



US Army Corps
of Engineers
Baltimore District

FINAL
TECHNICAL MEMORANDUM

Evaluation of Articles to Determine Radioactivity
Using Lanthanum Bromide Gamma Spectroscopy

GREAT KILLS PARK
Staten Island, New York

18 August 2014

List of Acronyms and Abbreviations

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	U.S. Code of Federal Regulations
g/cm ³	grams per cubic centimeter
GKP	Great Kills Park
HPGe	High Purity Germanium Detector
ISOCS	<i>In situ</i> Object Counting System
keV	kiloelectron Volt
LaBr	Lanthanum Bromide
NPS	U.S. National Park Service
TCRA	Time Critical Removal Action
μCi	microcurie
U.S.	United States
USACE	U.S. Army Corps of Engineers

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1.0 INTRODUCTION

1.1 Purpose

The purpose of this technical memorandum is to document the results of field measurements performed to identify radionuclides and determine radioactivity levels in six articles collected at Great Kills Park (GKP). Measurements were performed using a lanthanum bromide (LaBr) probe.

1.2 Background Information

The U.S. Army Corps of Engineers (USACE) is currently implementing a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Time Critical Removal Action (TCRA) at GKP to mitigate short term risk by removal of significant radioactive contaminants. This work is being performed under an Interagency Agreement between the USACE and the land manager, the National Park Service (NPS). During performance of the removal action, a number of small articles were excavated/removed and exhibited elevated levels of gamma radioactivity. These articles were packaged and stored in accordance with applicable laws, regulations, and industry practices to ensure protection of human health and the environment.

1.3 Problem Identification

Knowledge of the types and quantities of radioactive materials in the articles is necessary to:

- support collection of small aliquots of the articles for off-site radiochemical and possible chemical analysis;
- ensure articles are appropriately packaged and stored while awaiting disposition; and
- provide necessary information to support transport and disposal of the articles.

Prior to performance of this effort, information regarding the specific types and quantities of radioactive materials in the articles was not available. Gamma dose rate was available and provided sufficient information for safe, short-term, storage of the materials.

2.0 METHODOLOGY

This section describes the approach implemented during the action.

2.1 System Description

An *in situ* gamma spectroscopy system was used to perform measurements to identify and quantify radionuclides in the articles. The system consisted of a handheld multichannel analyzer with a 1.5 inch by 1.5 inch LaBr gamma detection probe.

The LaBr system was selected for this effort because it has adequate sensitivity and resolution to accurately identify and quantify radionuclides in the articles (based on gamma radioactivity levels and suspected contaminants). While the system has poorer resolution than a high purity germanium detector (HPGe), it is much easier and economical to field (no liquid nitrogen requirements) and data generated with the detector is of sufficient quality to meet the objectives outlined in Section 1.3.

Specific system hardware and software components that were utilized include:

- InSpector 1000 Digital Hand-Held Multichannel Analyzer
- IPROL-1 - Intelligent LaBr Probe with Sourceless Stabilization for the InSpector™ 1000
- Genie2K gamma analysis software
- ISOCS efficiency calibration software with characterization for LaBr probe

2.2 Initial System Setup and Testing

Prior to performance of measurements on articles, it was necessary to perform initial setup and testing of the system.

2.2.1 Initial Resolution Calibration

In order to accurately quantify radionuclides when multiple peaks across the energy spectrum are expected, it is appropriate to perform a resolution calibration with test sources of known energies. Peak resolution is a measurement of the width (or fatness) of a peak. Resolution changes as a function of energy and is used in the Genie2K software to interpret data collected by the detector.

A ten minute count was performed with barium-133 (Ba-133), cesium-137 (Cs-137), manganese-54 (Mn-54), and cobalt-60 (Co-60) sources positioned approximately six inches from the detector face. Table 1 identifies the specific sources used and the gamma energies used for the resolution calibration (see Appendix D for source calibration certificates). The resolution calibration was performed after downloading the measurement spectra into the Genie2K software. This resolution calibration was saved and was loaded into all measurement spectra

collected prior to quantitative analysis. Appendix A provides the analytical results of the analysis and Appendix B provides a screen shot of the spectra.

Table 1: Initial Energy and Shape Calibration Sources

Nuclide	Half life (years)	Cal Date	Source SN	Photon Energy (keV)	Intensity (%)	Emission Rate (per sec)
Ba-133	10.51	9/2/2011	9021110	80.1	34.06	13106
Ba-133	10.51	9/2/2011	9021110	276.4	7.16	2755
Ba-133	10.51	9/2/2011	9021110	302.9	18.33	7053
Ba-133	10.51	9/2/2011	9021110	356	62.05	23877
Cs-137	30.07	9/2/2011	902113	661.66	85.1	34006
Mn-54	0.855	9/2/2011	902119	834.8	99.98	42172
Co-60	5.2714	9/2/2011	902118	1173.24	99.97	34658.6
Co-60	5.2714	9/2/2011	902118	1332.5	99.99	34665.5

2.2.1 System ISOCS Efficiency Check

The ISOCS efficiency calibration software parameters are detector-specific and are based on numerous measurements performed with radioactive sources by the manufacturer at the time of ISOCS calibration. These measurements are used, along with Monte Carlo simulations, to describe the detector's efficiency as a function of incident photon energy and angle of incidence on the detector.

Detector response characteristics can change over time due to environmental factors, misuse, or physical damage to the system. In order to ensure the system used in this action could accurately quantify radionuclides across the energy spectrum, an evaluation was performed using radioactive calibration sources with known quantities traceable to the National Institute of Standards and Technology (NIST).

In accordance with *American National Standard for Calibration and Use of Germanium Spectrometers for the Measurement of Gamma-Ray Emission Rates of Radionuclides* (ANSI 42.14-1999), the system was evaluated at low and high gamma energies. Specifically, the Ba-133 and Co-60 sources listed in Table 1 were measured.

Each source was positioned 6.5 inches from the face of the detector and counted for 300 seconds (five minutes). The ISOCS software does not allow the user to specifically model a point source. Instead, the configuration is approximated using available ISOCS geometry templates. This specific configuration was modeled in the ISOCS software using the circular plane geometry. The source itself was modeled as a right circular cylinder of air with a diameter of 0.01 cm, height of 0.01 cm, and density of 0.0012 g/cm^3 . This small size, low atomic number, and low density approximates a point source with virtually no self-attenuation properties. Appendix C shows the ISOCS Geometry Composer Report (Point_at_6.5"), which identifies the specific modeling parameters used in the ISOCS model.

The Ba-133 source has a certified radioactivity level of $1.04 \text{ } \mu\text{Ci} \pm 5\%$ as of 09 September 2011 (see Appendix D for certificate). The BaBr measurement estimated the activity to be $1.03 \text{ } \mu\text{Ci}$ (decay corrected) based on a weighted average of all gamma lines identified. Ba-133 was specifically selected to evaluate the low energy response based on its 80 keV peak. The activity estimate based on that peak was $1.38 \pm 0.35 \text{ } \mu\text{Ci}$. This result is equivalent to the certified source activity when total propagated analysis uncertainty and certified source uncertainty are considered. Appendix A provides the analytical results of the analysis and Appendix B provides a screen shot of the spectra.

The Co-60 source has a certified radioactivity level of $0.937 \text{ } \mu\text{Ci} \pm 5\%$ as of 09 September 2011 (see Appendix D for certificate). Co-60 was specifically selected to evaluate the high energy response based on its 1332.5 keV peak. The LaBr activity estimate based on that peak was $0.860 \pm 0.06 \text{ } \mu\text{Ci}$. This result is equivalent to the certified source activity when total propagated analysis uncertainty and certified source uncertainty are considered. Appendix A provides the analytical results of the analysis and Appendix B provides a screen shot of the spectra.

The results of these evaluations indicate that the ISOCS efficiency calibration is accurate at low and high gamma energies. As a result, the system is considered acceptable to provide reasonably accurate activity estimates across the energy spectrum. It should be noted that the efficiency check was performed with the sources positioned in a geometry that results in source gammas being normally incident to the detector face and did not evaluate other incident gamma angles. Based on this consideration, measurements performed on articles, discussed in Section 2.3, were performed in a similar geometry.

2.3 Measurements Performed on Articles

The intent of this action was to perform measurements on articles with unknown radionuclides and radioactivity levels to identify and quantify radionuclides in the articles.

Articles were positioned in front of the detector face and counted for durations ranging from one minute to 30 minutes. Articles were brought into the counting area one at a time to minimize the

potential for interferences. Table 2 lists the six articles that were evaluated and lists some parameters used in their evaluation.

Table 2: Article Measurement Parameters

Article ID	Count Time (seconds)	Distance from LaBr (inches)	Estimated Diameter (inches)	Estimated Thickness (inches)	Estimated Density (g/cm ³)
D-05-04	1800	6	0.2	0.20	1.6
D-08-07	1800	1	0.2	0.04	0.1
H-12-26	1800	1	1.2	0.39	1.6
I-13-31	1800	6	0.8	0.79	4
N-20-29	1800	6	1.5	1.50	2.5
Cabrera Bag	60	1	1.2	0.10	1.6

When analysis count times were complete, the analyses was saved on the Inspector 1000 and transferred to a laptop computer for analysis with the Genie2K and ISOCS software. The resolution calibration was loaded to each analysis and saved in Genie2K for determination of radionuclide activity using Genie2K and ISOCS software.

2.3.1 ISOCS Efficiency Modeling and Determination of Radioactivity Levels

The ISOCS software is used to translate detector response into radionuclide activity levels. This is accomplished by developing an article-specific model in the ISOCS software and loading the model into Genie2K. The ISOCS software circular plane geometry template was used to model each of the six items evaluated. Specific parameters what were entered into the software include the distance from the article to the detector face, approximate diameter and thickness of the article, and the approximate density of the article. ISOCS models were refined, as necessary, by modifying the assumed density to ensure activity estimates for radionuclide with multiple gamma energies did not vary significantly.

Table 2 lists the modeling assumptions used for each article. The specific entries into the ISOCS software model are provided for each article in Appendix C.

3.0 RESULTS

Once ISOCS models were finalized, they were loaded into the Genie2K software and the spectra were analyzed. The analysis results (Appendix A) list peaks identified, radionuclides identified, and provide activity estimates for all radionuclides identified in units of μCi . Screen shots of spectra are provided in Appendix B. The following subsections provide brief summaries of the results of each article analysis.

It should be noted that potassium-40 (K-40) results are provided on some analyses as a quality control point. The K-40 results are not representative of radioactivity in the samples.

3.1 D-05-04 Results

Article D-05-04 was counted for 30 minutes. The analysis results identified Ra-226 and its progeny, bismuth-214 (Bi-214) and lead-214 (Pb-214). The progeny activities were slightly less than secular equilibrium indicating that some radon-222 (Rn-222) is likely escaping the article container. This is expected as radon is a noble gas and airborne Rn-222 has been identified in the article/waste storage container.

Uranium was not identified in the article. The analysis had adequate sensitivity to identify uranium at secular equilibrium concentrations via thorium-234 (Th-234).

Article D-05-04 contains approximately 7 μCi of Ra-226. No other significant radionuclides were identified.

3.2 D-08-07 Results

Article D-08-07 was counted for 30 minutes. The analysis results identified Ra-226 and its progeny, Bi-214 and Pb-214. The progeny activities were less than secular equilibrium indicating that Rn-222 is likely escaping the article container.

Uranium was not identified in the article. The analysis had adequate sensitivity to identify uranium at secular equilibrium concentrations via thorium-234 (Th-234).

Article D-08-07 contains approximately 0.02 μCi of Ra-226. No other significant radionuclides were identified.

3.3 H-12-26 Results

Article H-12-26 was counted for 30 minutes. The analysis results identified actinium-228 (Ac-228) and other Thorium Series progeny, lead-212 and bismuth-212. The analysis also identified Pb-214 (a Ra-226 progeny). However, it is suspected that the Pb-214 result may be a false positive due to interferences from overlapping Thorium Series radionuclide gammas.

Article H-12-26 contains approximately 0.01 μCi of Ac-228. The presence of Ac-228 indicates that radium-228 (Ra-228) and possibly thorium-232 (Th-232) are present in the article. Ra-226 may also be present in the article, but observed progeny peaks appear to be interferences from Thorium Series radionuclides.

No other significant radionuclides were identified.

3.4 I-13-21 Results

Article I-13-21 was counted for 30 minutes. The analysis results identified Ra-226 and its progeny, Bi-214 and Pb-214. The progeny activities appeared to be in secular equilibrium.

Uranium was not identified in the article. The analysis had adequate sensitivity to identify uranium at secular equilibrium concentrations via thorium-234 (Th-234).

Article I-13-21 contains approximately 1 μCi of Ra-226. No other significant radionuclides were identified.

3.5 N-20-29 Results

Article N-20-29 was counted for 30 minutes. The analysis results identified Ra-226 and its progeny, Bi-214 and Pb-214. The progeny activities were less than secular equilibrium indicating that Rn-222 is likely escaping the article container.

Uranium was not identified in the article. The analysis had adequate sensitivity to identify uranium at secular equilibrium concentrations via thorium-234 (Th-234).

Article N-20-29 contains approximately 7 μCi of Ra-226. No other significant radionuclides were identified.

3.6 “Cabrera Bag” Results

Article “Cabrera Bag” was counted for one minute. The count time was reduced from other analyses due to the high dose rate the article exhibited. The analysis results identified Ra-226 and its progeny, Bi-214 and Pb-214. The progeny activities were slightly less than secular equilibrium indicating that some Rn-222 is likely escaping the article container.

Uranium was not identified in the article. The analysis had adequate sensitivity to identify uranium at secular equilibrium concentrations via thorium-234 (Th-234).

Article “Cabrera Bag” contains approximately 6 μCi of Ra-226. No other significant radionuclides were identified.

4.0 CONCLUSION

The LaBr system was capable of identifying and accurately quantifying radionuclides in the articles. The results reported herein can be used to:

- support collection of small aliquots of the articles for off-site radiochemical and possible chemical analysis;
- ensure articles are appropriately packaged and stored while awaiting disposition; and
- provide necessary information to support transport and disposal of the articles.

The majority of the articles contained Ra-226 and its radioactive progeny. One article, H-12-26, contained Ac-228 (Thorium Series radionuclide) with no conclusive evidence of Ra-226. The presence of Ac-228 indicates that Ra-228 and possibly Th-232 are present in article H-12-26. Uranium was not positively identified in any of the articles.

APPENDIX A

Analysis Results

 ***** G A M M A S P E C T R U M A N A L Y S I S *****

Filename: C:\GENIE2K\CAMFILES\GKP\Initial Shape Cal.CNF

Report Generated On : 8/4/2014 1:38:59 PM

Sample Title : Initial Shape Calibration
 Sample Description :
 Sample Identification : Shape Cal
 Sample Type :
 Sample Geometry :

Peak Locate Threshold : 3.00
 Peak Locate Range (in channels) : 1 - 512
 Peak Area Range (in channels) : 1 - 512
 Identification Energy Tolerance : 0.500 FWHM

Sample Size : 1.000E+000

Sample Taken On : 7/17/2014 2:50:04 PM
 Acquisition Started : 7/17/2014 2:50:04 PM

Live Time : 600.0 seconds
 Real Time : 604.2 seconds

Dead Time : 0.70 %

Energy Calibration Used Done On : 7/17/2014
 Efficiency Calibration Used Done On : 10/14/2004
 Efficiency ID : 2X2_UNSHIELDED

ALL ACTIVITY RESULTS ARE ESTIMATES.
 Total propagated error is much greater than reported.

***** P E A K A N A L Y S I S R E P O R T *****

Detector Name: Sgc_LaBr_1R5x1R5

Sample Title: Initial Shape Calibration

Peak Analysis Performed on: 8/4/2014 1:38:59 PM

Peak Analysis From Channel: 1

Peak Analysis To Channel: 512

	Peak No.	ROI start	ROI end	Peak centroid	Energy (keV)	FWHM (keV)	Net Peak Area	Net Area Uncert.	Continuum Counts
	1	10-	18	14.69	48.64	3.37	3.71E+002	365.36	1.62E+004
	2	21-	32	26.86	84.76	9.94	4.52E+004	685.60	3.09E+004
	3	44-	58	51.66	158.36	20.11	4.65E+003	616.44	3.28E+004
M	4	85-	109	92.10	278.40	15.34	5.05E+003	269.50	2.14E+004
m	5	85-	109	100.98	304.76	16.22	1.21E+004	336.64	2.41E+004
	6	109-	128	118.75	357.53	18.52	3.63E+004	693.55	2.54E+004
	7	144-	163	152.01	456.25	17.59	8.56E+002	382.33	1.06E+004
	8	207-	234	221.22	661.70	27.11	1.85E+004	471.44	8.74E+003
	9	264-	294	279.42	834.46	28.95	8.75E+003	421.00	7.67E+003
	10	375-	411	393.71	1173.72	34.06	8.26E+003	314.94	3.12E+003
	11	428-	466	447.29	1332.78	39.31	7.75E+003	210.42	6.44E+002
	12	467-	503	487.08	1450.87	53.56	1.47E+003	124.64	4.58E+002

M = First peak in a multiplet region

m = Other peak in a multiplet region

F = Fitted singlet

Errors quoted at 1.960 sigma

ALL ACTIVITY RESULTS ARE ESTIMATES.

Total propagated error is much greater than reported.

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***** G A M M A S P E C T R U M A N A L Y S I S *****

Filename: C:\GENIE2K\CAMFILES\GKP\Ba-133 Check.CNF

Report Generated On : 8/4/2014 1:14:15 PM

Sample Title : Ba-133 Source Check
Sample Description : Source at 6.5"
Sample Identification : 1.04 uCi on 02 SEP 2011
Sample Type : SN 9021110
Sample Geometry :

Peak Locate Threshold : 3.00
Peak Locate Range (in channels) : 1 - 512
Peak Area Range (in channels) : 1 - 512
Identification Energy Tolerance : 0.500 FWHM

Sample Size : 1.000E+000

Sample Taken On : 9/2/2011 12:00:00 PM
Acquisition Started : 7/17/2014 3:24:20 PM

Live Time : 300.0 seconds
Real Time : 301.0 seconds

Dead Time : 0.32 %

Energy Calibration Used Done On : 7/17/2014
Efficiency Calibration Used Done On : 7/18/2014
Efficiency ID : POINT_AT_6.5"

ALL ACTIVITY RESULTS ARE ESTIMATES.
Total propagated error is much greater than reported.

***** P E A K A N A L Y S I S R E P O R T *****

Detector Name: Sgc_LaBr_1R5x1R5

Sample Title: InSpector 1000 spectrum

Peak Analysis Performed on: 8/4/2014 1:14:15 PM

Peak Analysis From Channel: 1

Peak Analysis To Channel: 512

	Peak No.	ROI start	ROI end	Peak centroid	Energy (keV)	FWHM (keV)	Net Peak Area	Net Area Uncert.	Continuum Counts
	1	21-	32	26.91	84.91	10.05	9.14E+003	308.80	6.27E+003
	2	45-	59	52.85	161.90	23.70	1.49E+003	270.01	6.08E+003
M	3	84-	109	92.70	280.18	14.77	9.03E+002	97.39	2.61E+003
m	4	84-	109	100.90	304.52	15.60	2.38E+003	129.80	2.43E+003
	5	109-	128	118.77	357.58	18.60	7.31E+003	261.37	2.99E+003
	6	466-	503	486.48	1449.09	47.93	8.35E+002	81.03	1.52E+002

M = First peak in a multiplet region

m = Other peak in a multiplet region

F = Fitted singlet

Errors quoted at 1.960 sigma

ALL ACTIVITY RESULTS ARE ESTIMATES.

Total propagated error is much greater than reported.

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 ***** N U C L I D E I D E N T I F I C A T I O N R E P O R T *****

Sample Title: InSpector 1000 spectrum
 Nuclide Library Used: C:\GENIE2K\CAMFILES\GKP Co60 Ba133.NLB

..... IDENTIFIED NUCLIDES

Nuclide Name	Id Confidence	Energy (keV)	Yield (%)	Activity (uCi/)	Activity Uncertainty
BA-133	0.899	81.00*	35.55	1.38154E+000	3.47336E-001
		276.40*	6.90	9.19713E-001	1.97780E-001
		302.84*	17.80	1.00396E+000	1.85181E-001
		356.01*	60.00	1.05424E+000	1.80193E-001
		383.85	8.70		

* = Energy line found in the spectrum.

@ = Energy line not used for Weighted Mean Activity

Energy Tolerance : 0.500 FWHM

Nuclide confidence index threshold = 0.30

Errors quoted at 1.960 sigma

ALL ACTIVITY RESULTS ARE ESTIMATES.

Total propagated error is much greater than reported.

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 ***** I N T E R F E R E N C E C O R R E C T E D R E P O R T *****

Nuclide Name	Nuclide Id Confidence	Wt mean Activity (uCi/)	Wt mean Activity Uncertainty
BA-133	0.899	1.030870E+000	1.032917E-001

? = nuclide is part of an undetermined solution

X = nuclide rejected by the interference analysis

@ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 1.960 sigma

***** U N I D E N T I F I E D P E A K S *****

Peak Locate Performed on: 8/4/2014 1:14:15 PM
 Peak Locate From Channel: 1
 Peak Locate To Channel: 512

Peak No.	Energy (keV)	Peak Size in Counts per Second	Peak CPS % Uncertainty	Peak Type	Tol. Nuclide
2	161.90	4.9683E+000	18.12	Sum	
6	1449.09	2.7833E+000	9.70		

M = First peak in a multiplet region

m = Other peak in a multiplet region

F = Fitted singlet

Errors quoted at 1.960 sigma

ALL ACTIVITY RESULTS ARE ESTIMATES.

Total propagated error is much greater than reported.

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***** N U C L I D E M D A R E P O R T *****

Detector Name: Sgc_LaBr_1R5x1R5
Sample Geometry:
Sample Title: InSpector 1000 spectrum
Nuclide Library Used: C:\GENIE2K\CAMFILES\GKP Co60 Ba133.NLB

Nuclide Name	Energy (keV)	Yield (%)	Line MDA (uCi/)	Nuclide MDA (uCi/)	Activity (uCi/)	Dec. Level (uCi/)
CO-60	1173.22	100.00	4.304E-002	4.20E-002	8.459E-002	2.108E-002
	1332.49	100.00	4.203E-002		-1.102E-001	2.052E-002

+ = Nuclide identified during the nuclide identification

* = Energy line found in the spectrum

> = MDA value not calculated

@ = Half-life too short to be able to perform the decay correction

ALL ACTIVITY RESULTS ARE ESTIMATES.

Total propagated error is much greater than reported.

 ***** G A M M A S P E C T R U M A N A L Y S I S *****

Filename: C:\GENIE2K\CAMFILES\GKP\Co-60 Check.CNF

Report Generated On : 8/4/2014 1:15:01 PM

Sample Title : Co-60 Check
 Sample Description : Source at 6.5"
 Sample Identification : 0.937 uCi on 02 SEP 2011
 Sample Type : SN 902118
 Sample Geometry :

Peak Locate Threshold : 3.00
 Peak Locate Range (in channels) : 1 - 512
 Peak Area Range (in channels) : 1 - 512
 Identification Energy Tolerance : 0.500 FWHM

Sample Size : 1.000E+000

Sample Taken On : 9/2/2011 12:00:00 PM
 Acquisition Started : 7/17/2014 3:13:16 PM

Live Time : 300.0 seconds
 Real Time : 300.9 seconds

Dead Time : 0.29 %

Energy Calibration Used Done On : 7/17/2014
 Efficiency Calibration Used Done On : 7/18/2014
 Efficiency ID : POINT_AT_6.5"

ALL ACTIVITY RESULTS ARE ESTIMATES.
 Total propagated error is much greater than reported.

***** P E A K A N A L Y S I S R E P O R T *****

Detector Name: Sgc_LaBr_1R5x1R5

Sample Title: Co-60 Check

Peak Analysis Performed on: 8/4/2014 1:15:01 PM

Peak Analysis From Channel: 1

Peak Analysis To Channel: 512

Peak No.	ROI start	ROI end	Peak centroid	Energy (keV)	FWHM (keV)	Net Peak Area	Net Area Uncert.	Continuum Counts
1	11-	17	14.01	46.60	4.86	1.02E+003	99.50	8.32E+002
2	375-	411	393.56	1173.26	35.27	2.64E+003	182.82	1.08E+003
3	428-	466	447.32	1332.86	38.69	2.35E+003	122.41	2.63E+002
4	466-	503	486.34	1448.67	49.08	8.48E+002	86.34	1.90E+002

M = First peak in a multiplet region

m = Other peak in a multiplet region

F = Fitted singlet

Errors quoted at 1.960 sigma

ALL ACTIVITY RESULTS ARE ESTIMATES.

Total propagated error is much greater than reported.

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 ***** N U C L I D E I D E N T I F I C A T I O N R E P O R T *****

Sample Title: Co-60 Check
 Nuclide Library Used: C:\GENIE2K\CAMFILES\GKP Co60 Ba133.NLB

..... IDENTIFIED NUCLIDES

Nuclide Name	Id Confidence	Energy (keV)	Yield (%)	Activity (uCi/)	Activity Uncertainty
CO-60	0.998	1173.22*	100.00	8.55583E-001	7.29499E-002
		1332.49*	100.00	8.60178E-001	5.93985E-002

* = Energy line found in the spectrum.

@ = Energy line not used for Weighted Mean Activity

Energy Tolerance : 0.500 FWHM

Nuclide confidence index threshold = 0.30

Errors quoted at 1.960 sigma

ALL ACTIVITY RESULTS ARE ESTIMATES.
 Total propagated error is much greater than reported.

 ***** I N T E R F E R E N C E C O R R E C T E D R E P O R T *****

Nuclide Name	Nuclide Id Confidence	Wt mean Activity (uCi/)	Wt mean Activity Uncertainty
CO-60	0.998	8.583464E-001	4.606090E-002

? = nuclide is part of an undetermined solution

X = nuclide rejected by the interference analysis

@ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 1.960 sigma

***** U N I D E N T I F I E D P E A K S *****

Peak Locate Performed on: 8/4/2014 1:15:01 PM
 Peak Locate From Channel: 1
 Peak Locate To Channel: 512

Peak No.	Energy (keV)	Peak Size in Counts per Second	Peak CPS % Uncertainty	Peak Type	Tol. Nuclide
1	46.60	3.3896E+000	9.78		
4	1448.67	2.8267E+000	10.18		

M = First peak in a multiplet region

m = Other peak in a multiplet region

F = Fitted singlet

Errors quoted at 1.960 sigma

ALL ACTIVITY RESULTS ARE ESTIMATES.

Total propagated error is much greater than reported.

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***** N U C L I D E M D A R E P O R T *****

Detector Name: Sgc_LaBr_1R5x1R5
Sample Geometry:
Sample Title: Co-60 Check
Nuclide Library Used: C:\GENIE2K\CAMFILES\GKP Co60 Ba133.NLB

	Nuclide Name	Energy (keV)	Yield (%)	Line MDA (uCi/)	Nuclide MDA (uCi/)	Activity (uCi/)	Dec. Level (uCi/)
+	CO-60	1173.22*	100.00	8.394E-002	4.83E-002	8.556E-001	4.153E-002
		1332.49*	100.00	4.827E-002		8.602E-001	2.364E-002

+ = Nuclide identified during the nuclide identification

* = Energy line found in the spectrum

> = MDA value not calculated

@ = Half-life too short to be able to perform the decay correction

ALL ACTIVITY RESULTS ARE ESTIMATES.

Total propagated error is much greater than reported.

 ***** G A M M A S P E C T R U M A N A L Y S I S *****

Filename: C:\GENIE2K\CAMFILES\GKP\D-05-04.CNF

Report Generated On : 8/4/2014 1:20:12 PM

Sample Title : D-05-04
 Sample Description :
 Sample Identification : D-05-04
 Sample Type :
 Sample Geometry :

Peak Locate Threshold : 3.00
 Peak Locate Range (in channels) : 1 - 512
 Peak Area Range (in channels) : 1 - 512
 Identification Energy Tolerance : 0.500 FWHM

Sample Size : 1.000E+000

Sample Taken On : 7/17/2014 5:10:30 PM
 Acquisition Started : 7/17/2014 5:10:30 PM

Live Time : 1800.0 seconds
 Real Time : 1821.6 seconds

Dead Time : 1.18 %

Energy Calibration Used Done On : 7/17/2014
 Efficiency Calibration Used Done On : 7/18/2014
 Efficiency ID : D-05-04

ALL ACTIVITY RESULTS ARE ESTIMATES.
 Total propagated error is much greater than reported.

***** P E A K A N A L Y S I S R E P O R T *****

Detector Name: Sgc_LaBr_1R5x1R5

Sample Title: D-05-04

Peak Analysis Performed on: 8/4/2014 1:20:12 PM

Peak Analysis From Channel: 1

Peak Analysis To Channel: 512

Peak No.	ROI start	ROI end	Peak centroid	Energy (keV)	FWHM (keV)	Net Peak Area	Net Area Uncert.	Continuum Counts
1	11-	19	15.12	49.92	6.79	8.57E+003	971.86	1.12E+005
2	20-	30	25.50	80.72	11.87	2.04E+005	1572.49	1.85E+005
3	43-	56	50.50	154.93	20.30	7.56E+003	1476.94	2.04E+005
4	56-	69	62.39	190.21	13.95	3.31E+004	1461.73	1.90E+005
5	75-	89	80.89	245.14	15.06	4.79E+004	1394.84	1.60E+005
6	91-	108	99.29	299.76	16.72	1.03E+005	1517.95	1.53E+005
7	108-	148	117.56	353.98	18.58	1.88E+005	2359.24	2.06E+005
8	190-	244	203.94	610.39	25.19	1.46E+005	1838.48	9.32E+004
9	247-	272	257.64	769.81	29.12	1.24E+004	813.91	3.77E+004
10	300-	329	313.05	934.27	28.04	5.64E+003	776.63	3.19E+004
11	358-	393	376.14	1121.57	35.41	2.73E+004	824.70	2.72E+004
12	400-	434	416.04	1240.00	35.86	9.12E+003	695.66	2.17E+004
13	446-	485	466.10	1388.59	46.17	8.45E+003	749.76	2.30E+004

M = First peak in a multiplet region

m = Other peak in a multiplet region

F = Fitted singlet

Errors quoted at 1.960 sigma

ALL ACTIVITY RESULTS ARE ESTIMATES.

Total propagated error is much greater than reported.

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 ***** N U C L I D E I D E N T I F I C A T I O N R E P O R T *****

Sample Title: D-05-04
 Nuclide Library Used: C:\GENIE2K\CAMFILES\GKP Library.NLB

..... IDENTIFIED NUCLIDES

Nuclide Name	Id Confidence	Energy (keV)	Yield (%)	Activity (uCi/)	Activity Uncertainty
BI-214	0.917	609.31*	46.30	5.80382E+000	4.38745E-001
		768.36*	5.04	5.65670E+000	5.04298E-001
		806.17	1.23		
		934.06*	3.21	4.83386E+000	7.18733E-001
		1120.29*	15.10	5.90070E+000	3.50913E-001
		1155.19	1.69		
		1238.11*	5.94	5.49540E+000	4.94147E-001
		1280.96	1.47		
		1385.31*	8.76	3.83545E+000	3.81127E-001
		1509.19	2.19		
		1661.28	1.15		
		1729.60	3.05		
		1764.49	15.80		
		1847.44	2.12		
PB-214	0.981	2118.54	1.21		
		79.00*	21.80	6.56446E+000	1.69926E+000
		241.98*	7.49	5.25212E+000	7.72787E-001
		295.21*	19.20	5.11655E+000	7.51517E-001
		351.92*	37.20	5.53335E+000	7.57068E-001
RA-226	0.988	785.91	1.10		
		186.21*	3.28	7.31159E+000	9.97175E-001

* = Energy line found in the spectrum.

@ = Energy line not used for Weighted Mean Activity

Energy Tolerance : 0.500 FWHM

Nuclide confidence index threshold = 0.30

Errors quoted at 1.960 sigma

ALL ACTIVITY RESULTS ARE ESTIMATES.

Total propagated error is much greater than reported.

 ***** I N T E R F E R E N C E C O R R E C T E D R E P O R T *****

	Nuclide Name	Nuclide Id Confidence	Wt mean Activity (uCi/)	Wt mean Activity Uncertainty
X	PB-212	0.970		
	BI-214	0.917	5.257351E+000	1.820795E-001
	PB-214	0.981	5.379487E+000	4.250068E-001
	RA-226	0.988	7.311594E+000	9.971753E-001

? = nuclide is part of an undetermined solution

X = nuclide rejected by the interference analysis

@ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 1.960 sigma

***** U N I D E N T I F I E D P E A K S *****

Peak Locate Performed on: 8/4/2014 1:20:12 PM
 Peak Locate From Channel: 1
 Peak Locate To Channel: 512

Peak No.	Energy (keV)	Peak Size in Counts per Second	Peak CPS % Uncertainty	Peak Type	Tol. Nuclide
1	49.92	4.7596E+000	11.34		
3	154.93	4.1999E+000	19.54	Sum	

M = First peak in a multiplet region

m = Other peak in a multiplet region

F = Fitted singlet

Errors quoted at 1.960 sigma

ALL ACTIVITY RESULTS ARE ESTIMATES.

Total propagated error is much greater than reported.

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 ***** N U C L I D E M D A R E P O R T *****

Detector Name: Sgc_LaBr_1R5x1R5
 Sample Geometry:
 Sample Title: D-05-04
 Nuclide Library Used: C:\GENIE2K\CAMFILES\GKP Library.NLB

	Nuclide Name	Energy (keV)	Yield (%)	Line MDA (uCi/)	Nuclide MDA (uCi/)	Activity (uCi/)	Dec. Level (uCi/)
	K-40	1460.81	10.67	3.894E-001	3.89E-001	4.245E-001	1.942E-001
+	BI-214	609.31*	46.30	1.122E-001	1.12E-001	5.804E+000	5.605E-002
		768.36*	5.04	6.011E-001		5.657E+000	2.999E-001
		806.17	1.23	2.841E+000		3.151E+001	1.418E+000
		934.06*	3.21	1.100E+000		4.834E+000	5.489E-001
		1120.29*	15.10	2.754E-001		5.901E+000	1.374E-001
		1155.19	1.69	2.732E+000		5.753E+001	1.363E+000
		1238.11*	5.94	6.789E-001		5.495E+000	3.387E-001
		1280.96	1.47	2.812E+000		1.917E+001	1.402E+000
		1385.31*	8.76	5.557E-001		3.835E+000	2.772E-001
		1509.19	2.19	1.647E+000		2.133E+000	8.209E-001
>		1661.28	1.15	0.000E+000		0.000E+000	0.000E+000
>		1729.60	3.05	0.000E+000		0.000E+000	0.000E+000
>		1764.49	15.80	0.000E+000		0.000E+000	0.000E+000
>		1847.44	2.12	0.000E+000		0.000E+000	0.000E+000
>		2118.54	1.21	0.000E+000		0.000E+000	0.000E+000
+	PB-214	79.00*	21.80	7.018E-002	7.02E-002	6.564E+000	3.504E-002
		241.98*	7.49	2.447E-001		5.252E+000	1.222E-001
		295.21*	19.20	1.151E-001		5.117E+000	5.747E-002
		351.92*	37.20	1.091E-001		5.533E+000	5.451E-002
		785.91	1.10	3.131E+000		3.402E+001	1.562E+000
	PA-234M	766.36	0.29	1.135E+001	4.27E+000	1.206E+002	5.665E+000
		1001.03	0.84	4.268E+000		-5.081E+000	2.129E+000
	TH-234	63.29	4.50	5.260E-001	5.26E-001	5.093E+001	2.628E-001
		92.38	2.60	9.586E-001		4.930E+001	4.789E-001
		92.80	2.60	9.553E-001		4.973E+001	4.773E-001
		112.81	0.26	9.312E+000		-2.968E+002	4.652E+000

+ = Nuclide identified during the nuclide identification

* = Energy line found in the spectrum

> = MDA value not calculated

@ = Half-life too short to be able to perform the decay correction

ALL ACTIVITY RESULTS ARE ESTIMATES.

Total propagated error is much greater than reported.

***** G A M M A S P E C T R U M A N A L Y S I S *****

Filename: C:\GENIE2K\CAMFILES\GKP\D-08-07.CNF

Report Generated On : 8/4/2014 1:20:55 PM

Sample Title : D-08-07
Sample Description :
Sample Identification : D-08-07
Sample Type :
Sample Geometry :

Peak Locate Threshold : 3.00
Peak Locate Range (in channels) : 1 - 512
Peak Area Range (in channels) : 1 - 512
Identification Energy Tolerance : 0.500 FWHM

Sample Size : 1.000E+000

Sample Taken On : 7/17/2014 5:49:56 PM
Acquisition Started : 7/17/2014 5:49:56 PM

Live Time : 1800.0 seconds
Real Time : 1804.3 seconds

Dead Time : 0.24 %

Energy Calibration Used Done On : 7/17/2014
Efficiency Calibration Used Done On : 7/18/2014
Efficiency ID : D-08-07

ALL ACTIVITY RESULTS ARE ESTIMATES.
Total propagated error is much greater than reported.

***** P E A K A N A L Y S I S R E P O R T *****

Detector Name: Sgc_LaBr_1R5x1R5

Sample Title: D-08-07

Peak Analysis Performed on: 8/4/2014 1:20:55 PM

Peak Analysis From Channel: 1

Peak Analysis To Channel: 512

Peak No.	ROI start	ROI end	Peak centroid	Energy (keV)	FWHM (keV)	Net Peak Area	Net Area Uncert.	Continuum Counts
1	10-	18	14.06	46.76	4.49	5.41E+003	274.63	6.69E+003
2	20-	30	25.71	81.34	12.81	6.49E+003	416.27	1.63E+004
3	58-	70	62.50	190.53	11.18	1.19E+003	361.37	1.25E+004
4	76-	89	80.66	244.45	14.13	1.18E+003	312.93	8.84E+003
5	90-	108	99.45	300.24	16.89	2.39E+003	349.07	8.69E+003
6	108-	127	117.65	354.26	18.07	4.63E+003	329.63	6.76E+003
7	191-	217	203.96	610.46	25.08	3.47E+003	292.64	4.30E+003
8	253-	278	268.81	802.96	9.69	4.31E+002	256.43	3.93E+003
9	359-	390	375.85	1120.69	21.04	5.13E+002	237.42	2.83E+003
10	467-	503	487.50	1452.13	47.51	4.70E+003	232.26	1.66E+003

M = First peak in a multiplet region

m = Other peak in a multiplet region

F = Fitted singlet

Errors quoted at 1.960 sigma

ALL ACTIVITY RESULTS ARE ESTIMATES.

Total propagated error is much greater than reported.

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 ***** N U C L I D E I D E N T I F I C A T I O N R E P O R T *****

Sample Title: D-08-07

Nuclide Library Used: C:\GENIE2K\CAMFILES\GKP Library.NLB

..... IDENTIFIED NUCLIDES

Nuclide Name	Id Confidence	Energy (keV)	Yield (%)	Activity (uCi/)	Activity Uncertainty
K-40	0.944	1460.81*	10.67	1.49906E-001	1.04610E-002
BI-214	0.643	609.31*	46.30	1.08549E-002	1.22232E-003
		768.36	5.04		
		806.17*	1.23	6.72131E-002	4.01858E-002
		934.06	3.21		
		1120.29*	15.10	9.01834E-003	4.19927E-003
		1155.19	1.69		
		1238.11	5.94		
		1280.96	1.47		
		1385.31	8.76		
		1509.19	2.19		
		1661.28	1.15		
		1729.60	3.05		
		1764.49	15.80		
		1847.44	2.12		
		2118.54	1.21		
PB-214	0.981	79.00*	21.80	1.18382E-002	3.08217E-003
		241.98*	7.49	8.94302E-003	2.69427E-003
		295.21*	19.20	8.52184E-003	1.76085E-003
		351.92*	37.20	1.01029E-002	1.55221E-003
		785.91	1.10		
RA-226	0.986	186.21*	3.28	1.71724E-002	5.66377E-003

* = Energy line found in the spectrum.

@ = Energy line not used for Weighted Mean Activity

Energy Tolerance : 0.500 FWHM

Nuclide confidence index threshold = 0.30

Errors quoted at 1.960 sigma

ALL ACTIVITY RESULTS ARE ESTIMATES.

Total propagated error is much greater than reported.

 ***** I N T E R F E R E N C E C O R R E C T E D R E P O R T *****

	Nuclide Name	Nuclide Id Confidence	Wt mean Activity (uCi/)	Wt mean Activity Uncertainty
	K-40	0.944	1.499063E-001	1.046097E-002
X	PB-212	0.976		
	BI-214	0.643	1.075963E-002	1.173113E-003
	PB-214	0.981	9.606211E-003	1.009847E-003
	RA-226	0.986	1.717241E-002	5.663774E-003

? = nuclide is part of an undetermined solution

X = nuclide rejected by the interference analysis

@ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 1.960 sigma

***** U N I D E N T I F I E D P E A K S *****

Peak Locate Performed on: 8/4/2014 1:20:55 PM
 Peak Locate From Channel: 1
 Peak Locate To Channel: 512

Peak No.	Energy (keV)	Peak Size in Counts per Second	Peak CPS % Uncertainty	Peak Type	Tol. Nuclide
1	46.76	3.0034E+000	5.08		

M = First peak in a multiplet region

m = Other peak in a multiplet region

F = Fitted singlet

Errors quoted at 1.960 sigma

ALL ACTIVITY RESULTS ARE ESTIMATES.

Total propagated error is much greater than reported.

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 ***** N U C L I D E M D A R E P O R T *****

Detector Name: Sgc_LaBr_1R5x1R5
 Sample Geometry:
 Sample Title: D-08-07
 Nuclide Library Used: C:\GENIE2K\CAMFILES\GKP Library.NLB

	Nuclide Name	Energy (keV)	Yield (%)	Line MDA (uCi/)	Nuclide MDA (uCi/)	Activity (uCi/)	Dec. Level (uCi/)
+	K-40	1460.81*	10.67	1.022E-002	1.02E-002	1.499E-001	5.068E-003
+	BI-214	609.31*	46.30	1.422E-003	1.42E-003	1.085E-002	7.067E-004
		768.36	5.04	1.595E-002		-2.950E-002	7.924E-003
		806.17*	1.23	6.670E-002		6.721E-002	3.314E-002
		934.06	3.21	3.181E-002		7.519E-002	1.581E-002
		1120.29*	15.10	6.930E-003		9.018E-003	3.441E-003
		1155.19	1.69	6.239E-002		2.497E-001	3.098E-002
		1238.11	5.94	1.656E-002		-7.988E-004	8.211E-003
		1280.96	1.47	6.090E-002		-2.383E-001	3.017E-002
		1385.31	8.76	1.528E-002		1.364E-001	7.592E-003
		1509.19	2.19	6.143E-002		-2.261E-002	3.050E-002
>		1661.28	1.15	0.000E+000		0.000E+000	0.000E+000
>		1729.60	3.05	0.000E+000		0.000E+000	0.000E+000
>		1764.49	15.80	0.000E+000		0.000E+000	0.000E+000
>		1847.44	2.12	0.000E+000		0.000E+000	0.000E+000
>		2118.54	1.21	0.000E+000		0.000E+000	0.000E+000
+	PB-214	79.00*	21.80	1.184E-003	1.11E-003	1.184E-002	5.897E-004
		241.98*	7.49	3.899E-003		8.943E-003	1.939E-003
		295.21*	19.20	2.020E-003		8.522E-003	1.005E-003
		351.92*	37.20	1.109E-003		1.010E-002	5.517E-004
		785.91	1.10	7.748E-002		1.493E-001	3.851E-002
	PA-234M	766.36	0.29	2.718E-001	1.17E-001	-7.584E-001	1.351E-001
		1001.03	0.84	1.173E-001		-6.231E-002	5.827E-002
	TH-234	63.29	4.50	7.781E-003	7.78E-003	1.585E-001	3.878E-003
		92.38	2.60	1.480E-002		1.462E-001	7.377E-003
		92.80	2.60	1.485E-002		1.510E-001	7.405E-003
		112.81	0.26	1.542E-001		-5.373E-001	7.690E-002

+ = Nuclide identified during the nuclide identification

* = Energy line found in the spectrum

> = MDA value not calculated

@ = Half-life too short to be able to perform the decay correction

ALL ACTIVITY RESULTS ARE ESTIMATES.

Total propagated error is much greater than reported.

***** G A M M A S P E C T R U M A N A L Y S I S *****

Filename: C:\GENIE2K\CAMFILES\GKP\H-12-26.CNF

Report Generated On : 8/4/2014 1:21:39 PM

Sample Title : H-12-26
Sample Description :
Sample Identification : H-12-26
Sample Type :
Sample Geometry :

Peak Locate Threshold : 3.00
Peak Locate Range (in channels) : 1 - 512
Peak Area Range (in channels) : 1 - 512
Identification Energy Tolerance : 0.500 FWHM

Sample Size : 1.000E+000

Sample Taken On : 7/17/2014 6:26:49 PM
Acquisition Started : 7/17/2014 6:26:49 PM

Live Time : 1800.0 seconds
Real Time : 1804.1 seconds

Dead Time : 0.23 %

Energy Calibration Used Done On : 7/17/2014
Efficiency Calibration Used Done On : 7/18/2014
Efficiency ID : H-12-26

ALL ACTIVITY RESULTS ARE ESTIMATES.
Total propagated error is much greater than reported.

***** P E A K A N A L Y S I S R E P O R T *****

Detector Name: Sgc_LaBr_1R5x1R5

Sample Title: H-12-26

Peak Analysis Performed on: 8/4/2014 1:21:39 PM

Peak Analysis From Channel: 1

Peak Analysis To Channel: 512

	Peak No.	ROI start	ROI end	Peak centroid	Energy (keV)	FWHM (keV)	Net Peak Area	Net Area Uncert.	Continuum Counts
	1	21-	31	26.19	82.78	17.37	4.96E+003	414.22	1.67E+004
	2	36-	49	42.95	132.51	9.34	4.71E+002	488.71	2.24E+004
	3	73-	88	79.97	242.40	13.87	6.00E+003	425.73	1.37E+004
	4	106-	124	114.31	344.33	26.68	2.22E+003	328.73	7.68E+003
M	5	143-	180	155.11	465.44	15.47	2.34E+002	16.01	3.95E+003
m	6	143-	180	171.40	513.82	28.49	8.54E+002	24.24	5.38E+003
	7	183-	209	196.34	587.84	29.21	3.19E+003	318.13	5.29E+003
	8	236-	253	243.12	726.70	14.40	2.08E+002	177.57	2.46E+003
	9	253-	274	266.87	797.20	5.27	3.30E+002	232.62	3.67E+003
	10	295-	317	305.46	911.74	25.17	5.15E+002	255.75	4.26E+003
	11	318-	342	326.08	972.96	10.37	6.01E+002	229.50	3.18E+003
	12	367-	387	376.25	1121.88	5.59	1.91E+002	157.56	1.73E+003
	13	467-	503	487.02	1450.70	51.40	4.62E+003	224.76	1.52E+003

M = First peak in a multiplet region

m = Other peak in a multiplet region

F = Fitted singlet

Errors quoted at 1.960 sigma

ALL ACTIVITY RESULTS ARE ESTIMATES.

Total propagated error is much greater than reported.

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 ***** N U C L I D E I D E N T I F I C A T I O N R E P O R T *****

Sample Title: H-12-26
 Nuclide Library Used: C:\GENIE2K\CAMFILES\GKP Library.NLB

..... IDENTIFIED NUCLIDES

Nuclide Name	Id Confidence	Energy (keV)	Yield (%)	Activity (uCi/)	Activity Uncertainty
K-40	0.924	1460.81*	10.67	1.85219E-001	1.28305E-002
BI-212	0.987	727.17*	11.80	3.94056E-003	3.38112E-003
		785.42*	2.00	4.03420E-002	2.85815E-002
		1620.56	2.75		
PB-212	0.886	238.63*	44.60	1.04587E-002	1.67587E-003
		300.09	3.41		
PB-214	0.634	79.00*	21.80	1.35325E-002	3.41004E-003
		241.98*	7.49	6.22776E-002	9.97916E-003
		295.21	19.20		
		351.92*	37.20	6.36622E-003	1.28962E-003
		785.91*	1.10	7.33491E-002	5.19663E-002
AC-228	0.463	89.95	2.10		
		93.35	3.50		
		129.08*	2.80	9.96172E-003	1.04242E-002
		209.28	4.40		
		270.23	3.60		
		327.64	3.20		
		338.32*	11.40	2.07740E-002	4.20822E-003
		409.51	2.13		
		463.00*	4.40	7.64558E-003	9.61294E-004
		794.70*	4.60	1.75400E-002	1.24267E-002
		911.60*	27.70	5.16998E-003	2.58262E-003
		964.60	5.20		
		969.11*	16.60	1.06901E-002	4.12523E-003
		1587.90	3.71		

* = Energy line found in the spectrum.

@ = Energy line not used for Weighted Mean Activity

Energy Tolerance : 0.500 FWHM

Nuclide confidence index threshold = 0.30

Errors quoted at 1.960 sigma

ALL ACTIVITY RESULTS ARE ESTIMATES.

Total propagated error is much greater than reported.

 ***** I N T E R F E R E N C E C O R R E C T E D R E P O R T *****

Nuclide Name	Nuclide Id Confidence	Wt mean Activity (uCi/)	Wt mean Activity Uncertainty
K-40	0.924	1.852186E-001	1.283047E-002
BI-212	0.987	4.168455E-003	3.357819E-003
PB-212	0.886	9.568609E-003	1.688530E-003
PB-214	0.634	5.300264E-003	1.228760E-003
AC-228	0.463	7.379895E-003	8.728054E-004

? = nuclide is part of an undetermined solution

X = nuclide rejected by the interference analysis

@ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 1.960 sigma

***** U N I D E N T I F I E D P E A K S *****

Peak Locate Performed on: 8/4/2014 1:21:39 PM
 Peak Locate From Channel: 1
 Peak Locate To Channel: 512

Peak No.	Energy (keV)	Peak Size in Counts per Second	Peak CPS % Uncertainty	Peak Type	Tol. Nuclide
m 6	513.82	4.7424E-001	2.84		
7	587.84	1.7733E+000	9.97	Sum	
12	1121.88	1.0618E-001	82.44		

M = First peak in a multiplet region

m = Other peak in a multiplet region

F = Fitted singlet

Errors quoted at 1.960 sigma

ALL ACTIVITY RESULTS ARE ESTIMATES.

Total propagated error is much greater than reported.

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 ***** N U C L I D E M D A R E P O R T *****

Detector Name: Sgc_LaBr_1R5x1R5
 Sample Geometry:
 Sample Title: H-12-26
 Nuclide Library Used: C:\GENIE2K\CAMFILES\GKP Library.NLB

	Nuclide Name	Energy (keV)	Yield (%)	Line MDA (uCi/)	Nuclide MDA (uCi/)	Activity (uCi/)	Dec. Level (uCi/)
+	K-40	1460.81*	10.67	1.230E-002	1.23E-002	1.852E-001	6.096E-003
	BI-214	609.31	46.30	2.179E-003	2.18E-003	1.506E-002	1.084E-003
		768.36	5.04	2.207E-002		-2.561E-002	1.097E-002
		806.17	1.23	9.915E-002		-7.659E-002	4.931E-002
		934.06	3.21	4.453E-002		1.561E-001	2.215E-002
		1120.29	15.10	8.077E-003		-4.046E-003	4.008E-003
		1155.19	1.69	7.348E-002		1.948E-001	3.646E-002
		1238.11	5.94	1.989E-002		3.253E-002	9.862E-003
		1280.96	1.47	7.410E-002		-1.128E-001	3.670E-002
		1385.31	8.76	1.902E-002		1.751E-001	9.448E-003
		1509.19	2.19	7.602E-002		-2.780E-002	3.774E-002
>		1661.28	1.15	0.000E+000		0.000E+000	0.000E+000
>		1729.60	3.05	0.000E+000		0.000E+000	0.000E+000
>		1764.49	15.80	0.000E+000		0.000E+000	0.000E+000
>		1847.44	2.12	0.000E+000		0.000E+000	0.000E+000
>		2118.54	1.21	0.000E+000		0.000E+000	0.000E+000
+	PB-214	79.00*	21.80	1.795E-003	1.52E-003	1.353E-002	8.937E-004
		241.98*	7.49	6.955E-003		6.228E-002	3.464E-003
		295.21	19.20	3.820E-003		1.082E-003	1.904E-003
		351.92*	37.20	1.524E-003		6.366E-003	7.579E-004
		785.91*	1.10	8.650E-002		7.335E-002	4.295E-002
	PA-234M	766.36	0.29	3.765E-001	1.62E-001	-6.917E-001	1.872E-001
		1001.03	0.84	1.623E-001		-3.573E-001	8.065E-002
	TH-234	63.29	4.50	1.179E-002	1.18E-002	8.545E-002	5.876E-003
		92.38	2.60	2.166E-002		-2.538E-002	1.080E-002
		92.80	2.60	2.177E-002		1.488E-001	1.086E-002
		112.81	0.26	2.257E-001		-9.880E-002	1.126E-001

+ = Nuclide identified during the nuclide identification

* = Energy line found in the spectrum

> = MDA value not calculated

@ = Half-life too short to be able to perform the decay correction

ALL ACTIVITY RESULTS ARE ESTIMATES.

Total propagated error is much greater than reported.

 ***** G A M M A S P E C T R U M A N A L Y S I S *****

Filename: C:\GENIE2K\CAMFILES\GKP\I-13-21.CNF

Report Generated On : 8/4/2014 1:25:40 PM

Sample Title : I-13-21
 Sample Description :
 Sample Identification : I-13-21
 Sample Type :
 Sample Geometry :

Peak Locate Threshold : 3.00
 Peak Locate Range (in channels) : 1 - 512
 Peak Area Range (in channels) : 1 - 512
 Identification Energy Tolerance : 0.500 FWHM

Sample Size : 1.000E+000

Sample Taken On : 7/17/2014 4:36:19 PM
 Acquisition Started : 7/17/2014 4:36:19 PM

Live Time : 1800.0 seconds
 Real Time : 1806.3 seconds

Dead Time : 0.35 %

Energy Calibration Used Done On : 7/17/2014
 Efficiency Calibration Used Done On : 7/18/2014
 Efficiency ID : I-13-21

ALL ACTIVITY RESULTS ARE ESTIMATES.
 Total propagated error is much greater than reported.

 ***** P E A K A N A L Y S I S R E P O R T *****

Detector Name: Sgc_LaBr_1R5x1R5

Sample Title: I-13-21

Peak Analysis Performed on: 8/4/2014 1:25:40 PM

Peak Analysis From Channel: 1

Peak Analysis To Channel: 512

	Peak No.	ROI start	ROI end	Peak centroid	Energy (keV)	FWHM (keV)	Net Peak Area	Net Area Uncert.	Continuum Counts
	1	10-	18	14.20	47.17	3.97	4.13E+003	343.34	1.25E+004
M	2	19-	37	25.02	79.29	16.47	8.94E+003	406.62	3.94E+004
m	3	19-	37	31.80	99.41	17.60	1.20E+004	457.39	4.47E+004
	4	45-	56	49.98	153.39	16.45	6.67E+002	560.61	3.25E+004
	5	58-	69	62.28	189.91	13.57	1.64E+003	533.41	2.90E+004
	6	76-	89	80.71	244.61	13.57	1.45E+003	542.16	2.73E+004
	7	90-	108	99.36	299.98	16.04	6.91E+003	641.65	2.97E+004
	8	109-	127	117.57	354.02	18.63	1.77E+004	593.79	2.19E+004
M	9	190-	231	203.78	609.93	25.26	2.08E+004	346.55	1.17E+004
m	10	190-	231	223.29	667.85	26.46	3.40E+002	154.67	8.93E+003
	11	245-	273	258.41	772.09	19.99	1.25E+003	450.16	1.11E+004
	12	302-	328	312.64	933.08	17.92	9.60E+002	372.03	8.02E+003
	13	358-	393	375.96	1121.02	34.27	4.70E+003	408.95	7.06E+003
	14	400-	434	415.78	1239.24	39.76	1.73E+003	340.23	5.29E+003
M	15	446-	503	467.99	1394.20	51.29	1.34E+003	149.89	6.06E+003
m	16	446-	503	490.99	1462.49	52.25	3.94E+003	200.47	5.69E+003

M = First peak in a multiplet region

m = Other peak in a multiplet region

F = Fitted singlet

Errors quoted at 1.960 sigma

ALL ACTIVITY RESULTS ARE ESTIMATES.

Total propagated error is much greater than reported.

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 ***** N U C L I D E I D E N T I F I C A T I O N R E P O R T *****

Sample Title: I-13-21

Nuclide Library Used: C:\GENIE2K\CAMFILES\GKP Library.NLB

..... IDENTIFIED NUCLIDES

Nuclide Name	Id Confidence	Energy (keV)	Yield (%)	Activity (uCi/)	Activity Uncertainty
K-40	0.998	1460.81*	10.67	1.99543E+000	1.41496E-001
BI-214	0.912	609.31*	46.30	1.16320E+000	8.89199E-002
		768.36*	5.04	7.81171E-001	2.86349E-001
		806.17	1.23		
		934.06*	3.21	1.10871E+000	4.33944E-001
		1120.29*	15.10	1.34384E+000	1.35701E-001
		1155.19	1.69		
		1238.11*	5.94	1.36305E+000	2.76588E-001
		1280.96	1.47		
		1385.31*	8.76	7.95674E-001	9.55651E-002
		1509.19	2.19		
		1661.28	1.15		
		1729.60	3.05		
		1764.49	15.80		
		1847.44	2.12		
		2118.54	1.21		
PB-214	0.992	79.00*	21.80	5.55893E-001	1.54278E-001
		241.98*	7.49	2.49211E-001	9.98937E-002
		295.21*	19.20	5.24618E-001	9.08135E-002
		351.92*	37.20	7.83363E-001	1.09899E-001
		785.91*	1.10	3.57918E+000	1.31200E+000
RA-226	0.990	186.21*	3.28	5.84698E-001	2.05010E-001

* = Energy line found in the spectrum.

@ = Energy line not used for Weighted Mean Activity

Energy Tolerance : 0.500 FWHM

Nuclide confidence index threshold = 0.30

Errors quoted at 1.960 sigma

ALL ACTIVITY RESULTS ARE ESTIMATES.

Total propagated error is much greater than reported.

 ***** I N T E R F E R E N C E C O R R E C T E D R E P O R T *****

Nuclide Name	Nuclide Id Confidence		Wt mean Activity (uCi/)	Wt mean Activity Uncertainty
K-40	0.998		1.995432E+000	1.414961E-001
X PB-212	0.975			
BI-214	0.912		1.056858E+000	5.582909E-002
PB-214	0.992		5.076060E-001	5.369541E-002
RA-226	0.990		5.846980E-001	2.050100E-001

? = nuclide is part of an undetermined solution
 X = nuclide rejected by the interference analysis
 @ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 1.960 sigma

ALL ACTIVITY RESULTS ARE ESTIMATES.
 Total propagated error is much greater than reported.

***** U N I D E N T I F I E D P E A K S *****

Peak Locate Performed on: 8/4/2014 1:25:40 PM
 Peak Locate From Channel: 1
 Peak Locate To Channel: 512

Peak No.	Energy (keV)	Peak Size in Counts per Second	Peak CPS % Uncertainty	Peak Type	Tol. Nuclide
1	47.17	2.2935E+000	8.32		
m 3	99.41	6.6787E+000	3.80	D-Esc.	
4	153.39	3.7056E-001	84.05	Sum	
m 10	667.85	1.8897E-001	45.47		

M = First peak in a multiplet region
 m = Other peak in a multiplet region
 F = Fitted singlet

Errors quoted at 1.960 sigma

ALL ACTIVITY RESULTS ARE ESTIMATES.
 Total propagated error is much greater than reported.

 ***** N U C L I D E M D A R E P O R T *****

Detector Name: Sgc_LaBr_1R5x1R5
 Sample Geometry:
 Sample Title: I-13-21
 Nuclide Library Used: C:\GENIE2K\CAMFILES\GKP Library.NLB

	Nuclide Name	Energy (keV)	Yield (%)	Line MDA (uCi/)	Nuclide MDA (uCi/)	Activity (uCi/)	Dec. Level (uCi/)
+	K-40	1460.81*	10.67	1.789E-001	1.79E-001	1.995E+000	8.878E-002
+	BI-214	609.31*	46.30	2.826E-002	2.83E-002	1.163E+000	1.405E-002
		768.36*	5.04	4.702E-001		7.812E-001	2.342E-001
		806.17	1.23	1.933E+000		5.931E+000	9.627E-001
		934.06*	3.21	7.144E-001		1.109E+000	3.556E-001
		1120.29*	15.10	1.861E-001		1.344E+000	9.268E-002
		1155.19	1.69	1.712E+000		1.246E+001	8.525E-001
		1238.11*	5.94	4.403E-001		1.363E+000	2.191E-001
		1280.96	1.47	1.727E+000		2.996E+000	8.590E-001
		1385.31*	8.76	2.160E-001		7.957E-001	1.072E-001
		1509.19	2.19	1.233E+000		-2.941E-001	6.132E-001
>		1661.28	1.15	0.000E+000		0.000E+000	0.000E+000
>		1729.60	3.05	0.000E+000		0.000E+000	0.000E+000
>		1764.49	15.80	0.000E+000		0.000E+000	0.000E+000
>		1847.44	2.12	0.000E+000		0.000E+000	0.000E+000
>		2118.54	1.21	0.000E+000		0.000E+000	0.000E+000
+	PB-214	79.00*	21.80	5.761E-002	3.97E-002	5.559E-001	2.872E-002
		241.98*	7.49	1.554E-001		2.492E-001	7.749E-002
		295.21*	19.20	7.926E-002		5.246E-001	3.953E-002
		351.92*	37.20	3.971E-002		7.834E-001	1.980E-002
		785.91*	1.10	2.154E+000		3.579E+000	1.073E+000
	PA-234M	766.36	0.29	7.645E+000	2.93E+000	3.234E+001	3.808E+000
		1001.03	0.84	2.933E+000		-3.433E-001	1.460E+000
	TH-234	63.29	4.50	3.877E-001	3.88E-001	3.684E+000	1.934E-001
		92.38	2.60	6.859E-001		9.238E+000	3.423E-001
		92.80	2.60	6.878E-001		-1.666E-001	3.432E-001
		112.81	0.26	6.678E+000		-9.152E+000	3.333E+000

+ = Nuclide identified during the nuclide identification

* = Energy line found in the spectrum

> = MDA value not calculated

@ = Half-life too short to be able to perform the decay correction

ALL ACTIVITY RESULTS ARE ESTIMATES.

Total propagated error is much greater than reported.

 ***** G A M M A S P E C T R U M A N A L Y S I S *****

Filename: C:\GENIE2K\CAMFILES\GKP\N-20-29.CNF

Report Generated On : 8/4/2014 1:26:44 PM

Sample Title : N-20-29
 Sample Description :
 Sample Identification : N-20-29
 Sample Type :
 Sample Geometry :

Peak Locate Threshold : 3.00
 Peak Locate Range (in channels) : 1 - 512
 Peak Area Range (in channels) : 1 - 512
 Identification Energy Tolerance : 0.500 FWHM

Sample Size : 1.000E+000

Sample Taken On : 7/17/2014 3:44:40 PM
 Acquisition Started : 7/17/2014 3:44:40 PM

Live Time : 1800.0 seconds
 Real Time : 1814.5 seconds

Dead Time : 0.80 %

Energy Calibration Used Done On : 7/17/2014
 Efficiency Calibration Used Done On : 7/17/2014
 Efficiency ID : N20-29

ALL ACTIVITY RESULTS ARE ESTIMATES.
 Total propagated error is much greater than reported.

***** P E A K A N A L Y S I S R E P O R T *****

Detector Name: Sgc_LaBr_1R5x1R5

Sample Title: N-20-29

Peak Analysis Performed on: 8/4/2014 1:26:44 PM

Peak Analysis From Channel: 1

Peak Analysis To Channel: 512

Peak No.	ROI start	ROI end	Peak centroid	Energy (keV)	FWHM (keV)	Net Peak Area	Net Area Uncert.	Continuum Counts
1	20-	30	25.33	80.22	12.90	7.55E+004	1118.14	1.05E+005
2	43-	56	49.97	153.35	20.70	9.93E+003	1307.21	1.58E+005
3	58-	69	62.29	189.94	14.74	1.57E+004	1116.65	1.24E+005
4	74-	89	80.86	245.04	14.71	2.17E+004	1243.79	1.27E+005
5	90-	108	99.21	299.51	16.61	4.79E+004	1295.37	1.15E+005
6	108-	127	117.51	353.84	18.57	9.60E+004	1198.19	7.93E+004
7	190-	216	203.89	610.25	25.31	7.85E+004	927.77	3.33E+004
8	244-	272	257.62	769.74	26.79	5.59E+003	721.01	2.81E+004
9	301-	328	312.78	933.49	31.34	3.82E+003	585.64	1.90E+004
10	358-	393	375.95	1121.00	34.36	1.58E+004	654.69	1.74E+004
11	402-	434	415.69	1238.97	40.08	5.39E+003	522.84	1.28E+004
M 12	447-	503	467.13	1391.66	50.58	5.43E+003	273.24	1.57E+004
m 13	447-	503	491.31	1463.42	51.50	2.92E+003	241.11	1.45E+004

M = First peak in a multiplet region

m = Other peak in a multiplet region

F = Fitted singlet

Errors quoted at 1.960 sigma

ALL ACTIVITY RESULTS ARE ESTIMATES.

Total propagated error is much greater than reported.

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 ***** N U C L I D E I D E N T I F I C A T I O N R E P O R T *****

Sample Title: N-20-29
 Nuclide Library Used: C:\GENIE2K\CAMFILES\GKP Library.NLB

..... IDENTIFIED NUCLIDES

Nuclide Name	Id Confidence	Energy (keV)	Yield (%)	Activity (uCi/)	Activity Uncertainty
K-40	0.995	1460.81*	10.67	1.67165E+000	1.60739E-001
BI-214	0.914	609.31*	46.30	5.02152E+000	3.79080E-001
		768.36*	5.04	3.98722E+000	5.67890E-001
		806.17	1.23		
		934.06*	3.21	5.01274E+000	8.18173E-001
		1120.29*	15.10	5.10905E+000	3.37064E-001
		1155.19	1.69		
		1238.11*	5.94	4.82051E+000	5.21082E-001
		1280.96	1.47		
		1385.31*	8.76	3.62731E+000	2.44175E-001
		1509.19	2.19		
		1661.28	1.15		
		1729.60	3.05		
		1764.49	15.80		
		1847.44	2.12		
		2118.54	1.21		
PB-214	0.981	79.00*	21.80	5.59901E+000	1.48025E+000
		241.98*	7.49	4.34724E+000	6.74579E-001
		295.21*	19.20	4.20532E+000	6.25122E-001
		351.92*	37.20	4.90203E+000	6.70803E-001
		785.91	1.10		
RA-226	0.989	186.21*	3.28	6.55012E+000	9.65378E-001

* = Energy line found in the spectrum.

@ = Energy line not used for Weighted Mean Activity

Energy Tolerance : 0.500 FWHM

Nuclide confidence index threshold = 0.30

Errors quoted at 1.960 sigma

ALL ACTIVITY RESULTS ARE ESTIMATES.
 Total propagated error is much greater than reported.

 ***** I N T E R F E R E N C E C O R R E C T E D R E P O R T *****

	Nuclide Name	Nuclide Id Confidence	Wt mean Activity (uCi/)	Wt mean Activity Uncertainty
	K-40	0.995	1.671650E+000	1.607392E-001
X	PB-212	0.971		
	BI-214	0.914	4.370355E+000	1.565356E-001
	PB-214	0.981	4.541052E+000	3.667351E-001
	RA-226	0.989	6.550122E+000	9.653777E-001

? = nuclide is part of an undetermined solution

X = nuclide rejected by the interference analysis

@ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 1.960 sigma

***** U N I D E N T I F I E D P E A K S *****

Peak Locate Performed on: 8/4/2014 1:26:44 PM
 Peak Locate From Channel: 1
 Peak Locate To Channel: 512

Peak No.	Energy (keV)	Peak Size in Counts per Second	Peak CPS % Uncertainty	Peak Type	Tol. Nuclide
2	153.35	5.5163E+000	13.17	Sum	

M = First peak in a multiplet region

m = Other peak in a multiplet region

F = Fitted singlet

Errors quoted at 1.960 sigma

ALL ACTIVITY RESULTS ARE ESTIMATES.

Total propagated error is much greater than reported.

 ***** N U C L I D E M D A R E P O R T *****

Detector Name: Sgc_LaBr_1R5x1R5
 Sample Geometry:
 Sample Title: N-20-29
 Nuclide Library Used: C:\GENIE2K\CAMFILES\GKP Library.NLB

	Nuclide Name	Energy (keV)	Yield (%)	Line MDA (uCi/)	Nuclide MDA (uCi/)	Activity (uCi/)	Dec. Level (uCi/)
I	K-40	1460.81*	10.67	3.218E-001	3.22E-001	1.672E+000	1.601E-001
+	BI-214	609.31*	46.30	8.050E-002	8.05E-002	5.022E+000	4.016E-002
		768.36*	5.04	8.472E-001		3.987E+000	4.226E-001
		806.17	1.23	3.523E+000		2.737E+001	1.757E+000
		934.06*	3.21	1.266E+000		5.013E+000	6.312E-001
		1120.29*	15.10	3.309E-001		5.109E+000	1.650E-001
		1155.19	1.69	3.209E+000		4.515E+001	1.601E+000
		1238.11*	5.94	7.570E-001		4.821E+000	3.773E-001
		1280.96	1.47	3.266E+000		1.207E+001	1.628E+000
		1385.31*	8.76	3.912E-001		3.627E+000	1.947E-001
		1509.19	2.19	1.968E+000		-8.184E-002	9.802E-001
>		1661.28	1.15	0.000E+000		0.000E+000	0.000E+000
>		1729.60	3.05	0.000E+000		0.000E+000	0.000E+000
>		1764.49	15.80	0.000E+000		0.000E+000	0.000E+000
>		1847.44	2.12	0.000E+000		0.000E+000	0.000E+000
>		2118.54	1.21	0.000E+000		0.000E+000	0.000E+000
+	PB-214	79.00*	21.80	1.222E-001	8.87E-002	5.599E+000	6.098E-002
		241.98*	7.49	4.073E-001		4.347E+000	2.034E-001
		295.21*	19.20	1.805E-001		4.205E+000	9.013E-002
		351.92*	37.20	8.866E-002		4.902E+000	4.426E-002
		785.91	1.10	3.893E+000		3.583E+001	1.942E+000
	PA-234M	766.36	0.29	1.415E+001	5.25E+000	6.778E+001	7.057E+000
		1001.03	0.84	5.247E+000		-5.373E+000	2.616E+000
	TH-234	63.29	4.50	9.432E-001	9.43E-001	-1.171E-001	4.710E-001
		92.38	2.60	1.539E+000		4.288E+001	7.689E-001
		92.80	2.60	1.544E+000		4.757E+001	7.710E-001
		112.81	0.26	1.497E+001		-1.972E+002	7.476E+000

+ = Nuclide identified during the nuclide identification

* = Energy line found in the spectrum

> = MDA value not calculated

@ = Half-life too short to be able to perform the decay correction

ALL ACTIVITY RESULTS ARE ESTIMATES.

Total propagated error is much greater than reported.

***** G A M M A S P E C T R U M A N A L Y S I S *****

Filename: C:\GENIE2K\CAMFILES\GKP\Cabrera Bag.CNF

Report Generated On : 8/4/2014 1:18:56 PM

Sample Title : Cabrera Bag
Sample Description :
Sample Identification : Cabrera Bag
Sample Type :
Sample Geometry :

Peak Locate Threshold : 3.00
Peak Locate Range (in channels) : 1 - 512
Peak Area Range (in channels) : 1 - 512
Identification Energy Tolerance : 0.500 FWHM

Sample Size : 1.000E+000

Sample Taken On :
Acquisition Started : 7/17/2014 7:03:25 PM

Live Time : 60.0 seconds
Real Time : 65.8 seconds

Dead Time : 8.83 %

Energy Calibration Used Done On : 7/17/2014
Efficiency Calibration Used Done On : 7/18/2014
Efficiency ID : CABRERA_BAG

ALL ACTIVITY RESULTS ARE ESTIMATES.
Total propagated error is much greater than reported.

***** P E A K A N A L Y S I S R E P O R T *****

Detector Name: Sgc_LaBr_1R5x1R5

Sample Title: Cabrera Bag

Peak Analysis Performed on: 8/4/2014 1:18:56 PM

Peak Analysis From Channel: 1

Peak Analysis To Channel: 512

	Peak No.	ROI start	ROI end	Peak centroid	Energy (keV)	FWHM (keV)	Net Peak Area	Net Area Uncert.	Continuum Counts
	1	20-	30	25.60	81.01	12.36	5.31E+004	829.18	5.30E+004
	2	42-	56	49.69	152.53	20.61	4.35E+003	904.05	7.25E+004
	3	57-	70	62.54	190.67	14.28	1.12E+004	846.67	6.38E+004
	4	75-	89	80.99	245.43	15.10	1.69E+004	813.14	5.40E+004
	5	90-	108	99.40	300.08	16.90	3.42E+004	922.72	5.55E+004
M	6	108-	148	117.67	354.33	18.07	6.60E+004	624.73	3.99E+004
m	7	108-	148	138.68	416.68	19.56	4.14E+002	249.00	2.98E+004
M	8	190-	236	203.88	610.22	25.32	5.06E+004	308.69	1.66E+004
m	9	190-	236	225.05	673.07	26.59	3.10E+002	99.90	1.46E+004
	10	244-	272	258.08	771.12	25.94	4.01E+003	526.26	1.47E+004
	11	297-	329	313.94	936.93	32.70	2.47E+003	484.94	1.15E+004
	12	358-	393	376.27	1121.95	32.14	9.39E+003	487.08	9.52E+003
	13	399-	434	416.14	1240.29	38.94	2.83E+003	429.98	8.24E+003
	14	447-	485	466.50	1389.78	53.35	3.70E+003	412.46	6.91E+003

M = First peak in a multiplet region

m = Other peak in a multiplet region

F = Fitted singlet

Errors quoted at 1.960 sigma

ALL ACTIVITY RESULTS ARE ESTIMATES.

Total propagated error is much greater than reported.

APPENDIX A: page 40 of 43

 ***** N U C L I D E I D E N T I F I C A T I O N R E P O R T *****

Sample Title: Cabrera Bag
 Nuclide Library Used: C:\GENIE2K\CAMFILES\GKP Library.NLB

..... IDENTIFIED NUCLIDES

Nuclide Name	Id Confidence	Energy (keV)	Yield (%)	Activity (uCi/)	Activity Uncertainty
BI-214	0.916	609.31*	46.30	5.23707E+000	3.91803E-001
		768.36*	5.04	4.81800E+000	6.96371E-001
		806.17	1.23		
		934.06*	3.21	5.62389E+000	1.14938E+000
		1120.29*	15.10	5.39637E+000	3.93510E-001
		1155.19	1.69		
		1238.11*	5.94	4.54895E+000	7.23664E-001
		1280.96	1.47		
		1385.31*	8.76	4.48496E+000	5.38608E-001
		1509.19	2.19		
		1661.28	1.15		
		1729.60	3.05		
		1764.49	15.80		
		1847.44	2.12		
PB-214	0.981	2118.54	1.21		
		79.00*	21.80	3.39087E+000	8.68618E-001
		241.98*	7.49	4.34168E+000	6.60288E-001
		295.21*	19.20	4.10490E+000	6.09909E-001
		351.92*	37.20	4.82800E+000	6.58935E-001
RA-226	0.985	785.91	1.10		
		186.21*	3.28	5.51254E+000	8.24567E-001

* = Energy line found in the spectrum.

@ = Energy line not used for Weighted Mean Activity

Energy Tolerance : 0.500 FWHM

Nuclide confidence index threshold = 0.30

Errors quoted at 1.960 sigma

ALL ACTIVITY RESULTS ARE ESTIMATES.

Total propagated error is much greater than reported.

 ***** I N T E R F E R E N C E C O R R E C T E D R E P O R T *****

	Nuclide Name	Nuclide Id Confidence	Wt mean Activity (uCi/)	Wt mean Activity Uncertainty
X	PB-212	0.967		
	BI-214	0.916	5.073970E+000	2.174538E-001
	PB-214	0.981	4.251480E+000	3.407905E-001
	RA-226	0.985	5.512542E+000	8.245674E-001

? = nuclide is part of an undetermined solution

X = nuclide rejected by the interference analysis

@ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 1.960 sigma

***** U N I D E N T I F I E D P E A K S *****

Peak Locate Performed on: 8/4/2014 1:18:56 PM
 Peak Locate From Channel: 1
 Peak Locate To Channel: 512

	Peak No.	Energy (keV)	Peak Size in Counts per Second	Peak CPS % Uncertainty	Peak Type	Tol. Nuclide
	2	152.53	7.2556E+001	20.77	Sum	
m	7	416.68	6.8968E+000	60.17	Tol.	AC-228
m	9	673.07	5.1702E+000	32.20		

M = First peak in a multiplet region

m = Other peak in a multiplet region

F = Fitted singlet

Errors quoted at 1.960 sigma

ALL ACTIVITY RESULTS ARE ESTIMATES.

Total propagated error is much greater than reported.

APPENDIX A: page 42 of 43

 ***** N U C L I D E M D A R E P O R T *****

Detector Name: Sgc_LaBr_1R5x1R5
 Sample Geometry:
 Sample Title: Cabrera Bag
 Nuclide Library Used: C:\GENIE2K\CAMFILES\GKP Library.NLB

	Nuclide Name	Energy (keV)	Yield (%)	Line MDA (uCi/)	Nuclide MDA (uCi/)	Activity (uCi/)	Dec. Level (uCi/)
	K-40	1460.81	10.67	5.883E-001	5.88E-001	-3.726E-001	2.927E-001
+	BI-214	609.31*	46.30	6.240E-002	6.24E-002	5.237E+000	3.106E-002
		768.36*	5.04	1.036E+000		4.818E+000	5.161E-001
		806.17	1.23	4.386E+000		2.218E+001	2.186E+000
		934.06*	3.21	1.824E+000		5.624E+000	9.091E-001
		1120.29*	15.10	4.344E-001		5.396E+000	2.164E-001
		1155.19	1.69	4.293E+000		5.401E+001	2.139E+000
		1238.11*	5.94	1.129E+000		4.549E+000	5.621E-001
		1280.96	1.47	4.477E+000		1.425E+001	2.229E+000
		1385.31*	8.76	8.064E-001		4.485E+000	4.016E-001
		1509.19	2.19	2.424E+000		-1.872E+000	1.205E+000
>		1661.28	1.15	0.000E+000		0.000E+000	0.000E+000
>		1729.60	3.05	0.000E+000		0.000E+000	0.000E+000
>		1764.49	15.80	0.000E+000		0.000E+000	0.000E+000
>		1847.44	2.12	0.000E+000		0.000E+000	0.000E+000
>		2118.54	1.21	0.000E+000		0.000E+000	0.000E+000
+	PB-214	79.00*	21.80	7.467E-002	6.81E-002	3.391E+000	3.725E-002
		241.98*	7.49	3.334E-001		4.342E+000	1.664E-001
		295.21*	19.20	1.713E-001		4.105E+000	8.550E-002
		351.92*	37.20	6.813E-002		4.828E+000	3.396E-002
		785.91	1.10	4.838E+000		2.687E+001	2.411E+000
	PA-234M	766.36	0.29	1.762E+001	6.62E+000	8.908E+001	8.781E+000
		1001.03	0.84	6.623E+000		-4.577E+000	3.299E+000
	TH-234	63.29	4.50	5.343E-001	5.34E-001	-5.353E-001	2.667E-001
		92.38	2.60	1.014E+000		3.057E+001	5.065E-001
		92.80	2.60	1.013E+000		2.874E+001	5.060E-001
		112.81	0.26	1.023E+001		-1.435E+002	5.109E+000

+ = Nuclide identified during the nuclide identification

* = Energy line found in the spectrum

> = MDA value not calculated

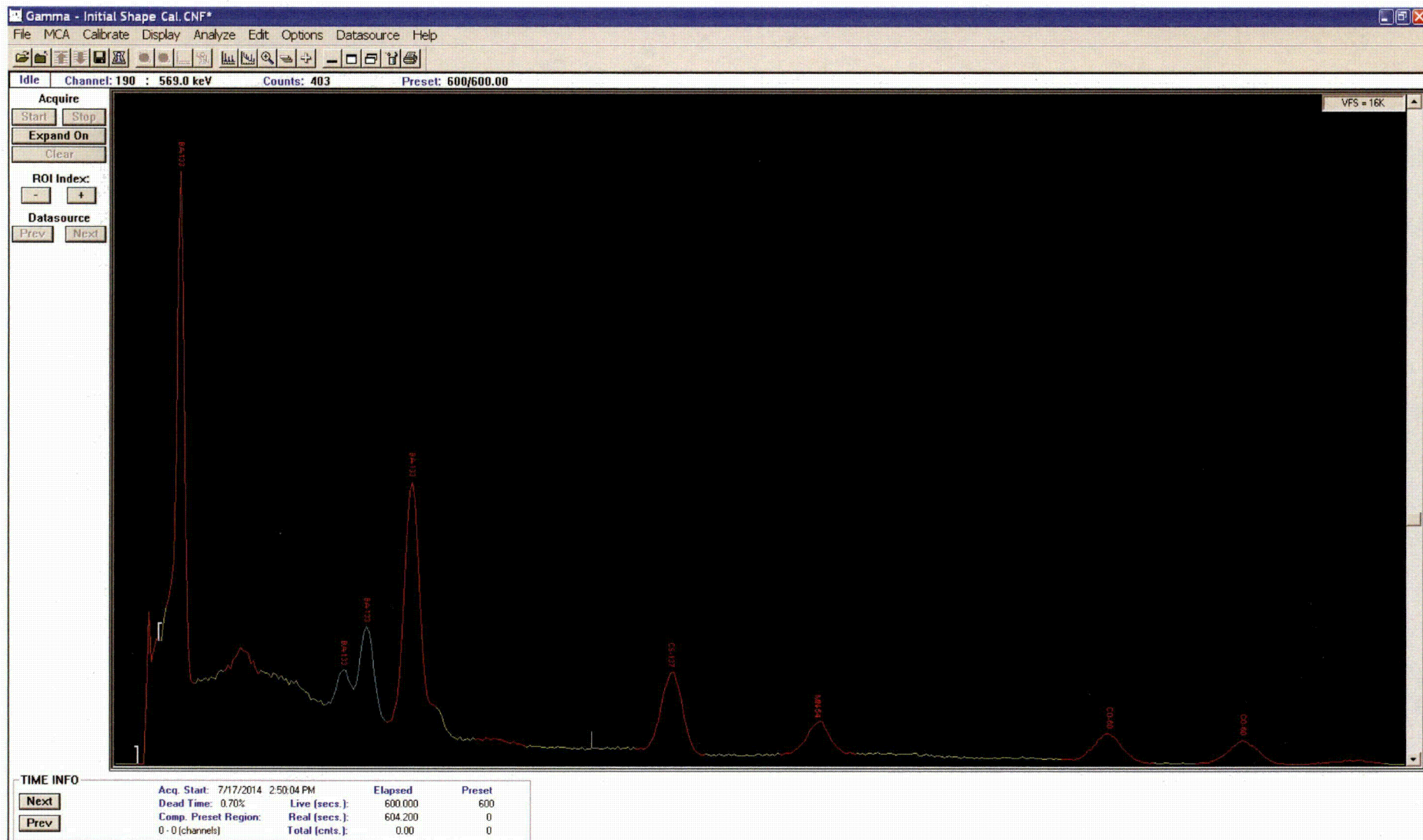
@ = Half-life too short to be able to perform the decay correction

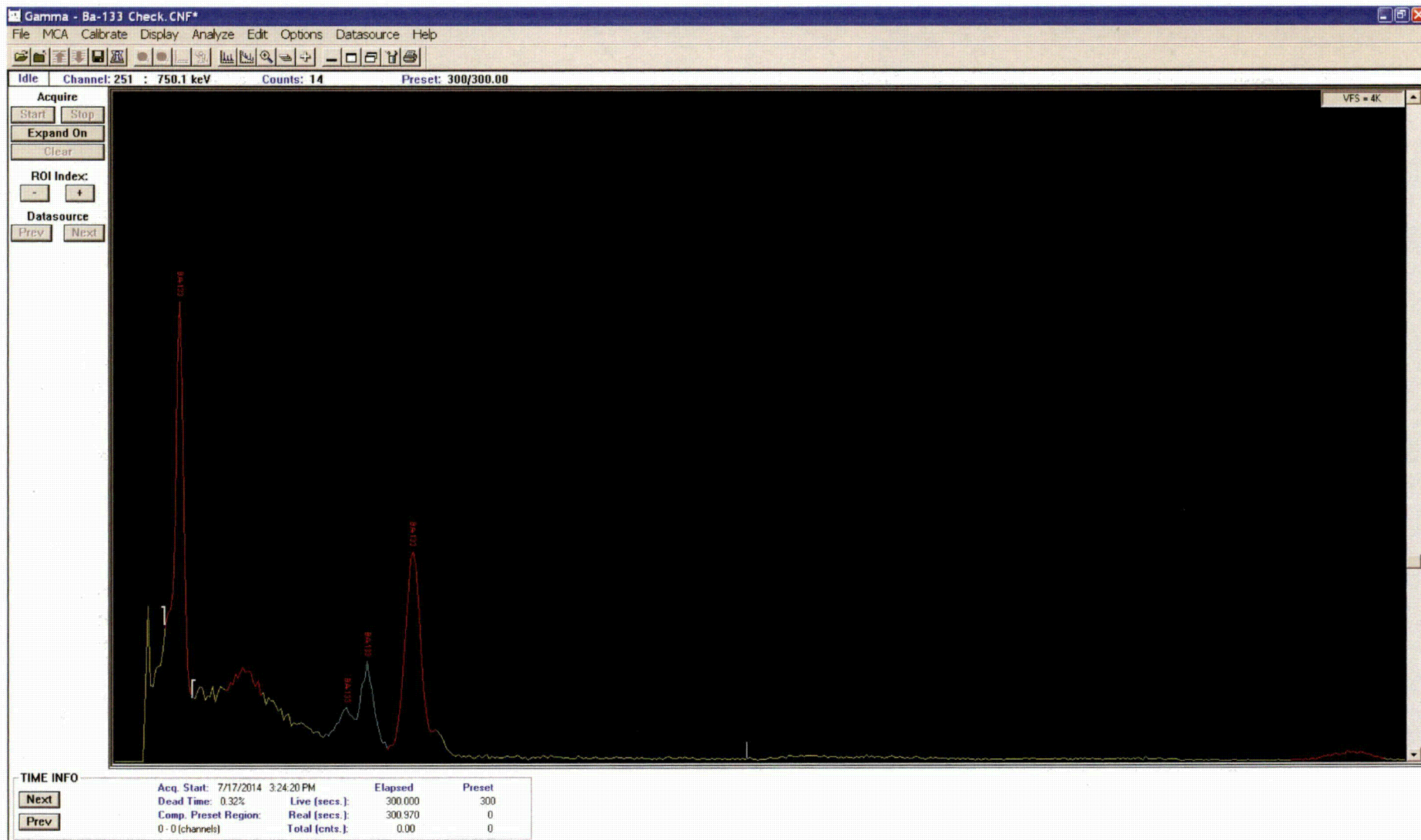
ALL ACTIVITY RESULTS ARE ESTIMATES.

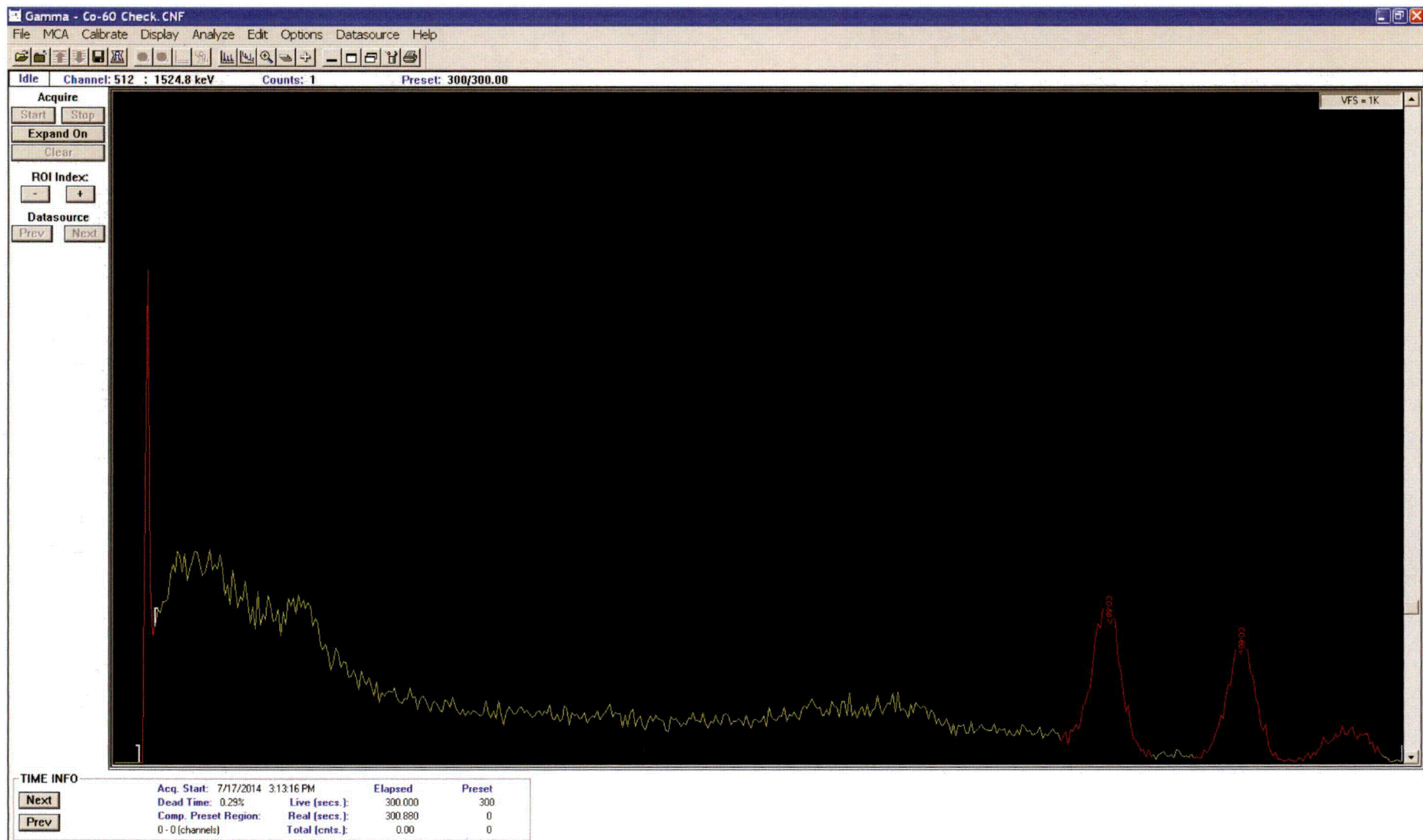
Total propagated error is much greater than reported.

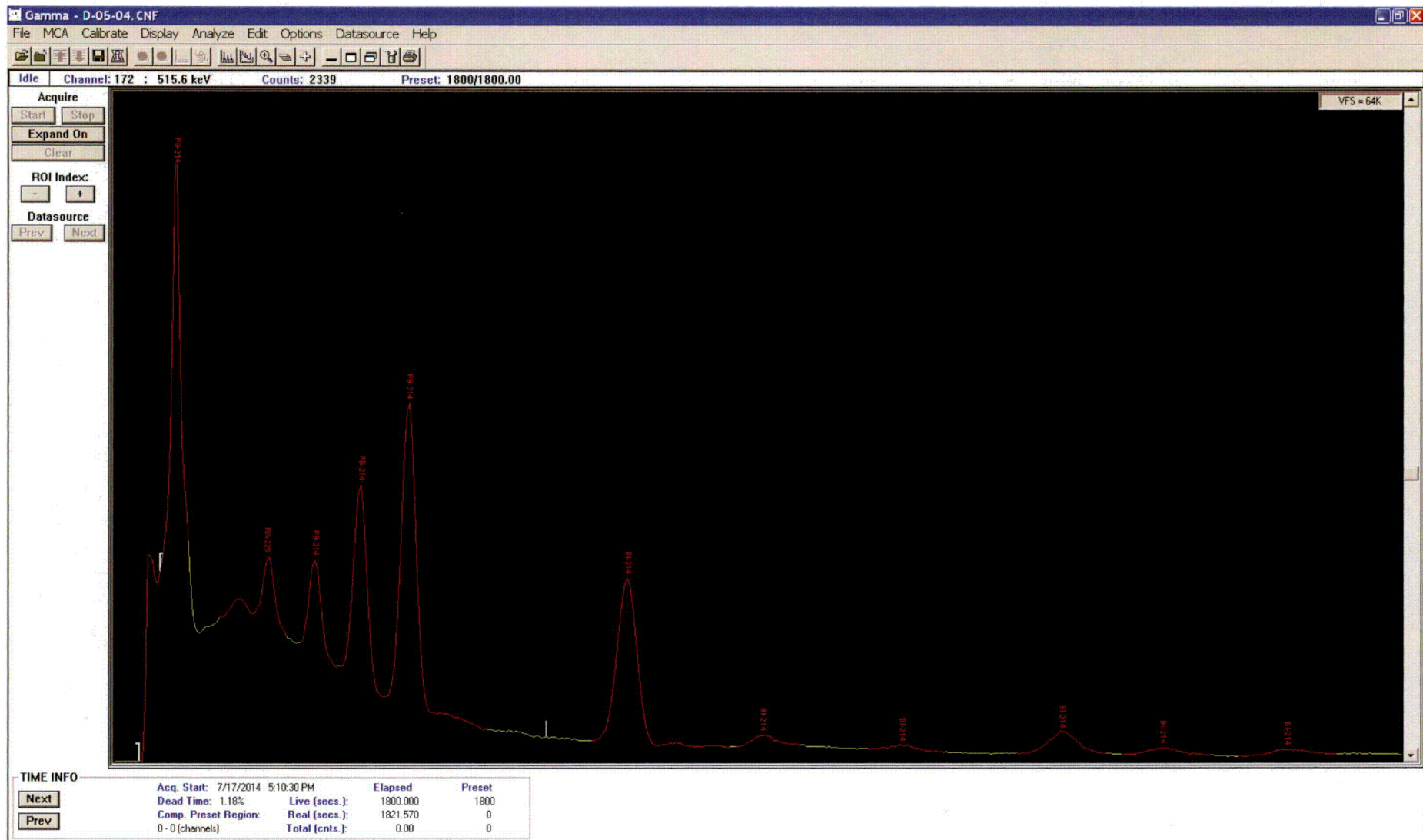
APPENDIX B

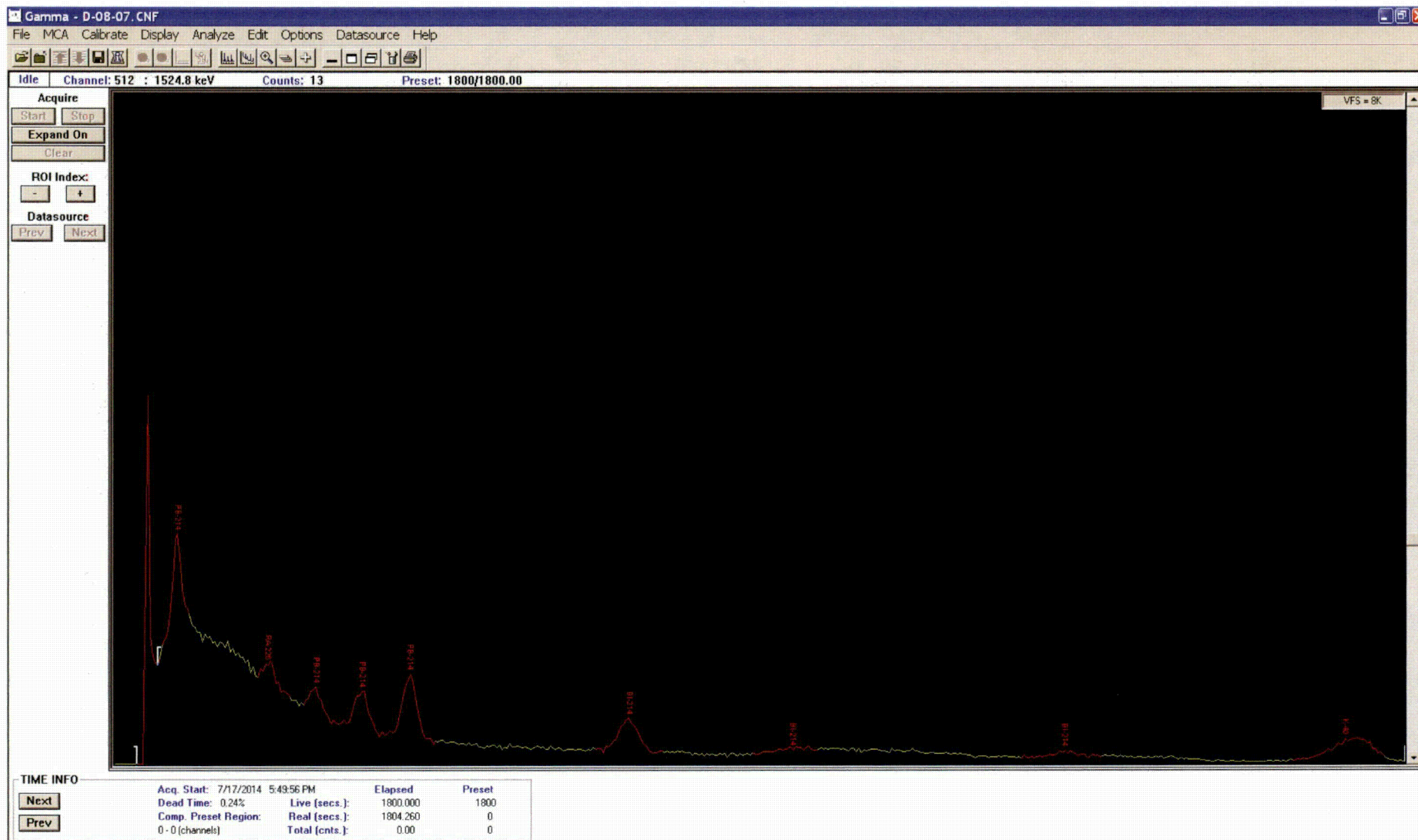
Gamma Spectra Screen Shots

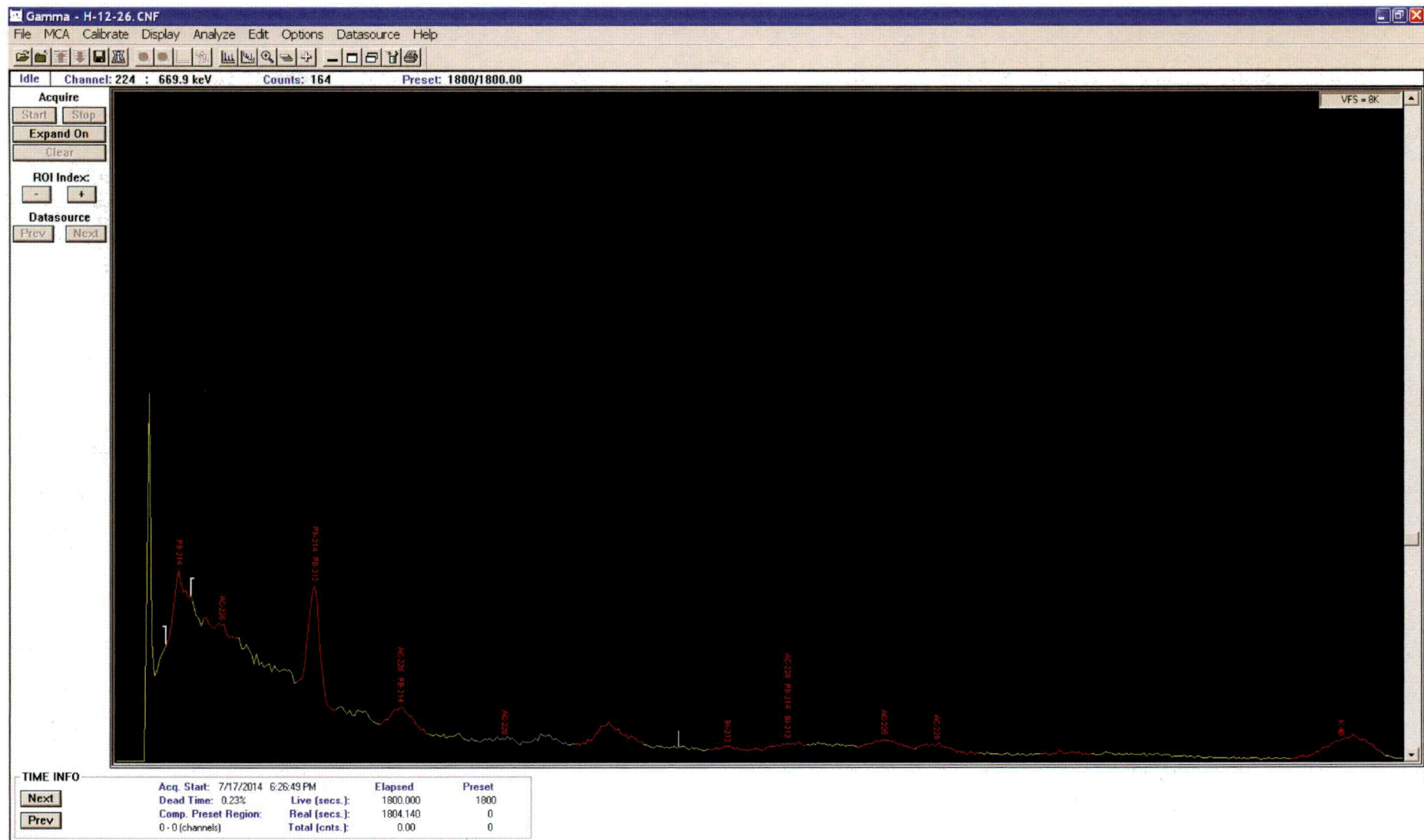


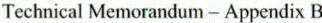














APPENDIX C

ISOCS Models

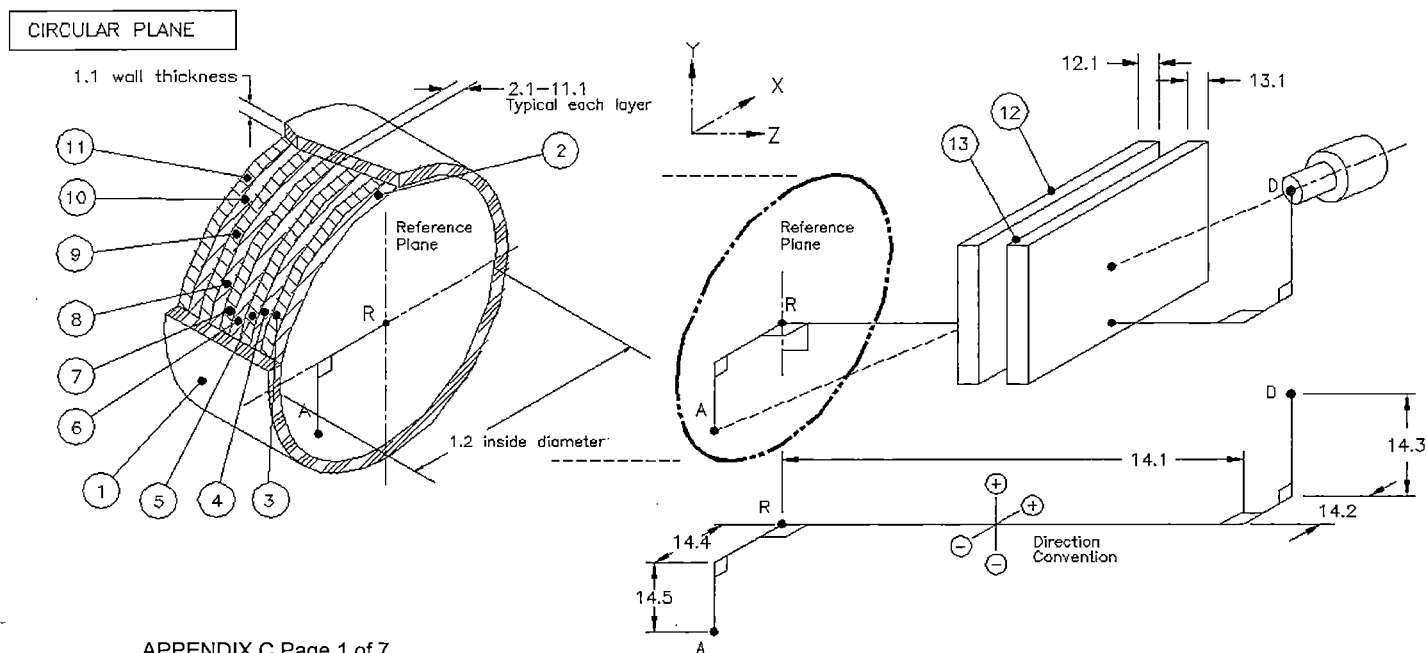
A Geometry Composer Report

Date: Monday, August 04, 2014
 Description: Point_at_6.5"
 Comment: Point_at_6.5"
 File Name: c:\genie2k\isocs\data\geometry\in-situ\circular_plane\gkp point at 6.75 in.geo
 Software: ISOCS
 Template: CIRCULAR_PLANE, Version: default
 Detector: LaBr_s
 Environment: Temperature= 22 C, Pressure= 760 mmHg, Rel.Humidity= 30%
 Integration: Convergence= 1.00%, MDRPN= 2^(4) CRPN= 2^(4)

# Geometry Compon.	Dimensions (cm):						Material	D(g/cm3)	R.Conc.
	d1	d2	d3	d4	d5	d6			
1 Side Walls	0.10	0.01					acrylic	1.17	
2 Layer 1	0.00						csteel	7.86	1.00
3 Layer 2							none		
4 Layer 3							none		
5 Layer 4							none		
6 Layer 5							none		
7 Layer 6							none		
8 Layer 7							none		
9 Layer 8							none		
10 Layer 9							none		
11 Layer 10							none		
12 Absorber1							none		
13 Absorber2							none		
14 Source-Detector	16.51								

List of energies for efficiency curve generation:

59.5 88.0 122.1 165.9 391.7 661.7 898.0 1173.2 1332.5 1836.0



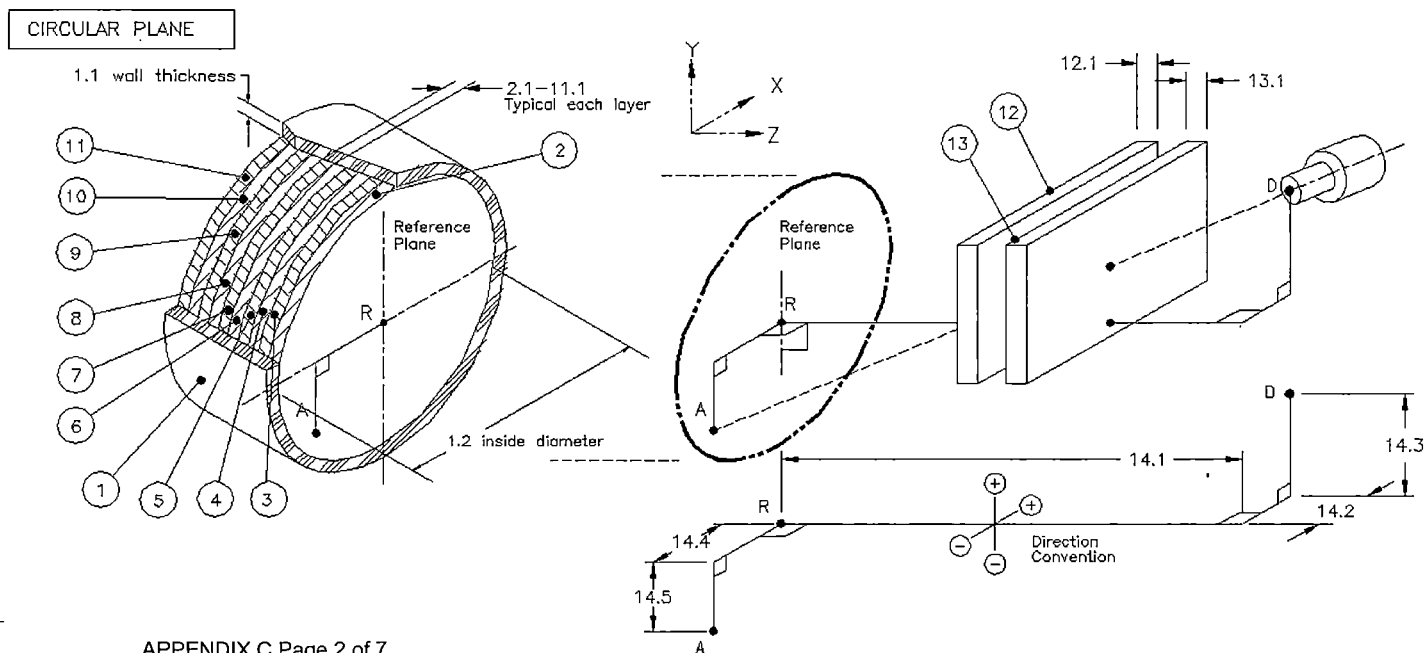
A Geometry Composer Report

Date: Monday, August 04, 2014
 Description: D-05-04
 Comment: D-05-04
 File Name: c:\genie2k\isocs\data\geometry\in-situ\circular_plane\gkp d-05-04.geo
 Software: ISOCS
 Template: CIRCULAR_PLANE, Version: default
 Detector: LaBr_s
 Environment: Temperature= 22 C, Pressure= 760 mmHg, Rel.Humidity= 30%
 Integration: Convergence= 1.00%, MDRPN= 2⁽⁴⁾ CRPN= 2⁽⁴⁾

# Geometry Compon.	Dimensions (cm):						Material	D(g/cm3)	R.Conc.
	d1	d2	d3	d4	d5	d6			
1 Side Walls		0.50					none		
2 Layer 1	0.50						dirt1	1.60	1.00
3 Layer 2							none		
4 Layer 3							none		
5 Layer 4							none		
6 Layer 5							none		
7 Layer 6							none		
8 Layer 7							none		
9 Layer 8							none		
10 Layer 9							none		
11 Layer 10							none		
12 Absorber1							none		
13 Absorber2							none		
14 Source-Detector	15.24								

List of energies for efficiency curve generation:

59.5 88.0 122.1 165.9 391.7 661.7 898.0 1173.2 1332.5 1836.0



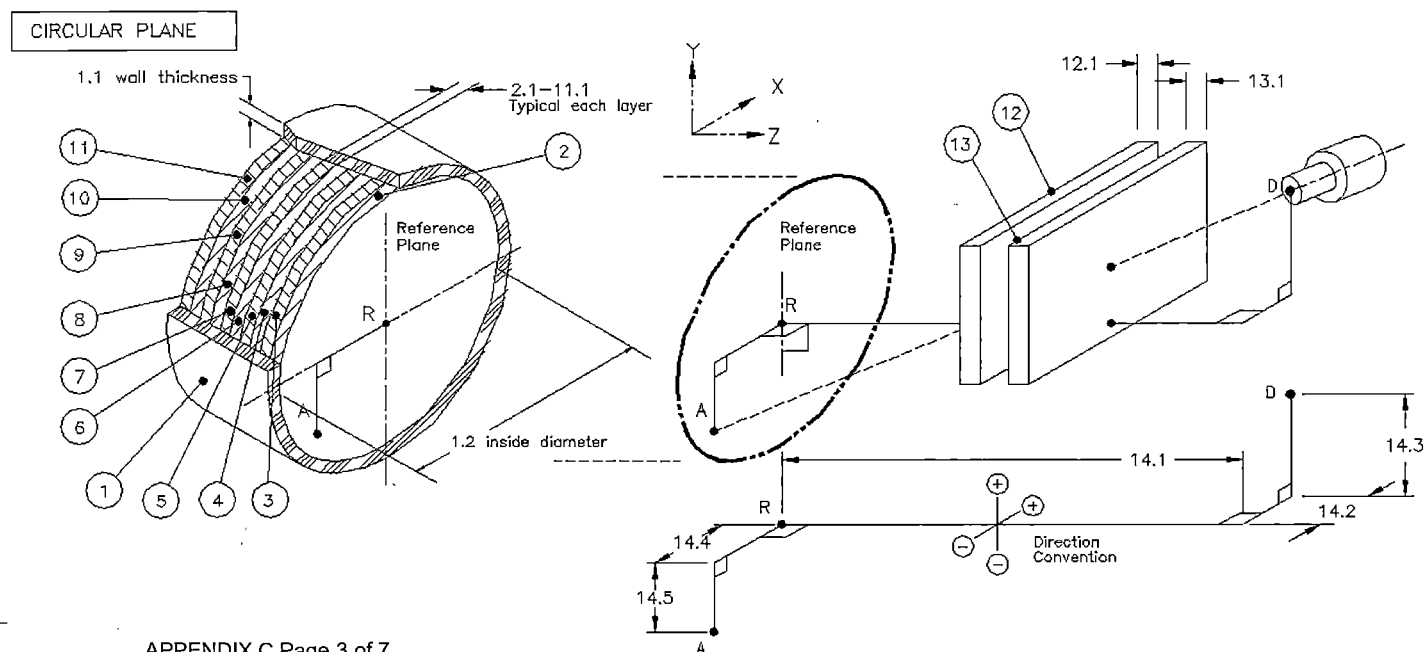
A Geometry Composer Report

Date: Monday, August 04, 2014
 Description: D-08-07
 Comment: D-08-07
 File Name: c:\genie2k\isocs\data\geometry\in-situ\circular_plane\gkp d-08-07.geo
 Software: ISOCS
 Template: CIRCULAR_PLANE, Version: default
 Detector: LaBr_s
 Environment: Temperature= 22 C, Pressure= 760 mmHg, Rel.Humidity= 30%
 Integration: Convergence= 1.00%, MDRPN= 2⁽⁴⁾ CRPN= 2⁽⁴⁾

#	Geometry Compon.	Dimensions (inch):						Material	D(g/cm3)	R.Conc.
		d1	d2	d3	d4	d5	d6			
1	Side Walls		0.20					none		
2	Layer 1	0.04						dirt1	0.10	1.00
3	Layer 2							none		
4	Layer 3							none		
5	Layer 4							none		
6	Layer 5							none		
7	Layer 6							none		
8	Layer 7							none		
9	Layer 8							none		
10	Layer 9							none		
11	Layer 10							none		
12	Absorber1							none		
13	Absorber2							none		
14	Source-Detector	1.00								

List of energies for efficiency curve generation:

59.5 88.0 122.1 165.9 391.7 661.7 898.0 1173.2 1332.5 1836.0



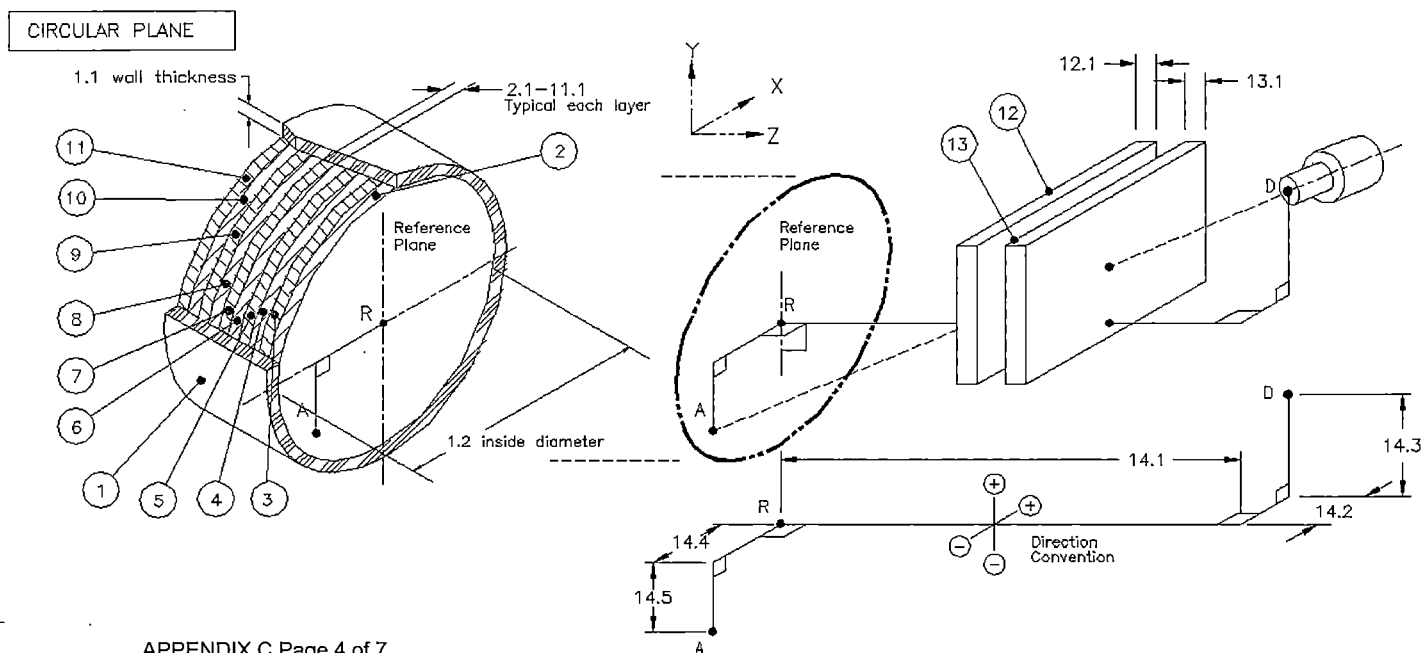
A Geometry Composer Report

Date: Monday, August 04, 2014
 Description: H-12-26
 Comment: H-12-26
 File Name: c:\genie2k\isocs\data\geometry\in-situ\circular_plane\gkp h-12-26.geo
 Software: ISOCS
 Template: CIRCULAR_PLANE, Version: default
 Detector: LaBr_s
 Environment: Temperature= 22 C, Pressure= 760 mmHg, Rel.Humidity= 30%
 Integration: Convergence= 1.00%, MDRPN= 2⁽⁴⁾ CRPN= 2⁽⁴⁾

# Geometry Compon.	Dimensions (cm):						Material	D(g/cm3)	R.Conc.
	d1	d2	d3	d4	d5	d6			
1 Side Walls		3.00					none		
2 Layer 1	1.00						dirt1	1.60	1.00
3 Layer 2							none		
4 Layer 3							none		
5 Layer 4							none		
6 Layer 5							none		
7 Layer 6							none		
8 Layer 7							none		
9 Layer 8							none		
10 Layer 9							none		
11 Layer 10							none		
12 Absorber1							none		
13 Absorber2							none		
14 Source-Detector	2.54								

List of energies for efficiency curve generation:

59.5 88.0 122.1 165.9 391.7 661.7 898.0 1173.2 1332.5 1836.0



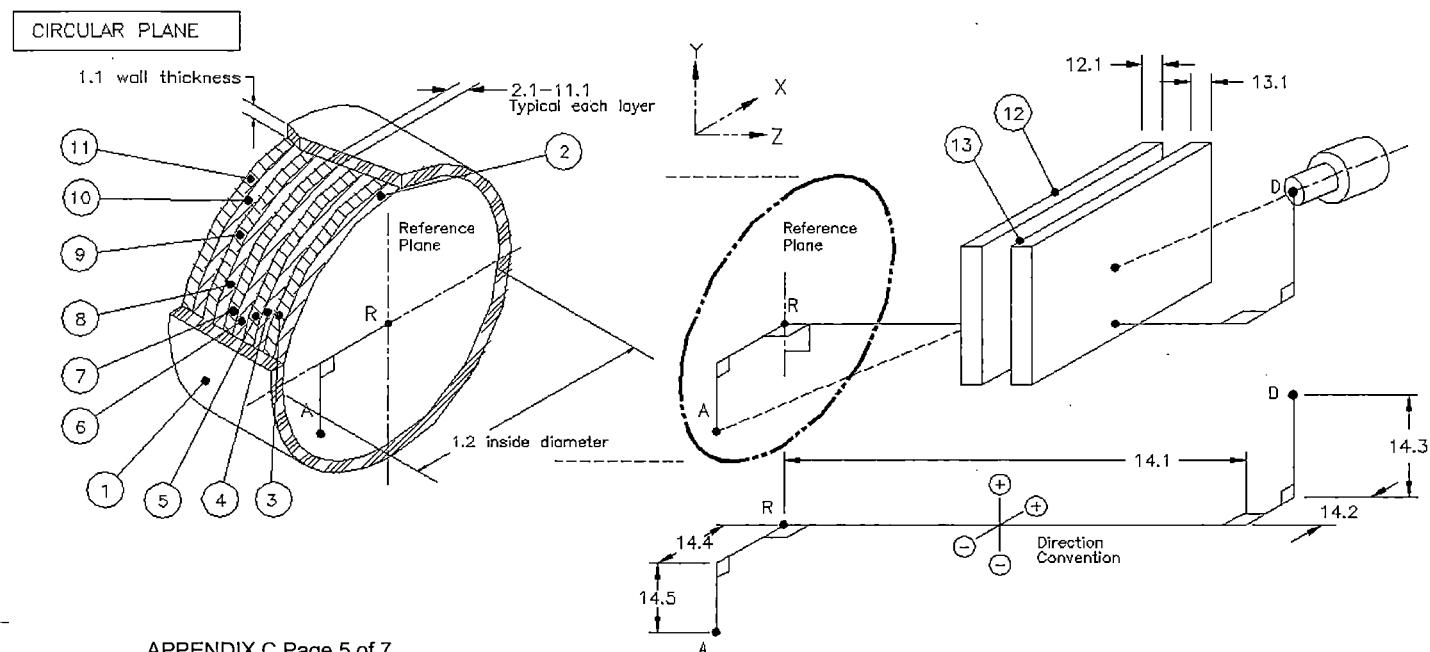
A Geometry Composer Report

Date: Monday, August 04, 2014
 Description: I-13-21
 Comment: I-13-21
 File Name: c:\genie2k\isocs\data\geometry\in-situ\circular_plane\gkp i-13-21.geo
 Software: ISOCS
 Template: CIRCULAR_PLANE, Version: default
 Detector: LaBr_s
 Environment: Temperature= 22 C, Pressure= 760 mmHg, Rel.Humidity= 30%
 Integration: Convergence= 1.00%, MDRPN= 2^(4) CRPN= 2^(4)

#	Geometry Compon.	Dimensions (cm):						Material	D(g/cm3)	R.Conc.
		d1	d2	d3	d4	d5	d6			
1	Side Walls		2.00					none		
2	Layer 1	2.00						dirt1	4.00	1.00
3	Layer 2							none		
4	Layer 3							none		
5	Layer 4							none		
6	Layer 5							none		
7	Layer 6							none		
8	Layer 7							none		
9	Layer 8							none		
10	Layer 9							none		
11	Layer 10							none		
12	Absorber1							none		
13	Absorber2							none		
14	Source-Detector	15.24								

List of energies for efficiency curve generation:

59.5 88.0 122.1 165.9 391.7 661.7 898.0 1173.2 1332.5 1836.0



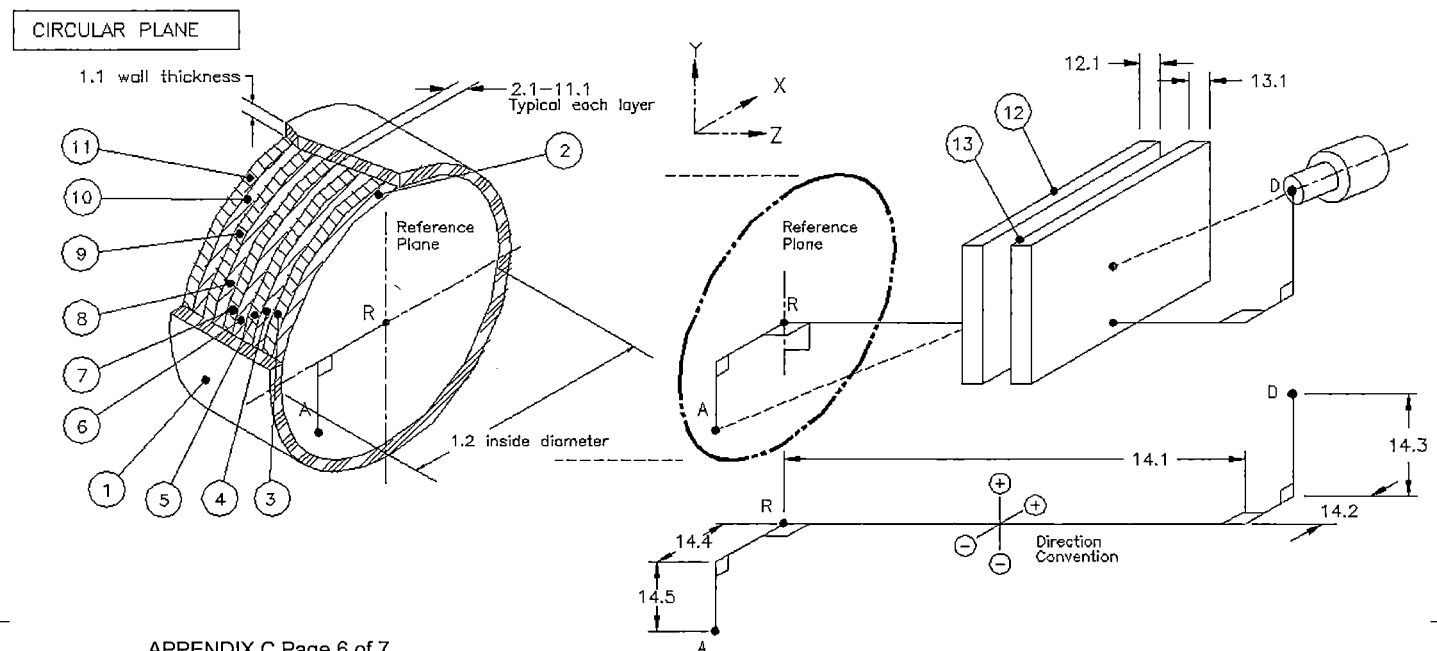
A Geometry Composer Report

Date: Monday, August 04, 2014
 Description: N20-29
 Comment: N20-29
 File Name: c:\genie2k\isocs\data\geometry\in-situ\circular_plane\gkp n-20-29.geo
 Software: ISOCS
 Template: CIRCULAR_PLANE, Version: default
 Detector: LaBr_s
 Environment: Temperature= 22 C, Pressure= 760 mmHg, Rel.Humidity= 30%
 Integration: Convergence= 1.00%, MDRPN= 2⁽⁴⁾ CRPN= 2⁽⁴⁾

#	Geometry Compon.	Dimensions (inch):						Material	D(g/cm3)	R.Conc.
		d1	d2	d3	d4	d5	d6			
1	Side Walls		1.50					none		
2	Layer 1	1.50						dirt1	2.50	1.00
3	Layer 2							none		
4	Layer 3							none		
5	Layer 4							none		
6	Layer 5							none		
7	Layer 6							none		
8	Layer 7							none		
9	Layer 8							none		
10	Layer 9							none		
11	Layer 10							none		
12	Absorber1							none		
13	Absorber2							none		
14	Source-Detector	6.00								

List of energies for efficiency curve generation:

59.5 88.0 122.1 165.9 391.7 661.7 898.0 1173.2 1332.5 1836.0



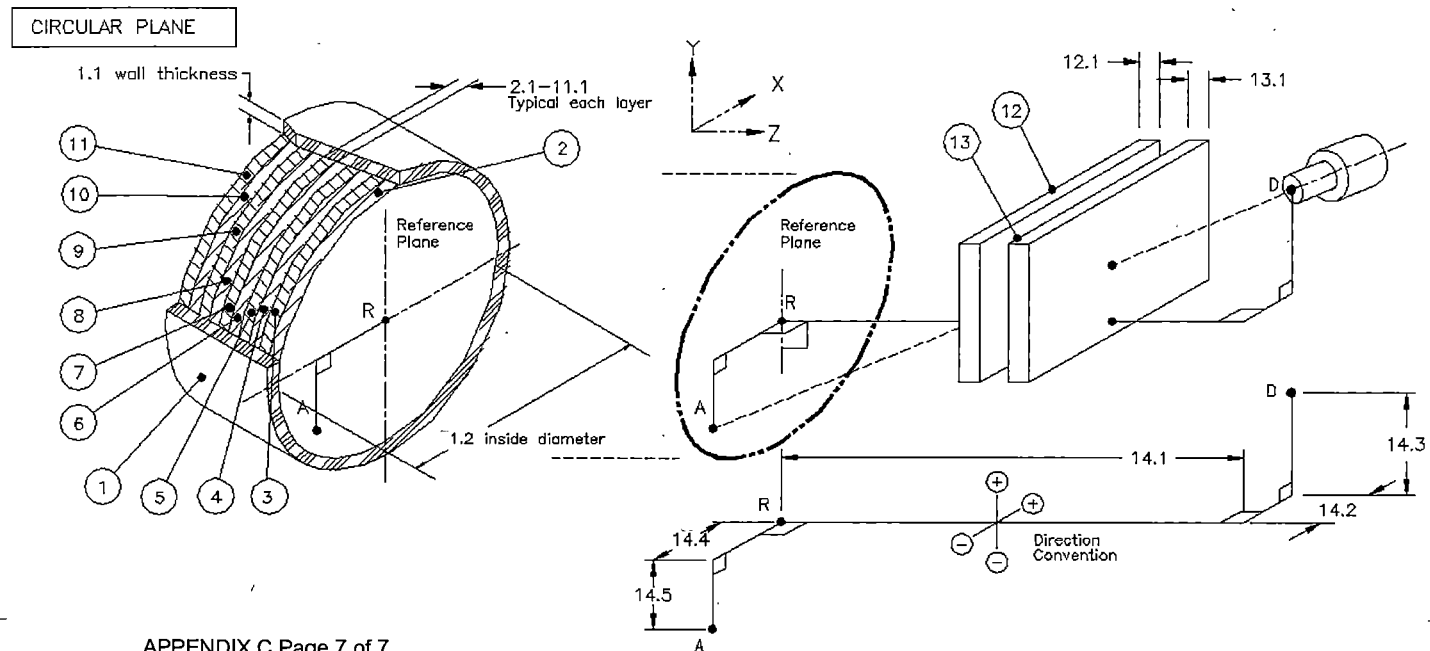
A Geometry Composer Report

Date: Monday, August 04, 2014
 Description: Cabrera_Bag
 Comment: Cabrera_Bag
 File Name: c:\genie2k\isocs\data\geometry\in-situ\circular_plane\gkp cabrera bag.geo
 Software: ISOCS
 Template: CIRCULAR_PLANE, Version: default
 Detector: LaBr_s
 Environment: Temperature= 22 C, Pressure= 760 mmHg, Rel.Humidity= 30%
 Integration: Convergence= 1.00%, MDRPN= 2^(4) CRPN= 2^(4)

#	Geometry Compon.	Dimensions (cm):						Material	D(g/cm3)	R.Conc.
		d1	d2	d3	d4	d5	d6			
1	Side Walls		3.00					none		
2	Layer 1	0.25						dirt1	1.60	1.00
3	Layer 2							none		
4	Layer 3							none		
5	Layer 4							none		
6	Layer 5							none		
7	Layer 6							none		
8	Layer 7							none		
9	Layer 8							none		
10	Layer 9							none		
11	Layer 10							none		
12	Absorber1							none		
13	Absorber2							none		
14	Source-Detector	2.54								

List of energies for efficiency curve generation:

59.5 88.0 122.1 165.9 391.7 661.7 898.0 1173.2 1332.5 1836.0



APPENDIX D

Source Calibration Certificates

Certificate of Calibration

Radioactive material, Limited Quantity NOS UN2910,
Exempt Quantity 10CFR30.18, BS 5288/C11111

This source has been calibrated using a HPGe detector whose efficiency was established with the NIST traceable mixed nuclide standard SRS: 80899-854. The stated activity is the weighted average of the measured gamma lines with an estimated uncertainty of 5%.

Radionuclide: Ba-133
Half-Life: 10.51 years
Decay Constant: 0.0001808
Serial Number: 9021110

Calibration Date: September 2, 2011 **Activity:** 1.04 uCi. 38,480 Bq.

Photon Energy (keV)	Intensity (%)	Emission Rate (sec-1)
80.1	34.06	13,106
276.4	7.16	2,755
302.9	18.33	7,053
356.0	62.05	23,877
383.9	8.94	3,440

Certified by: 

Date: September 6, 2011

Certificate of Calibration

Radioactive material, Limited Quantity NOS UN2910,
Exempt Quantity 10CFR30.18, BS 5288/C11111

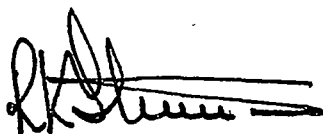
This source has been calibrated using a HPGe detector whose efficiency was established with the NIST traceable mixed nuclide standard SRS: 80899-854. The stated activity is the weighted average of the measured gamma lines with an estimated uncertainty of 5%.

Radionuclide: Co-60
Half-Life: 5.2714 Years
Decay Constant: 0.0003604
Serial Number: 902118

Calibration Date: September 2, 2011 **Activity:** 0.937 uCi. 34,669.0 Bq.

Photon Energy (keV)	Intensity (%)	Emission Rate (sec-1)
1173.24	99.97	34658.6
1332.5	99.99	34665.5

Certified by:



Date: September 6, 2011

Certificate of Calibration

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Exempt Quantity 10CFR30.18, BS 5288/C11111

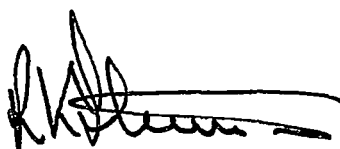
This source has been calibrated using a HPGe detector whose efficiency was established with the NIST traceable mixed nuclide standard SRS: 80899-854. The stated activity is the weighted average of the measured gamma lines with an estimated uncertainty of 5%.

Radionuclide: Cs-137
Half-Life: 30.07 years
Decay Constant: 0.02305
Serial Number: 902113

Calibration Date: September 2, 2011 **Activity:** 1.08 uCi. 39,960 Bq.

Photon Energy (keV)	Intensity (%)	Emission Rate (sec-1)
661.66	85.1	34,006

Certified by:



Date: September 6, 2011

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Radioactive material, Limited Quantity NOS UN2910,
Exempt Quantity 10CFR30.18, BS 5288/C11111

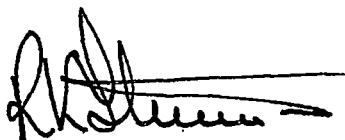
This source has been calibrated using a HPGe detector whose efficiency was established with the NIST traceable mixed nuclide standard SRS: 80899-854. The stated activity is the weighted average of the measured gamma lines with an estimated uncertainty of 5%.

Radionuclide: Mn-54
Half-Life: 312.3 Days
Decay Constant: 0.00221934
Serial Number: 902119

Calibration Date: September 2, 2011 **Activity:** 1.14 uCi 42,180 Bq.

Photon Energy (keV)	Intensity (%)	Emission Rate (sec-1)
834.8	99.98	42,172

Certified by:



Date: September 6, 2011