1.49 c	
97	1238.84	2475.61	839	115	81	1225	1.68 a	
98	1247.47	2492.83	651	152	117	1960	2.55 b	
99	1282.14	2562.02	228	103	81	1163	1.80 a	
100	1288.20	2574.13	133	121	98	1480	2.24 b	
101	1374.92	2747.22	179	87	68	938	1.68 a	
102	1378.45	2754.27	636	107	78	1125	1.97 b	
103	1385.98	2769.30	84	73	58	750	1.37 c	
104	1402.18	2801.64	213	100	79	1095	2.17 a	
105	1408.78	2814.80	306	81	60	758	1.53 b	
106	1461.44	2919.91	7659	196	73	952	2.20 a	HiResid
107	1496.60	2990.09	1110	103	64	760	1.98 a	
108	1502.31	3001.50	547	95	68	823	2.14 b	
109	1510.11	3017.05	234	84	64	760	1.94 c	
110	1513.57	3023.96	419	92	68	823	2.09 d	
111	1529.14	3055.05	57	67	54	590	1.58 a	
112	1539.20	3075.13	82	70	56	628	1.71 a	

PEAK SEARCH RESULTS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET/MDA COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)	FLAG
113	1558.18	3113.00	247	82	62	684	2.18	a
114	1581.46	3159.48	696	104	74	902	2.50	a
115	1588.99	3174.50	3681	146	66	782	2.09	b
116	1593.18	3182.86	2020	127	74	902	2.44	c
117	1621.50	3239.40	1736	114	64	717	2.12	a
118	1625.73	3247.83	272	76	56	607	1.84	b
119	1631.39	3259.13	1955	120	67	772	2.25	c
120	1639.05	3274.42	465	81	56	607	1.85	d
121	1662.12	3320.46	101	54	41	389	1.12	a
122	1667.21	3330.64	173	78	60	666	1.94	b
123	1679.78	3355.72	127	80	63	709	2.16	a
124	1686.20	3368.53	123	89	71	818	2.38	b
125	1730.47	3456.89	408	87	63	703	2.11	a
126	1765.35	3526.53	1957	121	68	786	2.29	a
127	1807.06	3609.76	106	82	65	753	2.18	a
128	1848.44	3692.37	197	98	77	947	2.54	a
129	1887.76	3770.85	73	69	55	601	1.68	a

210802D02.SPC Analyzed by

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SEEKER B A C K G R O U N D S U B T R A C T R E S U L T S Vers. 2.2.1

ALS Laboratory Group - Fort Collins
GammaScan

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Background File:. . . . . DET020707.BKG (210707-2 LONGBKGCAL)

Bkg.File Detector #: 2

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BACKGROUND SUBTRACT RESULTS

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PK#	ENERGY (keV)	OLD NET COUNTS	OLD UN-CERTAINTY	OLD CR.LEVEL	NEW NET COUNTS	NEW UN-CERTAINTY	NEW CR.LEVEL	FLAG
1	63.45	529	268	217	350	325	266	
3	74.83	22901	538	366	22778	556	384	
4	77.13	40971	658	427	40846	678	447	
7	84.33	5766	514	404	5674	540	427	
8	87.20	-835	639	527	-872	654	540	NET<CL
10	93.25	15893	527	381	15473	555	408	
11	99.60	3820	513	410	3781	548	439	
18	186.03	3870	390	304	3598	417	329	
19	199.19	1091	370	299	774	398	324	
25	238.74	183421	917	269	183168	925	289	
26	241.25	19648	461	301	19551	475	316	
32	295.36	8073	308	206	8009	331	229	
38	352.03	14177	343	203	13982	372	237	
45	509.28	1343	218	169	1341	338	272	
46	511.14	19623	348	169	17517	443	292	
49	558.67	247	141	113	-74	184	152	NET<CL
51	571.27	525	268	218	451	283	230	
53	583.49	62580	536	157	62478	543	174	
54	609.62	11335	281	151	11166	314	191	
69	803.41	259	144	115	95	181	148	NET<CL
77	911.78	43429	434	99	43342	448	135	
93	1120.90	2490	149	91	2447	160	103	
102	1378.45	636	107	78	606	121	91	
106	1461.44	7659	196	73	7417	214	105	
126	1765.35	1957	121	68	1908	133	83	

210802D02.SPC Analyzed by

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SEEKER F I N A L A C T I V I T Y R E P O R T Version 2.2.1

ALS Laboratory Group - Fort Collins

GammaScan

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Geo 13 / Solid

Sample ID: 2106442-2 GS210619-1

Sampling Start: 06/14/2021 12:00:00	Counting Start: 07/10/2021 14:01:00
Sampling Stop: 06/14/2021 12:00:00	Decay Time. . . . . 6.26e+002 Hrs
Buildup Time. . . . . 0.00e+000 Hrs	Live Time . . . . . 60000 Sec
Sample Size . . . . . 4.05e+002 g	Real Time . . . . . 60274 Sec
Collection Efficiency 1.0000	Spectrum File 210802D02.SPC
Cr. Level Confidence Interval: 95 %	Det. Limit Confidence Interval: 95 %

Detector #: 2 (Detector 2)

Efficiency File: (D02)(Sh13).EFF (Geo 13 Eff Cal)

Eff=10^[-8.02E+01 +1.04E+02*L +-4.58E+01*L^2 +6.67E+00*L^3] 10/10/2020

Eff.= EXP[-2.35E-01 + -5.84E-01 * En + -1.09E-02 * En^2] Above 300.00 keV

Library File: NATURAL(SUB RA228).LI (Natural.LIB)

MEASURED or MDA CONCENTRATIONS

Nuclide	ENERGY (keV)	N E T	Concentration (pCi/g)	MDA	Critical Level	Halflife (hrs)
Th-234	Average:	x	1.28E+01 +- 4.89E-01	. . . .	. . . .	3.92E+13
	63.29		1.36E+00 +- 1.26E+00	2.08E+00	1.03E+00	3.92E+13
	92.50		1.48E+01 +- 5.31E-01	7.83E-01	3.90E-01	3.92E+13
Pb-212	Average:	x	2.17E+01 +- 1.08E-01	. . . .	. . . .	1.27E+14
	115.18		1.65E+01 +- 2.60E+00	4.14E+00	2.06E+00	1.27E+14
	238.63		2.17E+01 +- 1.10E-01	6.90E-02	3.43E-02	1.27E+14
	300.09		1.97E+01 +- 5.66E-01	7.12E-01	3.53E-01	1.27E+14
U-235	Average:	x	-3.81E-02 +- 1.26E-01	. . . .	. . . .	6.17E+12
	185.72		I.D.	. . . .	. . . .	6.17E+12
	205.31		3.94E-01 +- 3.08E-01	5.05E-01	2.51E-01	6.17E+12
	143.76	N	-1.25E-01 +- 1.38E-01	2.29E-01	1.14E-01	6.17E+12
Tl-208	Average:	x	6.71E+00 +- 5.47E-02	. . . .	. . . .	1.27E+14
	277.36		6.16E+00 +- 2.63E-01	3.64E-01	1.81E-01	1.27E+14
	583.14		6.68E+00 +- 5.81E-02	3.75E-02	1.86E-02	1.27E+14
	860.47		7.37E+00 +- 2.08E-01	2.01E-01	9.94E-02	1.27E+14
Pb-214	Average:	x	2.20E+00 +- 8.57E-02	. . . .	. . . .	1.40E+07
	295.22		2.20E+00 +- 9.10E-02	1.27E-01	6.30E-02	1.40E+07
	351.99		2.20E+00 +- 2.55E-01	3.80E-01	1.90E-01	1.40E+07
Ra-228	Average:	x	2.10E+01 +- 1.42E-01	. . . .	. . . .	5.04E+04
	338.40		2.03E+01 +- 2.46E-01	2.11E-01	1.05E-01	5.04E+04
	911.07		2.12E+01 +- 2.19E-01	1.34E-01	6.62E-02	5.04E+04

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MEASURED or MDA CONCENTRATIONS

Nuclide	ENERGY (keV)	N E T	Concentration (pCi/g)		MDA	Critical Level	Halflife (hrs)
	968.90		2.18E+01	+- 2.85E-01	1.54E-01	7.58E-02	5.04E+04
Bi-214	Average:x		2.27E+00	+- 5.88E-02	. . . .	. . . .	1.40E+07
	609.32		2.26E+00	+- 6.36E-02	7.79E-02	3.87E-02	1.40E+07
	1120.28		2.36E+00	+- 1.54E-01	2.02E-01	9.95E-02	1.40E+07
Bi-212	727.17		2.19E+01	+- 4.73E-01	4.78E-01	2.37E-01	1.27E+14
Pa-234m	1001.03		2.37E+00	+- 1.69E+00	2.74E+00	1.34E+00	3.92E+13
K-40	1460.75		1.19E+01	+- 3.45E-01	3.42E-01	1.69E-01	1.12E+13
Pb-210	46.50	N	4.76E+00	+- 7.56E+00	1.25E+01	6.20E+00	1.95E+05
Th-227	236.00	N	-1.07E+01	+- 3.91E+00	6.44E+00P	3.22E+00	1.90E+05
Cs-137	661.62	N	-7.11E-03	+- 2.09E-02	3.49E-02B	1.73E-02	2.64E+05

MEASURED TOTAL: 1.08E+02 +- 1.10E+01 pCi/g

UNKNOWN,SUM or ESCAPE PEAKS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)	FLAG
2	72.74	148.09	1202	434	352	25025	0.89	1095DEsc
3	74.83	152.25	22778	556	384	27012	0.84	1095DEsc
4	77.13	156.84	40846	678	447	31052	0.83	Unknown
5	79.42	161.41	526	315	257	14612	0.83	Unknown
6	81.26	165.08	-4692	506	431	31654	1.50	Deleted
7	84.33	171.22	5674	540	427	27880	1.09	Unknown
8	87.20	176.94	-872	654	540	47451	0.07	Deleted
9	89.94	182.41	-15205	645	568	54972	3.46	Deleted
11	99.60	201.70	3781	548	439	26579	1.10	1121DEsc
12	105.43	213.32	5679	474	370	23311	1.17	Unknown
13	108.93	220.32	1791	360	287	16651	0.89	Unknown
15	129.19	260.76	8991	414	302	18433	0.74	Unknown
16	154.12	310.52	3222	358	280	15759	0.90	Unknown
17	166.50	335.23	405	284	231	11814	0.72	Unknown
19	199.19	400.48	774	398	324	16563	0.99	Unknown
21	209.21	420.46	15640	396	253	12871	0.80	Unknown
22	211.98	426.00	38	216	177	7723	0.48	Deleted
23	216.05	434.12	1236	358	289	15445	1.02	1239DEsc
24	233.36	468.67	266	213	173	7394	0.49	Unknown
26	241.25	484.42	19551	475	316	14378	1.27	Unknown
27	252.75	507.38	946	279	224	9261	0.96	Unknown
28	270.40	542.62	12559	371	243	10102	1.09	Unknown
30	279.21	560.20	503	266	215	8563	1.06	Unknown
31	288.33	578.40	1264	295	235	9436	1.11	Unknown
34	321.64	644.88	503	216	174	6072	0.82	Unknown
35	328.10	657.77	9498	310	198	7257	1.05	Unknown
37	341.09	683.71	1101	270	215	7887	1.10	Unknown

UNKNOWN,SUM or ESCAPE PEAKS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)	FLAG
38	352.03	705.55	13982	372	237	7012	1.08	SPLIT
39	409.72	820.69	5206	270	188	6007	1.12	Unknown
40	440.72	882.56	334	179	144	4365	0.97	1461DEsc
41	453.14	907.35	830	182	142	4262	0.93	Unknown
42	463.20	927.44	10635	281	157	4857	1.16	Unknown
43	478.50	957.97	278	154	123	3463	0.78	1502DEsc
44	503.98	1008.83	453	191	153	4624	1.13	Unknown
45	509.28	1019.41	1341	338	272	5284	1.27	Unknown
46	511.14	1023.12	17517	443	292	5284	1.38	Unknown
47	546.83	1094.36	514	199	159	4677	1.33	Unknown
48	550.17	1101.02	337	215	174	5262	1.40	Unknown
49	558.67	1117.99	-74	184	152	2914	0.77	Deleted
50	562.80	1126.24	1874	195	144	4080	1.21	Unknown
51	571.27	1143.13	451	283	230	6993	1.96	1593DEsc
52	573.10	1146.79	245	141	113	2914	0.84	1593DEsc
55	616.24	1232.91	167	182	148	4071	1.35	1639DEsc
56	652.24	1304.76	132	180	147	3977	1.39	Deleted
57	666.19	1332.59	303	165	133	3482	1.11	1686DEsc
58	702.66	1405.39	337	199	161	4501	1.42	Unknown
59	707.78	1415.62	422	216	175	5001	1.69	1730DEsc
61	742.78	1485.48	57	99	81	1609	0.71	Deleted
62	755.68	1511.21	1737	188	139	3354	1.40	Unknown
63	763.92	1527.67	1092	175	133	3070	1.44	Unknown
64	768.80	1537.41	983	173	133	3070	1.53	Unknown
65	772.75	1545.30	2614	203	144	3411	1.56	1282SEsc
66	782.72	1565.19	831	151	115	2438	1.29	Unknown
67	786.03	1571.81	1975	177	126	2743	1.42	1807DEsc
68	795.43	1590.57	7130	224	122	2567	1.50	Unknown
69	803.41	1606.49	95	181	148	2306	1.43	Deleted
70	806.55	1612.75	162	95	75	1281	0.85	Unknown
71	830.96	1661.48	831	135	101	1875	1.33	Unknown
72	836.14	1671.82	2915	181	119	2344	1.59	Unknown
73	840.72	1680.97	1626	166	119	2344	1.65	Unknown
75	894.08	1787.47	418	104	78	1332	1.16	Unknown
76	904.84	1808.95	1108	138	99	1827	1.65	Unknown
78	934.54	1868.22	487	119	91	1521	1.62	Unknown
79	944.79	1888.68	123	89	71	1092	1.09	Unknown
80	952.53	1904.13	184	97	77	1218	1.24	Unknown
81	959.15	1917.36	346	85	63	913	1.02	Unknown
82	965.27	1929.57	7850	209	91	1522	1.72	Unknown
84	976.72	1952.41	64	83	67	986	1.17	Deleted
85	988.85	1976.62	240	98	77	1149	1.49	Unknown
87	1034.01	2066.77	260	90	69	988	1.39	Unknown
88	1040.86	2080.44	108	79	63	865	1.21	Unknown
89	1065.66	2129.93	281	100	77	1158	1.41	Unknown
90	1079.31	2157.19	705	114	83	1264	1.59	1589SEsc

210802D02.SPC Analyzed by

UNKNOWN,SUM or ESCAPE PEAKS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)	FLAG
91	1094.91	2188.32	761	150	114	1861	2.54	Unknown
92	1111.12	2220.68	492	109	82	1238	1.66	1622SEsc
94	1153.51	2305.29	112	70	55	697	0.97	Unknown
95	1154.64	2307.55	207	101	79	1162	1.59	1667SEsc
96	1156.09	2310.44	187	93	73	1046	1.49	1667SEsc
97	1238.84	2475.61	839	115	81	1225	1.68	Unknown
98	1247.47	2492.83	651	152	117	1960	2.55	Unknown
99	1282.14	2562.02	228	103	81	1163	1.80	Unknown
100	1288.20	2574.13	133	121	98	1480	2.24	Unknown
101	1374.92	2747.22	179	87	68	938	1.68	Unknown
102	1378.45	2754.27	606	121	91	1125	1.97	Unknown
103	1385.98	2769.30	84	73	58	750	1.38	Unknown
104	1402.18	2801.64	213	100	79	1095	2.17	Unknown
105	1408.78	2814.80	306	81	60	758	1.53	Unknown
107	1496.60	2990.09	1110	103	64	760	1.98	Unknown
108	1502.31	3001.50	547	95	68	823	2.14	Unknown
109	1510.11	3017.05	234	84	64	760	1.94	Unknown
110	1513.57	3023.96	419	92	68	823	2.09	Unknown
111	1529.14	3055.05	57	67	54	590	1.58	Unknown
112	1539.20	3075.13	82	70	56	628	1.71	Unknown
113	1558.18	3113.00	247	82	62	684	2.18	Unknown
114	1581.46	3159.48	696	104	74	903	2.50	Unknown
115	1588.99	3174.50	3681	146	66	782	2.09	Unknown
116	1593.18	3182.86	2020	127	74	903	2.44	Unknown
117	1621.50	3239.40	1736	114	64	717	2.12	Unknown
118	1625.73	3247.83	272	76	56	607	1.84	Unknown
119	1631.39	3259.13	1955	120	67	772	2.25	Unknown
120	1639.05	3274.42	465	81	56	607	1.85	Unknown
121	1662.12	3320.46	101	54	41	389	1.12	Unknown
122	1667.21	3330.64	173	78	60	666	1.94	Unknown
123	1679.78	3355.72	127	80	63	709	2.16	Unknown
124	1686.20	3368.53	123	89	71	818	2.38	Unknown
125	1730.47	3456.89	408	87	63	703	2.11	Unknown
126	1765.35	3526.53	1908	133	83	786	2.29	Unknown
127	1807.06	3609.76	106	82	65	753	2.18	Unknown
128	1848.44	3692.37	197	98	77	947	2.54	Unknown
129	1887.76	3770.85	73	69	55	601	1.68	Unknown
131	352.03	705.55	1002	3099	237	7012	1.08	1375DEsc

c:\SEEKER\BIN\210802d02.res Analysis Results Saved.

210802D02.SPC Analyzed by JH

SEEKER G A M M A A N A L Y S I S R E S U L T S PS Version 1.8.4

ALS Laboratory Group - Fort Collins
GammaScan

Geo 13 / Solid

Sample ID: 2106442-2 GS210619-1

Sampling Start: 06/14/2021 12:00:00	Counting Start: 07/10/2021 14:01:00
Sampling Stop: 06/14/2021 12:00:00	Decay Time. . . . . 6.26E+002 Hrs
Buildup Time. . . . . 0.00E+000 Hrs	Live Time . . . . . 60000 Sec
Sample Size . . . . . 4.05E+002 g	Real Time . . . . . 60274 Sec
Collection Efficiency 1.0000	Spc. File 210802D02.SPC

Detector #: 2 (Detector 2)

Energy(keV)= -1.45 + 0.501*Ch + 0.00E+00*Ch^2 + 0.00E+00*Ch^3 07/10/2021
FWHM(keV) = 0.59 + 0.019*En + 4.08E-04*En^2 + 0.00E+00*En^3 07/29/2020
Where En = Sqrt(Energy in keV)

Search Sensitivity: 1.00 | Sigma Multiplier: 2.00 | Search Start/End: 80/4000

PEAK SEARCH RESULTS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET/MDA COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)		FLAG
1	63.45	129.53	529	268	217	11617	0.51	a	
2	72.74	148.09	1202	434	352	25025	0.89		
3	74.83	152.25	22901	538	366	27012	0.84		
4	77.13	156.84	40971	658	427	31052	0.83		
5	79.42	161.41	526	315	257	14612	0.83		
6	81.26	165.08	-4692	506	431	31654	1.50		NET< CL
7	84.33	171.22	5766	514	404	27880	1.09		
8	87.20	176.94	-835	639	527	47451	0.07		NET< CL
9	89.94	182.41	-15205	645	568	54972	3.46		NET< CL
10	93.25	189.01	15893	527	381	24742	0.99		
11	99.60	201.70	3820	513	410	26579	1.10		
12	105.43	213.32	5679	474	370	23311	1.17	a	
13	108.93	220.32	1791	360	287	16651	0.89	b	
14	115.31	233.05	2287	360	286	16448	0.85	a	
15	129.19	260.76	8991	414	302	18433	0.74	a	
16	154.12	310.52	3222	358	280	15759	0.90	a	
17	166.50	335.23	405	284	231	11814	0.72	a	
18	186.03	374.21	3870	390	304	17084	0.99	a	
19	199.19	400.48	1091	370	299	16563	0.99	a	
20	203.95	409.97	410	321	262	13803	0.82	b	
21	209.21	420.46	15640	396	253	12871	0.80	a	HiResid

210802D02.SPC Analyzed by

PEAK SEARCH RESULTS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET/MDA COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)		FLAG
22	211.98	426.00	38	216	177	7723	0.48	b	NET< CL HiResid
23	216.05	434.12	1236	358	289	15445	1.02	c	HiResid
24	233.36	468.67	266	213	173	7394	0.49	a	
25	238.74	479.42	183421	917	269	13413	0.97	a	HiResid
26	241.25	484.42	19648	461	301	14378	1.27	b	HiResid
27	252.75	507.38	946	279	224	9261	0.96	a	
28	270.40	542.62	12559	371	243	10102	1.09	a	
29	277.55	556.88	7331	313	215	8563	0.94	a	
30	279.21	560.20	503	266	215	8563	1.06	b	
31	288.33	578.40	1264	295	235	9436	1.11	a	
32	295.36	592.44	8073	308	206	7816	0.95	a	
33	300.28	602.25	11465	329	206	7816	1.02	b	
34	321.64	644.88	503	216	174	6072	0.82	a	
35	328.10	657.77	9498	310	198	7257	1.05	a	
36	338.44	678.42	37015	450	191	6760	1.04	a	
37	341.09	683.71	1101	270	215	7887	1.10	b	
38	352.03	705.55	14177	343	203	7012	1.08	a	
39	409.72	820.69	5206	270	188	6007	1.12	a	
40	440.72	882.56	334	179	144	4365	0.97	a	
41	453.14	907.35	830	182	142	4262	0.93	a	
42	463.20	927.44	10635	281	157	4857	1.16	a	
43	478.50	957.97	278	154	123	3463	0.78	a	
44	503.98	1008.83	453	191	153	4624	1.13	a	
45	509.28	1019.42	1343	218	169	5284	1.27	b	
46	511.14	1023.12	19623	348	169	5284	1.38	c	
47	546.83	1094.36	514	199	159	4677	1.33	a	
48	550.17	1101.02	337	215	174	5262	1.40	b	
49	558.67	1117.99	247	141	113	2914	0.77	a	
50	562.80	1126.24	1874	195	144	4080	1.21	b	
51	571.27	1143.13	525	268	218	6993	1.96	a	
52	573.10	1146.79	245	141	113	2914	0.84	b	
53	583.49	1167.54	62580	536	157	4573	1.31	a	
54	609.62	1219.70	11335	281	151	4189	1.34	a	
55	616.24	1232.91	167	182	148	4071	1.35	a	
56	652.24	1304.76	132	180	147	3977	1.39	a	NET< CL
57	666.19	1332.59	303	165	133	3482	1.11	a	
58	702.66	1405.39	337	199	161	4501	1.42	a	
59	707.78	1415.62	422	216	175	5001	1.69	b	
60	727.64	1455.26	13599	294	147	3746	1.45	a	
61	742.78	1485.48	57	99	81	1609	0.71	a	NET< CL
62	755.68	1511.21	1737	188	139	3354	1.40	a	
63	763.92	1527.67	1092	175	133	3070	1.44	a	
64	768.80	1537.41	983	173	133	3070	1.53	b	
65	772.75	1545.30	2614	203	144	3411	1.56	c	
66	782.72	1565.19	831	151	115	2438	1.29	a	

210802D02.SPC Analyzed by

PEAK SEARCH RESULTS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET/MDA COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)	FLAG
67	786.03	1571.81	1975	177	126	2743	1.42 b	
68	795.43	1590.57	7130	224	122	2567	1.50 a	
69	803.41	1606.49	259	144	115	2306	1.43 a	
70	806.55	1612.75	162	95	75	1281	0.85 b	
71	830.96	1661.48	831	135	101	1875	1.33 a	
72	836.14	1671.82	2915	181	119	2344	1.59 b	
73	840.72	1680.97	1626	166	119	2344	1.65 c	
74	860.99	1721.42	7633	215	103	1958	1.58 a	
75	894.08	1787.47	418	104	78	1332	1.16 a	
76	904.84	1808.95	1108	138	99	1827	1.65 a	
77	911.78	1822.79	43429	434	99	1827	1.59 b	
78	934.54	1868.22	487	119	91	1521	1.62 a	
79	944.79	1888.68	123	89	71	1092	1.09 a	
80	952.53	1904.13	184	97	77	1218	1.24 a	
81	959.15	1917.36	346	85	63	913	1.02 b	
82	965.27	1929.57	7850	209	91	1522	1.72 c	
83	969.48	1937.96	26078	341	91	1522	1.65 d	
84	976.72	1952.41	64	83	67	986	1.17 a	NET< CL
85	988.85	1976.62	240	98	77	1149	1.49 a	
86	1001.53	2001.94	104	75	59	804	0.96 a	
87	1034.01	2066.77	260	90	69	988	1.39 a	
88	1040.86	2080.44	108	79	63	865	1.21 b	
89	1065.66	2129.93	281	100	77	1158	1.41 a	
90	1079.31	2157.19	705	114	83	1264	1.59 a	
91	1094.91	2188.32	761	150	114	1861	2.54 a	
92	1111.12	2220.68	492	109	82	1238	1.66 a	
93	1120.90	2240.21	2490	149	91	1404	1.89 a	
94	1153.51	2305.29	112	70	55	697	0.97 a	
95	1154.64	2307.55	207	101	79	1162	1.59 b	
96	1156.09	2310.44	187	93	73	1046	1.49 c	
97	1238.84	2475.61	839	115	81	1225	1.68 a	
98	1247.47	2492.83	651	152	117	1960	2.55 b	
99	1282.14	2562.02	228	103	81	1163	1.80 a	
100	1288.20	2574.13	133	121	98	1480	2.24 b	
101	1374.92	2747.22	179	87	68	938	1.68 a	
102	1378.45	2754.27	636	107	78	1125	1.97 b	
103	1385.98	2769.30	84	73	58	750	1.37 c	
104	1402.18	2801.64	213	100	79	1095	2.17 a	
105	1408.78	2814.80	306	81	60	758	1.53 b	
106	1461.44	2919.91	7659	196	73	952	2.20 a	HiResid
107	1496.60	2990.09	1110	103	64	760	1.98 a	
108	1502.31	3001.50	547	95	68	823	2.14 b	
109	1510.11	3017.05	234	84	64	760	1.94 c	
110	1513.57	3023.96	419	92	68	823	2.09 d	
111	1529.14	3055.05	57	67	54	590	1.58 a	
112	1539.20	3075.13	82	70	56	628	1.71 a	

210802D02.SPC Analyzed by

PEAK SEARCH RESULTS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET/MDA COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)	FLAG
113	1558.18	3113.00	247	82	62	684	2.18	a
114	1581.46	3159.48	696	104	74	902	2.50	a
115	1588.99	3174.50	3681	146	66	782	2.09	b
116	1593.18	3182.86	2020	127	74	902	2.44	c
117	1621.50	3239.40	1736	114	64	717	2.12	a
118	1625.73	3247.83	272	76	56	607	1.84	b
119	1631.39	3259.13	1955	120	67	772	2.25	c
120	1639.05	3274.42	465	81	56	607	1.85	d
121	1662.12	3320.46	101	54	41	389	1.12	a
122	1667.21	3330.64	173	78	60	666	1.94	b
123	1679.78	3355.72	127	80	63	709	2.16	a
124	1686.20	3368.53	123	89	71	818	2.38	b
125	1730.47	3456.89	408	87	63	703	2.11	a
126	1765.35	3526.53	1957	121	68	786	2.29	a
127	1807.06	3609.76	106	82	65	753	2.18	a
128	1848.44	3692.37	197	98	77	947	2.54	a
129	1887.76	3770.85	73	69	55	601	1.68	a

210802D02.SPC Analyzed by

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SEEKER B A C K G R O U N D S U B T R A C T R E S U L T S Vers. 2.2.1

ALS Laboratory Group - Fort Collins

GammaScan

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Background File:. . . . . DET020707.BKG (210707-2 LONGBKGCAL)

Bkg.File Detector #: 2

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BACKGROUND SUBTRACT RESULTS

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PK#	ENERGY (keV)	OLD NET COUNTS	OLD UN-CERTAINTY	OLD CR.LEVEL	NEW NET COUNTS	NEW UN-CERTAINTY	NEW CR.LEVEL	FLAG
1	63.45	529	268	217	350	325	266	
3	74.83	22901	538	366	22778	556	384	
4	77.13	40971	658	427	40846	678	447	
7	84.33	5766	514	404	5674	540	427	
8	87.20	-835	639	527	-872	654	540	NET<CL
10	93.25	15893	527	381	15473	555	408	
11	99.60	3820	513	410	3781	548	439	
18	186.03	3870	390	304	3598	417	329	
19	199.19	1091	370	299	774	398	324	
25	238.74	183421	917	269	183168	925	289	
26	241.25	19648	461	301	19551	475	316	
32	295.36	8073	308	206	8009	331	229	
38	352.03	14177	343	203	13982	372	237	
45	509.28	1343	218	169	1341	338	272	
46	511.14	19623	348	169	17517	443	292	
49	558.67	247	141	113	-74	184	152	NET<CL
51	571.27	525	268	218	451	283	230	
53	583.49	62580	536	157	62478	543	174	
54	609.62	11335	281	151	11166	314	191	
69	803.41	259	144	115	95	181	148	NET<CL
77	911.78	43429	434	99	43342	448	135	
93	1120.90	2490	149	91	2447	160	103	
102	1378.45	636	107	78	606	121	91	
106	1461.44	7659	196	73	7417	214	105	
126	1765.35	1957	121	68	1908	133	83	

210802D02.SPC Analyzed by

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SEEKER F I N A L A C T I V I T Y R E P O R T Version 2.2.1

ALS Laboratory Group - Fort Collins

GammaScan

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Geo 13 / Solid

Sample ID: 2106442-2 GS210619-1

Sampling Start: 06/14/2021 12:00:00	Counting Start: 07/10/2021 14:01:00
Sampling Stop: 06/14/2021 12:00:00	Decay Time. . . . . 6.26e+002 Hrs
Buildup Time. . . . . 0.00e+000 Hrs	Live Time . . . . . 60000 Sec
Sample Size . . . . . 4.05e+002 g	Real Time . . . . . 60274 Sec
Collection Efficiency 1.0000	Spectrum File 210802D02.SPC
Cr. Level Confidence Interval: 95 %	Det. Limit Confidence Interval: 95 %

Detector #: 2 (Detector 2)

Efficiency File: (D02)(Sh13).EFF (Geo 13 Eff Cal)

Eff=10^[-8.02E+01 +1.04E+02*L +-4.58E+01*L^2 +6.67E+00*L^3] 10/10/2020

Eff.= EXP[-2.35E-01 + -5.84E-01 * En + -1.09E-02 * En^2] Above 300.00 keV

Library File: . . . . . RA226.LIB (Ra-226 (215g steel can))

MEASURED or MDA CONCENTRATIONS

Nuclide	ENERGY (keV)	N E T	Concentration (pCi/g)	MDA	Critical Level	Halflife (hrs)
Ra-226	Average:x		2.24E+00 +- 5.07E-02	. . . .	. . . .	1.40E+07
	295.21		2.20E+00 +- 9.10E-02	1.27E-01	6.30E-02	1.40E+07
	351.92		2.20E+00 +- 2.55E-01	3.79E-01	1.90E-01	1.40E+07
	609.31		2.26E+00 +- 6.36E-02	7.79E-02	3.87E-02	1.40E+07
	1120.29		2.24E+00 +- 4.48E-01	5.95E-01	2.96E-01	1.40E+07

MEASURED TOTAL: 2.24E+00 +- 5.07E-02 pCi/g

UNKNOWN,SUM or ESCAPE PEAKS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)	FLAG
1	63.45	129.53	350	325	266	11617	0.51	Unknown
2	72.74	148.09	1202	434	352	25025	0.89	1095DEsc
3	74.83	152.25	22778	556	384	27012	0.84	1095DEsc
4	77.13	156.84	40846	678	447	31052	0.83	Unknown
5	79.42	161.41	526	315	257	14612	0.83	Unknown
6	84.33	171.22	5674	540	427	27880	1.09	Unknown
7	93.25	189.01	15473	555	408	24742	0.99	Unknown

210802D02.SPC Analyzed by

UNKNOWN,SUM or ESCAPE PEAKS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)	FLAG
8	99.60	201.70	3781	548	439	26579	1.10	1121DEsc
9	105.43	213.32	5679	474	370	23311	1.17	Unknown
10	108.93	220.32	1791	360	287	16651	0.89	Unknown
11	115.31	233.05	2287	360	286	16448	0.85	Unknown
12	129.19	260.76	8991	414	302	18433	0.74	Unknown
13	154.12	310.52	3222	358	280	15759	0.90	Unknown
14	166.50	335.23	405	284	231	11814	0.72	Unknown
15	186.03	374.21	3598	417	329	17084	0.99	Unknown
16	199.19	400.48	774	398	324	16563	0.99	Unknown
17	203.95	409.97	410	321	262	13803	0.82	Unknown
18	209.21	420.46	15640	396	253	12871	0.80	Unknown
19	216.05	434.12	1236	358	289	15445	1.02	1239DEsc
20	233.36	468.67	266	213	173	7394	0.49	Unknown
21	238.74	479.42	183168	925	289	13413	0.97	Unknown
22	241.25	484.42	19551	475	316	14378	1.27	Unknown
23	252.75	507.38	946	279	224	9261	0.96	Unknown
24	270.40	542.62	12559	371	243	10102	1.09	Unknown
25	277.55	556.88	7331	313	215	8563	0.94	Unknown
26	279.21	560.20	503	266	215	8563	1.06	Unknown
27	288.33	578.40	1264	295	235	9436	1.11	Unknown
29	300.28	602.25	11465	329	206	7816	1.02	Unknown
30	321.64	644.88	503	216	174	6072	0.82	Unknown
31	328.10	657.77	9498	310	198	7257	1.05	Unknown
32	338.44	678.42	37015	450	191	6760	1.04	Unknown
33	341.09	683.71	1101	270	215	7887	1.10	Unknown
34	352.03	705.55	13982	372	237	7012	1.08	1375DEsc
36	352.03	705.55	1002	3099	237	7012	1.08	Unknown
37	409.72	820.69	5206	270	188	6007	1.12	Unknown
38	440.72	882.56	334	179	144	4365	0.97	1461DEsc
39	453.14	907.35	830	182	142	4262	0.93	Unknown
40	463.20	927.44	10635	281	157	4857	1.16	Unknown
41	478.50	957.97	278	154	123	3463	0.78	1502DEsc
42	503.98	1008.83	453	191	153	4624	1.13	Unknown
43	509.28	1019.41	1341	338	272	5284	1.27	Unknown
44	511.14	1023.12	17517	443	292	5284	1.38	Unknown
45	546.83	1094.36	514	199	159	4677	1.33	Unknown
46	550.17	1101.02	337	215	174	5262	1.40	Unknown
47	562.80	1126.24	1874	195	144	4080	1.21	Unknown
48	571.27	1143.13	451	283	230	6993	1.96	1593DEsc
49	573.10	1146.79	245	141	113	2914	0.84	1593DEsc
50	583.49	1167.54	62478	543	174	4573	1.31	1095SEsc
52	616.24	1232.91	167	182	148	4071	1.35	1639DEsc
53	666.19	1332.59	303	165	133	3482	1.11	1686DEsc
54	702.66	1405.39	337	199	161	4501	1.42	Unknown
55	707.78	1415.62	422	216	175	5001	1.69	1730DEsc
56	727.64	1455.26	13599	294	147	3746	1.45	1239SEsc

UNKNOWN,SUM or ESCAPE PEAKS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)	FLAG
57	755.68	1511.21	1737	188	139	3354	1.40	Unknown
58	763.92	1527.67	1092	175	133	3070	1.44	Unknown
59	768.80	1537.41	983	173	133	3070	1.53	Unknown
60	772.75	1545.30	2614	203	144	3411	1.56	1282SEsc
61	782.72	1565.19	831	151	115	2438	1.29	Unknown
62	786.03	1571.81	1975	177	126	2743	1.42	1807DEsc
63	795.43	1590.57	7130	224	122	2567	1.50	Unknown
64	806.55	1612.75	162	95	75	1281	0.85	Unknown
65	830.96	1661.48	831	135	101	1875	1.33	Unknown
66	836.14	1671.82	2915	181	119	2344	1.59	Unknown
67	840.72	1680.97	1626	166	119	2344	1.65	Unknown
68	860.99	1721.42	7633	215	103	1958	1.58	Unknown
69	894.08	1787.47	418	104	78	1332	1.16	Unknown
70	904.84	1808.95	1108	138	99	1827	1.65	Unknown
71	911.78	1822.79	43342	448	135	1827	1.59	Unknown
72	934.54	1868.22	487	119	91	1521	1.62	Unknown
73	944.79	1888.68	123	89	71	1092	1.09	Unknown
74	952.53	1904.13	184	97	77	1218	1.24	Unknown
75	959.15	1917.36	346	85	63	913	1.02	Unknown
76	965.27	1929.57	7850	209	91	1522	1.72	Unknown
77	969.48	1937.96	26078	341	91	1522	1.65	Unknown
78	988.85	1976.62	240	98	77	1149	1.49	Unknown
79	1001.53	2001.94	104	75	59	804	0.96	1514SEsc
80	1034.01	2066.77	260	90	69	988	1.39	Unknown
81	1040.86	2080.44	108	79	63	865	1.21	Unknown
82	1065.66	2129.93	281	100	77	1158	1.41	Unknown
83	1079.31	2157.19	705	114	83	1264	1.59	1589SEsc
84	1094.91	2188.32	761	150	114	1861	2.54	Unknown
85	1111.12	2220.68	492	109	82	1238	1.66	1622SEsc
86	1120.90	2240.21	2447	160	103	1404	1.89	SPLIT
87	1153.51	2305.29	112	70	55	697	0.97	Unknown
88	1154.64	2307.55	207	101	79	1162	1.59	1667SEsc
89	1156.09	2310.44	187	93	73	1046	1.49	1667SEsc
90	1238.84	2475.61	839	115	81	1225	1.68	Unknown
91	1247.47	2492.83	651	152	117	1960	2.55	Unknown
92	1282.14	2562.02	228	103	81	1163	1.80	Unknown
93	1288.20	2574.13	133	121	98	1480	2.24	Unknown
94	1374.92	2747.22	179	87	68	938	1.68	Unknown
95	1378.45	2754.27	606	121	91	1125	1.97	Unknown
96	1385.98	2769.30	84	73	58	750	1.38	Unknown
97	1402.18	2801.64	213	100	79	1095	2.17	Unknown
98	1408.78	2814.80	306	81	60	758	1.53	Unknown
99	1461.44	2919.91	7417	214	105	952	2.20	Unknown
100	1496.60	2990.09	1110	103	64	760	1.98	Unknown
101	1502.31	3001.50	547	95	68	823	2.14	Unknown
102	1510.11	3017.05	234	84	64	760	1.94	Unknown

210802D02.SPC Analyzed by

UNKNOWN,SUM or ESCAPE PEAKS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)	FLAG
103	1513.57	3023.96	419	92	68	823	2.09	Unknown
104	1529.14	3055.05	57	67	54	590	1.58	Unknown
105	1539.20	3075.13	82	70	56	628	1.71	Unknown
106	1558.18	3113.00	247	82	62	684	2.18	Unknown
107	1581.46	3159.48	696	104	74	903	2.50	Unknown
108	1588.99	3174.50	3681	146	66	782	2.09	Unknown
109	1593.18	3182.86	2020	127	74	903	2.44	Unknown
110	1621.50	3239.40	1736	114	64	717	2.12	Unknown
111	1625.73	3247.83	272	76	56	607	1.84	Unknown
112	1631.39	3259.13	1955	120	67	772	2.25	Unknown
113	1639.05	3274.42	465	81	56	607	1.85	Unknown
114	1662.12	3320.46	101	54	41	389	1.12	Unknown
115	1667.21	3330.64	173	78	60	666	1.94	Unknown
116	1679.78	3355.72	127	80	63	709	2.16	Unknown
117	1686.20	3368.53	123	89	71	818	2.38	Unknown
118	1730.47	3456.89	408	87	63	703	2.11	Unknown
119	1765.35	3526.53	1908	133	83	786	2.29	Unknown
120	1807.06	3609.76	106	82	65	753	2.18	Unknown
121	1848.44	3692.37	197	98	77	947	2.54	Unknown
122	1887.76	3770.85	73	69	55	601	1.68	Unknown
124	1120.90	2240.21	122	983	103	1404	1.89	1631SEsc

c:\SEEKER\BIN\210802d02A.res Analysis Results Saved.

210799D01.SPC Analyzed by JH

SEEKER G A M M A A N A L Y S I S R E S U L T S PS Version 1.8.4

ALS Laboratory Group - Fort Collins
GammaScan

Geo 13 / Solid

Sample ID: GS210619-1MB GS210619-1

Sampling Start: 07/11/2021 13:00:00	Counting Start: 07/11/2021 13:16:08
Sampling Stop: 07/11/2021 13:00:00	Decay Time. . . . . 2.69E-001 Hrs
Buildup Time. . . . . 0.00E+000 Hrs	Live Time . . . . . 60000 Sec
Sample Size . . . . . 5.00E+002 g	Real Time . . . . . 60110 Sec
Collection Efficiency 1.0000	Spc. File 210799D01.SPC

Detector #: 1 (Detector 1)

Energy(keV)= -1.99 + 0.501*Ch + 0.00E+00*Ch^2 + 0.00E+00*Ch^3 07/11/2021
FWHM(keV) = 0.74 + 0.020*En + 4.70E-04*En^2 + 0.00E+00*En^3 08/22/2020
Where En = Sqrt(Energy in keV)

Search Sensitivity: 1.00 | Sigma Multiplier: 2.00 | Search Start/End: 80/4000

PEAK SEARCH RESULTS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET/MDA COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)		FLAG
1	53.86	111.47	69	109	89	1253	1.29	a	NET< CL
2	66.45	136.61	104	59	46	517	0.47	a	
3	69.37	142.43	13	56	46	517	0.50	b	NET< CL
4	74.94	153.55	95	60	47	547	0.49	a	
5	84.63	172.90	92	84	67	839	0.95	a	
6	92.59	188.79	172	102	81	1048	1.37	a	
7	97.05	197.68	55	61	49	524	0.66	b	
8	139.94	283.29	181	64	48	512	0.73	a	
9	154.18	311.72	62	83	67	829	1.06	a	NET< CL
10	185.72	374.67	162	103	82	1059	1.35	a	
11	198.32	399.84	119	72	57	648	0.74	a	
12	238.47	479.96	183	86	67	763	1.20	a	
13	261.42	525.78	24	51	41	417	0.59	a	NET< CL
14	295.08	592.97	44	71	58	655	1.12	a	NET< CL
15	351.66	705.90	175	75	58	624	1.23	a	
16	508.28	1018.53	-3	35	29	210	0.72	a	NET< CL Wide Pk
17	511.11	1024.17	1408	125	83	840	2.64	b	
18	537.99	1077.83	69	68	54	455	1.87	a	
19	558.44	1118.65	156	63	47	388	1.54	a	
20	569.80	1141.31	61	62	49	419	1.40	a	

210799D01.SPC Analyzed by

PEAK SEARCH RESULTS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET/MDA COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)		FLAG
21	583.43	1168.53	128	95	76	657	2.88	a	Wide Pk
22	596.33	1194.27	50	56	44	389	1.18	a	
23	609.33	1220.22	141	59	45	409	1.32	a	
24	768.70	1538.33	51	53	42	301	1.98	a	
25	802.83	1606.46	65	43	33	221	1.32	a	
26	911.38	1823.14	85	43	32	195	1.53	a	
27	1121.02	2241.58	47	55	44	290	2.72	a	
28	1461.11	2920.41	672	60	25	103	2.24	a	
29	1764.75	3526.49	78	28	18	55	2.35	a	

210799D01.SPC Analyzed by

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SEEKER B A C K G R O U N D S U B T R A C T R E S U L T S Vers. 2.2.1

ALS Laboratory Group - Fort Collins

GammaScan

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Background File:. . . . . DET010707.BKG (210707-1 LONGBKGCAL)

Bkg.File Detector #: 1

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BACKGROUND SUBTRACT RESULTS

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PK#	ENERGY (keV)	OLD NET COUNTS	OLD UN-CERTAINTY	OLD CR.LEVEL	NEW NET COUNTS	NEW UN-CERTAINTY	NEW CR.LEVEL	FLAG
2	66.45	104	59	46	-31	133	110	NET<CL
4	74.94	95	60	47	-28	152	125	NET<CL
6	92.59	172	102	81	25	181	149	NET<CL
8	139.94	181	64	48	101	125	101	NET<CL
9	154.18	62	83	67	20	131	107	NET<CL
10	185.72	162	103	82	65	195	160	NET<CL
11	198.32	119	72	57	-55	179	147	NET<CL
12	238.47	183	86	67	90	161	132	NET<CL
14	295.08	44	71	58	-0	165	135	NET<CL
15	351.66	175	75	58	73	122	100	NET<CL
17	511.11	1408	125	83	415	258	210	
19	558.44	156	63	47	-27	133	110	NET<CL
21	583.43	128	95	76	47	146	120	NET<CL
23	609.33	141	59	45	16	151	124	NET<CL
25	802.83	65	43	33	-53	93	77	NET<CL
26	911.38	85	43	32	16	89	73	NET<CL
27	1121.02	47	55	44	19	78	63	NET<CL
28	1461.11	672	60	25	27	134	110	NET<CL
29	1764.75	78	28	18	13	81	66	NET<CL

210799D01.SPC Analyzed by

SEEKER F I N A L A C T I V I T Y R E P O R T Version 2.2.1

ALS Laboratory Group - Fort Collins
GammaScan

Geo 13 / Solid

Sample ID: GS210619-1MB GS210619-1

Sampling Start: 07/11/2021 13:00:00	Counting Start: 07/11/2021 13:16:08
Sampling Stop: 07/11/2021 13:00:00	Decay Time. . . . . 2.69e-001 Hrs
Buildup Time. . . . . 0.00e+000 Hrs	Live Time . . . . . 60000 Sec
Sample Size . . . . . 5.00e+002 g	Real Time . . . . . 60110 Sec
Collection Efficiency 1.0000	Spectrum File 210799D01.SPC
Cr. Level Confidence Interval: 95 %	Det. Limit Confidence Interval: 95 %

Detector #: 1 (Detector 1)

Efficiency File: (D01)(Sh13).EFF (Geo 13 Eff Cal)
Eff=10^[-1.10E+02 +1.44E+02*L +-6.36E+01*L^2 +9.33E+00*L^3] 06/25/2021
Eff.= EXP[5.97E-01 + -8.38E-01 * En + 0.00E+00 * En^2] Above 300.00 keV

Library File: NATURAL(SUB RA228).LI (Natural.LIB)

MEASURED or MDA CONCENTRATIONS

Nuclide	ENERGY (keV)	N E T	Concentration (pCi/g)	MDA	Critical Level	Halflife (hrs)
Th-234	92.50	N	3.22E-02 +- 2.32E-01	3.85E-01	1.91E-01	3.92E+13
Pb-212	238.63	N	1.08E-02 +- 1.93E-02	3.19E-02	1.58E-02	1.27E+14
Pb-214	351.99	N	1.33E-02 +- 2.23E-02	3.68E-02	1.81E-02	1.40E+07
Tl-208	583.14	N	5.74E-03 +- 1.78E-02	2.95E-02	1.46E-02	1.27E+14
Bi-214	609.32	N	3.83E-03 +- 3.50E-02	5.81E-02	2.87E-02	1.40E+07
Ra-228	911.07	N	9.10E-03 +- 5.19E-02	8.67E-02	4.26E-02	5.04E+04
K-40	1460.75	N	5.38E-02 +- 2.71E-01	4.49E-01	2.22E-01	1.12E+13
Pb-210	46.50	N	-1.30E+00 +- 6.78E+00	1.14E+01	5.60E+00	1.95E+05
U-235	143.76	N	1.69E-03 +- 3.35E-02	5.61E-02	2.75E-02	6.17E+12
Th-227	236.00	N	4.51E-03 +- 5.36E-02	8.91E-02R	4.40E-02	1.90E+05
Cs-137	661.62	N	-3.37E-03 +- 7.14E-03	1.23E-02	5.98E-03	2.64E+05
Bi-212	727.17	N	1.30E-01 +- 9.29E-02	1.49E-01	7.19E-02	1.27E+14
Pa-234m	1001.03	N	8.66E-01 +- 1.15E+00	1.89E+00	9.09E-01	3.92E+13

MEASURED TOTAL: 1.13E+00 +- 1.98E+00 pCi/g

210799D01.SPC Analyzed by

UNKNOWN,SUM or ESCAPE PEAKS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)	FLAG
1	53.86	111.47	69	109	89	1253	1.29	Deleted
2	66.45	136.61	-31	133	110	517	0.47	Deleted
3	69.37	142.43	13	56	46	517	0.50	Deleted
4	74.94	153.55	-28	152	125	547	0.49	Deleted
5	84.63	172.90	92	84	67	839	0.95	Unknown
7	97.05	197.68	55	61	49	524	0.66	Unknown
8	139.94	283.29	101	125	101	512	0.73	Deleted
9	154.18	311.72	20	131	107	829	1.06	Deleted
10	185.72	374.67	65	195	160	1059	1.35	Deleted
11	198.32	399.84	-55	179	147	648	0.74	Deleted
13	261.42	525.78	24	51	41	417	0.59	Deleted
14	295.08	592.97	-0	165	135	655	1.12	Deleted
16	508.28	1018.53	-3	35	29	210	0.72	Deleted
17	511.11	1024.17	415	258	210	840	2.64	Unknown
18	537.99	1077.83	69	68	54	455	1.87	Unknown
19	558.44	1118.65	-27	133	110	388	1.54	Deleted
20	569.80	1141.31	61	62	49	419	1.40	Unknown
22	596.33	1194.27	50	56	44	389	1.18	Unknown
24	768.70	1538.33	51	53	42	301	1.98	Unknown
25	802.83	1606.46	-53	93	77	221	1.32	Deleted
27	1121.02	2241.58	19	78	63	290	2.72	Deleted
29	1764.75	3526.49	13	81	66	55	2.35	Deleted

c:\SEEKER\BIN\210799d01.res Analysis Results Saved.

210799D01.SPC Analyzed by JH

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SEEKER G A M M A A N A L Y S I S R E S U L T S PS Version 1.8.4

ALS Laboratory Group - Fort Collins
GammaScan

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Geo 13 / Solid

Sample ID: GS210619-1MB GS210619-1

Sampling Start:	07/11/2021 13:00:00	Counting Start:	07/11/2021 13:16:08
Sampling Stop:	07/11/2021 13:00:00	Decay Time.	2.69E-001 Hrs
Buildup Time.	0.00E+000 Hrs	Live Time	60000 Sec
Sample Size	5.00E+002 g	Real Time	60110 Sec
Collection Efficiency	1.0000	Spc. File	.210799D01.SPC

Detector #: 1 (Detector 1)

Energy(keV)= -1.99 + 0.501*Ch + 0.00E+00*Ch^2 + 0.00E+00*Ch^3 07/11/2021

FWHM(keV) = 0.74 + 0.020*En + 4.70E-04*En^2 + 0.00E+00*En^3 08/22/2020

Where En = Sqrt(Energy in keV)

Search Sensitivity: 1.00 | Sigma Multiplier: 2.00 | Search Start/End: 80/4000

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PEAK SEARCH RESULTS

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PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET/MDA COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)		FLAG
1	53.86	111.47	69	109	89	1253	1.29	a	NET< CL
2	66.45	136.61	104	59	46	517	0.47	a	
3	69.37	142.43	13	56	46	517	0.50	b	NET< CL
4	74.94	153.55	95	60	47	547	0.49	a	
5	84.63	172.90	92	84	67	839	0.95	a	
6	92.59	188.79	172	102	81	1048	1.37	a	
7	97.05	197.68	55	61	49	524	0.66	b	
8	139.94	283.29	181	64	48	512	0.73	a	
9	154.18	311.72	62	83	67	829	1.06	a	NET< CL
10	185.72	374.67	162	103	82	1059	1.35	a	
11	198.32	399.84	119	72	57	648	0.74	a	
12	238.47	479.96	183	86	67	763	1.20	a	
13	261.42	525.78	24	51	41	417	0.59	a	NET< CL
14	295.08	592.97	44	71	58	655	1.12	a	NET< CL
15	351.66	705.90	175	75	58	624	1.23	a	
16	508.28	1018.53	-3	35	29	210	0.72	a	NET< CL Wide Pk
17	511.11	1024.17	1408	125	83	840	2.64	b	
18	537.99	1077.83	69	68	54	455	1.87	a	
19	558.44	1118.65	156	63	47	388	1.54	a	
20	569.80	1141.31	61	62	49	419	1.40	a	

Page 001

210799D01.SPC Analyzed by

PEAK SEARCH RESULTS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET/MDA COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)	FLAG
21	583.43	1168.53	128	95	76	657	2.88 a	Wide Pk
22	596.33	1194.27	50	56	44	389	1.18 a	
23	609.33	1220.22	141	59	45	409	1.32 a	
24	768.70	1538.33	51	53	42	301	1.98 a	
25	802.83	1606.46	65	43	33	221	1.32 a	
26	911.38	1823.14	85	43	32	195	1.53 a	
27	1121.02	2241.58	47	55	44	290	2.72 a	
28	1461.11	2920.41	672	60	25	103	2.24 a	
29	1764.75	3526.49	78	28	18	55	2.35 a	

210799D01.SPC Analyzed by

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SEEKER B A C K G R O U N D S U B T R A C T R E S U L T S Vers. 2.2.1

ALS Laboratory Group - Fort Collins
GammaScan

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Background File:. . . . . DET010707.BKG (210707-1 LONGBKGCAL)

Bkg.File Detector #: 1

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BACKGROUND SUBTRACT RESULTS

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PK#	ENERGY (keV)	OLD NET COUNTS	OLD UN-CERTAINTY	OLD CR.LEVEL	NEW NET COUNTS	NEW UN-CERTAINTY	NEW CR.LEVEL	FLAG
2	66.45	104	59	46	-31	133	110	NET<CL
4	74.94	95	60	47	-28	152	125	NET<CL
6	92.59	172	102	81	25	181	149	NET<CL
8	139.94	181	64	48	101	125	101	NET<CL
9	154.18	62	83	67	20	131	107	NET<CL
10	185.72	162	103	82	65	195	160	NET<CL
11	198.32	119	72	57	-55	179	147	NET<CL
12	238.47	183	86	67	90	161	132	NET<CL
14	295.08	44	71	58	-0	165	135	NET<CL
15	351.66	175	75	58	73	122	100	NET<CL
17	511.11	1408	125	83	415	258	210	
19	558.44	156	63	47	-27	133	110	NET<CL
21	583.43	128	95	76	47	146	120	NET<CL
23	609.33	141	59	45	16	151	124	NET<CL
25	802.83	65	43	33	-53	93	77	NET<CL
26	911.38	85	43	32	16	89	73	NET<CL
27	1121.02	47	55	44	19	78	63	NET<CL
28	1461.11	672	60	25	27	134	110	NET<CL
29	1764.75	78	28	18	13	81	66	NET<CL

210799D01.SPC Analyzed by

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SEEKER F I N A L A C T I V I T Y R E P O R T Version 2.2.1

ALS Laboratory Group - Fort Collins

GammaScan

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Geo 13 / Solid

Sample ID: GS210619-1MB GS210619-1

Sampling Start: 07/11/2021 13:00:00	Counting Start: 07/11/2021 13:16:08
Sampling Stop: 07/11/2021 13:00:00	Decay Time. . . . . 2.69e-001 Hrs
Buildup Time. . . . . 0.00e+000 Hrs	Live Time . . . . . 60000 Sec
Sample Size . . . . . 5.00e+002 g	Real Time . . . . . 60110 Sec
Collection Efficiency 1.0000	Spectrum File 210799D01.SPC
Cr. Level Confidence Interval: 95 %	Det. Limit Confidence Interval: 95 %

Detector #: 1 (Detector 1)

Efficiency File: (D01)(Sh13).EFF (Geo 13 Eff Cal)

Eff=10^[-1.10E+02 +1.44E+02*L +-6.36E+01*L^2 +9.33E+00*L^3] 06/25/2021

Eff.= EXP[5.97E-01 + -8.38E-01 * En + 0.00E+00 * En^2] Above 300.00 keV

Library File: . . . . . RA226.LIB (Ra-226 (215g steel can))

MEASURED or MDA CONCENTRATIONS

Nuclide	ENERGY (keV)	N E T	Concentration (pCi/g)	MDA	Critical Level	Halflife (hrs)
Ra-226	351.92	N	3.06E-02 +- 1.36E-02	2.15E-02	1.05E-02	1.40E+07

MEASURED TOTAL: 3.06E-02 +- 1.36E-02 pCi/g

UNKNOWN,SUM or ESCAPE PEAKS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)	FLAG
1	84.63	172.90	92	84	67	839	0.95	Unknown
2	97.05	197.68	55	61	49	524	0.66	Unknown
3	511.11	1024.17	415	258	210	840	2.64	Unknown
4	537.99	1077.83	69	68	54	455	1.87	Unknown
5	569.80	1141.31	61	62	49	419	1.40	Unknown
6	596.33	1194.27	50	56	44	389	1.18	Unknown
7	768.70	1538.33	51	53	42	301	1.98	Unknown

c:\SEEKER\BIN\210799d01A.res Analysis Results Saved.

210798D01.SPC Analyzed by JH

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SEEKER G A M M A A N A L Y S I S R E S U L T S PS Version 1.8.4

ALS Laboratory Group - Fort Collins
GammaScan

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Geo 13 / Solid

Sample ID: GS210619-1LCS GS210619-1

Sampling Start:	07/11/2021 12:00:00	Counting Start:	07/11/2021 12:10:29
Sampling Stop:	07/11/2021 12:00:00	Decay Time.	1.75E-001 Hrs
Buildup Time.	0.00E+000 Hrs	Live Time	1800 Sec
Sample Size	5.00E+002 g	Real Time	1866 Sec
Collection Efficiency	1.0000	Spc. File	.210798D01.SPC

Detector #: 1 (Detector 1)

Energy(keV)= -1.99 + 0.501*Ch + 0.00E+00*Ch^2 + 0.00E+00*Ch^3 07/11/2021
FWHM(keV) = 0.74 + 0.020*En + 4.70E-04*En^2 + 0.00E+00*En^3 08/22/2020
Where En = Sqrt(Energy in keV)

Search Sensitivity: 1.00 | Sigma Multiplier: 2.00 | Search Start/End: 80/4000

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PEAK SEARCH RESULTS

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PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET/MDA COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)		FLAG
1	59.49	122.72	4753	179	94	1792	0.86	a	
2	87.94	179.50	7147	204	94	1767	0.82	a	HiResid
3	122.07	247.63	2092	146	93	1610	0.98	a	
4	136.47	276.36	223	117	93	1606	0.91	a	
5	165.82	334.95	154	100	79	1273	0.81	a	
6	228.65	460.36	56	83	67	1000	0.57	a	NET< CL
7	279.88	562.63	62	69	56	759	0.60	a	
8	297.18	597.16	65	88	71	1066	1.02	a	NET< CL
9	479.19	960.47	35	58	46	532	0.70	a	NET< CL
10	661.66	1324.68	17530	276	64	753	1.66	a	HiResid
11	1173.23	2345.79	13915	244	51	462	2.18	a	HiResid
12	1332.40	2663.51	12670	229	32	177	2.35	a	HiResid
13	1460.91	2920.01	23	19	13	32	1.94	a	

210798D01.SPC Analyzed by

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SEEKER B A C K G R O U N D S U B T R A C T R E S U L T S Vers. 2.2.1

ALS Laboratory Group - Fort Collins
GammaScan

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Background File:. . . . . DET010707.BKG (210707-1 LONGBKGCAL)

Bkg.File Detector #: 1

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BACKGROUND SUBTRACT RESULTS

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PK#	ENERGY (keV)	OLD NET COUNTS	OLD UN-CERTAINTY	OLD CR.LEVEL	NEW NET COUNTS	NEW UN-CERTAINTY	NEW CR.LEVEL	FLAG
3	122.07	2092	146	93	2092	146	93	
8	297.18	65	88	71	64	88	71	NET<CL
13	1460.91	23	19	13	4	19	15	NET<CL

210798D01.SPC Analyzed by

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SEEKER F I N A L A C T I V I T Y R E P O R T Version 2.2.1

ALS Laboratory Group - Fort Collins
GammaScan

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Geo 13 / Solid

Sample ID: GS210619-1LCS GS210619-1

Sampling Start: 07/11/2021 12:00:00	Counting Start: 07/11/2021 12:10:29
Sampling Stop: 07/11/2021 12:00:00	Decay Time. . . . . 1.75e-001 Hrs
Buildup Time. . . . . 0.00e+000 Hrs	Live Time . . . . . 1800 Sec
Sample Size . . . . . 5.00e+002 g	Real Time . . . . . 1866 Sec
Collection Efficiency 1.0000	Spectrum File 210798D01.SPC
Cr. Level Confidence Interval: 95 %	Det. Limit Confidence Interval: 95 %

Detector #: 1 (Detector 1)

Efficiency File: (D01)(Sh13).EFF (Geo 13 Eff Cal)

Eff=10^[-1.10E+02 +1.44E+02*L +-6.36E+01*L^2 +9.33E+00*L^3] 06/25/2021

Eff.= EXP[5.97E-01 + -8.38E-01 * En + 0.00E+00 * En^2] Above 300.00 keV

Library File: . . . .ANALYTICAL.LIB (Analytical)

MEASURED or MDA CONCENTRATIONS

Nuclide	ENERGY (keV)	N E T	Concentration (pCi/g)	MDA	Critical Level	Halflife (hrs)
Am-241	59.54		2.03E+02 +- 7.68E+00	8.19E+00	4.04E+00	3.79E+06
Cd-109	88.02		5.13E+02 +- 1.46E+01	1.36E+01	6.72E+00	1.11E+04
Co-57	122.07		3.95E+00 +- 2.75E-01	3.58E-01	1.76E-01	6.50E+03
Ce-139	165.85		3.01E-01 +- 1.95E-01	3.16E-01	1.55E-01	3.30E+03
Hg-203	279.18		1.34E-01 +- 1.50E-01	2.47E-01	1.20E-01	1.12E+03
Cs-137	661.62		7.86E+01 +- 1.24E+00	5.85E-01	2.86E-01	2.64E+05
Co-60	Average:x		8.65E+01 +- 1.09E+00	. . . .	. . . .	4.62E+04
	1173.21		8.59E+01 +- 1.51E+00	6.47E-01	3.15E-01	4.62E+04
	1332.48		8.71E+01 +- 1.57E+00	4.62E-01	2.22E-01	4.62E+04
Sn-113	391.68		MDA	6.27E-01	3.08E-01	2.76E+03
Y-88	898.02		MDA	8.15E-01	4.00E-01	2.56E+03

MEASURED TOTAL: 8.86E+02 +- 2.53E+01 pCi/g

UNKNOWN,SUM or ESCAPE PEAKS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)	FLAG
4	136.47	276.36	223	117	93	1606	0.91	Unknown

210798D01.SPC Analyzed by

UNKNOWN,SUM or ESCAPE PEAKS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)	FLAG
6	228.65	460.36	56	83	67	1000	0.57	Deleted
8	297.18	597.16	64	88	71	1066	1.02	Deleted
9	479.19	960.47	35	58	46	532	0.70	Deleted
13	1460.91	2920.01	4	19	15	32	1.94	Deleted

c:\SEEKER\BIN\210798d01.res Analysis Results Saved.

Gamma Spectrometer Run Log

Date: 7/10/2021 | 7/11/2021 Reviewed By/Date: TS 7/12/21

Sample ID	Ver[1]	Det. No.	Geo[2]	Count Dur. (min.)[3]	Start Time	Analyst	File ID.SPC	Saved?
210551-29	R	7	26	30	13:25	M	210756D07	
-30		10					210729D10	
GS210618-2MB		1					210795D01	
LCS		2			13:26		210801D02	
2106442-1		1	13	1000	14:20		210796D01	
-2		2	1		14:01		210802D02	
2106545-7		3	1		13:58		211060D03	
-8		4					211284D04	
-9		5					210747D05	
-10		7					210757D07	
-11		10					210730D10	
GS210619-LCS		1	13	30	12:10		210798D01	
-1MB	TS	1		1000	13:16		210799D01	TS
2106442-11		2					210805D02	TS
2106545-12		3	1				211062D03	TS
-13		4					211288D04Δ	TS
-14		5					210749D05	TS
-15		7			13:17		210759D07	TS
-16		10					210732D10	TS

7/10/21

7/11/21

TS 7/12/21

[1] Analyst will verify the position, detector, and geometry when the sample is removed from the detector.

[2] Calibration geometry.

[3] Count duration.

KEY: * sample was counted on a puck
↑ sample was counted with air flow arrow pointing up

495267 **B**

Δ Recount: Peak Shift

Form 754r16b.doc (10/27/11)

Technical Comments Regarding Analysis using the Natural (SubRa228).LIB Gamma Spectroscopy Library

Analysis using the **Natural (SubRa228).LIB** library is limited to the list of gamma emitting radionuclides specified by ALS Laboratory Group. ALS Laboratory Group specifies all values assigned to the nuclides in this library. In cases where multiple gamma emissions are used to quantify activity, the most abundant emission is used for quantification in the absence of any supporting gamma emissions. It should be noted that the current software program used for gamma spectroscopic analysis is limited to a +/- 2.0 keV photo-peak resolution tolerance. Thus, any gamma emissions occurring within the same +/- 2.0 keV range will suffer interference, consequently preventing accurate quantification. Nuclide specific information regarding analysis using the **Natural (SubRa228).LIB** library is as follows:

Nuclide: ^{228}Ra Energy: various Photon Abundance: various

All activity values for ^{228}Ra are calculated using the emissions of the ^{228}Ac daughter. It is assumed that secular equilibrium is achieved between the ^{228}Ra parent and the ^{228}Ac progeny.

Nuclide: ^{212}Bi, ^{212}Pb, ^{208}Tl Energy: various Photon Abundance: various

All activity values for ^{212}Bi, ^{212}Pb, and ^{208}Tl are calculated using the half-life, $t_{1/2}$=1.45E+10 years, of the long-lived ^{232}Th parent. It is assumed that secular equilibrium is achieved between the ^{232}Th parent and the ^{212}Bi, ^{212}Pb, ^{208}Tl progeny.

Nuclide: ^{214}Bi, ^{214}Pb Energy: various Photon Abundance: various

All activity values for ^{214}Bi and ^{214}Pb are calculated using the half-life, $t_{1/2}$=1600 years, of the long-lived ^{226}Ra parent. It is assumed that secular equilibrium is achieved between the ^{226}Ra parent and the ^{214}Bi and ^{214}Pb progeny.

Nuclide: ^{137}Cs Energy: 661.62 keV Photon Abundance: 0.8512

^{137}Cs does not emit any gamma photons useful for quantification. However, it can be assumed to be in secular equilibrium with the short-lived ^{137m}Ba daughter product. Therefore, the activity for ^{137}Cs is determined from the 661.62 keV gamma emission of the ^{137m}Ba daughter product. The calculated gamma photon abundance used in the library is the product of the 0.8998 abundance of the 661.62 keV ^{137m}Ba photon and the 0.946 branching ratio between ^{137}Ba and ^{137m}Ba.

Nuclide: ^{40}K Energy: 1460.75 keV Photon Abundance: 0.1100 (γ/dis)

The only gamma emission useful for quantification of this nuclide suffers from possible resolution interference due to the ^{228}Ac gamma emission occurring at 1459.2 keV (0.0104, abundance). Therefore, a possibility of a high bias to the ^{40}K results may occur in the presence of elevated ^{228}Ac activity.

Nuclide: ^{226}Ra Energy: 186.21 Photon Abundance: 0.0359

Quantifying ^{226}Ra activity using the 186.21 keV photo-peak is vulnerable to a significant high bias due to interference from gamma emissions from ^{235}U occurring at 185.72 keV (0.5720,

abundance). Therefore this nuclide will be "SI" flagged, indicating that significant spectral interference prohibits accurate quantification.

Nuclide: ^{234}Th & ^{234m}Pa Energy: various Photon Abundance: various

^{234}Th and ^{234m}Pa are assumed to be in secular equilibrium with their parent, ^{238}U. The activities for these nuclides are therefore calculated using the half-life of the parent, which is $t_{1/2}$=4.468E+9 years.

Nuclide: ^{227}Th Energy: 236.00 Photon Abundance: 0.1230

All activity values for ^{227}Th are calculated using the half-life, $t_{1/2}$=21.7 yrs, of the long-lived ^{227}Ac parent. It is assumed that secular equilibrium is achieved between the ^{227}Ac parent and the ^{227}Th progeny.

Nuclide: ^{234}Th Energy: 92.50 Photon Abundance: 0.0553

The 92.50 keV photo-peak used in this library for ^{234}Th quantification is actually two separate photo-peaks, occurring at 92.4 keV and 92.8 keV. The current software used for gamma spectroscopic analysis cannot resolve two photo-peaks that occur within the 2-keV resolution tolerance. Therefore, these two photopeaks are observed as a single photo-peak. Therefore, the average of the two photo-peak energies is used in this library. Also, the sum of the two photo-peak abundances, 0.0553, is used in the activity calculations for this observed 'single' photo-peak.

All activity values for ^{234}Th are calculated using the half-life, $t_{1/2}$=4.468E+09 yrs, of the long-lived ^{238}U parent. It is assumed that secular equilibrium is achieved between the ^{238}U parent and the ^{234}Th progeny.

Nuclide: ^{235}U Energy: 185.72 Photon Abundance: 0.5720

Quantifying ^{235}U activity using the 185.72 keV photo-peak is vulnerable to a significant high bias due to interference from gamma emissions from ^{226}Ra occurring at 186.21 keV (0.0328, abundance). Therefore, this emission will be used as an identifier only and not in the activity calculations for this nuclide.

Gamma Spectroscopist — 7/3/18 Date
Radiochemistry Instrumentation Laboratory

Radiochemistry Manager — 7/3/18 Date

Library File: Natural(SUB RA228).LIB
File I.D.: Natural.LIB

Pk. #	Energy (keV)	Isotope Name	2ndary Pk #	Type	Gamma Fraction	Halflife
19	727.17	Bi-212	0	NET	0.0658	1.4500E+10 yrs
17	609.32	Bi-214	24	NET	0.4609	1.6000E+03 yrs
24	1120.28	Bi-214	17	QUANT	0.1510	1.6000E+03 yrs
18	661.62	Cs-137	0	NET	0.8512	3.0104E+01 yrs
25	1460.75	K-40	0	NET	0.1100	1.2800E+09 yrs
23	1001.03	Pa-234m	0	NET	0.0059	4.4680E+09 yrs
1	46.50	Pb-210	0	NET	0.0405	2.2260E+01 yrs
4	115.18	Pb-212	10	QUANT	0.0059	1.4500E+10 yrs
10	238.63	Pb-212	13	NET	0.4330	1.4500E+10 yrs
13	300.09	Pb-212	4	QUANT	0.0327	1.4500E+10 yrs
12	295.22	Pb-214	15	QUANT	0.1920	1.6000E+03 yrs
15	351.99	Pb-214	12	NET	0.3710	1.6000E+03 yrs
14	338.40	Ra-228	21	QUANT	0.1127	5.7500E+00 yrs
21	911.07	Ra-228	22	NET	0.2580	5.7500E+00 yrs
22	968.90	Ra-228	14	QUANT	0.1580	5.7500E+00 yrs
9	236.00	Th-227	0	NET	0.1230	2.1700E+01 yrs
2	63.29	Th-234	3	QUANT	0.0390	4.4680E+09 yrs
3	92.50	Th-234	2	NET	0.0553	4.4680E+09 yrs
11	277.36	Tl-208	16	QUANT	0.0631	1.4500E+10 yrs
16	583.14	Tl-208	20	NET	0.8450	1.4500E+10 yrs
20	860.47	Tl-208	11	QUANT	0.1242	1.4500E+10 yrs
5	143.76	U-235	6	NET	0.1096	7.0379E+08 yrs
6	163.35	U-235	7	QUANT	0.0508	7.0379E+08 yrs
7	185.72	U-235	8	ID	0.5720	7.0379E+08 yrs
8	205.31	U-235	5	QUANT	0.0501	7.0379E+08 yrs

Technical Comments Regarding Gamma Spectroscopy Libraries

Library File: **Ra-226.LIB**

Nuclide: **Ra-226** Energy: various Photon Abundance: various

Samples analyzed by this library are sealed in a steel can and allowed to ingrow for a 21-day period to ensure the capture and full ingrowth of the Rn-222 gas and associated progeny. The Bi-214 and Pb-214 daughters are assumed to be in secular equilibrium with their parent, Ra-226. Ra-226 is then quantified from the ingrown Pb-214 and Bi-214 daughters using the 1600 year half-life of the Ra-226 parent.

Gamma Spectroscopist
Radiochemistry Instrumentation Laboratory

4-13-04
Date

OK
JB
4/14/04

OK
SH 4/3/02

Library File: Ra226.lib
File I.D.: Ra-226 (215g steel can)

	Energy (keV)	Isotope Name	2ndary Pk #	Type	Gamma Fraction	Halflife
1	295.21	Ra-226	2	QUANT	0.1920	1.6000E+03 yrs
2	351.92	Ra-226	3	NET	0.3710	1.6000E+03 yrs
3	609.31	Ra-226	4	QUANT	0.4609	1.6000E+03 yrs
4	1120.29	Ra-226	1	QUANT	0.1510	1.6000E+03 yrs

TECHNICAL BULLETIN ADDENDUM

The library used for analysis defines the gamma emission(s) to be used for analysis of each nuclide. If multiple gamma emissions are used for quantification, then a 'NET' quantification emission (or peak) must be defined in the library. This designation provides for the calculation of nuclide activity concentrations and detection limits in the case of non-presence of the nuclide. When the nuclide is not present, or the software is unable to resolve a peak at the library defined 'NET' energy, the software evaluates the 'NET' region of interest ('NET' peak energy +/- 2 keV) by performing a summation of the net counts above the background level. This 'NET' quantification can result in net negative, zero, or positive activity results, and is highly dependent on the spectral distribution in the region of interest of the 'NET' peak. In cases where only the 'NET' peak is found, and the software performs a net quantification, the nuclide result will be flagged with an 'NQ' qualifier on the final reports. This indicates that the nuclide is not detected or supported at any level above the reported MDC. Results are submitted without further qualification.

All nuclides specified in the library of analysis for gamma spectroscopy are evaluated for positive OR tentative identification on the following criteria:

- The individual abundances for the gamma emissions specified for each nuclide are summed to obtain a total nuclide abundance.
- From the total nuclide abundance, a positive identification criterion is set as 75% of this total nuclide abundance.
- For all nuclide peaks that are not net quantified, those peak abundances are summed. The total non-net quantified peak sum is compared to the calculated 75% abundance criterion. If this sum is greater than the 75% criterion, the nuclide is considered to be positively identified at the reported concentration. If the sum is less than the 75% criterion, the nuclide is tentatively identified at the reported concentration. These results will be flagged with a 'TI' qualifier on the final reports to indicate that the 75% abundance criterion was not met.

Section 6

QUALITY ASSURANCE SUMMARY REPORTS

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

Section 7

LABORATORY BENCH SHEETS

7

Radiochemistry Instrument Worksheet

ALS -- Fort Collins

Prep Batch: GS210619-1

Prep Procedure: GAMMASCAN Cnt 7/10/2021

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

Prep Num	Lab ID Collection Date	QC Type	Init Alq	Adj Alq %Moist	Units Geo.	Report Units	Cnt 1 File Cnt Dur (min)	Cnt 1 Inst/Det	Cnt 1 Count Date	Cnt 2 File Cnt Dur (min)	Cnt 2 Inst/Det	Cnt 2 Count Date	Cnt 3 File Cnt Dur (min)	Cnt 3 Inst/Det	Cnt 3 Count Date	Notes
1	2106442-1 06/14/21 12:03	SMP	425.7	377.6 11.293	g 13	pCi/g	1000	3	6/19/2021	1000	1	7/10/2021				
1	2106442-1 06/14/21 12:03	DUP	425.7	377.6 11.293	g 13	pCi/g		N/A			2	7/11/2021				
1	2106442-2 06/14/21 12:14	SMP	443.8	405 8.7523	g 13	pCi/g	1000	3	6/19/2021	100	2	7/10/2021				
1	GS210619-1 06/19/21 10:34	MB	500	500	g 13	pCi/g		N/A				7/11/2021				
1	GS210619-1 06/19/21 10:34	LCS	500	500	g 13	pCi/g		1		30						JH 7/13/2021

Analysis 1 Natrad (Sub Ra226). LIB

Analysis 2 Ra226. LIB

Spike Solution Information

Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
S1	Am-241	1098		444.544	DPM/g	06/19/21	500	g	NA
S1	Cd-109	1098		1,262.024	DPM/g	06/19/21	500	g	NA
S1	Ce-139	1098		0.899	DPM/g	06/19/21	500	g	NA
S1	Co-57	1098		8.934	DPM/g	06/19/21	500	g	NA
S1	Co-60	1098		191.699	DPM/g	06/19/21	500	g	NA
S1	Cs-137	1098		169.591	DPM/g	06/19/21	500	g	NA
S1	Hg-203	1098		0.000	DPM/g	06/19/21	500	g	NA
S1	Sn-113	1098		0.540	DPM/g	06/19/21	500	g	NA
S1	Y-88	1098		0.527	DPM/g	06/19/21	500	g	NA

Sample Barcodes

2106442-1 GS210619-1PS1	*GS210619-1PS1*	2106442-1DUP GS210619-1PS2	*GS210619-1PS2*	2106442-2 GS210619-1PS3	*GS210619-1PS3*
GS210619-1MB GS210619-1PS5	*GS210619-1PS5*	GS210619-1LCS GS210619-1PS6	*GS210619-1PS6*		

Radiochemistry Instrument Worksheet

ALS -- Fort Collins

Prep Batch: GS210619-1

Prep Procedure: Ra_226/228

Analytical QASS / NCR? Y / (N) NIA

Prep Num	Lab ID Collection Date	QC Type	Init Alq	Adj Alq %Moist	Units Geo.	Report Units	Cnt 1 File Cnt Dur (min)	Cnt 1 Inst/Det	Cnt 1 Count Date	Cnt 2 File Cnt Dur (min)	Cnt 2 Inst/Det	Cnt 2 Count Date	Cnt 3 File Cnt Dur (min)	Cnt 3 Inst/Det	Cnt 3 Count Date	Notes
1	2106442-1 06/14/21 12:03	SMP	425.7	377.6 11.293	g 13	pCi/g	See Gamma Sheet									
1	2106442-1 06/14/21 12:03	DUP	425.7	377.6 11.293	g 13	pCi/g										
1	2106442-2 06/14/21 12:14	SMP	443.8	405 8.7523	g 13	pCi/g										
1	GS210619-1A 06/19/21 10:34	MB	500	500	g 13	pCi/g										

Natural (Sub Ra226)
Ra226 Can (Bi/Pb) LIBR3
Duke

Spike Solution Information

Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
S1	Am-241	1098		444.544	DPM/g	06/19/21	500	g	NA
S1	Cd-109	1098		1,262.024	DPM/g	06/19/21	500	g	NA
S1	Ce-139	1098		0.899	DPM/g	06/19/21	500	g	NA
S1	Co-57	1098		8.934	DPM/g	06/19/21	500	g	NA
S1	Co-60	1098		191.699	DPM/g	06/19/21	500	g	NA
S1	Cs-137	1098		169.591	DPM/g	06/19/21	500	g	NA
S1	Hg-203	1098		0.000	DPM/g	06/19/21	500	g	NA
S1	Sn-113	1098		0.540	DPM/g	06/19/21	500	g	NA
S1	Y-88	1098		0.527	DPM/g	06/19/21	500	g	NA

Sample Barcodes

2106442-1 GS210619-1PS1	*GS210619-1PS1*	2106442-1DUP GS210619-1PS2	*GS210619-1PS2*	2106442-2 GS210619-1PS3	*GS210619-1PS3*
GS210619-1AMB GS210619-1PS4	*GS210619-1PS4*				

Reporting Units

LabID:	TstGrpName:	RptUnits:
2106442-1	GAMMA_Ra226	pCi/g
2106442-1	Gamma_NP_Custom	pCi/g
2106442-2	GAMMA_Ra226	pCi/g
2106442-2	Gamma_NP_Custom	pCi/g

Radiochemistry Prep Worksheet

ALS -- Fort Collins

Prep Batch: GS210619-1

Prep Procedure: GAMMASCAN

Reviewed By: jcp **Review Date:** 6/19/2021

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

Prep SOP: PAI 739 **Rev:** 13
Prep SOP: NONE
Matrix Class: solid

Prep Analyst: John C. Petrovic
Prep Date: 6/19/2021
Prep Dept: GM

Balance: 46
Balance: NA

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Alq g	Fin Alq g	Prep Basis	Geometry	Dish Weight (g)	Dry Weight + Dish Weight (g)	Standards	Prep Notes
1	1	2106442-1	SMP		425.7	425.7	As Received	13	47.9	473.6		
2	1	2106442-1	DUP		425.7	425.7	As Received	13	47.9	473.6		Count Duplicate
3	1	2106442-2	SMP		443.8	443.8	As Received	13	49.2	493		
4	1	GS210619-1	MB		500	500	As Received	13				
5	1	GS210619-1	LCS		500	500	As Received	13			S1	

Comments

Spiked By: N/A **Date:** N/A

Witnessed By: N/A **Date:** N/A

Spike Solution Information

Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
S1	Am-241	1098		444.544	DPM/g	06/19/21	500	g	NA
S1	Cd-109	1098		1,262.024	DPM/g	06/19/21	500	g	NA
S1	Ce-139	1098		0.899	DPM/g	06/19/21	500	g	NA
S1	Co-57	1098		8.934	DPM/g	06/19/21	500	g	NA
S1	Co-60	1098		191.699	DPM/g	06/19/21	500	g	NA
S1	Cs-137	1098		169.591	DPM/g	06/19/21	500	g	NA
S1	Hg-203	1098		0.000	DPM/g	06/19/21	500	g	NA
S1	Sn-113	1098		0.540	DPM/g	06/19/21	500	g	NA
S1	Y-88	1098		0.527	DPM/g	06/19/21	500	g	NA

Radiochemistry Prep Worksheet

ALS -- Fort Collins

Prep Batch: GS210619-1

Prep Procedure: Ra_226/228

Reviewed By: jcp **Review Date:** 6/19/2021

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

Prep SOP: PAI 739 **Rev:** 13
Prep SOP: NONE
Matrix Class: solid

Prep Analyst: John C. Petrovic
Prep Date: 6/19/2021
Prep Dept: GM

Balance: 46
Balance: NA

Samp Num	Prep Num	LabID	QC Type	Dish No.	Init Alq g	Fin Alq g	Prep Basis	Geometry	Dish Weight (g)	Dry Weight + Dish Weight (g)	Standards	Prep Notes
1	1	2106442-1	SMP		425.7	425.7	As Received	13	47.9	473.6		
2	1	2106442-1	DUP		425.7	425.7	As Received	13	47.9	473.6		Count Duplicate
3	1	2106442-2	SMP		443.8	443.8	As Received	13	49.2	493		
4	1	GS210619-1A	MB		500	500	As Received	13				

Comments

Spiked By: N/A **Date:** N/A

Witnessed By: N/A **Date:** N/A

Spike Solution Information

Soln #	Nuclide	SolnID	Exp Date	Prep Conc	Units	Prep Date	Aliquot	Units	Pipet ID
S1	Am-241	1098		444.544	DPM/g	06/19/21	500	g	NA
S1	Cd-109	1098		1,262.024	DPM/g	06/19/21	500	g	NA
S1	Ce-139	1098		0.899	DPM/g	06/19/21	500	g	NA
S1	Co-57	1098		8.934	DPM/g	06/19/21	500	g	NA
S1	Co-60	1098		191.699	DPM/g	06/19/21	500	g	NA
S1	Cs-137	1098		169.591	DPM/g	06/19/21	500	g	NA
S1	Hg-203	1098		0.000	DPM/g	06/19/21	500	g	NA
S1	Sn-113	1098		0.540	DPM/g	06/19/21	500	g	NA
S1	Y-88	1098		0.527	DPM/g	06/19/21	500	g	NA

Sample Condition Form (Solid)

Analyst: JA

Analysis Date: 6/19/2021

Method: Γ Spec

Work Order	Sample ID	Dry/Wet/ Moist	Texture	Remarks
		Sample Condition (Visual Appearance of Analysis Aliquot at Time of Prep)		
2106442	1	Dry	Soil	Packed As Received
↓	2	↓	↓	↓

JA 6/19/2021

Section 8

STANDARDS TRACEABILITY DOCUMENTS

RSO # 1098

Received 8/20/18

Eckert & Ziegler Analytics

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

CERTIFICATE OF CALIBRATION

Standard Reference Source

SRS Number: 110301
Source Description: 500 Grams Sand in 16 Ounce PP MRP Jar
Product Code: 8401-EG-SAN
Customer: ALS Laboratory Group
P.O. Number: FC001958, Item 1

This standard radionuclide source was prepared from an aliquot measured gravimetrically from a master radionuclide solution calibrated with a germanium gamma-ray spectrometer system. Additional radionuclides were added gravimetrically from solutions calibrated by gamma-ray spectrometry, ionization chamber, or liquid scintillation counting. Calibration and purity were checked using germanium gamma-ray spectrometry. At the time of calibration no interfering gamma-ray emitting impurities were detected. The gamma-ray emission rates for the most intense gamma-ray lines are given. Eckert & Ziegler Analytics (EZA) maintains traceability to the National Institute of Standards and Technology (NIST) through a Measurements Assurance Program as described in USNRC Regulatory Guide 4.15, Revision 2, July 2007, and compliance with ANSI N42.22-1995, "Traceability of Radioactive Sources to NIST."

Reference Date: 01-July-2018 12:00 PM EST

MGS Mixture

Isotope	Gamma-Ray Energy, keV	Half-Life, d	Activity, Bq	Flux, s^{-1}	Uncertainty u_A, %	Uncertainty u_B, %	Uncertainty U, %*	Calibration Method**
Am-241	59.5	1.580E+05	3.723E+03	1.336E+03	0.1	1.8	3.6	4π LS
Cd-109	88.0	4.614E+02	5.231E+04	1.936E+03	0.5	2.0	4.1	HPGe
Co-57	122.1	2.717E+02	1.183E+03	1.012E+03	0.4	1.7	3.4	HPGe
Ce-139	165.9	1.376E+02	1.775E+03	1.420E+03	0.4	1.7	3.6	HPGe
Hg-203	279.2	4.659E+01	3.778E+03	3.082E+03	0.3	1.7	3.5	HPGe
Sn-113	391.7	1.151E+02	3.081E+03	2.002E+03	0.4	1.9	3.9	HPGe
Cs-137	661.7	1.099E+04	1.514E+03	1.288E+03	0.7	1.9	4.1	HPGe
Y-88	898.0	1.066E+02	5.064E+03	4.745E+03	0.7	1.7	3.7	HPGe
Y-88	1836.1	———	———	5.024E+03	0.7	1.7	3.7	———
Co-60	1173.2	1.925E+03	2.362E+03	2.359E+03	0.7	1.8	3.9	HPGe
Co-60	1332.5	———	———	2.362E+03	0.7	1.8	3.9	———

Mixed Gamma (MGS) master solution is EZA's eight isotope mixture which is calibrated quarterly and consists of Cd-109, Co-57, Ce-139, Hg-203, Sn-113, Cs-137, Y-88, and Co-60. ***Uncertainty:** U - Relative expanded uncertainty, k = 2. See NIST Technical Note 1297, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results." ****Calibration Methods:** 4π LS - 4π Liquid Scintillation Counting, HPGe - High Purity Germanium Gamma-Ray Spectrometer, IC - Ionization Chamber.

(Certificate continued on reverse side)

Standard Re-Verified 09/01/2020.
New Exp. Date
=> 09/01/2021
@ 10/4/2023

SRS Number: 110301

Comments:
500.00 grams of customer supplied sand. Approximate volume: 290 mL

Expiration Date: 17-August-2019

This source was wipe tested in its inactive areas with leak test results < 185 Bq (5 nCi) of removable activity per ISO 9978:1992.

Source Prepared by: _____
A. Chirillo, Radiochemist

QC Approved by: _____ Date: 16-AUG-18
J. Lahr, Spectroscopist

Section 9

ADDITIONAL SUPPORTING DOCUMENTATION

Gamma Spectroscopy

Initial Calibration Standards Traceability

201087D01.SPC Analyzed by

****

SEEKER G A M M A A N A L Y S I S R E S U L T S PS Version 1.8.4

ALS Laboratory Group - Fort Collins
GammaScan

****

Geo 1 / Water

Sample ID: 082220-1 FWHM Cal (1119)

Sampling Start:	01/01/2020 10:00:00	Counting Start:	08/22/2020 13:03:17
Sampling Stop:	01/01/2020 10:00:00	Decay Time.	5.62E+003 Hrs
Buildup Time.	0.00E+000 Hrs	Live Time	7200 Sec
Sample Size	1.00E+000 L	Real Time	7441 Sec
Collection Efficiency	1.0000	Spc. File	.201087D01.SPC

Detector #: 1 (Detector 1)

Energy(keV)= -1.83 + 0.501*Ch + 0.00E+00*Ch^2 + 0.00E+00*Ch^3 08/22/2020
FWHM(keV) = 0.68 + 0.018*En + 5.50E-04*En^2 + 0.00E+00*En^3 08/22/2019
Where En = Sqrt(Energy in keV)

Search Sensitivity: 1.00 | Sigma Multiplier: 2.00 | Search Start/End: 80/4000

PEAK SEARCH RESULTS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET/MDA COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)	FLAG
1	59.44	122.21	32648	535	324	19398	0.90 a	HiResid
2	87.91	178.99	138172	874	378	26469	0.92 a	HiResid
3	122.06	247.10	89025	729	344	20235	1.07 a	
4	136.47	275.85	11614	441	317	17101	1.08 a	
5	165.84	334.41	75062	660	303	15640	1.12 a	
6	255.23	512.72	2070	293	229	9671	1.02 a	
7	279.19	560.50	11971	365	240	9829	1.19 a	
8	391.71	784.94	48092	504	204	7682	1.29 a	
9	509.78	1020.44	385	196	158	4915	1.22 a	
10	511.36	1023.60	1093	298	239	8426	1.93 b	
11	661.70	1323.46	80243	608	182	5771	1.54 a	
12	813.95	1627.13	743	208	165	5025	1.56 a	
13	898.10	1794.97	50727	505	187	6170	1.77 a	
14	1173.29	2343.85	85525	604	125	2880	1.96 a	HiResid
15	1325.15	2646.76	1086	138	100	1585	2.59 a	HiResid
16	1332.46	2661.34	78439	570	85	1288	2.08 b	HiResid
17	1835.90	3665.49	29550	348	44	325	2.45 a	HiResid

201087D01.SPC Analyzed by

****

SEEKER C A L I B R A T I O N R E S U L T S Version 2.0.4

****

Sample ID: 082220-1 FWHM Cal (1119)
Stds. Match Tolerance: 2.00 keV

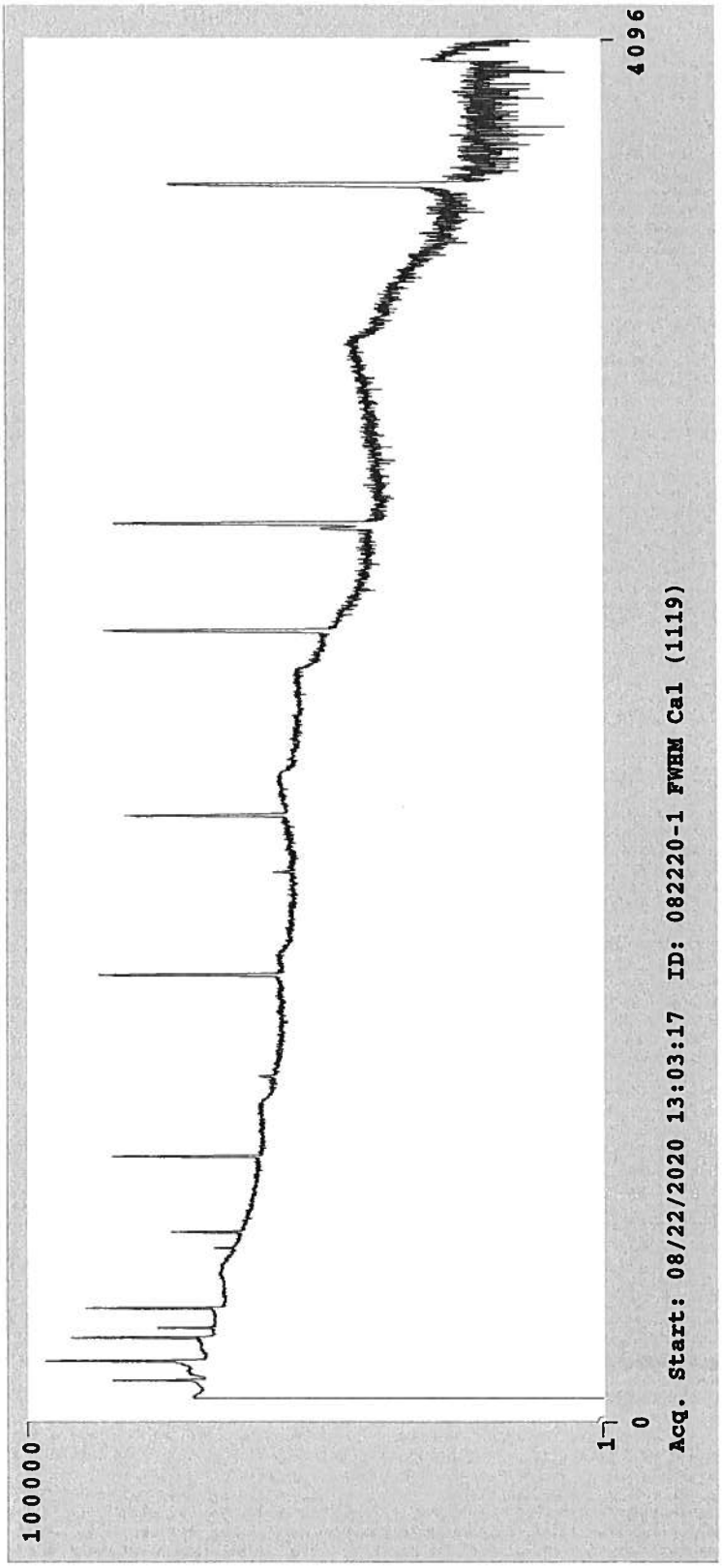
Detector Number: 01 Calibration Date. . . 08/22/2020 13:03:17

FWHM(keV) = 0.74 + 0.020*En + 4.70e-04*En^2 + 0.00e+00*En^3
(Where En = SQR(Energy in keV))

Pk. #	Energy (kev)	Measured FWHM(keV)	% Diff.	Calculated FWHM(keV)	% Diff.	Prev.Calc. FWHM(kev)
1	59.50	0.905	1.73	0.921	-8.74	0.847
2	88.04	0.916	5.28	0.967	-8.41	0.892
3	122.06	1.069	-5.27	1.015	-8.04	0.940
4	165.85	1.117	-4.19	1.072	-7.60	0.996
5	279.00	1.195	0.46	1.200	-6.59	1.126
6	391.68	1.294	1.52	1.314	-5.74	1.243
7	661.64	1.539	1.19	1.557	-4.11	1.496
8	898.02	1.768	-0.93	1.752	-2.99	1.701
9	1173.21	1.962	0.17	1.965	-1.94	1.928
10	1332.48	2.079	0.28	2.084	-1.42	2.055
11	1836.01	2.451	-0.23	2.446	-0.06	2.444

Calibration Results Saved.

8/22/20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4096
Acq. Start: 08/22/2020 13:03:17 ID: 082220-1 FWHM Cal (1119)

RSO# 1119 Rev 3 2-3-20

Eckert & Ziegler
Analytics

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

CERTIFICATE OF CALIBRATION
Standard Reference Source

SRS Number: 114986
Source Description: 1.0 Liter Solid in 138G GA-MA Beaker
Product Code: 8401-EG-SD
Customer: ALS Laboratory Group (Paragon)
P.O. Number: FC002657, Item 1

This standard radionuclide source was prepared from an aliquot measured gravimetrically from a master radionuclide solution calibrated with a germanium gamma-ray spectrometer system. Additional radionuclides were added gravimetrically from solutions calibrated by gamma-ray spectrometry, ionization chamber, or liquid scintillation counting. Calibration and purity were checked using germanium gamma-ray spectrometry. At the time of calibration no interfering gamma-ray emitting impurities were detected. The gamma-ray emission rates for the most intense gamma-ray lines are given. Eckert & Ziegler Analytics (EZA) maintains traceability to the National Institute of Standards and Technology (NIST) through a Measurements Assurance Program as described in USNRC Regulatory Guide 4.15, Revision 2, July 2007, and compliance with ANSI N42.22-1995, "Traceability of Radioactive Sources to NIST."

Density of solid matrix: 1.17 g/cm³ ± 3 %.

Reference Date: 01-January-2020 12:00 PM EST

MGS Mixture

Isotope	Gamma-Ray Energy, keV	Half-Life, d	Activity, Bq	Flux, s^{-1}	Uncertainty u_A, %	Uncertainty u_B, %	Uncertainty U, %*	Calibration Method**
Am-241	59.5	1.580E+05	3.612E+03	1.368E+03	0.1	1.8	3.7	4π LS
Cd-109	88.0	4.614E+02	5.212E+04	1.928E+03	0.5	2.0	4.2	HPGe
Co-57	122.1	2.717E+02	1.173E+03	1.004E+03	0.4	1.7	3.5	HPGe
Ce-139	165.9	1.376E+02	1.778E+03	1.422E+03	0.4	1.8	3.7	HPGe
Hg-203	279.2	4.659E+01	3.695E+03	3.014E+03	0.3	1.7	3.5	HPGe
Sn-113	391.7	1.151E+02	3.068E+03	1.994E+03	0.4	2.0	4.1	HPGe
Cs-137	661.7	1.099E+04	1.502E+03	1.278E+03	0.7	1.9	4.1	HPGe
Y-88	898.0	1.066E+02	5.104E+03	4.783E+03	0.7	1.7	3.7	HPGe
Y-88	1836.1	———	———	5.063E+03	0.7	1.7	3.7	———
Co-60	1173.2	1.925E+03	2.383E+03	2.379E+03	0.7	1.8	3.9	HPGe
Co-60	1332.5	———	———	2.382E+03	0.7	1.8	3.9	———

Mixed Gamma (MGS) master solution is EZA's eight isotope mixture which is calibrated quarterly and consists of Cd-109, Co-57, Ce-139, Hg-203, Sn-113, Cs-137, Y-88, and Co-60. ***Uncertainty:** U - Relative expanded uncertainty, $k = 2$. See NIST Technical Note 1297, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results." ****Calibration Methods:** 4π LS - 4π Liquid Scintillation Counting, HPGe - High Purity Germanium Gamma-Ray Spectrometer, IC - Ionization Chamber.

(Certificate continued on reverse side)

SRS Number: 114986

Expiration Date: 31-January-2021

This source was wipe tested in its inactive areas with leak test results < 185 Bq (5 nCi) of removable activity per ISO 9978:1992.

Source Prepared by: A. Herron

A. Herron, Radiochemist

QC Approved by: _____ Date: 29 Jan 20

A. Chen, Spectroscopist

200210D02.SPC Analyzed by

****

SEEKER G A M M A A N A L Y S I S R E S U L T S PS Version 1.8.4

ALS Laboratory Group - Fort Collins
GammaScan

****

Geo 1 / Water

Sample ID: 072920-2 FWHM Cal (1119)

Sampling Start: 01/01/2020 10:00:00	Counting Start: 07/29/2020 06:41:39
Sampling Stop: 01/01/2020 10:00:00	Decay Time. . . . . 5.04E+003 Hrs
Buildup Time. . . . . 0.00E+000 Hrs	Live Time . . . . . 1800 Sec
Sample Size . . . . . 1.00E+000 L	Real Time . . . . . 1885 Sec
Collection Efficiency 1.0000	Spc. File 200210D02.SPC

Detector #: 2 (Detector 2)

Energy(keV)= -1.33 + 0.501*Ch + 0.00E+00*Ch^2 + 0.00E+00*Ch^3 07/29/2020
FWHM(keV) = 0.41 + 0.047*En + 0.00E+00*En^2 + 0.00E+00*En^3 07/16/2020
Where En = Sqrt(Energy in keV)

Search Sensitivity: 1.00 | Sigma Multiplier: 2.00 | Search Start/End: 80/4000

PEAK SEARCH RESULTS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET/MDA COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)		FLAG
1	59.49	121.41	13558	315	174	6117	0.79	a	HiResid
2	72.97	148.31	162	124	100	2771	0.41	a	
3	87.97	178.25	52402	513	191	7358	0.81	a	HiResid
4	122.07	246.34	32161	405	155	4812	0.83	a	HiResid
5	136.55	275.23	3999	215	144	4152	0.76	a	HiResid
6	165.84	333.70	29005	379	137	3788	0.90	a	HiResid
7	255.19	512.06	854	174	134	3342	0.91	a	
8	279.19	559.98	6172	212	117	2895	1.03	a	
9	391.70	784.57	20627	317	110	2384	1.14	a	HiResid
10	509.01	1018.73	37	92	75	1289	0.75	a	NET< CL
									Wide Pk
11	511.34	1023.39	449	215	173	3866	2.40	b	
12	661.65	1323.45	31087	372	97	1924	1.36	a	HiResid
13	813.84	1627.26	376	118	92	1634	1.55	a	
14	875.37	1750.08	65	80	64	1025	0.90	a	
15	898.04	1795.32	23406	329	100	1936	1.53	a	HiResid
16	1173.19	2344.59	34610	383	76	1103	1.74	a	HiResid
17	1325.14	2647.92	583	118	89	1032	3.62	a	HiResid
									Wide Pk
18	1332.35	2662.30	31921	363	52	516	1.84	b	HiResid
19	1835.75	3667.20	14403	243	30	165	2.16	a	HiResid

200210D02.SPC Analyzed by

****

SEEKER C A L I B R A T I O N R E S U L T S Version 2.0.4

****

Sample ID: 072920-2 FWHM Cal (1119)
Stds. Match Tolerance: 2.00 keV

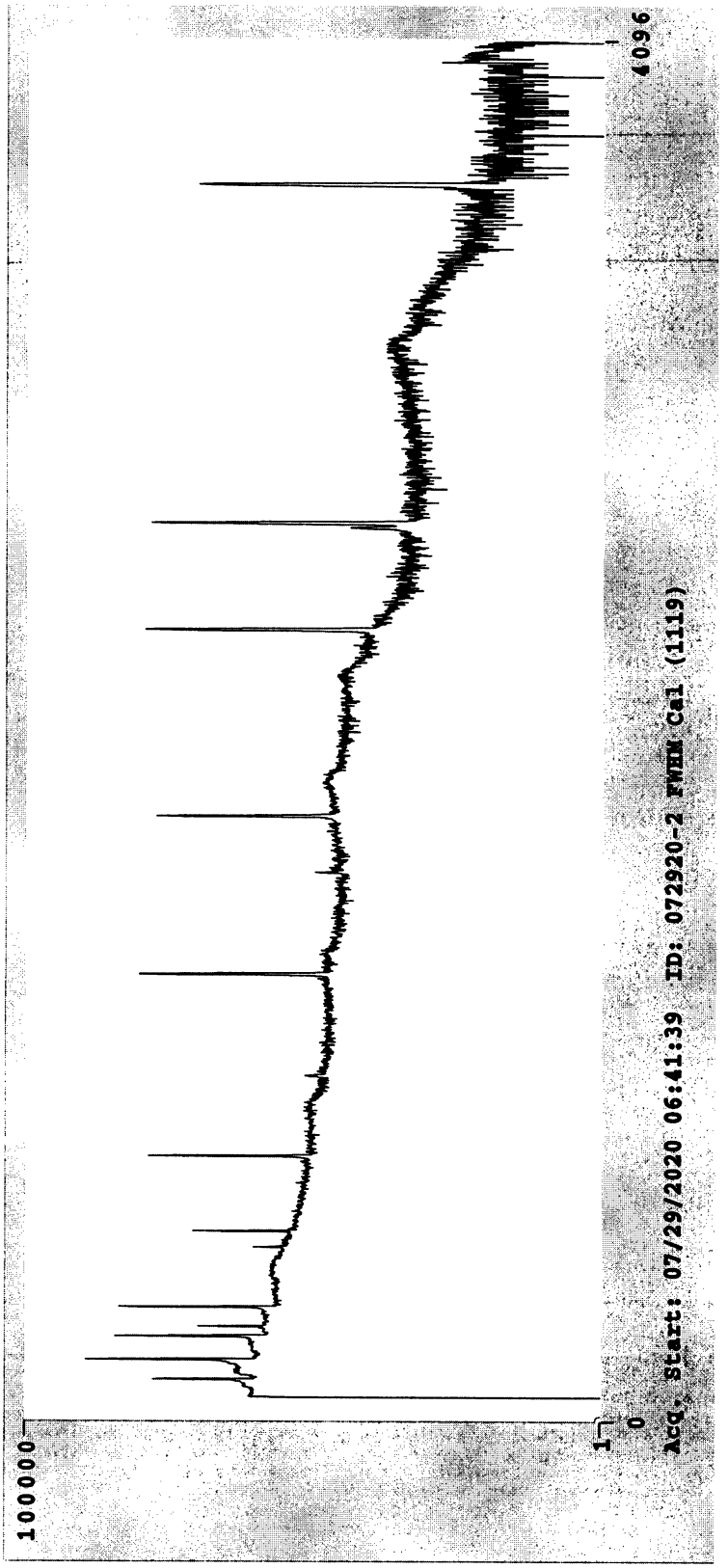
Detector Number: 02 Calibration Date. . . 07/29/2020 06:41:39

FWHM(keV) = 0.59 + 0.019*En + 4.08e-04*En^2 + 0.00e+00*En^3
(Where En = SQR(Energy in keV))

Pk. #	Energy (kev)	Measured FWHM(keV)	% Diff.	Calculated FWHM(keV)	% Diff.	Prev.Calc. FWHM(kev)
1	59.50	0.792	-3.37	0.766	0.77	0.772
2	88.04	0.810	0.04	0.810	4.79	0.851
3	122.06	0.831	2.93	0.856	7.87	0.929
4	165.85	0.897	1.23	0.908	10.45	1.015
5	279.00	1.027	0.05	1.028	13.92	1.194
6	391.68	1.136	-0.32	1.133	15.38	1.339
7	661.64	1.364	-0.59	1.356	16.12	1.617
8	898.02	1.529	0.31	1.533	15.53	1.815
9	1173.21	1.738	-0.61	1.728	14.32	2.016
10	1332.48	1.836	-0.00	1.836	13.49	2.122
11	1836.01	2.156	0.28	2.162	10.62	2.419

Calibration Results Saved.

OK JP 7/29/2020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4096
Acq. Start: 07/29/2020 06:41:39 ID: 07920-2 FWHM Cal (1119)

RSO# 1119 Rev 1 2-3-20

Eckert & Ziegler
Analytics

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Tel 404·352·8677
Fax 404·352·2837
www.ezag.com

CERTIFICATE OF CALIBRATION
Standard Reference Source

SRS Number: 114986
Source Description: 1.0 Liter Solid in 138G GA-MA Beaker
Product Code: 8401-EG-SD
Customer: ALS Laboratory Group (Paragon)
P.O. Number: FC002657, Item 1

This standard radionuclide source was prepared from an aliquot measured gravimetrically from a master radionuclide solution calibrated with a germanium gamma-ray spectrometer system. Additional radionuclides were added gravimetrically from solutions calibrated by gamma-ray spectrometry, ionization chamber, or liquid scintillation counting. Calibration and purity were checked using germanium gamma-ray spectrometry. At the time of calibration no interfering gamma-ray emitting impurities were detected. The gamma-ray emission rates for the most intense gamma-ray lines are given. Eckert & Ziegler Analytics (EZA) maintains traceability to the National Institute of Standards and Technology (NIST) through a Measurements Assurance Program as described in USNRC Regulatory Guide 4.15, Revision 2, July 2007, and compliance with ANSI N42.22-1995, "Traceability of Radioactive Sources to NIST."

Density of solid matrix: 1.17 g/cm³ ± 3 %.

Reference Date: 01-January-2020 12:00 PM EST

MGS Mixture

Isotope	Gamma-Ray Energy, keV	Half-Life, d	Activity, Bq	Flux, s^{-1}	Uncertainty u_A, %	Uncertainty u_B, %	Uncertainty U, %*	Calibration Method**
Am-241	59.5	1.580E+05	3.812E+03	1.368E+03	0.1	1.8	3.7	4π LS
Cd-109	88.0	4.614E+02	5.212E+04	1.928E+03	0.5	2.0	4.2	HPGe
Co-57	122.1	2.717E+02	1.173E+03	1.004E+03	0.4	1.7	3.5	HPGe
Ce-139	165.9	1.376E+02	1.778E+03	1.422E+03	0.4	1.8	3.7	HPGe
Hg-203	279.2	4.659E+01	3.696E+03	3.014E+03	0.3	1.7	3.5	HPGe
Sn-113	391.7	1.151E+02	3.068E+03	1.994E+03	0.4	2.0	4.1	HPGe
Cs-137	661.7	1.099E+04	1.502E+03	1.278E+03	0.7	1.9	4.1	HPGe
Y-88	898.0	1.066E+02	5.104E+03	4.783E+03	0.7	1.7	3.7	HPGe
Y-88	1836.1	———	———	5.063E+03	0.7	1.7	3.7	———
Co-60	1173.2	1.925E+03	2.383E+03	2.379E+03	0.7	1.8	3.9	HPGe
Co-60	1332.5	———	———	2.382E+03	0.7	1.8	3.9	———

Mixed Gamma (MGS) master solution is EZA's eight isotope mixture which is calibrated quarterly and consists of Cd-109, Co-57, Ce-139, Hg-203, Sn-113, Cs-137, Y-88, and Co-60. ***Uncertainty:** U - Relative expanded uncertainty, $k = 2$. See NIST Technical Note 1297, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results." ****Calibration Methods:** 4π LS - 4π Liquid Scintillation Counting, HPGe - High Purity Germanium Gamma-Ray Spectrometer, IC - Ionization Chamber.

(Certificate continued on reverse side)

SRS Number: 114986

Expiration Date: 31-January-2021

This source was wipe tested in its inactive areas with leak test results < 185 Bq (5 nCi) of removable activity per ISO 9978:1992.

Source Prepared by: A. Herron

A. Herron, Radiochemist

QC Approved by: _____ Date: 29 Jan 20

A. Chen, Spectroscopist

210686D01.SPC Analyzed by

****

SEEKER G A M M A A N A L Y S I S R E S U L T S PS Version 1.8.4

ALS Laboratory Group - Fort Collins
GammaScan

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Geo 13 / Solid

Sample ID: 062521-1 Geo 13 Eff Cal (1130)

Sampling Start:	07/01/2020 10:00:00	Counting Start:	06/25/2021 07:54:19
Sampling Stop:	07/01/2020 10:00:00	Decay Time.	8.61E+003 Hrs
Buildup Time.	0.00E+000 Hrs	Live Time	4500 Sec
Sample Size	5.00E+002 g	Real Time	4592 Sec
Collection Efficiency	1.0000	Spc. File	.210686D01.SPC

Detector #: 1 (Detector 1)

Energy(keV)= -2.00 + 0.501*Ch + 0.00E+00*Ch^2 + 0.00E+00*Ch^3 06/25/2021
FWHM(keV) = 0.74 + 0.020*En + 4.70E-04*En^2 + 0.00E+00*En^3 08/22/2020
Where En = Sqrt(Energy in keV)

Search Sensitivity: 1.00 | Sigma Multiplier: 2.00 | Search Start/End: 80/4000

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PEAK SEARCH RESULTS

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PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET/MDA COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)	FLAG
1	59.47	122.66	11609	310	183	6771	0.78 a	HiResid
2	87.98	179.54	57666	562	240	10647	0.93 a	
3	122.11	247.64	33418	447	212	8266	0.97 a	
4	136.54	276.43	4434	268	191	6739	1.05 a	
5	165.88	334.98	20601	363	183	6188	0.98 a	HiResid
6	255.19	513.18	741	228	182	6114	1.28 a	
7	279.33	561.35	1181	220	172	5479	1.23 a	
8	310.63	623.79	155	143	116	3063	0.79 a	
9	391.89	785.92	12836	292	151	4234	1.30 a	
10	511.35	1024.29	393	177	142	3486	1.47 a	
11	661.97	1324.82	45397	455	131	3189	1.64 a	HiResid
12	813.77	1627.70	261	234	191	4793	3.00 a	Wide Pk
13	898.48	1796.72	12630	282	140	3465	1.83 a	HiResid
14	1173.80	2346.06	46991	449	97	1667	2.20 a	HiResid
15	1333.06	2663.82	41650	424	95	1531	2.32 a	HiResid
16	1836.73	3668.80	7266	176	35	184	2.74 a	HiResid

210686D01.SPC Analyzed by

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SEEKER B A C K G R O U N D S U B T R A C T R E S U L T S Version 1.8.2

ALS Laboratory Group - Fort Collins
GammaScan

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Background File:. . . . . DET010623.BKG (062321-1 LONG BKG CAL)

Bkg.File Detector #: 1

BACKGROUND SUBTRACT RESULTS

PK#	ENERGY (keV)	OLD NET COUNTS	OLD UN-CERTAINTY	OLD CR.LEVEL	NEW NET COUNTS	NEW UN-CERTAINTY	NEW CR.LEVEL	FLAG
10	511.35	393	177	142	283	178	144	

210686D01.SPC Analyzed by

****

SEEKER C A L I B R A T I O N R E S U L T S Version 2.0.4

****

Sample ID: 062521-1 Geo 13 Eff Cal (1130)
Stds. Match Tolerance: 2.00 keV

Detector Number: 01 Calibration Date. . . 06/25/2021 07:54:19
Geometry File (D01)(Sh13).EFF ID. Geo 13 Eff Cal
Amount of Std. in Calib. Source: 500.000000 gm

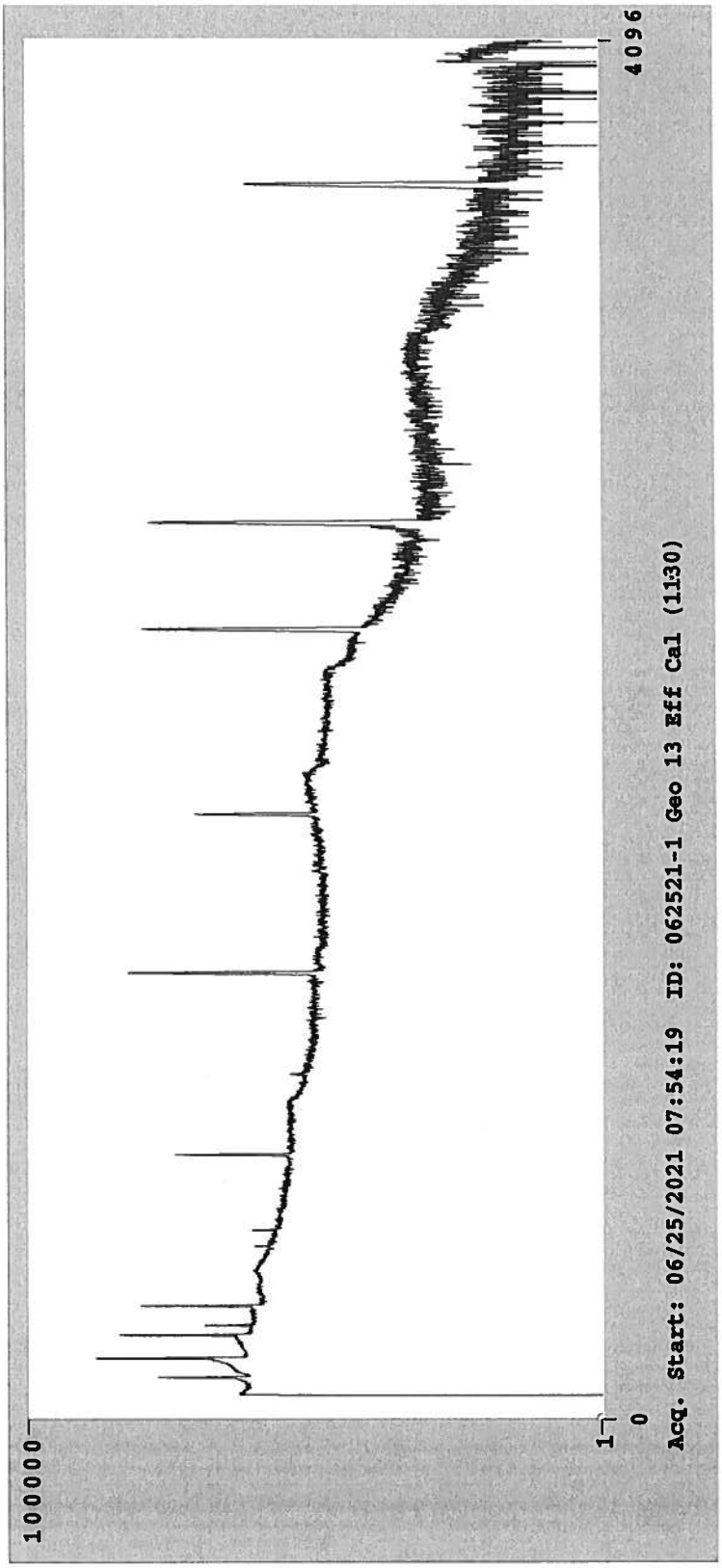
Crossover: 300.00 keV

Below Crossover Efficiency Fit:
Eff = 10 ^ [-1.10e+02 + 1.44e+02*En +-6.36e+01*En^2 + 9.33e+00*En^3]
(Where En = LOG(Energy in keV)) (Polynomial)
Above Knee Efficiency Fit:
Eff = exp ^ [5.97e-01 +-8.38e-01*En + 0.00e+00*En^2]
(Where En = Energy in keV) (Linear/Quad)

Pk. #	Energy (kev)	Measured Efficiency	% Difference	Calculated Efficiency	% Difference	Prev.Calc. Efficiency
1	59.50	1.94e-03	0.36	1.95e-03	10.05	2.16e-03
2	88.04	1.14e-02	-1.74	1.12e-02	1.36	1.14e-02
3	122.06	1.81e-02	2.68	1.86e-02	3.29	1.92e-02
4	165.85	1.94e-02	-1.57	1.91e-02	4.73	2.01e-02
5	279.00	1.79e-02	0.21	1.79e-02	-15.24	1.55e-02
6	391.68	1.20e-02	1.47	1.22e-02	-0.10	1.22e-02
7	661.64	8.00e-03	-1.84	7.86e-03	3.24	8.12e-03
8	898.02	6.02e-03	1.00	6.08e-03	4.88	6.40e-03
9	1173.21	4.97e-03	-2.14	4.86e-03	6.13	5.18e-03
10	1332.48	4.40e-03	-0.60	4.37e-03	6.67	4.68e-03
11	1836.01	3.27e-03	2.04	3.34e-03	7.89	3.63e-03

Calibration Results Saved.

OhOr 6/25/2021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Acq. Start: 06/25/2021 07:54:19 ID: 062521-1 Geo 13 Eff Cal (1130)

Gamma Efficiency Calibration - Crossover energy efficiency difference

Calibration 6/25/2021
Detector 1
Geometry 13
Crossover energy=300 keV

	EFF @ CROSSOVER	% DIFF*	MEETS ALS ACCEPTANCE CRITERIA?
LOWER EFFICIENCY CURVE	0.014917	-2.20%	OK
UPPER EFFICIENCY CURVE	0.015252	2.25%	OK

*When a single calibration curve does not meet ALS acceptance criteria, a split-fit efficiency calibration may be employed. This entails the use of two separate energy range calibrations, a low energy efficiency curve and a high energy efficiency curve. A crossover energy must be specified that marks where the software will use either the low energy efficiency curve or the high energy efficiency curve. It should be noted that if a nuclide is specified that has a gamma photon energy that is equal to **OR** within 15 keV of the crossover energy, the potential exists for the calculated efficiencies at the crossover energy to be significantly different than the true detection efficiency of the detector. At times by as much as 20%. This is an artifact of the non-equivalency of the calibration equations specified for each energy range. This may result in an effective high or low bias to the analytical results. This bias is reflected in the above calculated % difference. ALS Environmental will not accept any calibration with an effective % difference of greater than 5% without supervisory approval. Results are submitted without further qualification.

Efficiency equations

Polynomial 10^(A+B*(LOG(En))+C*(LOG(En))^2+D*(LOG(En))^3)

A	-1.104310E+02		
B	1.440889E+02		
C	-6.357339E+01	Calculated efficiency	0.014917
D	9.327247E+00		

En is energy in keV
Crossover energy 300

Linear e^(A+(B*(ln(En)))+(C*(ln(En))^2))

A	5.971200E-01		
B	-8.380697E-01		
C		Calculated efficiency	0.015252

En is energy in keV
Crossover energy 300

6/25/202

Standards File. Gsstd13.std
Assay Date 07/01/2020 10:00
ID.: Geo 13 Std#1130 500-g. mixed gamma

Pk #	Nuclide	Energy	Halflife	Br.Ratio	dps/gm
1	Am-241	59.50	4.320E+02 yrs	0.35900	7.43
2	Cd-109	88.04	4.626E+02 dys	0.03610	106.21
3	Co-57	122.06	2.718E+02 dys	0.85510	2.40
4	Ce-139	165.85	1.376E+02 dys	0.80350	3.58
5	Hg-203	279.00	4.661E+01 dys	0.77300	7.89
6	Sn-113	391.68	1.151E+02 dys	0.64900	6.35
7	Cs-137	661.64	3.007E+01 yrs	0.85120	3.03
8	Y-88	898.02	1.066E+02 dys	0.93400	10.29
9	Co-60	1173.21	5.271E+00 yrs	0.99980	4.78
10	Co-60	1332.48	5.271E+00 yrs	0.99990	4.79
11	Y-88	1836.01	1.066E+02 dys	0.99380	10.24

Eckert & Ziegler
Analytics

RSO #
1150
Rec'd
7-30-20

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

CERTIFICATE OF CALIBRATION

Standard Reference Source

SRS Number: 116626
Source Description: 500 Grams Sand in PP MRP Jar
Product Code: 8401-EG-SAN
Customer: ALS Laboratory Group
P.O. Number: FC002882, Item 1

This standard radionuclide source was prepared from an aliquot measured gravimetrically from a master radionuclide solution calibrated with a germanium gamma-ray spectrometer system. Additional radionuclides were added gravimetrically from solutions calibrated by gamma-ray spectrometry, ionization chamber, or liquid scintillation counting. Calibration and purity were checked using germanium gamma-ray spectrometry. At the time of calibration no interfering gamma-ray emitting impurities were detected. The gamma-ray emission rates for the most intense gamma-ray lines are given. Eckert & Ziegler Analytics (EZA) maintains traceability to the National Institute of Standards and Technology (NIST) through a Measurements Assurance Program as described in USNRC Regulatory Guide 4.15, Revision 2, July 2007, and compliance with ANSI N42.22-1995, "Traceability of Radioactive Sources to NIST."

Reference Date: 01-July-2020 12:00 PM EST
MGS Mixture

Isotope	Gamma-Ray Energy, keV	Half-Life, d	Activity, Bq	Flux, s^{-1}	Uncertainty u_A, %	Uncertainty u_B, %	Uncertainty U, %*	Calibration Method**
Am-241	59.5	1.580E+05	3.714E+03	1.333E+03	0.1	1.8	3.7	4π LS
Cd-109	88.0	4.614E+02	5.180E+04	1.917E+03	0.6	2.0	4.2	HPGe
Co-57	122.1	2.717E+02	1.197E+03	1.025E+03	0.4	1.7	3.5	HPGe
Ce-139	165.9	1.376E+02	1.798E+03	1.438E+03	0.4	1.8	3.7	HPGe
Hg-203	279.2	4.659E+01	3.741E+03	3.051E+03	0.3	1.7	3.5	HPGe
Sn-113	391.7	1.151E+02	3.171E+03	2.060E+03	0.4	2.0	4.1	HPGe
Cs-137	661.7	1.099E+04	1.515E+03	1.289E+03	0.7	1.9	4.1	HPGe
Y-88	898.0	1.066E+02	5.127E+03	4.804E+03	0.7	1.7	3.7	HPGe
Y-88	1836.1	———	———	5.086E+03	0.7	1.7	3.7	———
Co-60	1173.2	1.925E+03	2.396E+03	2.392E+03	0.7	1.8	3.9	HPGe
Co-60	1332.5	———	———	2.395E+03	0.7	1.8	3.9	———

Mixed Gamma (MGS) master solution is EZA's eight isotope mixture which is calibrated quarterly and consists of Cd-109, Co-57, Ce-139, Hg-203, Sn-113, Cs-137, Y-88, and Co-60. ***Uncertainty:** U - Relative expanded uncertainty, $k = 2$. See NIST Technical Note 1297, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results." ****Calibration Methods:** 4π LS - 4π Liquid Scintillation Counting, HPGe - High Purity Germanium Gamma-Ray Spectrometer, IC - Ionization Chamber.

(Certificate continued on reverse side)

SRS Number: 116626

Comments:
500.3 g of customer supplied sand.
Approximate volume: 290 mL

Expiration Date: 28-July-2021

This source was wipe tested in its inactive areas with leak test results < 185 Bq (5 nCi) of removable activity per ISO 9978:1992.

Source Prepared by: _____
M. Alfonso, Production Manager

QC Approved by: _____ Date: 23-JUL-20
J. Lamr, Spectroscopist

Geometry 13 Calibration Verification: Gamma Mixed Nuclide Source; Geometry 13

500-gram soil/solid geometry

Detector 1

VERIF. SOURCE : **1098** **REF DATE : 7/1/2018** **Count Date: 6/25/2021**

FROM CALIBRATION CERTIFICATE				FROM ANALYTICS.LIB		EXPECTED ACTIVITY						
Isotope	KeV	Half Life(y)	Gammas/Sec.	Gamma Fraction:	Mass of Standard		DPS	pCi/g	Activity	Recovery	Pass/Fail	# of Half Lives Expired
Am-241	59.5	432.0000	1336	0.3590	500 g	Am-241	3721.4	201.2	212	105%	Pass	0.01
Cd-109	88	1.2666	1936	0.0372		Cd-109	52043.0	2813.1	2850	101%	Pass	2.36
Co-57	122	0.7441	1012	0.8551		Co-57	1183.5	64.0	61.6	96%	Pass	4.01
Ce-139	166	0.3768	1420	0.8035		Ce-139	1767.3	95.5	76.9	>5 h-lives	>5 h-lives	7.92
Hg-203	279	0.1276	3082	0.7730		Hg-203	3987.1	215.5	NC	>5 h-lives	>5 h-lives	23.39
Sn-113	392	0.3151	2002	0.6490		Sn-113	3084.7	166.7	NC	>5 h-lives	>5 h-lives	9.47
Cs-137	662	30.0000	1288	0.8512		Cs-137	1513.2	81.8	83.0	101%	Pass	0.10
Y-88	898	0.2919	4745	0.9340		Y-88	5080.3	274.6	NC	>5 h-lives	>5 h-lives	10.22
Co-60	1173	5.2714	2359	0.9998		Co-60	2359.5	127.5	129	101%	Pass	0.57
Co-60	1332	5.2714	2362	0.9999		Co-60	2362.2	127.7	132	103%	Pass	0.57
Y-88	1836	0.2919	5024	0.9938		Y-88	5055.3	273.3	NC	>5 h-lives	>5 h-lives	10.22

NC = NOT CALCULATED DUE TO THE ACTIVITY BEING LESS THAN THE MDCa

6/25/2021

210687D01.SPC Analyzed by

SEEKER G A M M A A N A L Y S I S R E S U L T S PS Version 1.8.4

ALS Laboratory Group - Fort Collins
GammaScan

Geo 13 / Solid

Sample ID: 062521-1A Geo 13 Cal Ver (1098)

Sampling Start: 07/01/2018 10:00:00	Counting Start: 06/25/2021 09:35:19
Sampling Stop: 07/01/2018 10:00:00	Decay Time. . . . . 2.62E+004 Hrs
Buildup Time. . . . . 0.00E+000 Hrs	Live Time . . . . . 1800 Sec
Sample Size . . . . . 5.00E+002 g	Real Time . . . . . 1822 Sec
Collection Efficiency 1.0000	Spc. File 210687D01.SPC

Detector #: 1 (Detector 1)

Energy(keV)= -2.00 + 0.501*Ch + 0.00E+00*Ch^2 + 0.00E+00*Ch^3 06/25/2021
FWHM(keV) = 0.74 + 0.020*En + 4.70E-04*En^2 + 0.00E+00*En^3 08/22/2020
Where En = Sqrt(Energy in keV)

Search Sensitivity: 1.00 | Sigma Multiplier: 2.00 | Search Start/End: 80/4000

PEAK SEARCH RESULTS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET/MDA COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)		FLAG
1	59.53	122.78	4940	185	99	1811	0.93	a	HiResid
2	88.00	179.59	7778	213	98	1792	0.95	a	
3	122.15	247.72	2005	143	92	1566	0.98	a	
4	136.48	276.32	310	130	103	1819	1.08	a	
5	165.91	335.04	163	99	79	1257	0.81	a	
6	310.34	623.21	89	78	62	879	0.76	a	
7	349.73	701.81	50	63	51	630	0.64	a	NET< CL
8	511.17	1023.92	60	92	75	974	1.43	a	NET< CL
9	662.09	1325.06	17280	274	65	771	1.64	a	HiResid
10	1173.99	2346.44	14139	246	51	462	2.19	a	HiResid
11	1333.24	2664.18	12972	230	26	115	2.43	a	HiResid
12	1461.89	2920.87	30	17	10	23	1.52	a	

210687D01.SPC Analyzed by

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SEEKER B A C K G R O U N D S U B T R A C T R E S U L T S Vers. 2.2.1

ALS Laboratory Group - Fort Collins

GammaScan

****

Background File:. . . . . DET010623.BKG (062321-1 LONG BKG CAL)

Bkg.File Detector #: 1

==========

BACKGROUND SUBTRACT RESULTS

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PK#	ENERGY (keV)	OLD NET COUNTS	OLD UN-CERTAINTY	OLD CR.LEVEL	NEW NET COUNTS	NEW UN-CERTAINTY	NEW CR.LEVEL	FLAG
8	511.17	60	92	75	16	93	76	NET<CL
12	1461.89	30	17	10	11	17	13	NET<CL

210687D01.SPC Analyzed by

SEEKER F I N A L A C T I V I T Y R E P O R T Version 2.2.1

ALS Laboratory Group - Fort Collins
GammaScan

Geo 13 / Solid

Sample ID: 062521-1A Geo 13 Cal Ver (1098)

Sampling Start: 07/01/2018 10:00:00	Counting Start: 06/25/2021 09:35:19
Sampling Stop: 07/01/2018 10:00:00	Decay Time. . . . . 2.62e+004 Hrs
Buildup Time. . . . . 0.00e+000 Hrs	Live Time . . . . . 1800 Sec
Sample Size . . . . . 5.00e+002 g	Real Time . . . . . 1822 Sec
Collection Efficiency 1.0000	Spectrum File 210687D01.SPC
Cr. Level Confidence Interval: 95 %	Det. Limit Confidence Interval: 95 %

Detector #: 1 (Detector 1)

Efficiency File: (D01)(Sh13).EFF (Geo 13 Eff Cal)
Eff=10^[-1.10E+02 +1.44E+02*L +-6.36E+01*L^2 +9.33E+00*L^3] 06/25/2021
Eff.= EXP[5.97E-01 + -8.38E-01 * En + 0.00E+00 * En^2] Above 300.00 keV

Library File: . . . .ANALYTICAL.LIB (Analytical)

MEASURED or MDA CONCENTRATIONS

Nuclide	ENERGY (keV)	NET	Concentration (pCi/g)	MDA	Critical Level	Halflife (hrs)
Am-241	59.54		2.12E+02 +- 7.96E+00	8.63E+00	4.26E+00	3.79E+06
Cd-109	88.02		2.85E+03 +- 7.80E+01	7.30E+01	3.60E+01	1.11E+04
Co-57	122.07		6.16E+01 +- 4.40E+00	5.74E+00	2.83E+00	6.50E+03
Ce-139	165.85		7.69E+01 +- 4.69E+01	7.59E+01	3.73E+01	3.30E+03
Cs-137	661.62		8.30E+01 +- 1.32E+00	6.33E-01	3.10E-01	2.64E+05
Co-60	Average:x		1.31E+02 +- 1.62E+00	. . . .	. . . .	4.62E+04
	1173.21		1.29E+02 +- 2.25E+00	9.58E-01	4.66E-01	4.62E+04
	1332.48		1.32E+02 +- 2.34E+00	5.66E-01	2.69E-01	4.62E+04
Hg-203	279.18		MDA	3.99E+06	1.96E+06	1.12E+03
Sn-113	391.68		MDA	4.37E+02	2.15E+02	2.76E+03
Y-88	898.02		MDA	9.63E+02	4.73E+02	2.56E+03

MEASURED TOTAL: 3.41E+03 +- 1.40E+02 pCi/g

UNKNOWN,SUM or ESCAPE PEAKS

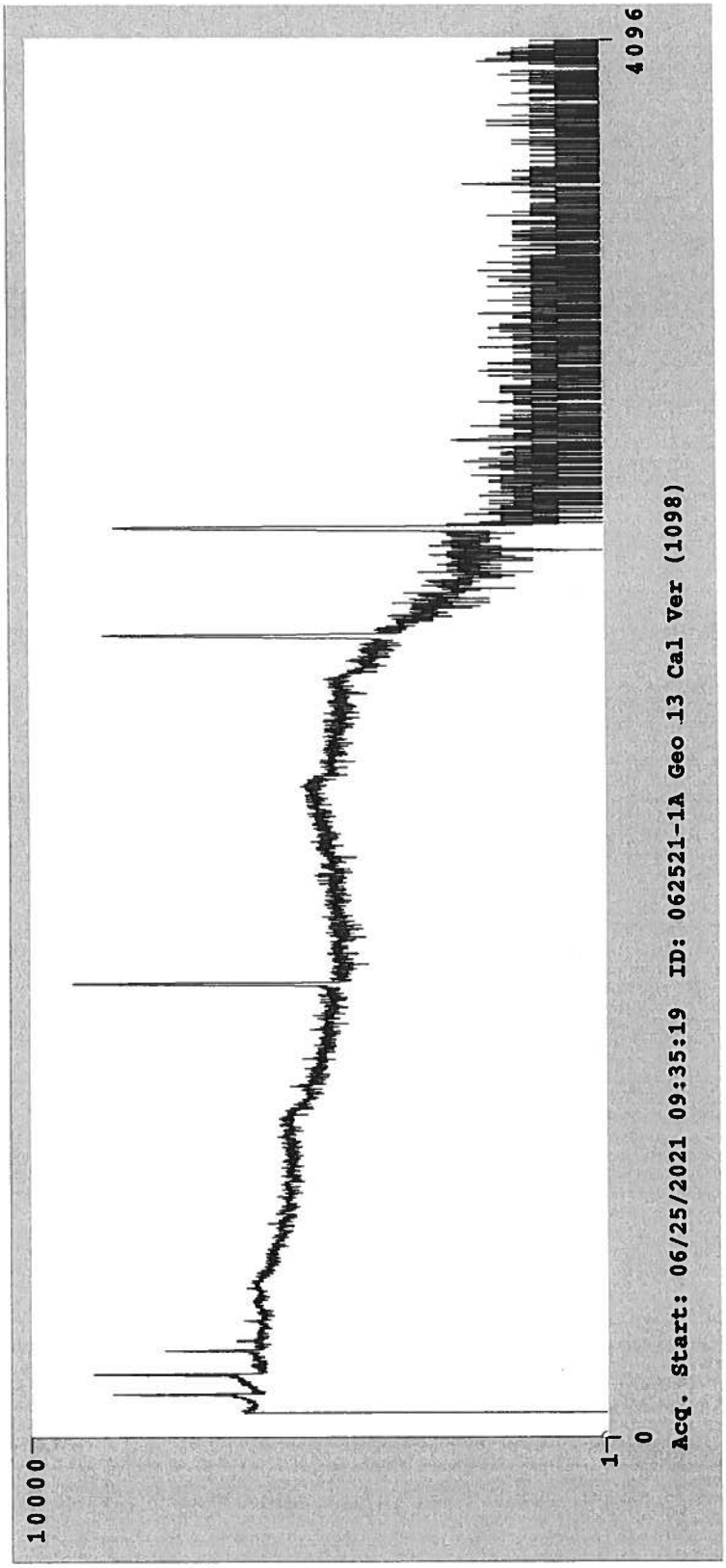
PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)	FLAG
4	136.48	276.32	310	130	103	1819	1.08	Unknown

210687D01.SPC Analyzed by

UNKNOWN,SUM or ESCAPE PEAKS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)	FLAG
6	310.34	623.21	89	78	62	879	0.76	1333DEsc
7	349.73	701.81	50	63	51	630	0.64	Deleted
8	511.17	1023.92	16	93	76	974	1.43	Deleted
12	1461.89	2920.87	11	17	13	23	1.52	Deleted

c:\SEEKER\BIN\210687d01.res Analysis Results Saved.


10000
1
0
4096
Acq. Start: 06/25/2021 09:35:19 ID: 062521-1A Geo 13 Cal Ver (1098)

RSO
$ 1098

Eckert & Ziegler
Analytics

Receival 8/20/18

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

CERTIFICATE OF CALIBRATION
Standard Reference Source

SRS Number: 110301
Source Description: 500 Grams Sand in 16 Ounce PP MRP Jar
Product Code: 8401-EG-SAN
Customer: ALS Laboratory Group
P.O. Number: FC001958, Item 1

This standard radionuclide source was prepared from an aliquot measured gravimetrically from a master radionuclide solution calibrated with a germanium gamma-ray spectrometer system. Additional radionuclides were added gravimetrically from solutions calibrated by gamma-ray spectrometry, ionization chamber, or liquid scintillation counting. Calibration and purity were checked using germanium gamma-ray spectrometry. At the time of calibration no interfering gamma-ray emitting impurities were detected. The gamma-ray emission rates for the most intense gamma-ray lines are given. Eckert & Ziegler Analytics (EZA) maintains traceability to the National Institute of Standards and Technology (NIST) through a Measurements Assurance Program as described in USNRC Regulatory Guide 4.15, Revision 2, July 2007, and compliance with ANSI N42.22-1995, "Traceability of Radioactive Sources to NIST."

Reference Date: 01-July-2018 12:00 PM EST
MGS Mixture

Isotope	Gamma-Ray Energy, keV	Half-Life, d	Activity, Bq	Flux, s^{-1}	Uncertainty u_A, %	Uncertainty u_B, %	Uncertainty U, %*	Calibration Method**
Am-241	59.5	1.580E+05	3.723E+03	1.336E+03	0.1	1.8	3.6	4π LS
Cd-109	88.0	4.614E+02	5.231E+04	1.936E+03	0.5	2.0	4.1	HPGe
Co-57	122.1	2.717E+02	1.169E+03	1.012E+03	0.4	1.7	3.4	HPGe
Ce-139	165.9	1.376E+02	1.776E+03	1.420E+03	0.4	1.7	3.6	HPGe
Hg-203	279.2	4.659E+01	3.778E+03	3.062E+03	0.3	1.7	3.5	HPGe
Sn-113	391.7	1.151E+02	3.081E+03	2.002E+03	0.4	1.9	3.9	HPGe
Cs-137	661.7	1.099E+04	1.614E+03	1.286E+03	0.7	1.9	4.1	HPGe
Y-88	898.0	1.066E+02	5.064E+03	4.745E+03	0.7	1.7	3.7	HPGe
Y-88	1836.1			5.024E+03	0.7	1.7	3.7	
Co-60	1173.2	1.926E+03	2.362E+03	2.359E+03	0.7	1.8	3.9	HPGe
Co-60	1332.5			2.362E+03	0.7	1.8	3.9	

Mixed Gamma (MGS) master solution is EZA's eight isotope mixture which is calibrated quarterly and consists of Cd-109, Co-57, Ce-139, Hg-203, Sn-113, Cs-137, Y-88, and Co-60. *Uncertainty: U - Relative expanded uncertainty, k = 2. See NIST Technical Note 1297, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results." **Calibration Methods: 4π LS - 4π Liquid Scintillation Counting, HPGe - High Purity Germanium Gamma-Ray Spectrometer, IC - Ionization Chamber.

Standard Re-Verified
09/01/2020.
New Exp. Date
=> 09/01/2021
QM 10/4/2023

(Certificate continued on reverse side)

Corporate Office
24937 Avenue Tibbitts Valencia, California 91355
Laboratory
1380 Seaboard Industrial Blvd. Atlanta, Georgia, 30318

SRS Number: 110301

Comments:
500.00 grams of customer supplied sand. Approximate volume: 290 mL

Expiration Date: 17-August-2019

This source was wipe tested in its inactive areas with leak test results < 185 Bq (5 nCi) of removable activity per ISO 9978:1992.

Source Prepared by: _____
A. Chirillo, Radiochemist

QC Approved by: _____ **Date:** 16-AUG-18
J. Lahr, Spectroscopist

200484D02.SPC Analyzed by

****

SEEKER G A M M A A N A L Y S I S R E S U L T S PS Version 1.8.4

ALS Laboratory Group - Fort Collins
GammaScan

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Geo 13 / Solid

Sample ID: 101020-2 Geo 13 Eff Cal (1130)

Sampling Start:	07/01/2020 10:00:00	Counting Start:	10/10/2020 09:38:46
Sampling Stop:	07/01/2020 10:00:00	Decay Time.	2.42E+003 Hrs
Buildup Time.	0.00E+000 Hrs	Live Time	1800 Sec
Sample Size	5.00E+002 g	Real Time	1887 Sec
Collection Efficiency	1.0000	Spc. File	.200484D02.SPC

Detector #: 2 (Detector 2)

Energy(keV)= -1.28 + 0.501*Ch + 0.00E+00*Ch^2 + 0.00E+00*Ch^3 10/10/2020
FWHM(keV) = 0.59 + 0.019*En + 4.08E-04*En^2 + 0.00E+00*En^3 07/29/2020
Where En = Sqrt(Energy in keV)

Search Sensitivity: 1.00 | Sigma Multiplier: 2.00 | Search Start/End: 80/4000

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PEAK SEARCH RESULTS

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PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET/MDA COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)		FLAG
1	59.51	121.32	13278	337	202	8250	0.78	a	HiResid
2	70.78	143.83	586	304	247	11241	0.91	a	
3	72.82	147.90	1232	271	216	9368	0.75	b	
4	82.46	167.13	1880	410	329	16041	1.53	a	HiResid Wide Pk
5	84.86	171.92	5380	629	503	26735	2.41	b	HiResid
6	87.97	178.13	58943	567	241	10694	0.91	c	HiResid
7	109.25	220.59	156	175	142	4972	0.42	a	
8	120.74	243.53	1577	445	360	16887	1.72	a	Wide Pk
9	122.09	246.22	36643	450	195	7676	0.84	b	
10	136.51	275.00	4808	263	183	6785	0.89	a	
11	165.84	333.54	40939	471	199	7314	0.90	a	HiResid
12	255.12	511.73	1184	183	140	3937	0.84	a	
13	279.17	559.73	25610	367	147	4017	1.02	a	HiResid
14	391.72	784.34	32928	400	139	3303	1.14	a	HiResid
15	509.98	1020.36	230	120	96	1934	0.98	a	Wide Pk
16	511.50	1023.39	759	217	173	4191	2.16	b	
17	540.32	1080.92	81	115	93	1829	0.93	a	NET< CL
18	661.69	1323.14	26326	356	121	2721	1.37	a	HiResid
19	814.00	1627.11	527	135	104	1887	1.55	a	
20	898.07	1794.90	39813	424	119	2595	1.57	a	HiResid

200484D02.SPC Analyzed by

PEAK SEARCH RESULTS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET/MDA COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)		FLAG
21	1173.23	2344.06	30450	366	92	1474	1.76	a	HiResid
22	1325.30	2647.56	1097	174	132	1786	4.19	a	HiResid Wide Pk
23	1332.42	2661.76	28087	346	70	824	1.89	b	HiResid
24	1658.26	3312.07	62	74	60	656	2.00	a	
25	1835.82	3666.44	25194	322	46	377	2.18	a	HiResid

200484D02.SPC Analyzed by

****

SEEKER C A L I B R A T I O N R E S U L T S Version 2.0.4

****

Sample ID: 101020-2 Geo 13 Eff Cal (1130)
Stds. Match Tolerance: 2.00 keV

Detector Number: 02 Calibration Date. . . 10/10/2020 09:38:46
Geometry File (D02)(Sh13).EFF ID. Geo 13 Eff Cal
Amount of Std. in Calib. Source: 500.000000 gm

Crossover: 300.00 keV

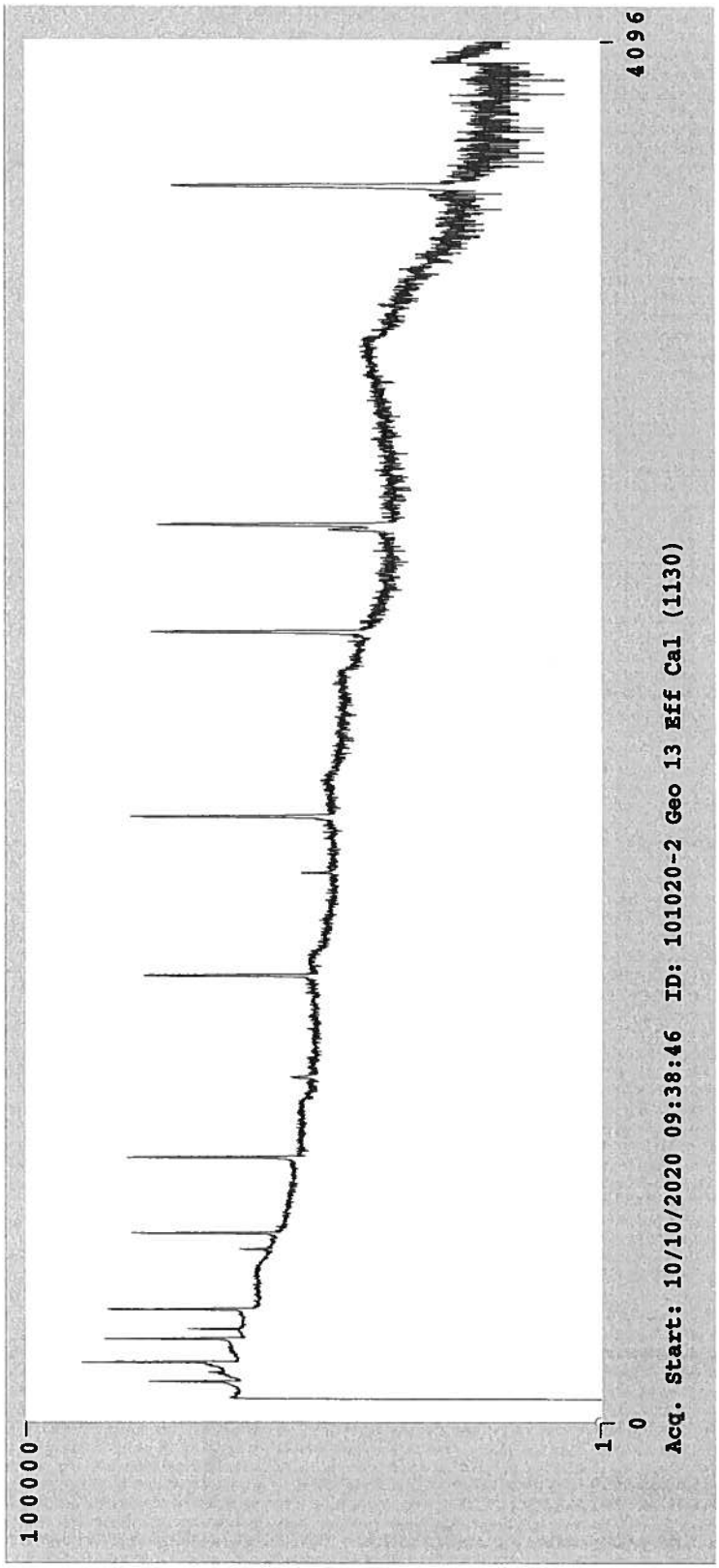
Below Crossover Efficiency Fit:
Eff = 10 ^ [-8.02e+01 + 1.04e+02*En +-4.58e+01*En^2 + 6.67e+00*En^3]
(Where En = LOG(Energy in keV)) (Polynomial)
Above Knee Efficiency Fit:
Eff = exp ^ [-2.35e-01 +-5.84e-01*En +-1.09e-02*En^2]
(Where En = Energy in keV) (Linear/Quad)

Pk. #	Energy (kev)	Measured Efficiency	% Difference	Calculated Efficiency	% Difference	Prev.Calc. Efficiency
1	59.50	5.54e-03	0.53	5.57e-03	-228.36	1.70e-03
2	88.04	1.99e-02	-2.59	1.94e-02	-60.02	1.21e-02
3	122.06	2.57e-02	3.93	2.67e-02	-20.35	2.22e-02
4	165.85	2.63e-02	-2.33	2.57e-02	-9.34	2.35e-02
5	279.00	2.09e-02	0.31	2.10e-02	-8.89	1.93e-02
6	391.68	1.63e-02	0.41	1.64e-02	-7.36	1.53e-02
7	661.64	1.14e-02	-1.66	1.12e-02	-6.72	1.05e-02
8	898.02	8.88e-03	1.25	8.99e-03	-8.01	8.32e-03
9	1173.21	7.33e-03	0.70	7.39e-03	-9.01	6.77e-03
10	1332.48	6.76e-03	-0.52	6.72e-03	-9.21	6.15e-03
11	1836.01	5.31e-03	-0.20	5.30e-03	-8.21	4.89e-03

Calibration Results Saved.

Δ OK-1 New Detector

OK gr 10/12/202


100000
1
0
4096
Acq. Start: 10/10/2020 09:38:46 ID: 101020-2 Geo 13 Eff Cal (1130)

Gamma Efficiency Calibration - Crossover energy efficiency difference

Calibration 10/10/2020
Detector 2
Geometry 13
Crossover energy=300 keV

	EFF @ CROSSOVER	% DIFF*	MEETS ALS ACCEPTANCE CRITERIA?
LOWER EFFICIENCY CURVE	0.019964	0.83%	OK
UPPER EFFICIENCY CURVE	0.019800	-0.82%	OK

*When a single calibration curve does not meet ALS acceptance criteria, a split-fit efficiency calibration may be employed. This entails the use of two separate energy range calibrations, a low energy efficiency curve and a high energy efficiency curve. A crossover energy must be specified that marks where the software will use either the low energy efficiency curve or the high energy efficiency curve. It should be noted that if a nuclide is specified that has a gamma photon energy that is equal to **OR** within 15 keV of the crossover energy, the potential exists for the calculated efficiencies at the crossover energy to be significantly different than the true detection efficiency of the detector. At times by as much as 20%. This is an artifact of the non-equivalency of the calibration equations specified for each energy range. This may result in an effective high or low bias to the analytical results. This bias is reflected in the above calculated % difference. ALS Environmental will not accept any calibration with an effective % difference of greater than 5% without supervisory approval. Results are submitted without further qualification.

Efficiency equations

Polynomial 10^(A+B*(LOG(En))+C*(LOG(En))^2+D*(LOG(En))^3)

A	-8.021020E+01		
B	1.041242E+02		
C	-4.576472E+01	Calculated efficiency	0.019964
D	6.671109E+00		

En is energy in keV
Crossover energy 300

Linear e^(A+(B*(ln(En)))+(C*(ln(En))^2))

A	-2.352143E-01		
B	-5.844166E-01		
C	-1.086439E-02	Calculated efficiency	0.019800

En is energy in keV
Crossover energy 300

On 10/12/2020

Standards File. Gsstd13.std
Assay Date 07/01/2020 10:00
ID.: Geo 13 Std#1130 500-g. mixed gamma

Pk #	Nuclide	Energy	Halflife	Br.Ratio	dps/gm
1	Am-241	59.50	4.320E+02 yrs	0.35900	7.43
2	Cd-109	88.04	4.626E+02 dys	0.03610	106.21
3	Co-57	122.06	2.718E+02 dys	0.85510	2.40
4	Ce-139	165.85	1.376E+02 dys	0.80350	3.58
5	Hg-203	279.00	4.661E+01 dys	0.77300	7.89
6	Sn-113	391.68	1.151E+02 dys	0.64900	6.35
7	Cs-137	661.64	3.007E+01 yrs	0.85120	3.03
8	Y-88	898.02	1.066E+02 dys	0.93400	10.29
9	Co-60	1173.21	5.271E+00 yrs	0.99980	4.78
10	Co-60	1332.48	5.271E+00 yrs	0.99990	4.79
11	Y-88	1836.01	1.066E+02 dys	0.99380	10.24

Also #
1130
Rec'd
7-30-20

Eckert & Ziegler
Analytics

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

CERTIFICATE OF CALIBRATION

Standard Reference Source

SRS Number: 116626
Source Description: 500 Grams Sand in PP MRP Jar
Product Code: 8401-EG-SAN
Customer: ALS Laboratory Group
P.O. Number: FC002882, Item 1

This standard radionuclide source was prepared from an aliquot measured gravimetrically from a master radionuclide solution calibrated with a germanium gamma-ray spectrometer system. Additional radionuclides were added gravimetrically from solutions calibrated by gamma-ray spectrometry, ionization chamber, or liquid scintillation counting. Calibration and purity were checked using germanium gamma-ray spectrometry. At the time of calibration no interfering gamma-ray emitting impurities were detected. The gamma-ray emission rates for the most intense gamma-ray lines are given. Eckert & Ziegler Analytics (EZA) maintains traceability to the National Institute of Standards and Technology (NIST) through a Measurements Assurance Program as described in USNRC Regulatory Guide 4.15, Revision 2, July 2007, and compliance with ANSI N42.22-1995, "Traceability of Radioactive Sources to NIST."

Reference Date: 01-July-2020 12:00 PM EST

MGS Mixture

Isotope	Gamma-Ray Energy, keV	Half-Life, d	Activity, Bq	Flux, s^{-1}	Uncertainty u_A, %	Uncertainty u_B, %	Uncertainty U, %*	Calibration Method**
Am-241	59.5	1.580E+05	3.714E+03	1.333E+03	0.1	1.8	3.7	4π LS
Cd-109	88.0	4.614E+02	5.180E+04	1.917E+03	0.5	2.0	4.2	HPGe
Co-57	122.1	2.717E+02	1.197E+03	1.025E+03	0.4	1.7	3.5	HPGe
Ce-139	165.9	1.376E+02	1.798E+03	1.438E+03	0.4	1.8	3.7	HPGe
Hg-203	279.2	4.659E+01	3.741E+03	3.051E+03	0.3	1.7	3.5	HPGe
Sn-113	391.7	1.151E+02	3.171E+03	2.060E+03	0.4	2.0	4.1	HPGe
Cs-137	661.7	1.099E+04	1.515E+03	1.289E+03	0.7	1.9	4.1	HPGe
Y-88	898.0	1.066E+02	5.127E+03	4.804E+03	0.7	1.7	3.7	HPGe
Y-88	1836.1	———	———	5.086E+03	0.7	1.7	3.7	———
Co-60	1173.2	1.925E+03	2.396E+03	2.392E+03	0.7	1.8	3.9	HPGe
Co-60	1332.5	———	———	2.395E+03	0.7	1.8	3.9	———

Mixed Gamma (MGS) master solution is EZA's eight isotope mixture which is calibrated quarterly and consists of Cd-109, Co-57, Ce-139, Hg-203, Sn-113, Cs-137, Y-88, and Co-60. ***Uncertainty:** U - Relative expanded uncertainty, $k = 2$. See NIST Technical Note 1297, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results." ****Calibration Methods:** 4π LS - 4π Liquid Scintillation Counting, HPGe - High Purity Germanium Gamma-Ray Spectrometer, IC - Ionization Chamber.

(Certificate continued on reverse side)

Corporate Office
24937 Avenue Tibbitts Valencia, California 91355

Laboratory
1380 Seaboard Industrial Blvd. Atlanta, Georgia 30318

SRS Number: 116626

Comments:
500.3 g of customer supplied sand.
Approximate volume: 290 mL

Expiration Date: 28-July-2021

This source was wipe tested in its inactive areas with leak test results < 185 Bq (5 nCi) of removable activity per ISO 9978:1992.

Source Prepared by: _____
M. Alfonso, Production Manager

QC Approved by: _____ Date: 23-JUL-20
J. Lahr, Spectroscopist

Geometry 13 Calibration Verification: Gamma Mixed Nuclide Source; Geometry 13

500-gram soil/solid geometry

Detector 2

VERIF. SOURCE : 1098 **REF DATE : 7/1/2018** **Count Date: 10/10/2020**

FROM CALIBRATION CERTIFICATE				FROM ANALYTICS.LIB		EXPECTED ACTIVITY						
Isotope	KeV	Half Life(y)	Gammas/Sec.	Gamma Fraction:	Mass of Standard		DPS	pCi/g	Activity	Recovery	Pass/Fail	# of Half Lives Expired
Am-241	59.5	432.0000	1336	0.3590	500 g	Am-241	3721.4	201.2	205	102%	Pass	0.01
Cd-109	88	1.2666	1936	0.0372		Cd-109	52043.0	2813.1	2740	97%	Pass	1.80
Co-57	122	0.7441	1012	0.8551		Co-57	1183.5	64.0	61.9	97%	Pass	3.06
Ce-139	166	0.3768	1420	0.8035		Ce-139	1767.3	95.5	101.0	106%	Pass	6.05
Hg-203	279	0.1276	3082	0.7730		Hg-203	3987.1	215.5	NC	>5 h-lives	>5 h-lives	17.85
Sn-113	392	0.3151	2002	0.6490		Sn-113	3084.7	166.7	151	91%	Pass	7.23
Cs-137	662	30.0000	1288	0.8512		Cs-137	1513.2	81.8	83.9	103%	Pass	0.08
Y-88	898	0.2919	4745	0.9340		Y-88	5080.3	274.6	NC	>5 h-lives	>5 h-lives	7.80
Co-60	1173	5.2714	2359	0.9998		Co-60	2359.5	127.5	128	100%	Pass	0.43
Co-60	1332	5.2714	2362	0.9999		Co-60	2362.2	127.7	130	102%	Pass	0.43
Y-88	1836	0.2919	5024	0.9938		Y-88	5055.3	273.3	NC	>5 h-lives	>5 h-lives	7.80

NC = NOT CALCULATED DUE TO THE ACTIVITY BEING LESS THAN THE MDCa

Oh 10/12/2020

200485D02.SPC Analyzed by

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SEEKER G A M M A A N A L Y S I S R E S U L T S PS Version 1.8.4

ALS Laboratory Group - Fort Collins
GammaScan

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Geo 13 / Solid

Sample ID: 101020-2A Geo 13 Cal Ver (1098)

Sampling Start:	07/01/2018 10:00:00	Counting Start:	10/10/2020 10:16:28
Sampling Stop:	07/01/2018 10:00:00	Decay Time.	2.00E+004 Hrs
Buildup Time.	0.00E+000 Hrs	Live Time	1800 Sec
Sample Size	5.00E+002 g	Real Time	1839 Sec
Collection Efficiency	1.0000	Spc. File	.200485D02.SPC

Detector #: 2 (Detector 2)

Energy(keV)= -1.28 + 0.501*Ch + 0.00E+00*Ch^2 + 0.00E+00*Ch^3 10/10/2020
FWHM(keV) = 0.59 + 0.019*En + 4.08E-04*En^2 + 0.00E+00*En^3 07/29/2020
Where En = Sqrt(Energy in keV)

Search Sensitivity: 1.00 | Sigma Multiplier: 2.00 | Search Start/End: 80/4000

PEAK SEARCH RESULTS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET/MDA COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)		FLAG
1	59.51	121.33	13639	281	128	3306	0.77	a	
2	87.96	178.11	18972	307	112	2535	0.82	a	
3	122.07	246.18	5614	190	96	1865	0.85	a	
4	136.50	274.99	725	123	91	1669	0.79	a	
5	165.80	333.46	1056	125	88	1569	0.89	a	
6	271.39	544.20	72	85	68	1031	0.65	a	
7	391.67	784.24	356	106	81	1222	0.96	a	
8	471.54	943.65	63	103	84	1389	1.20	a	NET< CL
9	507.53	1015.47	44	61	49	599	0.62	a	NET< CL
10	534.10	1068.50	56	84	68	907	1.15	a	NET< CL
11	661.59	1322.94	25369	330	71	940	1.32	a	HiResid
12	774.27	1547.83	58	71	57	649	1.09	a	
13	897.94	1794.65	375	120	93	1460	1.93	a	
14	1173.09	2343.78	23326	313	57	569	1.75	a	
15	1332.26	2661.45	21500	296	34	202	1.85	a	HiResid
16	1835.74	3666.28	197	34	15	40	2.25	a	

200485D02.SPC Analyzed by

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SEEKER B A C K G R O U N D S U B T R A C T R E S U L T S Vers. 2.2.1

ALS Laboratory Group - Fort Collins

GammaScan

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Background File:. . . . . DET020930.BKG (093020-2 LONG BKG CAL)

Bkg.File Detector #: 2

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BACKGROUND SUBTRACT RESULTS

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PK#	ENERGY (keV)	OLD NET COUNTS	OLD UN-CERTAINTY	OLD CR.LEVEL	NEW NET COUNTS	NEW UN-CERTAINTY	NEW CR.LEVEL	FLAG
2	87.96	18972	307	112	18968	307	112	

200485D02.SPC Analyzed by

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SEEKER F I N A L A C T I V I T Y R E P O R T Version 2.2.1

ALS Laboratory Group - Fort Collins

GammaScan

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Geo 13 / Solid

Sample ID: 101020-2A Geo 13 Cal Ver (1098)

Sampling Start: 07/01/2018 10:00:00	Counting Start: 10/10/2020 10:16:28
Sampling Stop: 07/01/2018 10:00:00	Decay Time. . . . . 2.00e+004 Hrs
Buildup Time. . . . . 0.00e+000 Hrs	Live Time . . . . . 1800 Sec
Sample Size . . . . . 5.00e+002 g	Real Time . . . . . 1839 Sec
Collection Efficiency 1.0000	Spectrum File 200485D02.SPC
Cr. Level Confidence Interval: 95 %	Det. Limit Confidence Interval: 95 %

Detector #: 2 (Detector 2)

Efficiency File: (D02)(Sh13).EFF (Geo 13 Eff Cal)

Eff=10^[-8.02E+01 +1.04E+02*L +-4.58E+01*L^2 +6.67E+00*L^3] 10/10/2020

Eff.= EXP[-2.35E-01 + -5.84E-01 * En + -1.09E-02 * En^2] Above 300.00 keV

Library File: . . . .ANALYTICAL.LIB (Analytical)

MEASURED or MDA CONCENTRATIONS

Nuclide	ENERGY (keV)	NET	Concentration (pCi/g)	MDA	Critical Level	Halflife (hrs)
Am-241	59.54		2.05E+02 +- 4.22E+00	3.89E+00	1.93E+00	3.79E+06
Cd-109	88.02		2.74E+03 +- 4.44E+01	3.28E+01	1.62E+01	1.11E+04
Co-57	122.07		6.19E+01 +- 2.10E+00	2.15E+00	1.06E+00	6.50E+03
Ce-139	165.85		1.01E+02 +- 1.20E+01	1.72E+01	8.46E+00	3.30E+03
Sn-113	391.68		1.51E+02 +- 4.48E+01	7.00E+01	3.44E+01	2.76E+03
Cs-137	661.62		8.39E+01 +- 1.09E+00	4.81E-01	2.36E-01	2.64E+05
Y-88	Average:x		2.60E+02 +- 3.91E+01	. . . .	. . . .	2.56E+03
	898.02		3.00E+02 +- 9.57E+01	1.51E+02	7.45E+01	2.56E+03
	1836.01		2.52E+02 +- 4.28E+01	4.23E+01	1.94E+01	2.56E+03
Co-60	Average:x		1.29E+02 +- 1.24E+00	. . . .	. . . .	4.62E+04
	1173.21		1.28E+02 +- 1.72E+00	6.39E-01	3.12E-01	4.62E+04
	1332.48		1.30E+02 +- 1.79E+00	4.25E-01	2.04E-01	4.62E+04
Hg-203	279.18		MDA	7.99E+04	3.93E+04	1.12E+03

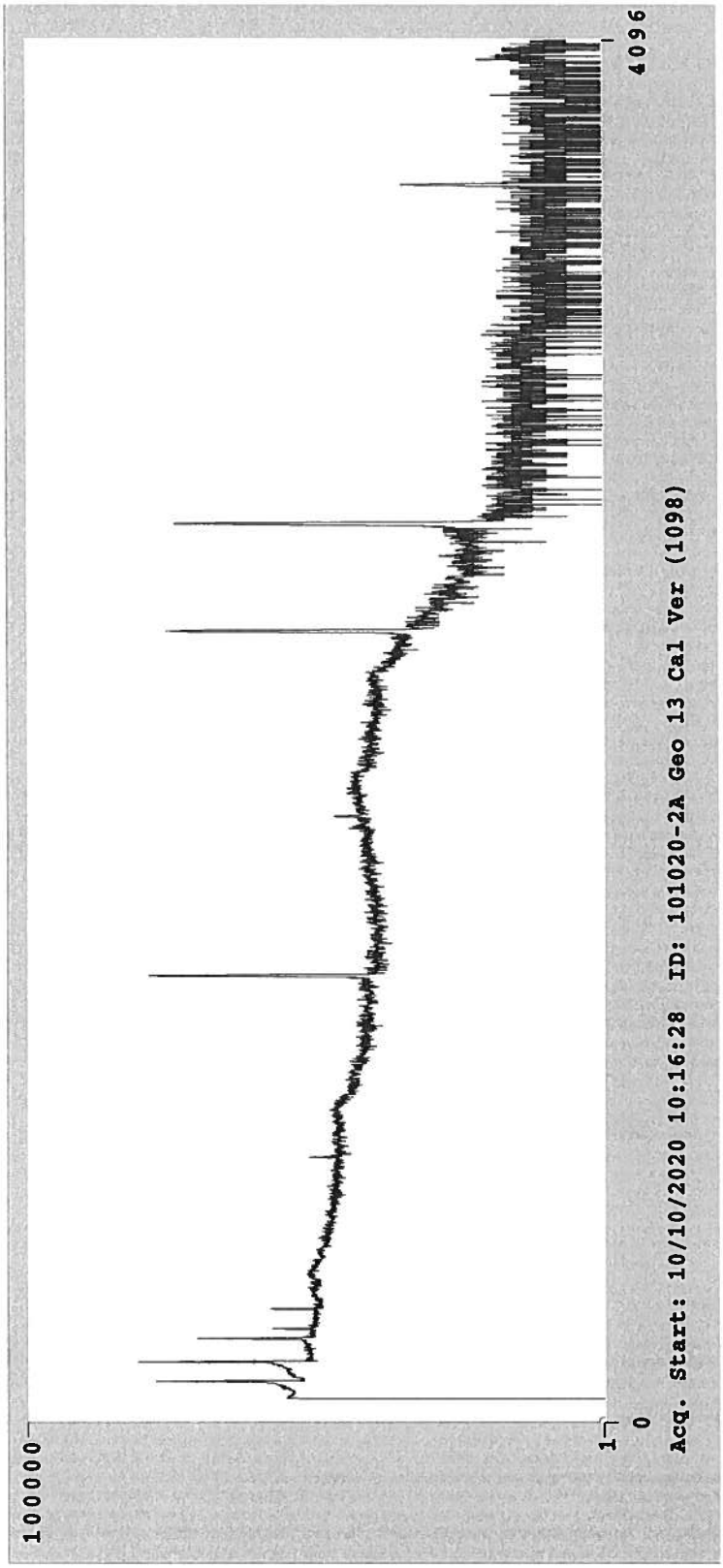
MEASURED TOTAL: 3.73E+03 +- 1.49E+02 pCi/g

200485D02.SPC Analyzed by

UNKNOWN,SUM or ESCAPE PEAKS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)	FLAG
4	136.50	274.99	725	123	91	1669	0.79	Unknown
6	271.39	544.20	72	85	68	1031	0.65	Unknown
8	471.54	943.65	63	103	84	1389	1.20	Deleted
9	507.53	1015.47	44	61	49	599	0.62	Deleted
10	534.10	1068.50	56	84	68	907	1.15	Deleted
12	774.27	1547.83	58	71	57	649	1.09	Unknown

c:\SEEKER\BIN\200485d02.res Analysis Results Saved.


100000
1
0
4096
Acq. Start: 10/10/2020 10:16:28 ID: 101020-2A Geo 13 Cal Ver (1098)

Eckert & Ziegler
Analytics

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

RSD # 1098

Received 8/20/18

CERTIFICATE OF CALIBRATION
Standard Reference Source

SRS Number: 110301
Source Description: 500 Grams Sand in 16 Ounce PP MRP Jar
Product Code: 8401-EG-SAN
Customer: ALS Laboratory Group
P.O. Number: FC001958, Item 1

This standard radionuclide source was prepared from an aliquot measured gravimetrically from a master radionuclide solution calibrated with a germanium gamma-ray spectrometer system. Additional radionuclides were added gravimetrically from solutions calibrated by gamma-ray spectrometry, ionization chamber, or liquid scintillation counting. Calibration and purity were checked using germanium gamma-ray spectrometry. At the time of calibration no interfering gamma-ray emitting impurities were detected. The gamma-ray emission rates for the most intense gamma-ray lines are given. Eckert & Ziegler Analytics (EZA) maintains traceability to the National Institute of Standards and Technology (NIST) through a Measurements Assurance Program as described in USNRC Regulatory Guide 4.15, Revision 2, July 2007, and compliance with ANSI N42.22-1995, "Traceability of Radioactive Sources to NIST."

Reference Date: 01-July-2018 12:00 PM EST
MGS Mixture

Isotope	Gamma-Ray Energy, keV	Half-Life, d	Activity, Bq	Flux, s^{-1}	Uncertainty u_A, %	Uncertainty u_B, %	Uncertainty U, %*	Calibration Method**
Am-241	59.5	1.580E+05	3.723E+03	1.336E+03	0.1	1.8	3.6	4π LS
Cd-109	88.0	4.614E+02	5.231E+04	1.936E+03	0.5	2.0	4.1	HPGe
Co-57	122.1	2.717E+02	1.183E+03	1.012E+03	0.4	1.7	3.4	HPGe
Ce-139	165.9	1.376E+02	1.775E+03	1.420E+03	0.4	1.7	3.6	HPGe
Hg-203	279.2	4.659E+01	3.778E+03	3.082E+03	0.3	1.7	3.5	HPGe
Sn-113	391.7	1.151E+02	3.081E+03	2.002E+03	0.4	1.9	3.9	HPGe
Cs-137	661.7	1.099E+04	1.514E+03	1.288E+03	0.7	1.9	4.1	HPGe
Y-88	898.0	1.066E+02	5.064E+03	4.745E+03	0.7	1.7	3.7	HPGe
Y-88	1836.1	———	———	5.024E+03	0.7	1.7	3.7	———
Co-60	1173.2	1.925E+03	2.362E+03	2.359E+03	0.7	1.8	3.9	HPGe
Co-60	1332.5	———	———	2.362E+03	0.7	1.8	3.9	———

Mixed Gamma (MGS) master solution is EZA's eight isotope mixture which is calibrated quarterly and consists of Cd-109, Co-57, Ce-139, Hg-203, Sn-113, Cs-137, Y-88, and Co-60. ***Uncertainty:** U - Relative expanded uncertainty, k = 2. See NIST Technical Note 1297, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results." ****Calibration Methods:** 4π LS - 4π Liquid Scintillation Counting, HPGe - High Purity Germanium Gamma-Ray Spectrometer, IC - Ionization Chamber.

(Certificate continued on reverse side)

Standard Re-Verified
09/01/2020.
New Exp. Date
=> 09/01/2021
@ 10/4/2023

Corporate Office
24937 Avenue Tibbitts Valencia, California 91355

Laboratory
1380 Seaboard Industrial Blvd. Atlanta, Georgia 30318

SRS Number: 110301

Comments:
500.00 grams of customer supplied sand. Approximate volume: 290 mL

Expiration Date: 17-August-2019

This source was wipe tested in its inactive areas with leak test results < 185 Bq (5 nCi) of removable activity per ISO 9978:1992.

Source Prepared by: _____
A. Chirillo, Radiochemist

QC Approved by: _____ Date: 16-AUG-18
J. Lahr, Spectroscopist

Gamma Spectroscopy

Quality Control Data

Weekly Background Calibrations

ALS

Gamma Spectrometer Calibration Log

Date: 7/7/21 Reviewed By/Date: TS 7/7/21

Det. No.	Out Of Service	Background		Source Check			Repeat Source Check			
		Started	OK	Started	OK	Failed Parameter(s)	OK	Failed Parameter(s)	Corrective Action Taken **	Removed from Service
1.		TS	TS	TS	TS					
2.		TS	TS	TS	TS					
3.		TS	TS	TS	TS					
4.		TS	TSΔ	TS	TS					
5.		TS	TS	TS	TS					
6.	TS	/	/	/	/					
7.		TS	TS	TS	TS					
8.	TS	/	/	/	/					
9.	TS	/	/	/	/					
10.		TS	TS	TS	TS					

.** **Corrective Action:**

Δ Re-run BKG

*** Due to detector____ failing two different QC parameters on the first and second daily check, a third daily check was performed. All QC parameters passed for the third daily check. Detector ____ is online for the date of _____

210770D01.SPC Analyzed by

SEEKER G A M M A A N A L Y S I S R E S U L T S PS Version 1.8.4

ALS Laboratory Group - Fort Collins
GammaScan

Long Background Calibration

Sample ID: 210707-1 LONGBKGCAL

Sampling Start: 07/07/2021 13:00:00	Counting Start: 07/07/2021 13:53:06
Sampling Stop: 07/07/2021 13:00:00	Decay Time. . . . . 8.85E-001 Hrs
Buildup Time. . . . . 0.00E+000 Hrs	Live Time . . . . . 60000 Sec
Sample Size . . . . . 1.00E+000 L	Real Time . . . . . 60107 Sec
Collection Efficiency 1.0000	Spc. File 210770D01.SPC

Detector #: 1 (Detector 1)

Energy(keV)= -1.99 + 0.501*Ch + 0.00E+00*Ch^2 + 0.00E+00*Ch^3 07/07/2021
FWHM(keV) = 0.74 + 0.020*En + 4.70E-04*En^2 + 0.00E+00*En^3 08/22/2020
Where En = Sqrt(Energy in keV)

Search Sensitivity: 1.00 | Sigma Multiplier: 2.00 | Search Start/End: 80/4000

PEAK SEARCH RESULTS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET/MDA COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)		FLAG
1	66.40	136.54	135	60	45	504	0.53	a	
2	74.97	153.64	123	70	54	657	0.66	a	
3	77.25	158.19	45	90	73	986	0.97	b	NET< CL
4	92.59	188.82	147	75	58	679	0.76	a	
5	122.29	248.11	22	50	40	403	0.51	a	NET< CL
6	139.96	283.39	80	53	41	424	0.56	a	
7	154.62	312.65	42	51	40	400	0.53	a	
8	185.70	374.70	98	83	66	806	0.99	a	
9	198.51	400.26	173	82	64	747	1.03	a	
10	222.40	447.96	58	66	53	559	0.76	a	
11	238.81	480.71	93	68	54	583	0.88	a	
12	295.21	593.31	44	74	60	710	1.15	a	NET< CL
13	352.02	706.72	102	48	36	319	0.74	a	
14	391.62	785.77	34	59	48	452	1.18	a	NET< CL
15	510.46	1023.01	407	88	64	609	1.98	a	Wide Pk
16	511.62	1025.32	992	113	77	761	2.52	b	
17	558.53	1118.98	183	59	43	340	1.38	a	
18	583.09	1168.00	81	55	43	345	1.37	a	
19	609.70	1221.11	125	69	54	538	1.61	a	
20	693.46	1388.33	70	74	59	559	2.12	a	
21	803.34	1607.69	118	41	29	180	1.22	a	

210770D01.SPC Analyzed by

PEAK SEARCH RESULTS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET/MDA COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)	FLAG
22	898.82	1798.29	51	51	41	276	1.96	a
23	911.78	1824.16	69	39	29	176	1.26	a
24	969.96	1940.31	41	47	38	236	1.89	a
25	1120.69	2241.21	27	27	21	108	0.97	a
26	1238.59	2476.57	38	40	31	171	2.12	a
27	1461.29	2921.14	646	60	26	114	2.30	a
28	1764.53	3526.49	65	38	28	114	3.07	a

210770D01.SPC Analyzed by

****

SEEKER B A C K G R O U N D Q. C. A N A L Y S I S Version 2.2.2

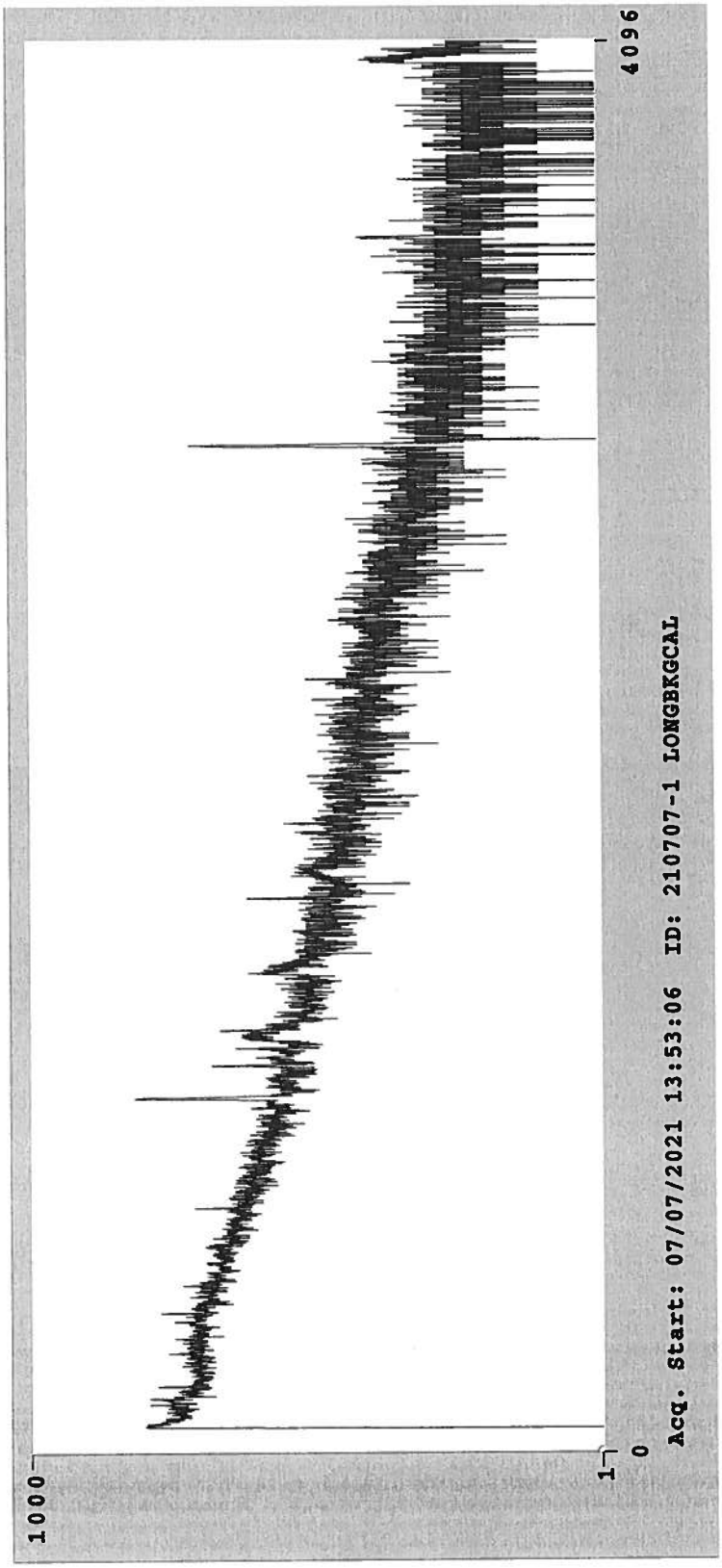
****

ID: 210707-1 LONGBKGCAL

Detector # 1 Background Q.C. Analysis for 07/07/2021 13:53:06

#	Parameter	Value	n Sigma Test	Bounds Test	T-Test
10	40-> 50 keV Bkg	3.810	N.A.	Pass	N.A.
11	50-> 150 keV Bkg	29.460	N.A.	Pass	N.A.
12	250-> 500 keV Bkg	36.901	N.A.	Pass	N.A.
13	500->1000 keV Bkg	34.652	N.A.	Pass	N.A.
14	1000->2000 keV Bkg	19.162	N.A.	Pass	N.A.
15	150-> 250 keV Bkg	25.232	N.A.	Pass	N.A.

Q.C. Results Saved.


1000
1
0
4096
Acq. Start: 07/07/2021 13:53:06 ID: 210707-1 LONGBKGCAL

210776D02.SPC Analyzed by

****

SEEKER G A M M A A N A L Y S I S R E S U L T S PS Version 1.8.4

ALS Laboratory Group - Fort Collins
GammaScan

****

Long Background Calibration

Sample ID: 210707-2 LONGBKGCAL

Sampling Start:	07/07/2021 13:00:00	Counting Start:	07/07/2021 13:53:39
Sampling Stop:	07/07/2021 13:00:00	Decay Time.	8.94E-001 Hrs
Buildup Time.	0.00E+000 Hrs	Live Time	60000 Sec
Sample Size	1.00E+000 L	Real Time	60107 Sec
Collection Efficiency	1.0000	Spc. File	.210776D02.SPC

Detector #: 2 (Detector 2)

Energy(keV)= -1.42 + 0.501*Ch + 0.00E+00*Ch^2 + 0.00E+00*Ch^3 07/07/2021
FWHM(keV) = 0.59 + 0.019*En + 4.08E-04*En^2 + 0.00E+00*En^3 07/29/2020
Where En = Sqrt(Energy in keV)

Search Sensitivity: 1.00 | Sigma Multiplier: 2.00 | Search Start/End: 80/4000

PEAK SEARCH RESULTS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET/MDA COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)		FLAG
1	46.69	96.05	89	57	45	490	0.54	a	
2	63.25	129.10	179	92	72	967	0.95	a	HiResid
3	66.53	135.64	262	94	72	967	0.92	b	HiResid
4	69.24	141.05	22	42	34	322	0.39	c	NET< CL HiResid
5	75.02	152.60	123	70	55	662	0.65	a	
6	77.18	156.92	125	81	64	828	0.78	b	
7	84.41	171.35	92	82	66	801	1.02	a	
8	87.17	176.86	37	71	58	668	0.79	b	NET< CL
9	92.74	187.97	421	87	63	731	0.94	a	HiResid
10	94.64	191.76	65	69	55	609	0.87	b	HiResid
11	98.43	199.33	39	96	78	975	1.24	c	NET< CL HiResid
12	140.00	282.31	181	73	56	632	0.84	a	
13	144.11	290.53	55	50	39	379	0.45	b	
14	163.52	329.27	35	67	54	598	0.81	a	NET< CL
15	185.88	373.91	272	74	54	598	0.77	a	
16	194.79	391.69	47	47	37	338	0.47	a	
17	198.46	399.03	317	73	53	563	0.78	b	
18	205.96	414.00	14	47	38	352	0.48	a	NET< CL
19	229.71	461.41	44	45	36	312	0.52	a	

210776D02.SPC Analyzed by

PEAK SEARCH RESULTS

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET/MDA COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	FWHM (keV)		FLAG
20	238.68	479.31	252	62	44	425	0.70	a	
21	242.21	486.36	97	57	44	425	0.70	b	
22	295.24	592.23	64	61	48	472	0.88	a	
23	351.84	705.22	195	73	55	524	1.14	a	
24	365.31	732.10	57	79	64	600	1.47	a	NET< CL
25	507.58	1016.12	2	129	106	1150	3.51	a	NET< CL Wide Pk
26	511.10	1023.15	2106	138	84	876	2.68	b	
27	558.62	1118.02	320	59	38	291	1.20	a	
28	569.93	1140.59	74	44	34	256	0.86	a	
29	583.30	1167.29	101	44	32	239	0.88	a	
30	596.43	1193.49	22	39	31	240	0.66	a	NET< CL
31	598.08	1196.80	128	77	60	600	1.67	b	
32	609.37	1219.33	169	70	54	533	1.32	a	
33	669.79	1339.95	45	41	32	219	0.90	a	
34	803.31	1606.49	163	55	40	281	1.45	a	
35	843.76	1687.24	36	42	33	230	1.00	a	
36	881.02	1761.63	22	28	22	117	0.77	a	
37	898.63	1796.78	59	54	42	300	1.90	a	
38	911.46	1822.39	87	55	43	293	2.10	a	
39	962.07	1923.43	66	46	35	218	1.82	a	
40	1120.47	2239.64	43	28	21	107	0.85	a	
41	1378.19	2754.14	30	28	21	93	1.54	a	
42	1461.01	2919.47	242	43	24	114	1.88	a	
43	1765.01	3526.34	49	28	20	77	1.80	a	

210776D02.SPC Analyzed by

****

SEEKER B A C K G R O U N D Q. C. A N A L Y S I S Version 2.2.2

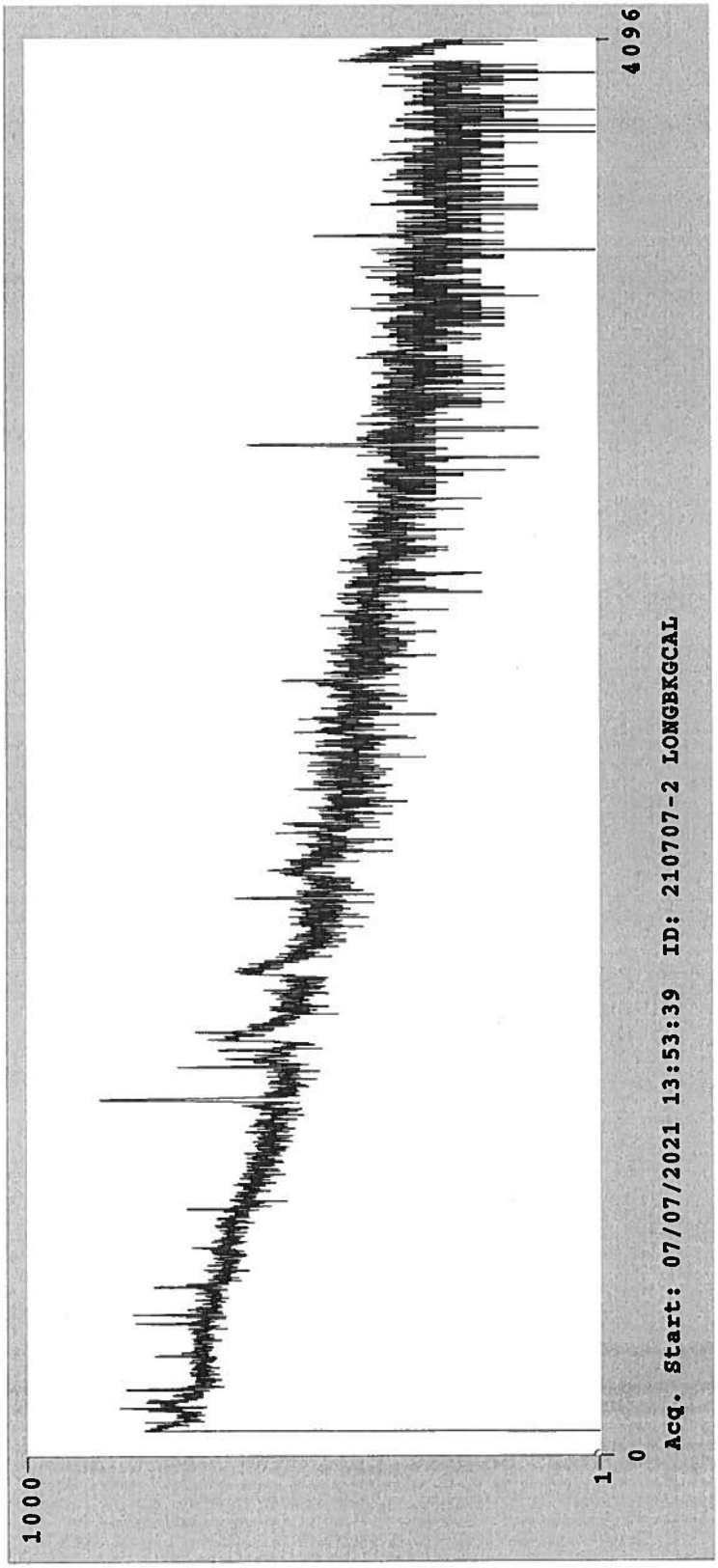
****

ID: 210707-2 LONGBKGCAL

Detector # 2 Background Q.C. Analysis for 07/07/2021 13:53:39

#	Parameter	Value	n Sigma Test	Bounds Test	T-Test
10	50-> 150 keV Bkg	28.039	N.A.	Pass	N.A.
11	150-> 250 keV Bkg	23.354	N.A.	Pass	N.A.
12	250-> 500 keV Bkg	35.311	N.A.	Pass	N.A.
13	500->1000 keV Bkg	38.858	N.A.	Pass	N.A.
14	1000->2000 keV Bkg	22.571	N.A.	Pass	N.A.
15	40-> 50 keV Bkg	3.633	N.A.	Pass	N.A.

Q.C. Results Saved.


1000
1
0
4096
Acq. Start: 07/07/2021 13:53:39 ID: 210707-2 LONGBKGCAL

Gamma Spectroscopy

Quality Control Data

Daily Instrument Performance Checks

New Gamma Standards RSO 967-976 Detectors 1-10

	RSO#	Am241 Act Bq	Eu152 Act Bq	Am241 Act DPS	Eu152 Act DPS
	967	36860	30240	36860	3024O
	968	36490	29930	36490	2993O
	969	36500	29940	36500	2994O
	970	36590	30010	36590	3001O
	971	36670	30080	36670	3008O
	972	36430	29890	36430	2989O
	973	36570	30000	36570	3000O
	974	37470	30740	37470	3074O
	975	37280	30580	37280	3058O
	976	37230	30540	37230	3054O
Average		**36809**	**30195**	**36809**	**30195**

Standards File. GSSTD99.STD
Assay Date 06/22/2012 12:00
ID.: Daily Check Sources Det 1-10

Pk #	Nuclide	Energy	Halflife	Br.Ratio	dps/gm
1	Am-241	59.54	4.331E+02 yrs	0.35900	13214.43
2	Eu-152	778.90	1.333E+01 yrs	0.12940	3907.23
3	Eu-152	1408.08	1.333E+01 yrs	0.21000	6340.95

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Rec 6-26-12
RSO# 967

CERTIFICATE OF CALIBRATION
Standard Radionuclide Source

91091

Eu-152 + Am-241 25.4 mm Diameter x 6 mm Thick Button

Customer: ALS Laboratory Group
P.O. No.: CEP12NAALS339, Item1

This standard radionuclide source was prepared gravimetrically from calibrated master solutions. 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." EZA is accredited by the Health Physics Society (HPS) for the production of NIST-traceable sources, and this source was produced in accordance with the HPS accreditation requirements. Customers may report any concerns with the accreditation program to the HPS Secretariat, 1313 Dolley Madison Blvd., Ste. 402, McLean, VA 22101.

Reference Date: 6/22/2012 12:00 PM EST

Isotope	Half-Life, Days	Activity (Bq)	Uncertainty* , % Type u_A	u_B	U	Calibration Method*
Eu-152	4.938E+03	3.024E+04	0.1	1.7	3.5	IC
Am-241	1.580E+05	3.686E+04	0.1	1.7	3.5	4π LS

Calibration Methods: 4π LS - 4 pi Liquid Scintillation Counting, HPGe - High Purity Germanium Gamma-Ray Spectrometer, IC - Ionization Chamber. **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%. Diameter of active area: 5 mm.

Source Prepared by: _____, for
M. I. Taskaeva, Radiochemist

QA Approved: _____ Date: 18 JUN 12
J.D. McCorvey, Counting Room Manager

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Rec 6-26-12
2
RSO# 968

CERTIFICATE OF CALIBRATION
Standard Radionuclide Source

91092

Eu-152 + Am-241 25.4 mm Diameter x 6 mm Thick Button

Customer: ALS Laboratory Group
P.O. No.: CEP12NAALS339, Item1

This standard radionuclide source was prepared gravimetrically from calibrated master solutions. 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." EZA is accredited by the Health Physics Society (HPS) for the production of NIST-traceable sources, and this source was produced in accordance with the HPS accreditation requirements. Customers may report any concerns with the accreditation program to the HPS Secretariat, 1313 Dolley Madison Blvd., Ste. 402, McLean, VA 22101.

Reference Date: 6/22/2012 12:00 PM EST

Isotope	Half-Life, Days	Activity (Bq)	Uncertainty* , % Type u_A	u_B	U	Calibration Method*
Eu-152	4.938E+03	2.993E+04	0.1	1.7	3.5	IC
Am-241	1.580E+05	3.649E+04	0.1	1.7	3.5	4π LS

Calibration Methods: 4π LS - 4 pi Liquid Scintillation Counting, HPGe - High Purity Germanium Gamma-Ray Spectrometer, IC - Ionization Chamber. **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%. Diameter of active area: 5 mm.

Source Prepared by: _____
K. Eardley, Radiochemist

QA Approved: _____ Date: 18 JUN 12
J.D. McCorvey, Counting Room Manager

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Rec 6-26-12
RSO# 969

CERTIFICATE OF CALIBRATION
Standard Radionuclide Source

91093

Eu-152 + Am-241 25.4 mm Diameter x 6 mm Thick Button

Customer: ALS Laboratory Group
P.O. No.: CEP12NAALS339, Item1

This standard radionuclide source was prepared gravimetrically from calibrated master solutions. 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." EZA is accredited by the Health Physics Society (HPS) for the production of NIST-traceable sources, and this source was produced in accordance with the HPS accreditation requirements. Customers may report any concerns with the accreditation program to the HPS Secretariat, 1313 Dolley Madison Blvd., Ste. 402, McLean, VA 22101.

Reference Date: 6/22/2012 12:00 PM EST

Isotope	Half-Life, Days	Activity (Bq)	Uncertainty* , % Type u_A	u_B	U	Calibration Method*
Eu-152	4.938E+03	2.994E+04	0.1	1.7	3.5	IC
Am-241	1.580E+05	3.650E+04	0.1	1.7	3.5	4π LS

Calibration Methods: 4π LS - 4 pi Liquid Scintillation Counting, HPGe - High Purity Germanium Gamma-Ray Spectrometer, IC - Ionization Chamber. **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%. Diameter of active area: 5 mm.

Source Prepared by: K. Eardley, Radiochemist

QA Approved: J.D. McCorvey, Counting Room Manager

Date: 18 JUN 12

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Rec 6-26-12
RSO# 970

CERTIFICATE OF CALIBRATION
Standard Radionuclide Source

91094

Eu-152 + Am-241 25.4 mm Diameter x 6 mm Thick Button

Customer: ALS Laboratory Group
P.O. No.: CEP12NAALS339, Item1

This standard radionuclide source was prepared gravimetrically from calibrated master solutions. 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." EZA is accredited by the Health Physics Society (HPS) for the production of NIST-traceable sources, and this source was produced in accordance with the HPS accreditation requirements. Customers may report any concerns with the accreditation program to the HPS Secretariat, 1313 Dolley Madison Blvd., Ste. 402, McLean, VA 22101.

Reference Date: 6/22/2012 12:00 PM EST

Isotope	Half-Life, Days	Activity (Bq)	Uncertainty* , % Type u_A	u_B	U	Calibration Method*
Eu-152	4.938E+03	3.001E+04	0.1	1.7	3.5	IC
Am-241	1.580E+05	3.659E+04	0.1	1.7	3.5	4π LS

Calibration Methods: 4π LS - 4 pi Liquid Scintillation Counting, HPGe - High Purity Germanium Gamma-Ray Spectrometer, IC - Ionization Chamber. **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%. Diameter of active area: 5 mm.

Source Prepared by: _____
K. Eardley, Radiochemist

QA Approved: _____ Date: 18 JUN 12
J.D. McCorvey, Counting Room Manager

ACCREDITED SOURCE CALIBRATION LABORATORY HEALTH PHYSICS SOCIETY FOUNDED 1956

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Rec 6-26-12
RSO# 971

CERTIFICATE OF CALIBRATION
Standard Radionuclide Source

91095

Eu-152 + Am-241 25.4 mm Diameter x 6 mm Thick Button

Customer: ALS Laboratory Group
P.O. No.: CEP12NAALS339, Item1

This standard radionuclide source was prepared gravimetrically from calibrated master solutions. 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." EZA is accredited by the Health Physics Society (HPS) for the production of NIST-traceable sources, and this source was produced in accordance with the HPS accreditation requirements. Customers may report any concerns with the accreditation program to the HPS Secretariat, 1313 Dolley Madison Blvd., Ste. 402, McLean, VA 22101.

Reference Date: 6/22/2012 12:00 PM EST

Isotope	Half-Life, Days	Activity (Bq)	Uncertainty* , % Type u_A	u_B	U	Calibration Method*
Eu-152	4.938E+03	3.008E+04	0.1	1.7	3.5	IC
Am-241	1.580E+05	3.667E+04	0.1	1.7	3.5	4π LS

Calibration Methods: 4π LS - 4 pi Liquid Scintillation Counting, HPGe - High Purity Germanium Gamma-Ray Spectrometer, IC - Ionization Chamber. **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%. Diameter of active area: 5 mm.

Source Prepared by: _____
K. Eardley, Radiochemist

QA Approved: _____ Date: 18 JUN 12
J.D. McCorvey, Counting Room Manager

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Re Ga-26-12
RSO# 972

CERTIFICATE OF CALIBRATION
Standard Radionuclide Source

91096

Eu-152 + Am-241 25.4 mm Diameter x 6 mm Thick Button

Customer: ALS Laboratory Group
P.O. No.: CEP12NAALS339, Item1

This standard radionuclide source was prepared gravimetrically from calibrated master solutions. 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." EZA is accredited by the Health Physics Society (HPS) for the production of NIST-traceable sources, and this source was produced in accordance with the HPS accreditation requirements. Customers may report any concerns with the accreditation program to the HPS Secretariat, 1313 Dolley Madison Blvd., Ste. 402, McLean, VA 22101.

Reference Date: 6/22/2012 12:00 PM EST

Isotope	Half-Life, Days	Activity (Bq)	Uncertainty* , % Type u_A	u_B	U	Calibration Method*
Eu-152	4.938E+03	2.989E+04	0.1	1.7	3.5	IC
Am-241	1.580E+05	3.643E+04	0.1	1.7	3.5	4π LS

Calibration Methods: 4π LS - 4 pi Liquid Scintillation Counting, HPGe - High Purity Germanium Gamma-Ray Spectrometer, IC - Ionization Chamber. **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%. Diameter of active area: 5 mm.

Source Prepared by: _____
K. Eardley, Radiochemist

QA Approved: _____ Date: 18JUN12
J.D. McCorvey, Counting Room Manager

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Rec 6-26-12
RSO# 973

CERTIFICATE OF CALIBRATION
Standard Radionuclide Source

91097

Eu-152 + Am-241 25.4 mm Diameter x 6 mm Thick Button

Customer: ALS Laboratory Group
P.O. No.: CEP12NAALS339, Item1

This standard radionuclide source was prepared gravimetrically from calibrated master solutions. 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." EZA is accredited by the Health Physics Society (HPS) for the production of NIST-traceable sources, and this source was produced in accordance with the HPS accreditation requirements. Customers may report any concerns with the accreditation program to the HPS Secretariat, 1313 Dolley Madison Blvd., Ste. 402, McLean, VA 22101.

Reference Date: 6/22/2012 12:00 PM EST

Isotope	Half-Life, Days	Activity (Bq)	Uncertainty* , % Type u_A	u_B	U	Calibration Method*
Eu-152	4.938E+03	3.000E+04	0.1	1.7	3.5	IC
Am-241	1.580E+05	3.657E+04	0.1	1.7	3.5	4π LS

Calibration Methods: 4π LS - 4 pi Liquid Scintillation Counting, HPGe - High Purity Germanium Gamma-Ray Spectrometer, IC - Ionization Chamber. **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%. Diameter of active area: 5 mm.

Source Prepared by: _____
K. Eardley, Radiochemist

QA Approved: _____ Date: 18 JUN 12
J.D. McCorvey, Counting Room Manager

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Rec 6-26-12
Rsvd 974

CERTIFICATE OF CALIBRATION
Standard Radionuclide Source

91098

Eu-152 + Am-241 25.4 mm Diameter x 6 mm Thick Button

Customer: ALS Laboratory Group
P.O. No.: CEP12NAALS339, Item1

This standard radionuclide source was prepared gravimetrically from calibrated master solutions. 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." EZA is accredited by the Health Physics Society (HPS) for the production of NIST-traceable sources, and this source was produced in accordance with the HPS accreditation requirements. Customers may report any concerns with the accreditation program to the HPS Secretariat, 1313 Dolley Madison Blvd., Ste. 402, McLean, VA 22101.

Reference Date: 6/22/2012 12:00 PM EST

Isotope	Half-Life, Days	Activity (Bq)	Uncertainty* , % Type u_A	u_B	U	Calibration Method*
Eu-152	4.938E+03	3.074E+04	0.1	1.7	3.5	IC
Am-241	1.580E+05	3.747E+04	0.1	1.7	3.5	4π LS

Calibration Methods: 4π LS - 4 pi Liquid Scintillation Counting, HPGe - High Purity Germanium Gamma-Ray Spectrometer, IC - Ionization Chamber. **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%. Diameter of active area: 5 mm.

Source Prepared by: K. Eardley, Radiochemist

QA Approved: J.D. McCorvey, Counting Room Manager Date: 18 JUN 12

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Rec 6-26-12
RSO# 975

CERTIFICATE OF CALIBRATION
Standard Radionuclide Source

91099

Eu-152 + Am-241 25.4 mm Diameter x 6 mm Thick Button

Customer: ALS Laboratory Group
P.O. No.: CEP12NAALS339, Item1

This standard radionuclide source was prepared gravimetrically from calibrated master solutions. 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." EZA is accredited by the Health Physics Society (HPS) for the production of NIST-traceable sources, and this source was produced in accordance with the HPS accreditation requirements. Customers may report any concerns with the accreditation program to the HPS Secretariat, 1313 Dolley Madison Blvd., Ste. 402, McLean, VA 22101.

Reference Date: 6/22/2012 12:00 PM EST

Isotope	Half-Life, Days	Activity (Bq)	Uncertainty* , % Type u_A	u_B	U	Calibration Method*
Eu-152	4.938E+03	3.058E+04	0.1	1.7	3.5	IC
Am-241	1.580E+05	3.728E+04	0.1	1.7	3.5	4π LS

Calibration Methods: 4π LS - 4 pi Liquid Scintillation Counting, HPGe - High Purity Germanium Gamma-Ray Spectrometer, IC - Ionization Chamber. **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%. Diameter of active area: 5 mm.

Source Prepared by: K. Eardley
K. Eardley, Radiochemist

QA Approved: J.D. McCorvey
J.D. McCorvey, Counting Room Manager

Date: 18JUN12

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Rec 6-26-12
RSO# 976

CERTIFICATE OF CALIBRATION

Standard Radionuclide Source

91100

Eu-152 + Am-241 25.4 mm Diameter x 6 mm Thick Button

Customer: ALS Laboratory Group
P.O. No.: CEP12NAALS339, Item1

This standard radionuclide source was prepared gravimetrically from calibrated master solutions. 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." EZA is accredited by the Health Physics Society (HPS) for the production of NIST-traceable sources, and this source was produced in accordance with the HPS accreditation requirements. Customers may report any concerns with the accreditation program to the HPS Secretariat, 1313 Dolley Madison Blvd., Ste. 402, McLean, VA 22101.

Reference Date: 6/22/2012 12:00 PM EST

Isotope	Half-Life, Days	Activity (Bq)	Uncertainty*, % Type u_A	u_B	U	Calibration Method*
Eu-152	4.938E+03	3.054E+04	0.1	1.7	3.5	IC
Am-241	1.580E+05	3.723E+04	0.1	1.7	3.5	4π LS

Calibration Methods: 4π LS - 4 pi Liquid Scintillation Counting, HPGe - High Purity Germanium Gamma-Ray Spectrometer, IC - Ionization Chamber. **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%. Diameter of active area: 5 mm.

Source Prepared by: _____
K. Eardley, Radiochemist

QA Approved: _____ Date: 18JUN12
J.D. McCorvey, Counting Room Manager

ACCREDITED SOURCE CALIBRATION LABORATORY HEALTH PHYSICS SOCIETY FOUNDED 1955

Multi-Isotope Certificate, Rev 2 04-08-2010

ANA Form005 Rev. —

ALS

Gamma Spectrometer Calibration Log

Date: 7/10/2021 Reviewed By/Date: JP 7/10/2021

Det. No.	Out Of Service	Background		Source Check			Repeat Source Check			
		Started	OK	Started	OK	Failed Parameter(s)	OK	Failed Parameter(s)	Corrective Action Taken **	Removed from Service
1.				JP	JP					
2.				JP	/	140Ce Cnt	JP		Cen Adj	
3.				JP	JP					
4.				JP	/	140Ce Cnt	JP		Cen Adj	
5.				JP	JP					
6.	JP			/	/					
7.				JP	JP					
8.	JP			/	/					
9.	JP			/	/					
10.				JP	JP					

. Corrective Action:**

*** Due to detector____ failing two different QC parameters on the first and second daily check, a third daily check was performed. All QC parameters passed for the third daily check. Detector ____ is online for the date of _____

210786D01.SPC Analyzed by

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SEEKER D E T E C T O R Q. C. A N A L Y S I S Version 2.2.2

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ID: DAILY CHECK

Detector # 1 Detector Q.C. Analysis for 07/10/2021 08:01:27

Standards File #: 99 (Daily Check Sources Det 1-10)

#	Parameter	Value	n Sigma Test	Bounds Test	T-Test
1	60 keV Centroid	122.798	N.A.	Pass	N.A.
2	60 keV FWHM	9.344E-01	N.A.	Pass	N.A.
3	60 keV Efficiency	1.921E-03	N.A.	Pass	N.A.
16	779 keV Centroid	1558.562	N.A.	Pass	N.A.
17	779 keV FWHM	1.687	N.A.	Pass	N.A.
18	779 keV Efficiency	1.696E-02	N.A.	Pass	N.A.
19	1408 keV Centroid	2813.982	N.A.	Pass	N.A.
20	1408 keV FWHM	2.342	N.A.	Pass	N.A.
21	1408 keV Efficiency	7.058E-03	N.A.	Pass	N.A.

210791D02.SPC Analyzed by

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SEEKER D E T E C T O R Q. C. A N A L Y S I S Version 2.2.2

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ID: DAILY CHECK

Detector # 2 Detector Q.C. Analysis for 07/10/2021 08:01:37

Standards File #: 99 (Daily Check Sources Det 1-10)

#	Parameter	Value	n Sigma Test	Bounds Test	T-Test
1	60 keV Centroid	121.667	N.A.	Pass	N.A.
2	60 keV FWHM	7.588E-01	N.A.	Pass	N.A.
3	60 keV Efficiency	4.304E-03	N.A.	Pass	N.A.
17	779 keV Centroid	1556.963	N.A.	Pass	N.A.
19	779 keV FWHM	1.457	N.A.	Pass	N.A.
20	779 keV Efficiency	2.701E-02	N.A.	Pass	N.A.
21	1408 keV Centroid	2811.987	N.A.	<FAIL>	N.A.
22	1408 keV FWHM	1.980	N.A.	Pass	N.A.
23	1408 keV Efficiency	1.156E-02	N.A.	Pass	N.A.

210792D02.SPC Analyzed by

SEEKER D E T E C T O R Q. C. A N A L Y S I S Version 2.2.2

ID: DAILY CHECK
Detector # 2 Detector Q.C. Analysis for 07/10/2021 08:10:22
Standards File #: 99 (Daily Check Sources Det 1-10)

#	Parameter	Value	n Sigma Test	Bounds Test	T-Test
1	60 keV Centroid	121.692	N.A.	Pass	N.A.
2	60 keV FWHM	7.578E-01	N.A.	Pass	N.A.
3	60 keV Efficiency	4.350E-03	N.A.	Pass	N.A.
17	779 keV Centroid	1557.658	N.A.	Pass	N.A.
19	779 keV FWHM	1.401	N.A.	Pass	N.A.
20	779 keV Efficiency	2.592E-02	N.A.	Pass	N.A.
21	1408 keV Centroid	2813.363	N.A.	Pass	N.A.
22	1408 keV FWHM	1.940	N.A.	Pass	N.A.
23	1408 keV Efficiency	1.076E-02	N.A.	Pass	N.A.

ALS

Gamma Spectrometer Calibration Log

Date: 7/11/2024 Reviewed By/Date: JP 7/11/2024

Det. No.	Out Of Service	Background		Source Check			Repeat Source Check			
		Started	OK	Started	OK	Failed Parameter(s)	OK	Failed Parameter(s)	Corrective Action Taken **	Removed from Service
1.				JP	JP					
2.				JP	JP					
3.				JP	JP					
4.				JP	/	1408 Cert	JP		Count Adj	
5.				JP	JP					
6.				/	/					
7.				JP	JP					
8.				/	/					
9.				/	/					
10.				JP	JP					

.** **Corrective Action:**

*** Due to detector____ failing two different QC parameters on the first and second daily check, a third daily check was performed. All QC parameters passed for the third daily check. Detector ____ is online for the date of _____

210797D01.SPC Analyzed by

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SEEKER D E T E C T O R Q. C. A N A L Y S I S Version 2.2

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ID: DAILY CHECK
Detector # 1 Detector Q.C. Analysis for 07/11/2021 12:01:59
Standards File #: 99 (Daily Check Sources Det 1-10)

#	Parameter	Value	n Sigma Test	Bounds Test	T-Test
1	60 keV Centroid	122.759	N.A.	Pass	N.A.
2	60 keV FWHM	8.159E-01	N.A.	Pass	N.A.
3	60 keV Efficiency	1.895E-03	N.A.	Pass	N.A.
16	779 keV Centroid	1558.813	N.A.	Pass	N.A.
17	779 keV FWHM	1.798	N.A.	Pass	N.A.
18	779 keV Efficiency	1.846E-02	N.A.	Pass	N.A.
19	1408 keV Centroid	2814.500	N.A.	Pass	N.A.
20	1408 keV FWHM	2.459	N.A.	Pass	N.A.
21	1408 keV Efficiency	7.078E-03	N.A.	Pass	N.A.

210803D02.SPC Analyzed by

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SEEKER D E T E C T O R Q. C. A N A L Y S I S Version 2.2.2

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ID: DAILY CHECK
Detector # 2 Detector Q.C. Analysis for 07/11/2021 12:08:06
Standards File #: 99 (Daily Check Sources Det 1-10)

#	Parameter	Value	n Sigma Test	Bounds Test	T-Test
1	60 keV Centroid	121.756	N.A.	Pass	N.A.
2	60 keV FWHM	7.289E-01	N.A.	Pass	N.A.
3	60 keV Efficiency	4.307E-03	N.A.	Pass	N.A.
17	779 keV Centroid	1558.200	N.A.	Pass	N.A.
19	779 keV FWHM	1.433	N.A.	Pass	N.A.
20	779 keV Efficiency	2.662E-02	N.A.	Pass	N.A.
21	1408 keV Centroid	2814.362	N.A.	Pass	N.A.
22	1408 keV FWHM	1.946	N.A.	Pass	N.A.
23	1408 keV Efficiency	1.118E-02	N.A.	Pass	N.A.

ALS

Gamma Spectrometer Calibration Log

Date: 7/12/21 Reviewed By/Date: TS 7/12/21

Det. No.	Out Of Service	Background		Source Check			Repeat Source Check			
		Started	OK	Started	OK	Failed Parameter(s)	OK	Failed Parameter(s)	Corrective Action Taken **	Removed from Service
1.				TS	TS					
2.				TS	TS					
3.				TS	TS					
4.				TS	/	1408 Cent	TS		Gain Adj	
5.				TS	TS					
6.	TS			/	/					
7.				TS	TS					
8.	TS			/	/					
9.	TS			/	/					
10.				TS						

.** **Corrective Action:**

*** Due to detector____ failing two different QC parameters on the first and second daily check, a third daily check was performed. All QC parameters passed for the third daily check. Detector ____ is online for the date of _____

210800D01.SPC Analyzed by

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SEEKER D E T E C T O R Q. C. A N A L Y S I S Version 2.2

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ID: DAILY CHECK

Detector # 1 Detector Q.C. Analysis for 07/12/2021 07:28:46

Standards File #: 99 (Daily Check Sources Det 1-10)

#	Parameter	Value	n Sigma Test	Bounds Test	T-Test
1	60 keV Centroid	122.669	N.A.	Pass	N.A.
2	60 keV FWHM	8.789E-01	N.A.	Pass	N.A.
3	60 keV Efficiency	1.911E-03	N.A.	Pass	N.A.
16	779 keV Centroid	1558.729	N.A.	Pass	N.A.
17	779 keV FWHM	1.733	N.A.	Pass	N.A.
18	779 keV Efficiency	1.733E-02	N.A.	Pass	N.A.
19	1408 keV Centroid	2814.337	N.A.	Pass	N.A.
20	1408 keV FWHM	2.474	N.A.	Pass	N.A.
21	1408 keV Efficiency	7.310E-03	N.A.	Pass	N.A.

Q.C. Results Saved.

210806D02.SPC Analyzed by

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SEEKER D E T E C T O R Q. C. A N A L Y S I S Version 2.2.2

****

ID: DAILY CHECK

Detector # 2 Detector Q.C. Analysis for 07/12/2021 07:28:54

Standards File #: 99 (Daily Check Sources Det 1-10)

#	Parameter	Value	n Sigma Test	Bounds Test	T-Test
1	60 keV Centroid	121.626	N.A.	Pass	N.A.
2	60 keV FWHM	7.749E-01	N.A.	Pass	N.A.
3	60 keV Efficiency	4.407E-03	N.A.	Pass	N.A.
17	779 keV Centroid	1558.178	N.A.	Pass	N.A.
19	779 keV FWHM	1.437	N.A.	Pass	N.A.
20	779 keV Efficiency	2.676E-02	N.A.	Pass	N.A.
21	1408 keV Centroid	2814.270	N.A.	Pass	N.A.
22	1408 keV FWHM	1.988	N.A.	Pass	N.A.
23	1408 keV Efficiency	1.129E-02	N.A.	Pass	N.A.

Q.C. Results Saved.