MICHAEL PISANI & ASSOCIATES

07-214 / 0494255 Hero Lands

STANDARD LEVEL IV
REPORT OF ANALYSIS

WORK ORDER #19-04089-OR

June 3, 2019

EBERLINE ANALYTICAL/OAK RIDGE LABORATORY
OAK RIDGE, TN

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Eberline Services – Oak Ridge Laboratory

LABORATORY DATA SUPPORT CHECKLIST

MP-001-3

Eberline Services Work Order # 19-04089

The checklist items listed below are to be initialed by appropriate staff upon completion/verification.

Date for Partial	Initials	Date	Initials	Checklist Items
		4/18/19	AB	Sample Log-In
		5/16/19		Data Compilation
		5-21-19	MLT	First Technical Data Review
		5/21/19	JB	Second Technical Data Review
		5/24/19		Data Entry/Electronic Deliverable
		5/24/19		Case Narrative
		5/31/19	EMT	Electronic Deliverable Proof
		5/31/19	JB	Samples Analyzed within Holding Time Yes? ☑ No? ☐
		5/31/19	JB	QA/QC Review
				Client in Possession of Data Electronic or Hard Copy
				Invoiced by Laboratory

Technical/Clerical Corrections, Signatures Needed, Problems, Etc	Date/Initials

Date package approved by: _____ 5/31/19

Laboratory Manager — Date

Copy No. _____

SECTION I

CHAIN OF CUSTODY
& pH CHECK

Chain of Custody Record

№

Eberline Services
601 Scarboro Road
Oak Ridge, TN 37830
(865) 481-0683 Phone • (865) 483-4621 Fax

EBERLINE SERVICES

Project Name: HERO LANDS	Project Number: 07-214 / 0499255
Send Report To: DAVE UPTHEGROVE	Sampler (Print Name): ED BROGAN
Address: 3838 N CAUSEWAY	Sampler (Print Name): Aaron Joner
STE 3000	Shipment Method: FED EX
METAIRIE LA 70002	Airbill Number:
Phone: 281 600-1000	Laboratory Receiving:
Fax:	

Analysis Requested: Ra-226 / Ra-228

REC'D APR 17 2019

19-04089

Page 1 of 2

Purchase Order #: _____

Field Sample ID	Sample Date	Sample Time	Sample Matrix	Number of Containers	Comments, Special Instructions, etc.	Lab Sample ID (to be completed by lab)
BC 27A	4-2-19	1030	W	1		
BC 27B		1152				
BC 26		1310				
BC 11		1440				
BC 12		1615				
BC 24A	4-3-19	0755				
BC 24B		0925				
BC 21B		1115				
BC 21A		1315				
BC 13		1515				
BC 14		1705				
BC 28B	4-8-19	1045				
BC 28A		1215				
BC 16		1515			SAMPLE HAS PRODUCT	
BC 15		1645				
BC 22A	4-9-19	0830				
BC 22B		1000				

COPY

Relinquished by: (Signature)	Received by: (Signature)	Date:	Time:
	ED FX		
Relinquished by: (Signature) FedEx	Received by: (Signature) Randall Spencer	Date: 10/17/19	Time: 1014
Relinquished by: (Signature)	Received by: (Signature)	Date:	Time:

Sample Custodian Remarks (Completed By Laboratory):

QA/QC Level	Turnaround	Sample Receipt	
		Total # Containers Received?	
Level I ☐	Routine ☐	COC Seals Present?	
Level II ☐	24 Hour ☐	COC Seals Intact?	
Level III ☐	1 Week ☐	Received Containers Intact?	
Other ☐	Other _____	Temperature?	

0005

Chain of Custody Record

№

Eberline Services
601 Scarboro Road
Oak Ridge, TN 37830
(865) 481-0683 Phone • (865) 483-4621 Fax

EBERLINE SERVICES

Project Name: HERO LANDS	Project Number: 07-214/0494255
Send Report To: DAVE UPTHEGROVE	Sampler (Print Name): ED GRAHAM
Address: 3838 N CAUSEWAY	Sampler (Print Name):
MIDLAND TX 79707	Shipment Method: FED EX
STE 3000	Airbill Number:
Phone: 281 605-1000	Laboratory Receiving:
Fax:	

Page 2 of 2

REC'D APR 17 2019

Purchase Order #: 19 04089

Field Sample ID	Sample Date	Sample Time	Sample Matrix	Number of Containers	Analysis Requested: Ra 226/Ra 228	Comments, Special Instructions, etc.	Lab Sample ID (to be completed by lab)
5 BC 9	4-9-19	1210	W	1	1		
6 BC 10	1	1455	1	1	1		
7 BC 23	1	1650	1	1	1		

Relinquished by: (Signature)	Received by: (Signature)	Date:	Time:
	FED EX		
Relinquished by: (Signature)	Received by: (Signature)	Date:	Time:
FedEx	Randolph Spencer	4/10/19	1014
Relinquished by: (Signature)	Received by: (Signature)	Date:	Time:

Sample Custodian Remarks (Completed By Laboratory):

QA/QC Level	Turnaround	Sample Receipt	
		Total # Containers Received?	
Level I ☐	Routine ☐	COC Seals Present?	
Level II ☐	24 Hour ☐	COC Seals Intact?	
Level III ☐	1 Week ☐	Received Containers Intact?	
Other ☐	Other _____	Temperature?	

9000

EBERLINE SERVICES
Oak Ridge Laboratory

Internal Chain of Custody

Work Order #	**19-04089**
Lab Deadline	**4/30/2019**
Analysis	**Ra226 - Level 4**
Sample Matrix	**Water**

Comments	Sample Fraction	HP 210 / 270 Detector Activity	Storage Location
	04	30	KK1.4
	05	29	KK1.4
	06	33	KK1.4
	07	34	KK1.4

	Location (circle one)					Initials	Date
Received by	(Sample Storage)	Rough Prep	Prep	Separations	Count Room	Harvey	4/29/19 0000
Relinquished by	Sample Storage	Rough Prep	(Prep)	Separations	Count Room	Harvey	4/30/19 0000
Received by	Sample Storage	Rough Prep	Prep	(Separations)	Count Room	DB 4/30/19	0800
Relinquished by	Sample Storage	Rough Prep	Prep	(Separations)	Count Room	DB 5/1/19	1505
Received by	Sample Storage	Rough Prep	Prep	Separations	(Count Room)	KB 5/1/19	1511
Relinquished by	Sample Storage	Rough Prep	Prep	Separations	(Count Room)	KP 5/2/19	0600
Received by	(Sample Storage)	Rough Prep	Prep	Separations	Count Room		
Relinquished by	Sample Storage	Rough Prep	Prep	Separations	Count Room		
Received by	Sample Storage	Rough Prep	Prep	Separations	Count Room		
Relinquished by	Sample Storage	Rough Prep	Prep	Separations	Count Room		
Received by	Sample Storage	Rough Prep	Prep	Separations	Count Room		
Relinquished by	Sample Storage	Rough Prep	Prep	Separations	Count Room		
Received by	Sample Storage	Rough Prep	Prep	Separations	Count Room		
Relinquished by	Sample Storage	Rough Prep	Prep	Separations	Count Room		

EBERLINE SERVICES
Oak Ridge Laboratory

Internal Chain of Custody

Work Order #	19-04089
Lab Deadline	4/30/2019
Analysis	Ra228 - Level 4
Sample Matrix	Water

Comments	Sample Fraction	HP 210 / 270 Detector Activity	Storage Location
	04	30	KK1.4
	05	29	KK1.4
	06	33	KK1.4
	07	34	KK1.4

	Location (circle one)					Initials	Date
Received by	(Sample Storage)	Rough Prep	Prep	Separations	Count Room	~~Harvey~~	~~4/29/19~~ 0600
Relinquished by	Sample Storage	Rough Prep	(Prep)	Separations	Count Room	~~Harvey~~	~~4/30/19~~ 0600
Received by	Sample Storage	Rough Prep	Prep	(Separations)	Count Room	DB 4/30/19	0800
Relinquished by	Sample Storage	Rough Prep	Prep	(Separations)	Count Room	DB 5/1/19	1505
Received by	Sample Storage	Rough Prep	Prep	Separations	(Count Room)	ICB 5/1/19	1511
Relinquished by	Sample Storage	Rough Prep	Prep	Separations	(Count Room)	XP 5/2/19	0600
Received by	(Sample Storage)	Rough Prep	Prep	(Separations)	Count Room	DB 5/2/19	0910
Relinquished by	Sample Storage	Rough Prep	Prep	(Separations)	Count Room	DB 5/3/19	1215
Received by	Sample Storage	Rough Prep	Prep	Separations	(Count Room)	ICB 5/3/19	1220
Relinquished by	Sample Storage	Rough Prep	Prep	Separations	(Count Room)	ICB 5/3/19	1428
Received by	(Sample Storage)	Rough Prep	Prep	Separations	Count Room		
Relinquished by	Sample Storage	Rough Prep	Prep	Separations	Count Room		
Received by	Sample Storage	Rough Prep	Prep	Separations	Count Room		
Relinquished by	Sample Storage	Rough Prep	Prep	Separations	Count Room		

EBERLINE SERVICES
Oak Ridge Laboratory

Internal Chain of Custody

Work Order #	**19-04089**
Lab Deadline	**4/22/2019**
Analysis	**TDS - Level 4**
Sample Matrix	**Water**

Comments

Sample Fraction	HP 210 / 270 Detector Activity	Storage Location
04	30	KK1.4
05	29	KK1.4
06	33	KK1.4
07	34	KK1.4

	Location (circle one)					Initials	Date
Received by	(Sample Storage)	Rough Prep	Prep	Separations	Count Room 8:00	[signature]	4-22-19
Relinquished by	Sample Storage	Rough Prep	Prep	Separations	Count Room 8:30	[signature]	4-22-19
Received by	Sample Storage	Rough Prep	Prep	Separations	Count Room		
Relinquished by	Sample Storage	Rough Prep	Prep	Separations	Count Room		
Received by	Sample Storage	Rough Prep	Prep	Separations	Count Room		
Relinquished by	Sample Storage	Rough Prep	Prep	Separations	Count Room		
Received by	Sample Storage	Rough Prep	Prep	Separations	Count Room		
Relinquished by	Sample Storage	Rough Prep	Prep	Separations	Count Room		
Received by	Sample Storage	Rough Prep	Prep	Separations	Count Room		
Relinquished by	Sample Storage	Rough Prep	Prep	Separations	Count Room		
Received by	Sample Storage	Rough Prep	Prep	Separations	Count Room		
Relinquished by	Sample Storage	Rough Prep	Prep	Separations	Count Room		
Received by	Sample Storage	Rough Prep	Prep	Separations	Count Room		
Relinquished by	Sample Storage	Rough Prep	Prep	Separations	Count Room		

EBERLINE SERVICES

Sample Receiving Report
(Volumes, pH, & CPM)

Internal Work Order
19-04089
Received By
RSPENCER

FR	ClientID	# Btls	Comments	Matrix	Storage	Rec Vol Ttl	CPM Max
01	LCS	0		WA	KK1.4		
02	BLANK	0		WA	KK1.4		
03	DUP	0		WA	KK1.4		
04	BC 22B	1		WA	KK1.4	3.76	30
			Container Number	pH Orig	pH Final	Volume (L)	CPM
			1	7	7	3.7600	30
05	BC 9	1		WA	KK1.4	3.76	29
			Container Number	pH Orig	pH Final	Volume (L)	CPM
			1	7	7	3.7600	29
06	BC 10	1		WA	KK1.4	3.76	33
			Container Number	pH Orig	pH Final	Volume (L)	CPM
			1	7	7	3.7600	33
07	BC 23	1		WA	KK1.4	3.76	34
			Container Number	pH Orig	pH Final	Volume (L)	CPM
			1	7	7	3.7600	34

Received by: Randolph Spencer Date: 4-18-19

SECTION II

SAMPLE ACKNOWLEDGEMENT

Client Name	Contract/PO	Project Type	Date Received	Required Turnaround Days	Eberline Services Work Order
Michael Pisani & Associates, Inc.	0494255	Environmental	04/17/2019	21	19-04089
Project Name	**Client WO**	**Sample Disp**	**Lab Deadline**	**Internal Deadline**	**Client Deadline**
HERO LANDS	07-214 HERO LANDS	W	04/30/2019	05/07/2019	05/08/2019

Internal ID	Client ID	Sample Date	Matrix	Storage	Ra226	Ra228	TDS																						Ttl
01	LCS	04/18/19	WA	KK1.4	X	X	X																						3
02	BLANK	04/18/19	WA	KK1.4	X	X	X																						3
03	DUP	04/18/19	WA	KK1.4	X	X	X																						3
04	BC 22B	04/09/19 10:00	WA	KK1.4	X	X	X																						3
05	BC 9	04/09/19 12:10	WA	KK1.4	X	X	X																						3
06	BC 10	04/09/19 14:55	WA	KK1.4	X	X	X																						3
07	BC 23	04/09/19 16:50	WA	KK1.4	X	X	X																						3
																													0
																													0
																													0
																													0
																													0
																													0
																													0
																													0
																													0
																													0
																													0
																													0
																													0
			Totals Per Analysis (non QA samples)		4	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

EBERLINE SERVICES

Sample Log In Report

Oak Ridge Laboratory
601 Scarboro Rd.
Oak Ridge, TN 37830

Voice: (865) 481-0683
Fax: (865) 483-4621

Invoice
Accounts Payable
Michael Pisani & Associates
840 W Sam Houston Pkwy N Suite 600
Houston, TX 77024
Voice 281-242-5700
Fax 281-520-4625

Contact
Dave Upthegrove
Voice 832-786-5006
Fax

Report Data
Dave Upthegrove
Michael Pisani & Associates
840 W Sam Houston Pkwy N Suite 600
Houston, TX 77478
Voice 832-786-5006
Fax

Printed: 4/18/2019 12:35 PM

Eberline Services – Oak Ridge Laboratory

SAMPLE RECEIPT CHECKLIST
MP-001.2

WORK ORDER # 19-04089

SAMPLE MATRIX/MATRICES:

(CIRCLE ONE OR BOTH)

(AQUEOUS) NON-AQUEOUS

WERE SAMPLES:

(CIRCLE EITHER YES, NO, OR N/A)

Received in good condition?	(Y)	N	
If aqueous, properly preserved	(Y)	N	N/A

WERE CHAIN OF CUSTODY SEALS:

Present on outside of package?	(Y)	N
Unbroken on outside of package?	(Y)	N
Present on samples?	(Y)	N
Unbroken on samples?	(Y)	N
Was chain of custody present upon sample receipt?	(Y)	N

IF THE RESPONSE TO ANY OF THE ABOVE IS NO, A DISCREPANT SAMPLE RECEIPT REPORT (DSR) HAS BEEN ISSUED.

REMARKS: _____

SIGNATURE: Randolph Spencer DATE: 4-18-19

SECTION III

CASE NARRATIVE

EBERLINE ANALYTICAL

EBERLINE ANALYTICAL CORPORATION
601 SCARBORO ROAD
OAK RIDGE, TENNESSEE 37830
PHONE (865) 481-0683
FAX (865) 483-4621

EBS-OR-45508

June 3, 2019

Dave Upthegrove
ERM
840 W Sam Houston Pkwy N #600
Houston, TX 77478

CASE NARRATIVE
Work Order # 19-04089-OR

SAMPLE RECEIPT

This work order contains four water samples received 04/17/2019. Samples were analyzed for Radium-226/228 and Total Dissolved Solids.

CLIENT ID	LAB ID
BC 22B	19-04089-04
BC 9	19-04089-05
BC 10	19-04089-06
BC 23	19-04089-07

ANALYTICAL METHODS

Radium-226 was analyzed using EPA Method 903.0 Modified. Radium-228 was analyzed using EPA Method 904.0. Total Dissolved Solids were performed using Standard Methods 2540C.

ANALYTICAL RESULTS

Combined Standard Uncertainty is reported at 1-sigma value.

Minimum Detectable Activity (MDA) values for data represented in this report are sample-specific. MDA measurements are determined based on factors and conditions including instrument settings, aliquot size and matrix type.

RADIUM-226

Samples were prepared by removing representative aliquots followed by filtering and mixed acid digestions as appropriate. This was followed by precipitations of Radium/Barium Sulfate. Precipitates were dissolved in alkaline EDTA. Radium was selectively precipitated and then mounted on micro-porous filter media. Samples were counted by alpha spectroscopy using an energy specific region of interest for Radium-226. Inherent self-absorption from elemental Barium was corrected for in the final result. Chemical recovery was calculated by the use of a Barium-133 tracer, which was determined by HPGe gamma spectroscopy.

ANALYTICAL RESULTS CONTINUED

RADIUM-226 CONTINUED

Samples demonstrated acceptable results for all Radium-226 analyses. Chemical recovery was acceptable for all samples. The Radium-226 method blank demonstrated an acceptable result. Results for the Radium-226 duplicate demonstrated a high relative percent difference; however, normalized difference is within acceptable limits for the analytical technique. Results for the Radium-226 laboratory control sample demonstrated an acceptable percent recovery.

RADIUM-228

Following alpha spectroscopy analysis of Radium-226, Barium/Radium Sulfate precipitates were redissolved and allowed for sufficient ingrowth of the Actinium-228 daughter. After ingrowth, Actinium-228 was selectively precipitated. Precipitates were filtered and beta emissions for Actinium-228 were then counted on a gas proportional counter. Chemical recovery was determined by the use of a Barium-133 tracer, the activity of which was determined by HPGe gamma spectroscopy and an elemental Yttrium carrier by gravimetric measurements. The product of these two recoveries was used to calculate chemical yield.

Samples demonstrated acceptable results for all Radium-228 analyses. Chemical recovery was acceptable for all samples. The Radium-228 method blank demonstrated an acceptable result. Results for the Radium-228 duplicate demonstrated a high relative percent difference; however, normalized difference is within acceptable limits for the analytical technique. Results for the Radium-228 laboratory control sample demonstrated an acceptable percent recovery.

TOTAL DISSOLVED SOLIDS (TDS)

A volumetric aliquot of each sample was filtered through a tared 0.45µm filter media into a tared 250ml beaker. Samples were dried on a hot plate and were allowed to cool. The TDS content was determined by reweighing tared beakers.

Samples demonstrated Total Dissolved Solids content that ranged from 11,025.0 to 62,889.0 mg/L.

CERTIFICATION OF ACCURACY

I certify that this data report is in compliance with the terms and conditions of the Purchase Order, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hard copy data package has been authorized by the cognizant project manager or his/her designee to be accurate as verified by the following signature.

M.R. McDougall
Laboratory Manager

Date: 6/3/2019

Eberline Analytical wants and encourages your feedback regarding our performance providing radioanalytical services. Please visit http://eberlineanalytical.com/ to provide us with feedback on our services.

SECTION IV

ANALYTICAL RESULTS SUMMARY

Eberline Analytical
Final Report of Analysis

Report To:
Dave Upthegrove
ERM
840 W Sam Houston Pkwy N Suite 600
Houston, TX 77478

Work Order Details:
SDG: 19-04089
Project: 07-214 Hero Lands
Analysis Category: ENVIRONMENTAL
Sample Matrix: WA

Lab ID	Sample Type	Client ID	Sample Date	Receipt Date	Analysis Date	Batch ID	Analyte	Method	Result	CU	CSU	MDA	Report Units
19-04089-01	LCS	KNOWN	04/18/19 00:00	4/17/2019	5/1/2019	19-04089	Radium-226	EPA 903.0 Modified	1.00E+01	4.61E-01			pCi/l
19-04089-01	LCS	SPIKE	04/18/19 00:00	4/17/2019	5/1/2019	19-04089	Radium-226	EPA 903.0 Modified	1.10E+01	1.57E+00	2.81E+00	2.60E-01	pCi/l
19-04089-02	MBL	BLANK	04/18/19 00:00	4/17/2019	5/1/2019	19-04089	Radium-226	EPA 903.0 Modified	-6.50E-02	1.65E-01	1.66E-01	4.81E-01	pCi/l
19-04089-03	DUP	BC 22B	04/09/19 10:00	4/17/2019	5/1/2019	19-04089	Radium-226	EPA 903.0 Modified	1.21E+00	3.39E-01	4.25E-01	2.09E-01	pCi/l
19-04089-04	DO	BC 22B	04/09/19 10:00	4/17/2019	5/1/2019	19-04089	Radium-226	EPA 903.0 Modified	1.72E+00	4.47E-01	5.77E-01	1.98E-01	pCi/l
19-04089-05	TRG	BC 9	04/09/19 12:10	4/17/2019	5/1/2019	19-04089	Radium-226	EPA 903.0 Modified	1.76E+00	4.90E-01	6.15E-01	2.33E-01	pCi/l
19-04089-06	TRG	BC 10	04/09/19 14:55	4/17/2019	5/1/2019	19-04089	Radium-226	EPA 903.0 Modified	8.50E+00	1.84E+00	2.57E+00	7.47E-01	pCi/l
19-04089-07	TRG	BC 23	04/09/19 16:50	4/17/2019	5/1/2019	19-04089	Radium-226	EPA 903.0 Modified	9.98E+00	1.92E+00	2.85E+00	5.24E-01	pCi/l
19-04089-01	LCS	KNOWN	04/18/19 00:00	4/17/2019	5/3/2019	19-04089	Radium-228	EPA 904.0	8.98E+00	4.58E-01			pCi/l
19-04089-01	LCS	SPIKE	04/18/19 00:00	4/17/2019	5/3/2019	19-04089	Radium-228	EPA 904.0	8.93E+00	7.37E-01	2.15E+00	8.63E-01	pCi/l
19-04089-02	MBL	BLANK	04/18/19 00:00	4/17/2019	5/3/2019	19-04089	Radium-228	EPA 904.0	5.67E-01	4.00E-01	4.20E-01	7.92E-01	pCi/l
19-04089-03	DUP	BC 22B	04/09/19 10:00	4/17/2019	5/3/2019	19-04089	Radium-228	EPA 904.0	1.11E+00	4.70E-01	5.33E-01	8.92E-01	pCi/l
19-04089-04	DO	BC 22B	04/09/19 10:00	4/17/2019	5/3/2019	19-04089	Radium-228	EPA 904.0	7.01E-01	4.40E-01	4.68E-01	8.66E-01	pCi/l
19-04089-05	TRG	BC 9	04/09/19 12:10	4/17/2019	5/3/2019	19-04089	Radium-228	EPA 904.0	1.38E+00	4.76E-01	5.69E-01	8.82E-01	pCi/l
19-04089-06	TRG	BC 10	04/09/19 14:55	4/17/2019	5/3/2019	19-04089	Radium-228	EPA 904.0	2.98E+00	6.12E-01	9.11E-01	1.03E+00	pCi/l
19-04089-07	TRG	BC 23	04/09/19 16:50	4/17/2019	5/3/2019	19-04089	Radium-228	EPA 904.0	5.45E+00	5.74E-01	1.36E+00	6.97E-01	pCi/l
19-04089-04	TRG	BC 22B	04/09/19 10:00	4/17/2019	4/23/2019	19-04089	TDS	SM2540C	1.86E+04				mg/l
19-04089-05	TRG	BC 9	04/09/19 12:10	4/17/2019	4/23/2019	19-04089	TDS	SM2540C	1.10E+04				mg/l
19-04089-06	TRG	BC 10	04/09/19 14:55	4/17/2019	4/23/2019	19-04089	TDS	SM2540C	4.11E+04				mg/l
19-04089-07	TRG	BC 23	04/09/19 16:50	4/17/2019	4/23/2019	19-04089	TDS	SM2540C	6.29E+04				mg/l

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (1-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample; MBL=Blank; DUP=Duplicate; TRG=Normal Sample; DO=Duplicate Original

0018

SECTION V

ANALYTICAL STANDARD

Ba-6
(# 6a)

National Institute of Standards & Technology

Certificate

ORIGINAL

Standard Reference Material 4251C
Barium-133 Radioactivity Standard

ORIGINAL

This Standard Reference Material (SRM) consists of radioactive barium-133 chloride, non-radioactive barium chloride, and hydrochloric acid dissolved in 5 mL of distilled water. The solution is contained in a flame-sealed NIST borosilicate-glass ampoule. The SRM is intended for the calibration of ionization chambers and solid-state gamma-ray spectrometry systems.

Radiological Hazard

The SRM ampoule contains barium-133 with a total activity of approximately 2.5 MBq. Barium-133 decays by electron capture and during the decay process X-rays and gamma-rays with energies from 4 to 400 keV are emitted. Most of these photons escape from the SRM ampoule and can represent a radiation hazard. Approximate unshielded dose rates at several distances (as of the reference time) are given in note [a]*. Appropriate shielding and/or distance should be used to minimize personnel exposure. The SRM should be used only by persons qualified to handle radioactive material.

Chemical Hazard

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

Storage and Handling

The SRM should be stored and used at a temperature between 5 and 65 °C. The solution in an unopened ampoule should remain stable and homogeneous until at least June 2004.

The ampoule (or any subsequent container) should always be clearly marked as containing radioactive material. If the ampoule is transported it should be packed, marked, labeled, and shipped in accordance with the applicable national, international, and carrier regulations. The solution in the ampoule is a dangerous good (hazardous material) both because of the radioactivity and because of the strong acid.

Preparation

This Standard Reference Material was prepared in the Physics Laboratory, Ionizing Radiation Division, Radioactivity Group, J.M.R. Hutchinson, Group Leader. The overall technical direction and physical measurements leading to certification were provided by L.L. Lucas of the Radioactivity Group and D.B. Golas, Nuclear Energy Institute Research Associate.

The support aspects involved in the preparation, certification, and issuance of this SRM were coordinated through the Standard Reference Materials Program by N.M. Trahey.

Gaithersburg, Maryland 20899
October 1994

Thomas E. Gills, Chief
Standard Reference Materials Program

*Notes and references are on pages 5 and 6.

EBERLINE SERVICES

QUALITY CONTROL PROGRAM
QCP-009

Rev.8; 11/10/03
Title: **Radioactive Reference Standards Solutions & Records**

EBERLINE SERVICES - OAK RIDGE LABORATORY
RADIOACTIVE REFERENCE STANDARD SOLUTIONS
SECONDARY DILUTION RECERTIFICATION

	QCP-009-1-A	Date	4/26/19
Solution Reference #	NIST SRM4251C	Solution #	Ba-6a

Principal Radionuclide	Half Life, Years	Half Life, Days
^{133}Ba	1.048E+01	3.828E+03

Radionuclide of Interest: ^{133}Ba
Parent Solution Conc.: 1.48E+05 dpm/ml

Reference Date: 9/1/1993 0:00

Chemical Composition of Standard Solution
$^{133}BaCl_2$ in 1M HCl

Dilution Instructions:

Dilution Solvent Used: 1M HCl

SECONDARY VOLUMETRIC DILUTION

Vol. Parent Solution: 25.0000 ml
Total Activity: 3.6950E+06 dpm
Final Volume: 1000.00 ml

Final Activity Concentration: 3.6950E+03 dpm/ml

NOTES:

This activity concentration is based on the original reference date listed above. All activities are corrected to the date and time of analysis by the laboratory data processing software.

Expiration Date: April 25, 2020

Verified & Approved By _____ Date: 4/26/19

QC Approval _____ Date: 4/26/19

Ra-5

QA/QC REVIEWED
Date 2/8/94 Initials WT

CERTIFICATE OF CALIBRATION
ALPHA STANDARD SOLUTION

Radionuclide:	Ra-226	Customer:	TMA EBERLINE
Half Life:	1600 ± 7 years	P.O.No.:	VH1888
Catalog No.:	7226	Reference Date:	February 1 1994 12:00 PST.
Source No.:	453-26	Contained Radioactivity: (Ra-226)	1.001 μCi.
		Contained Radioactivity: (Ra-226)	37.0 kBq.

Description of Solution

a. Mass of solution:	5.1864 g (in a 5 ml Flame Sealed Ampoule)
b. Chemical form:	Ra(NO3)2 in 1 N HNO3
c. Carrier content:	None added
d. Density:	1.0318 g/ml @ 20°C.

Radioimpurities: None detected(other than daughters)

Radioactive Daughters
Rn-222, Po-218, At-218, Pb-214, Bi-214, Po-214, Tl-210, Pb-210, Bi-210, Po-210 and Tl-206.

Radionuclide Concentration

(Ra-226) 0.1929 μCi/g.

Method of Calibration

Weighed aliquots of the solution were assayed using gamma spectrometry:
Energy peak(s) integrated under: 186 keV.
Branching ratio(s) used: 0.0351 gamma rays per decay.

Uncertainty of Measurement

a. Systematic uncertainty in instrument calibration:	±3.4%
b. Random uncertainty in assay:	±3.1%
c. Random uncertainty in weighing(s):	±0.2%
d. Total uncertainty at the 99% confidence level:	±4.6%

NIST Traceability

This calibration is implicitly traceable to the National Institute of Standards and Technology.

Leak Test(s)

See reverse side for Leak Test(s) applied to this source.

Notes

1. Nuclear data were taken from "Table of Radioactive Isotopes", edited by Virginia S. Shirley, 1986.
2. IPL participates in an NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials (As in NRC Regulatory Guide 4.15).

Ana U. Huerta
QUALITY CONTROL

Feb. 3, 1994
Date Signed

ISOTOPE PRODUCTS LABORATORIES
1800 North Keystone Street
Burbank, California 91504
(818) 843 - 7000

EBERLINE SERVICES

QUALITY CONTROL PROGRAM
MP 009

Rev.8; 11/01/03
Title: Radioactive Reference Standards Solutions & Records

EBERLINE SERVICES - OAK RIDGE LABORATORY
RADIOACTIVE REFERENCE SOLUTIONS
PRIMARY DILUTION RECERTIFICATION
MP 009

CURRENT DATE 9/17/2018 0:00
SOLUTION REFERENCE # IPL 453-26 **SOLUTION #** Ra-5

Principal Radionuclide	Half Life, Years	Half Life, Days
^{226}Radium	1.600E+03	5.844E+05

Radionuclide ^{226}Radium
Certified Activity 1.001E+00 µCi
Certified Concentration µCi per gram
Reference Date 2/1/1994 0:00

Ampoule /Solution Gross Weight, Grams
Empty Ampoule Weight, Grams
Solution Net Weight, Grams
Total Activity in Ampoule 1.0010 µCi

Chemical Composition of Standard Solution
$^{228}Ra(NO_3)_2$ in 1M HNO_3

Dilution Instructions:

Dilution Solvent Used 1M HNO_3

Dilute to a volume of 1000.00 **milliliters**

Certified Total Activity of 1.0010 µCi **Which Equals** 2.222E+06 **dpm at the date listed above**

And after dilution the activity of this solution is **2.222E+03** **dpm/ml**

This activity concentration is based on the original reference date listed above. All activities are corrected to the date and time of analysis by the laboratory data processing software.

Expiration Date: September 10, 2019

Verified & Approved By _____ Date: 9/17/2018

QC Approval _____ Date: 9/18/18

EBERLINE SERVICES

QUALITY CONTROL PROGRAM
MP 009

Rev.8; 11/01/03
Title: **Radioactive Reference Standards Solutions & Records**

EBERLINE SERVICES - OAK RIDGE LABORATORY
RADIOACTIVE REFERENCE STANDARD SOLUTIONS
SECONDARY DILUTION RECERTIFICATION

	MP 009	Date	9/17/2018 0:00
Solution Reference #	IPL-453-26	Solution #	Ra-5b

Principal Radionuclide	Half Life, Years	Half Life, Days
^{226}Radium	1.600E+03	5.844E+05

Radionuclide of Interest	^{226}Radium	Reference Date	2/1/1994 0:00
Parent Solution Conc.	2.22E+03 dpm/ml		

Chemical Composition of Standard Solution
$^{226}Ra(NO_3)_2$ in 1M HNO_3

Dilution Instructions: **Dilution Solvent Used** 1M HNO_3

SECONDARY VOLUMETRIC DILUTION

Vol. Parent Solution:	20.0000 ml	Final Activity Concentration:	4.4440E+01 dpm/ml
Total Activity:	4.4440E+04 dpm		
Final Volume:	1000.00 ml		

This activity concentration is based on the original reference date listed above. All activities are corrected to the date and time of analysis by the laboratory data processing software.

NOTES:

Expiration Date: 10-Sep-19

Verified & Approved By _____ Date: 9/17/2018 0:00

QC Approval _____ Date: 9/18/18

ANALYTICS #411 Rec'd 2/15/06 R Trenton

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

Phone (404) 352-8677
Fax (404) 352-2837

CERTIFICATE OF CALIBRATION

Standard Radionuclide Source

Ra-228

72325-207

Ra-228 5 mL Liquid in Flame Sealed Vial

This standard radionuclide source was prepared gravimetrically from a calibrated master solution. The master solution was calibrated using a germanium gamma spectrometer system.

Radionuclide purity and calibration were checked using a germanium gamma spectrometer system. The nuclear decay rate and assay date for this source are given below.

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

ISOTOPE:	Ra-228
ACTIVITY (dps):	4.022 E3
HALF-LIFE:	5.75 years
CALIBRATION DATE:	February 10, 2006 12:00 EST
RELATIIVE EXPANDED UNCERTAINTY (k=2):	4.0%

Impurities: γ-impurities <0.1%

5.10721 grams 0.1M HCl solution with 50 µg/g Ba carrier.

P O NUMBER 00003181, Item 1

SOURCE PREPARED BY: M Taskaeva
M. Taskaeva, Radiochemist

Q A APPROVED: M. Mc 2-13-06

EBERLINE SERVICES

QUALITY CONTROL PROGRAM

MP-009

Rev.8; 1/10/03
Title: Radioactive Reference Standards Solutions & Records

EBERLINE SERVICES - OAK RIDGE LABORATORY
RADIOACTIVE REFERENCE SOLUTIONS
RECERTIFICATION
MP 009

		CURRENT DATE	2/5/2019 0:00
SOLUTION REFERENCE #	Analytics 7235-207	SOLUTION #	Ra-12

Principal Radionuclide	Half Life, Years	Half Life, Days
^{228}Ra	5.750E+00	2.100E+03

Radionuclide	^{228}Ra	Reference Date	2/10/2006 0:00
Certified Activity	1.087E-01	µCi	
Certified Concentration		µCi per gram	

Ampoule /Solution Gross	9.0741	Weight, Grams
Empty Ampoule	3.9858	Weight, Grams
Solution Net	5.0883	Weight, Grams
Total Activity in Ampoule	0.1087	µCi

Chemical Composition of Standard Solution

$^{228}Ra(NO_3)_2$ in 0.5 M HCl

Dilution Instructions: **Dilution Solvent Used** 0.5 M HCl

Dilute to a volume of 991.00 **Kg**

Certified Total Activity of 0.1087 **µCi** **Which Equals** 2.413E+05 **dpm at the date listed above**

And after dilution the activity of this solution is 2.435E+02 **dpm/ml**

This activity concentration is based on the original reference date listed above. All activities are corrected to the date and time of analysis by the laboratory data processing software.

Expiration Date: January 31, 2020

Recertified By _____ Date: 2/5/19

QC Approval _____ Date: 2/5/19

SECTION VI

QUALITY CONTROL SAMPLE RESULTS SUMMARY

WO	Analysis	Run	Activity Units	Aliquot Units	Client Name
19-04089	Ra226	1	pCi	l	Michael Pisani & Associates, Inc.

Laboratory Control Sample

Analyte		LCS Measured	CSU Measured	LCS Expected	Uncert. Expected	Known	Known Error	Result	CSU	Standard ID	Standard ACT (dpm)	Standard Error	Standard Added (g)
RA-226		110.14%	25.47%	100.00%	4.60%	1.00E+01	4.61E-01	1.10E+01	2.81E+00	Ra-5b	4.40E+01	4.60E+00	5.06E-01

Matrix Spike

Analyte	*Normalized Difference*	*MS Actual % Rec*	*Expected MS Result*	*Expected MS Uncert*	*Actual MS Result*	*Actual MS CSU*	*Sample Result*	*Sample CSU*	*Sample Aliquot*	*Standard ID*	*Standard ACT (dpm)*	*Standard Error %*	*Standard Added (g)*

Duplicate Results

Analyte	*Normalized Difference*	*RPD*	*Original Result*	*Original CSU*	*Duplicate Result*	*Duplicate CSU*
RA-226	1.40	34.93	1.72E+00	5.77E-01	1.21E+00	4.25E-01

QC Summary

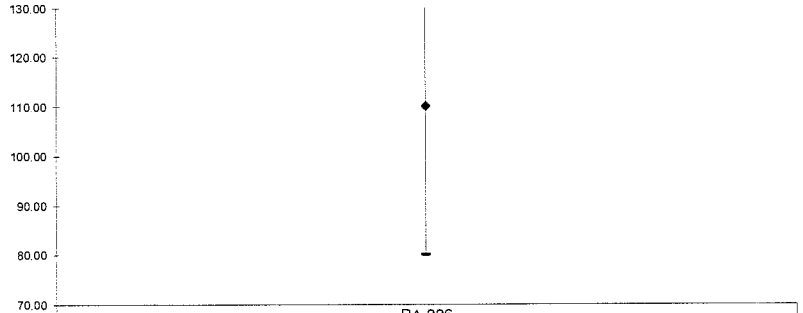
LCS Relative Bias	*LCS % R*		*MS % R*	*MS ND*	*Rep RPD*	*Rep ND*
1.10	OK				INV	OK

0028

Version

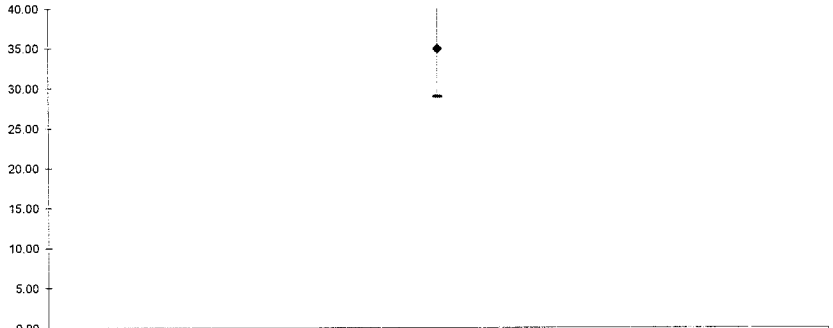
WO	Analysis	Run	Activity Units	Aliquot Units	Client Name
19-04089	Ra226	1	pCi	l	Michael Pisani & Associates, Inc.

LCS % Recovery



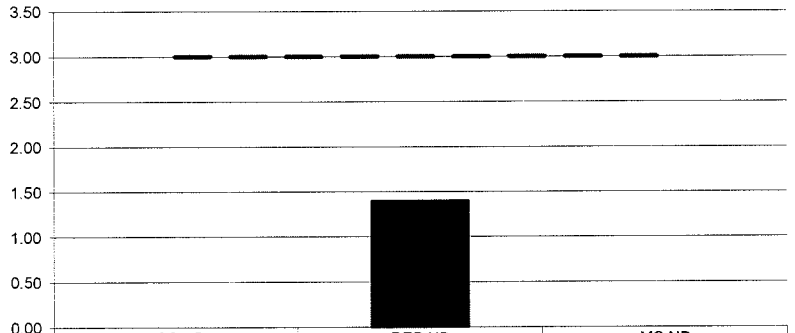
	RA-226
Lower Error	80.07
Upper Error	140.21
%R	110.14
LCL	75
Mean	100
UCL	125

Replicate Sample RPD



	RA-226
Lower Error	40.89
Upper Error	28.98
RPD	34.93
CL	35

Normalized Difference



	LCS ND	REP ND	MS ND
RA-226	0.00	1.40	0.00
UCL	3	3	3

No Matrix Spike

0029

Version

WO	Analysis	Run	Activity Units	Aliquot Units	Client Name
19-04089	Ra228	1	pCi	l	Michael Pisani & Associates, Inc.

Laboratory Control Sample

Analyte		LCS Measured	CSU Measured	LCS Expected	Uncert. Expected	Known	Known Error	Result	CSU	Standard ID	Standard ACT (dpm)	Standard Error	Standard Added (g)
RA-228		99.46%	24.10%	100.00%	5.10%	8.98E+00	4.58E-01	8.93E+00	2.15E+00	Ra-12	4.95E+01	5.10E+00	4.03E-01

Matrix Spike

Analyte	*Normalized Difference*	*MS Actual % Rec*	*Expected MS Result*	*Expected MS Uncert*	*Actual MS Result*	*Actual MS CSU*	*Sample Result*	*Sample CSU*	*Sample Aliquot*	*Standard ID*	*Standard ACT (dpm)*	*Standard Error %*	*Standard Added (g)*

Duplicate Results

Analyte	*Normalized Difference*	*RPD*	*Original Result*	*Original CSU*	*Duplicate Result*	*Duplicate CSU*
RA-228	1.12	44.73	7.01E-01	4.68E-01	1.11E+00	5.33E-01

QC Summary

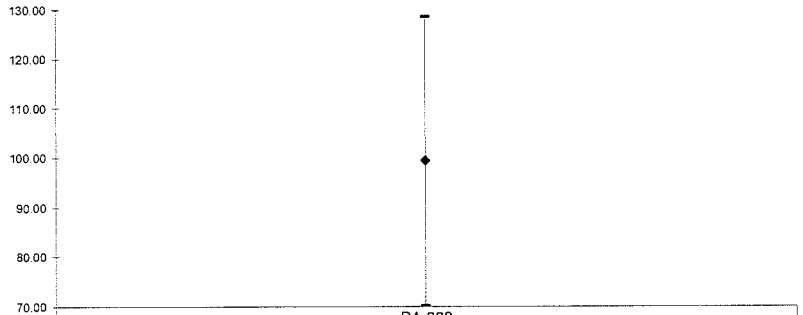
LCS Relative Bias	*LCS % R*		*MS % R*	*MS ND*	*Rep RPD*	*Rep ND*
0.99	OK				INV	OK

0030

Version

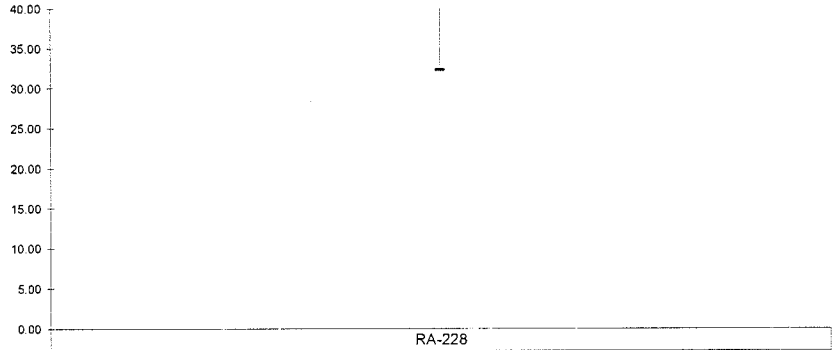
WO	Analysis	Run	Activity Units	Aliquot Units	Client Name
19-04089	Ra228	1	pCi	I	Michael Pisani & Associates, Inc.

LCS % Recovery



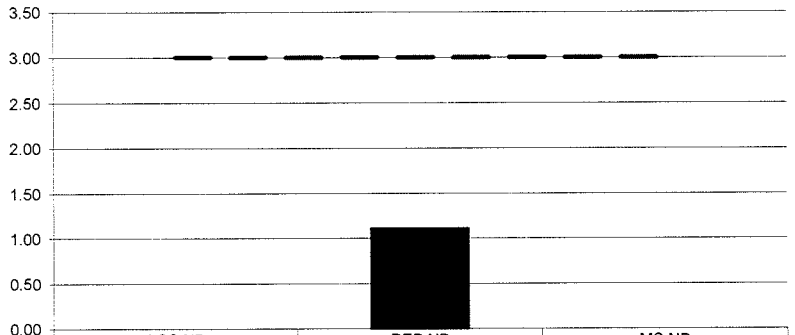
	RA-228
Lower Error	70.26
Upper Error	128.66
%R	99.46
LCL	75
Mean	100
UCL	125

Replicate Sample RPD



	RA-228
Lower Error	57.12
Upper Error	32.34
RPD	44.73
CL	35

Normalized Difference



	LCS ND	REP ND	MS ND
RA-228	0.00	1.12	0.00
UCL	3	3	3

No Matrix Spike

0031

Version

SECTION VII

LABORATORY TECHNICIAN'S NOTES

RA-226 NOTES

EBERLINE SERVICES

Work Order Analysis Notes

Oak Ridge Laboratory
601 Scarboro Rd.
Oak Ridge, TN 37830
Voice: 865.481.0683
www.eberlineservices.com

Internal Work Order	19-04089
Analysis Code	Ra226
Run Number	1

#	Date	Dept	User	Notes
1	04/29/19 10:35	PREP	JHARVEY	ALIQUOTED AND FILTERED SAMPLES- ADDED SPIKE AND TRACERS- PH'D SAMPLES- PRECIPITATED WITH BA AND PB CARRIERS AND AMMONIUM SULFATE- DECANTED SAMPLES AND CENTRIFUGED- SUBMITTED RADIUM PRECIP TO SEPARATIONS

J Harvey
4/29/19

EBERLINE SERVICES

Work Order Analysis Notes

Oak Ridge Laboratory
601 Scarboro Rd.
Oak Ridge, TN 37830
Voice: 865.481.0683
www.eberlineservices.com

Internal Work Order	19-04089
Analysis Code	Ra226
Run Number	1

#	Date	Dept	User	Notes
1	04/29/19 10:35	PREP	JHARVEY	ALIQUOTED AND FILTERED SAMPLES- ADDED SPIKE AND TRACERS- PH'D SAMPLES- PRECIPITATED WITH BA AND PB CARRIERS AND AMMONIUM SULFATE- DECANTED SAMPLES AND CENTRIFUGED- SUBMITTED RADIUM PRECIP TO SEPARATIONS
2	05/01/19 15:04	CHEM	DBUSH	ADDED EDTA TO SAMPLES AND LET SIT. ADDED AMMONIUM SULFATE AND ACETIC ACID TO SAMPLES. FILTERED ONTO TARED FILTER PAPERS, LET DRY UNDER HEAT LAMP, REWEIGHED, AND SUBMITTED TO COUNT.

5/1/19

EBERLINE SERVICES

Reagents Used in an Analysis

Internal Work Order	
19-04089	
Analysis Code	Run
Ra226	1

Reagent ID	Reagent Name	Reagent Concentration	Analyst ID	Date Recorded
020284P	Ammonium Hydroxide	Reagent Grade	JHARVEY	4/29/2019
020902D01	Ammonium Sulfate	200 mg/ml	JHARVEY	4/29/2019
020921D03	Barium Carrier	1 mg/ml	JHARVEY	4/29/2019
019767D02	Lead Carrier	166 mg/ml	JHARVEY	4/29/2019
020995P	Nitric Acid	Reagent Grade	JHARVEY	4/29/2019
020912P	Acetic Acid	Reagent Grade	DBUSH	5/1/2019
020416D03	Ammonium Sulfate	200 mg/ml	DBUSH	5/1/2019
020809S	EDTA	0.25M	DBUSH	5/1/2019

Alpha 3

Date	Sample #	Client	Loadtime	Counttime	Analysis	Tech
4/29/19	1904076A (1-3,5)	UCOR	0833	2hr50min	Am^{241}	ICP
4/29/19	1904076A (1-3,5)	UCOR	0834	2hr50min	Am^{243}	ICP
4/29/19	1904067A (1-4)	Access	1137	2hr50-	Rad	ICB
4/29/19	1904069A (1-4)	Access	1138	2hr50-	Rad	ICB
4/29/19	1904076A (1-3,5)	UCOR	1142	2hr50-	Pu^{242}	ICB
4/29/19	1904129A (1)	USA	1148	2hr50-	UU	ICB
4/29/19	1904076A (1)	UCOR	1436	2hr50-	PU	ICB
4/30/19	Daily Pulser	Lab	0508	10 min	Na	ICP
4/30/19	1903117A (1-15)	Zion	0803	2hr50min	Am^{241}	ICP
4/30/19	1904076A (1-3,5)	UCOR	0804	2hr50min	Np	ICP
4/30/19	1904129A (1-4)	USA	1059	2hr50-	Rad	ICB
4/30/19	1904080A (1-6)	Gulf Coast	1117	2hr50-	Rad	ICB
5/1/19	Daily Pulser	Lab	0557	10min	Na	ICP
5/1/19	1904077A (2-4)	UCOR	0841	2hr50min	Pu^{242}	ICP
5/1/19	1903117A (1-15)	Zion	0849	2hr50min	Np	ICP
5/1/19	1904077A (1-4)	UCOR	0853	2hr50min	Np	ICP
5/1/19	1904093A (1-7)	TN Dept of Health	1143	2hr50-	UU	ICB
5/1/19	1904077A (1-4)	UCOR	1144	2hr50-	Th	ICB
5/1/19	1904077A (1-4)	UCOR	1145	2hr50-	Th^{228}	ICB
5/1/19	1904076A (1-3,5)	UCOR	1422	2hr50-	Rada	ICB
5/1/19	1904077A (1-4)	UCOR	1438	2hr50-	Rad	ICB
5/1/19	1904093A (4)	TN Dept of Health	1448	2hr50-	UU	ICB
5/1/19	1904089A (1-7)	MPA	1624	2hr50-	Rad	ICB

RA-228 NOTES

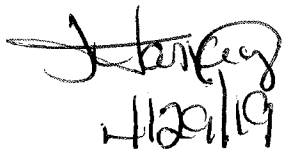
EBERLINE SERVICES

Work Order Analysis Notes

Oak Ridge Laboratory
601 Scarboro Rd.
Oak Ridge, TN 37830
Voice: 865.481.0683
www.eberlineservices.com

Internal Work Order	19-04089
Analysis Code	Ra228
Run Number	1

#	Date	Dept	User	Notes
1	04/29/19 10:36	PREP	JHARVEY	ALIQUOTED AND FILTERED SAMPLES- ADDED SPIKE AND TRACERS- PH'D SAMPLES- PRECIPITATED WITH BA AND PB CARRIERS AND AMMONIUM SULFATE- DECANTED SAMPLES AND CENTRIFUGED- SUBMITTED RADIUM PRECIP TO SEPARATIONS



EBERLINE SERVICES

Work Order Analysis Notes

Oak Ridge Laboratory
601 Scarboro Rd.
Oak Ridge, TN 37830
Voice: 865.481.0683
www.eberlineservices.com

Internal Work Order	19-04089
Analysis Code	Ra228
Run Number	1

#	Date	Dept	User	Notes
1	04/29/19 10:36	PREP	JHARVEY	ALIQUOTED AND FILTERED SAMPLES- ADDED SPIKE AND TRACERS- PH'D SAMPLES- PRECIPITATED WITH BA AND PB CARRIERS AND AMMONIUM SULFATE- DECANTED SAMPLES AND CENTRIFUGED- SUBMITTED RADIUM PRECIP TO SEPARATIONS
2	05/03/19 12:12	CHEM	DBUSH	ADDED FILTER PAPERS FROM COUNT ROOM TO LABELED C-TUBES, FILLED WITH EDTA SOLUTION AND LET SIT OVERNIGHT. REMOVED FILTER FROM EDTA-ADDED 2MLS YTTRIUM 9MG/ML CARRIER ADDED 18N NAOH TO SAMPLES AND RECORDED T1. HOT BATHED FOR 15 MIN, CENTRIFUGED AND DISCARDED SUPERNANT. ADDED 6N HNO3, DI WATER, AND 10N NAOH. HOT BATHED FOR 15 MIN, CENTRIFUGED AND DISCARDED SUPERNANT. ADDED 1N HNO3, DI WATER, AND AMMONIUM OXALATE. FILTERED ONTO TARED FILTER PAPERS. LET DRY UNDER HEAT LAMP, REWEIGHED AND SUBMITTED TO COUNT.

5/3/19

EBERLINE SERVICES

Reagents Used in an Analysis

Internal Work Order	
19-04089	
Analysis Code	Run
Ra228	1

Reagent ID	Reagent Name	Reagent Concentration	Analyst ID	Date Recorded
020284P	Ammonium Hydroxide	Reagent Grade	JHARVEY	4/29/2019
020902D01	Ammonium Sulfate	200 mg/ml	JHARVEY	4/29/2019
020921D03	Barium Carrier	1 mg/ml	JHARVEY	4/29/2019
019767D02	Lead Carrier	166 mg/ml	JHARVEY	4/29/2019
020995P	Nitric Acid	Reagent Grade	JHARVEY	4/29/2019
020416D04	Ammonium Oxalate	5%	DBUSH	5/3/2019
020241D07	Nitric Acid	1N	DBUSH	5/3/2019
020774D19	Nitric Acid	6N	DBUSH	5/3/2019
020241D06	Sodium Hydroxide	10M	DBUSH	5/3/2019
020241D05	Sodium Hydroxide	18M	DBUSH	5/3/2019
021061S	Yttrium Carrier	9 mg/ml	DBUSH	5/3/2019

Aqua LB4110

Date	Sample #	Client	Load time	Count time	Analysis	Tech
5/1/19	1904135AB (3-15)	IKON	1318	2 hrs	αβ	ICP
5/1/19	1904066 Ra (1-4)	Access Analytical	1325	2 hrs	Ra^8	ICP
5/1/19	1904067 Ra (1-4)	Access Analytical	1327	2 hrs	Ra^8	ICP
5/1/19	1904135AB (4, 16, 17)	IKON	1523	2 hr	αβ	ICB
5/1/19	1903058 SR (4-6)	DOE	1614	1 hr	TOT Sr	ICB
5/2/19	Daily Blgd/QC	Lab	0516/0626	1 hr/30 min	αβ	ICP
5/2/19	Cross Talk	Lab	0659	5 min	αβ	ICP
5/2/19	Cross Talk	Lab	0707	5 min	αβ	ICP
5/2/19	1905007AB (2-4)	Materion	0718	1 hr	αβ	ICP
5/2/19	1903056AB (1-6)	DOE	0719	2 hrs	αβ	ICP
~~5/2/19~~	~~1903062AB (1)~~	KP 5/2/19	~~0721~~	~~30 min~~	~~αβ~~	~~ICP~~
5/2/19	1905007AB (1)	Materion	0721	30 min	αβ	ICP
5/2/19	1904076SY (1)	UCOR	0813	30 min	Sr^{90}	ICP
5/2/19	1904076SY (2, 3, 5)	UCOR	0823	2 hrs	Sr^{90}	ICP
5/2/19	1904076SY (7)	UCOR	0845	2 hrs	Sr^{90}	ICP
5/2/19	1903062AB (1-3)	DOE	0922	2 hrs	αβ	ICP
5/2/19	1903062AB (10)	DOE	1123	2 hrs	αβ	ICP
5/2/19	1903062AB (11)	DOE	1326	2 hrs	αβ	ICP
5/2/19	1904066RA (9-12)	MPA	1447	2 hr	Raw	ICB
5/2/19	1903062AB (12)	DOE	1602	2 hr	αβ	ICB
5/3/19	Daily Blgd/QC	Lab	0517/	1 hr/30 min	αβ	ICP
5/3/19	Cross Talk	Lab	0659	5 min	αβ	ICP
5/3/19	Cross Talk	Lab	0707	5 min	αβ	ICP
5/3/19	1904047Sr (2-10)	Zion	0722	2 hrs	Tot Sr	ICP
5/3/19	1904047Sr (1)	Zion	0938	30 min	Tot Sr	ICP
5/3/19	1904089RA (1-7)	MPA	1225	2 hrs	Raw	ICB

TDS NOTES

EBERLINE SERVICES

Work Order Analysis Notes

Oak Ridge Laboratory
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Internal Work Order	19-04089
Analysis Code	TDS
Run Number	1

#	Date	Dept	User	Notes
1	04/22/19 14:51	PREP	JPACHELLA	Samples were filtered, aliquoted into tared beakers, dried, and reweighed.

4-22-19 J Pachella

SECTION VIII

ANALYTICAL DATA (RADIUM-226)

19-04089
Ra226
Run 1

Work Order	19-04089
Analysis Code	Ra226
Run	1
Date Received	4/17/2019
Lab Deadline	4/30/2019
Client	Michael Pisani & Associates, Inc.
Project	HERO LANDS
Report Level	4
Activity Units	pCi
Aliquot Units	l
Matrix	WA
Method	EPA 903.0 Modified
Instrument Type	Alpha Spectroscopy
Radiometric Tracer	Ba-133
Radiometric Sol#	Ba-6a
Tracer Act (dpm/g)	455.5
Carrier	
Carrier Conc (mg/ml)	

Internal Fraction	Sample Desc	Client ID	Login CPM	Sample Date	Sample Aliquot
01	LCS	LCS		04/18/19 00:00	1.0000E+00
02	MBL	BLANK		04/18/19 00:00	1.0000E+00
03	DUP	BC 22B	30	04/09/19 10:00	1.0000E+00
04	DO	BC 22B	30	04/09/19 10:00	1.0000E+00
05	TRG	BC 9	29	04/09/19 12:10	1.0000E+00
06	TRG	BC 10	33	04/09/19 14:55	5.0000E-01
07	TRG	BC 23	34	04/09/19 16:50	5.0000E-01

0046

* SAF1 is used for Gross Alpha and all other radionuclides. SAF2 is used for Gross Beta only. ^ Indicates estimated SAF value.
** Actual mass exceeded the calibration curve range. Results should be qualified as appropriate.

19-04089
Ra226
Run 1

Internal Fraction	Sample Desc	Tracer Aliquot (g)	Tracer Total ACT (dpm)	Radiometric Tracer (pCi)	Radiometric % Rec	Grav Carrier Added (ml)	Grav Filter Tare (g)	Grav Filter Final (g)	Grav Filter Net (g)	Grav % Rec	Mean % Rec	SAF 1*	SAF 2*
01	LCS	2.2045	1004.1	668.0	147.68		0.0209	0.0300	0.0091		110.00	3.00^	1.00
02	MBL	2.2033	1003.6	569.0	125.86		0.0207	0.0308	0.0101		110.00	3.00^	1.00
03	DUP	2.2045	1004.1	682.0	150.78		0.0209	0.0253	0.0044		110.00	1.37	1.00
04	DO	2.1975	1001.0	693.0	153.70		0.0208	0.0260	0.0052		110.00	1.81	1.00
05	TRG	2.2000	1002.1	505.0	111.88		0.0210	0.0268	0.0058		110.00	2.08	1.00
06	TRG	2.1968	1000.6	428.0	94.96		0.0202	0.0277	0.0075		94.96	2.64	1.00
07	TRG	2.1945	999.6	652.0	144.80		0.0199	0.0334	0.0135		110.00	3.00^	1.00

* SAF1 is used for Gross Alpha and all other radionuclides. SAF2 is used for Gross Beta only. ^ Indicates estimated SAF value.
** Actual mass exceeded the calibration curve range. Results should be qualified as appropriate.

19-04089
Ra226
Run 1

Internal Fraction	Sample Desc	Rough Prep Date	Rough Prep By	Prep Date	Prep By	Sep t0 Date/Time	Sep t0 By	Sep t1 Date/Time	Sep t1 By
01	LCS			04/29/19 06:47	JHARVEY	05/01/19 08:58	DBUSH		
02	MBL			04/29/19 06:47	JHARVEY	05/01/19 08:58	DBUSH		
03	DUP			04/29/19 06:47	JHARVEY	05/01/19 08:58	DBUSH		
04	DO			04/29/19 06:47	JHARVEY	05/01/19 08:58	DBUSH		
05	TRG			04/29/19 06:47	JHARVEY	05/01/19 08:58	DBUSH		
06	TRG			04/29/19 06:47	JHARVEY	05/01/19 13:35	DBUSH		
07	TRG			04/29/19 06:47	JHARVEY	05/01/19 13:35	DBUSH		

0048

* SAF1 is used for Gross Alpha and all other radionuclides. SAF2 is used for Gross Beta only. ^ Indicates estimated SAF value.
** Actual mass exceeded the calibration curve range. Results should be qualified as appropriate.

Preliminary Data Report & Analytical Calculations

Work Order: 19-04089-Ra226-1

Client	Eberline Analytical Work Order	Analysis Code	Run
Michael Pisani & Associates, Inc.	19-04089	Ra226	1

Lab Fraction	Nuclide	Sample Desc	Client Identification	Activity Units	Results	Error Estimate	MDA	LCS Known	LCS %R	LCS Flag	RPD Flag	MDA Flag	Blank Flag
01	RA-226	LCS	LCS	pCi/l	1.10E+01	1.57E+00	2.60E-01	1.00E+01	110.14	OK		OK	
02	RA-226	MBL	BLANK	pCi/l	-6.50E-02	1.65E-01	4.81E-01					OK	OK
03	RA-226	DUP	BC 22B	pCi/l	1.21E+00	3.39E-01	2.09E-01				INV	OK	
04	RA-226	DO	BC 22B	pCi/l	1.72E+00	4.47E-01	1.98E-01					OK	
05	RA-226	TRG	BC 9	pCi/l	1.76E+00	4.90E-01	2.33E-01					OK	
06	RA-226	TRG	BC 10	pCi/l	8.50E+00	1.84E+00	7.47E-01					OK	
07	RA-226	TRG	BC 23	pCi/l	9.98E+00	1.92E+00	5.24E-01					OK	

Preliminary Data Report & Analytical Calculations

Work Order: 19-04089-Ra226-1

Run	Analysis Code	Eberline Analytical Work Order	Client
1	Ra226	19-04089	Michael Pisani & Associates, Inc.

Lab Fraction	Nuclide	Sample Desc	Sample Date	Sample Aliquot	Radiometric % Rec	Grav % Rec	Mean % Rec	SAF	Sep t0 Date/Time	Sep t1 Date/Time
01	RA-226	LCS	04/18/19 00:00	1.00E+00	100.00	0.00	110.00		5/1/2019 8:58	
02	RA-226	MBL	04/18/19 00:00	1.00E+00	100.00	0.00	110.00		5/1/2019 8:58	
03	RA-226	DUP	04/09/19 10:00	1.00E+00	100.00	0.00	110.00		5/1/2019 8:58	
04	RA-226	DO	04/09/19 10:00	1.00E+00	100.00	0.00	110.00		5/1/2019 8:58	
05	RA-226	TRG	04/09/19 12:10	1.00E+00	100.00	0.00	110.00		5/1/2019 8:58	
06	RA-226	TRG	04/09/19 14:55	5.00E-01	94.96	0.00	94.96		5/1/2019 13:35	
07	RA-226	TRG	04/09/19 16:50	5.00E-01	100.00	0.00	110.00		5/1/2019 13:35	

0050

Preliminary Data Report & Analytical Calculations

Work Order: 19-04089-Ra226-1

Run	Analysis Code	Eberline Analytical Work Order	Client
1	Ra226	19-04089	Michael Pisani & Associates, Inc.

Lab Fraction	Nuclide	Sample Desc	Counting Date/Time	Halflife (days)	Detect	Carrier	Count Time	Counts	Bkg CPM	Eff
01	RA-226	LCS	05/01/19 16:25		A_Spec	Alpha_038	170	2.03 E+02	2.00 E-03	14.6
02	RA-226	MBL	05/01/19 16:25		A_Spec	Alpha_039	170	-1.23 E+00	1.90 E-02	15
03	RA-226	DUP	05/01/19 16:25		A_Spec	Alpha_040	170	5.36 E+01	2.00 E-02	16.1
04	RA-226	DO	05/01/19 16:25		A_Spec	Alpha_041	170	5.96 E+01	8.00 E-03	16.6
05	RA-226	TRG	05/01/19 16:25		A_Spec	Alpha_042	170	5.16 E+01	8.00 E-03	16.2
06	RA-226	TRG	05/01/19 16:25		A_Spec	Alpha_043	170	8.61 E+01	1.10 E-02	14.9
07	RA-226	TRG	05/01/19 16:25		A_Spec	Alpha_044	170	1.07 E+02	4.00 E-03	17.1

Count Room Report
Client: Michael Pisani Associat

19-04089-Ra226-1 (pCi/l) in WA
Tracer ID: Ba-6a

#38-47

Internal Fraction	*Sample Desc*	*Client ID*	*Sample Date*	*Sample Aliquot*	*Tracer Aliquot (g)*	*Tracer ACT (dpm)*	*Radiometric Tracer (pCi)*	*Radiometric % Rec*	*SAF 1**	*SAF 2**
01	**LCS**	LCS	04/18/19 00:00	1.0000	2.2045	1004.1498	668.0000	147.68	3.00^	1.00
02	**MBL**	BLANK	04/18/19 00:00	1.0000	2.2033	1003.6032	569.0000	125.86	3.00^	1.00
03	**DUP**	BC 22B	04/09/19 10:00	1.0000	2.2045	1004.1498	682.0000	150.78	1.37	1.00
04	**DO**	BC 22B	04/09/19 10:00	1.0000	2.1975	1000.9613	693.0000	153.70	1.81	1.00
05	**TRG**	BC 9	04/09/19 12:10	1.0000	2.2000	1002.1000	505.0000	111.88	2.08	1.00
06	**TRG**	BC 10	04/09/19 14:55	0.5000	2.1968	1000.6424	428.0000	94.96	2.64	1.00
07	**TRG**	BC 23	04/09/19 16:50	0.5000	2.1945	999.5948	652.0000	144.80	3.00^	1.00

Spike and Tracer Worksheet

Internal Work Order	Run	Analysis Code	Date	Technician	Technician Initials	Witness Initials
19-04089	1	Ra226	4/29/2019 6:43	JHARVEY		

LCS & Matrix Spikes					LCS	MS	LCSD	MSD	LCS		MS		LCSD		MSD	
Isotope	Sol #	Activity dpm/g	Solution Date	Approx Addition	Volume Used (g)	Volume Used (g)	Volume Used (g)	Volume Used (g)	Known pCi	Error Estimate	Added pCi	Error Estimate	Known pCi	Error Estimate	Added pCi	Error Estimate
Ra-226	Ra-5b	43.960	4/29/2019	0.500	0.5057				10.01	0.461	0.00	0.000	0.00	0.000	0.00	0.000

Tracers

fraction	Isotope	Sol #	Activity dpm/g	Solution Date	Volume Used (g)	Approx Addition
01	Ba-133	Ba-6a	455.500	4/29/2019	2.2045	2.2200
02	Ba-133	Ba-6a	455.500	4/29/2019	2.2033	2.2200
03	Ba-133	Ba-6a	455.500	4/29/2019	2.2045	2.2200
04	Ba-133	Ba-6a	455.500	4/29/2019	2.1975	2.2200
05	Ba-133	Ba-6a	455.500	4/29/2019	2.2000	2.2200
06	Ba-133	Ba-6a	455.500	4/29/2019	2.1968	2.2200
07	Ba-133	Ba-6a	455.500	4/29/2019	2.1945	2.2200

Balance Printer Tapes

Tracer	LCS

Matrix Spike

0053

Eberline Analytical
Oak Ridge Laboratory

Aliquot Worksheet

Printed: 5/1/2019 1:35 PM

Work Order	Run	Analysis Code	Rpt Units	Lab Deadline	Technician
19-04089	1	Ra226	liters	4/30/2019	DBUSH

Lab Fraction	Michael Pisani & Associates, Inc. Client ID	Sample Type	Muffle Data Ratio Post/Pre	Dilution Data No of Dils	Dil Factor	Ratio	Aliquot Data Aliquot	Net Equiv	MS Aliquot Data Aliquot	Net Equiv	H-3 Solids Only Water Added (ml)	H3 Dist Aliq
01	LCS	LCS				1.00E+00	1.0000E+00	1.0000E+00				
02	BLANK	MBL				1.00E+00	1.0000E+00	1.0000E+00				
03	BC 22B	DUP				1.00E+00	1.0000E+00	1.0000E+00				
04	BC 22B	DO				1.00E+00	1.0000E+00	1.0000E+00				
05	BC 9	TRG				1.00E+00	1.0000E+00	1.0000E+00				
06	BC 10	TRG				1.00E+00	5.0000E-01	5.0000E-01				
07	BC 23	TRG				1.00E+00	5.0000E-01	5.0000E-01				

Comments	

0054

Technician: DBush Date: 5/1/19

Gravimetric Worksheet

Work Order	Run	Analysis Code	Gravimetric Carrier	Carrier Conc (mg/ml)	Technician
19-04089	**1**	**Ra226**			**DBUSH**

TRetec	Michael Pisani & Associates, Inc.	Sample	Carrier Data	Filter Data			Gravimetric
Fraction	Client ID	Type	Carrier Added (ml)	Filter Tare (g)	Filter Final (g)	Filter Net (g)	% Recovery
01	LCS	LCS		0.0209	0.0300	**0.0091**	
02	BLANK	MBL		0.0207	0.0308	**0.0101**	
03	DUP	DUP		0.0209	0.0253	**0.0044**	
04	BC 22B	DO		0.0208	0.0260	**0.0052**	
05	BC 9	TRG		0.0210	0.0268	**0.0058**	
06	BC 10	TRG		0.0202	0.0277	**0.0075**	
07	BC 23	TRG		0.0199	0.0334	**0.0135**	

0055

Technician: _____ Date: 5 / 1 / 19

Apex-Alpha™

Sample Description: SPIKE
Spectrum File: \\OR-ALPHA1\Canberra\ApexAlpha\Root\Data\00002415
Batch Identification: 1904089A-RA
Sample Identification: 01
Sample Geometry: Shelf 2
Procedure Description: Ra

Detector Name: Alpha_038
Chamber Serial Number: 04026478B
Detector Serial Number: 91134
Env. Background: System Bkgd 243631
Reagent Blank: <not performed>

Sample Size: 1.000E+000 +/- 0.000E+000 liter
Generic Mult. Factor: 3.000E+000 Generic Div. Factor: 1.000E+000
Sample Date/Time: 5/1/2019 3:12:41 PM
Acquisition Date/Time: 5/1/2019 4:25:05 PM
Acquisition Live Time: 170.0 minutes
Acquisition Real Time: 170.0 minutes

Chem. Recovery Factor: 1.0000 +/- 0.0000
Counting Efficiency: 0.1461 +/- 0.0026 on 2/22/2019 8:51:47 AM
Effective Efficiency: 0.1461 +/- 0.0026

Control Certificate Name: Ra226_Ra-5b
Chem. Recov. of Control: RA-226 0.367143 +/- 0.028803
Peak Match Tolerance: 0.350 MeV

PEAK AREA REPORT

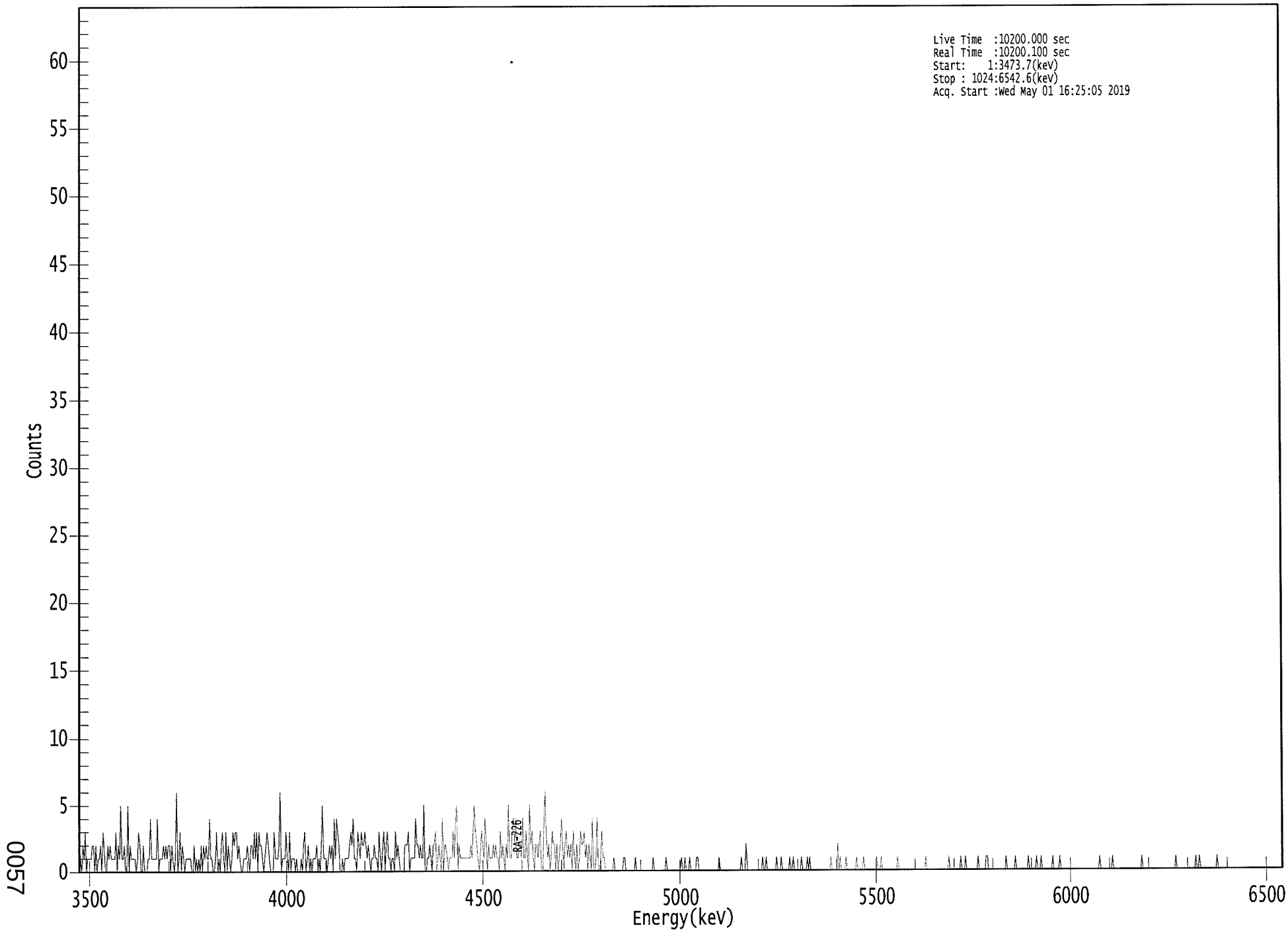
Nuclide	Energy (MeV)	Net Pk Area	Pk Area Error %	Ambient Backgnd	Reagent Backgnd	FWHM (keV)
RA-224	5.486	11.66	58.37	0.34	0.00E+000	3.0
RA-226	4.623	202.66	13.78	0.34	0.00E+000	6.0

NUCLIDE ANALYSIS RESULTS

Nuclide	Id Conf.	Energy (keV)	Activity (pCi/liter)	MDA (pCi/liter)
RA-224	0.949	5685.50*	6.67E-001 +/- 3.90E-001	2.74E-001 +/- 9.45E-003
RA-226	0.966	4785.00*	1.10E+001 +/- 1.57E+000	2.60E-001 +/- 8.99E-003

AG
5/2/19

0000241532.CNF



****
***** S P E C T R A L D A T A R E P O R T *****
****

Sample Title: 01

Elapsed Live time: 10200
Elapsed Real Time: 10200

Channel							
1:	2	1	0	2	1	3	0	1
9:	1	1	1	2	2	0	2	0
17:	1	1	2	0	3	2	0	0
25:	2	1	2	1	1	1	1	3
33:	0	2	1	5	1	1	2	0
41:	0	5	0	2	1	1	1	1
49:	0	1	3	2	0	0	2	0
57:	0	0	1	1	4	1	1	1
65:	1	1	4	0	1	1	1	2
73:	1	2	1	2	2	0	2	1
81:	0	1	6	0	1	3	0	2
89:	1	0	1	1	1	1	1	0
97:	0	2	0	1	0	1	0	2
105:	0	2	1	2	1	1	4	1
113:	1	0	0	1	3	0	1	0
121:	2	3	1	0	3	0	2	1
129:	0	1	3	2	3	3	1	2
137:	1	0	0	1	1	1	2	1
145:	0	2	2	1	3	1	3	0
153:	3	2	2	1	0	1	2	3
161:	2	1	0	0	0	3	1	1
169:	1	2	6	0	1	1	1	3
177:	1	0	3	0	1	1	1	0
185:	1	0	0	0	1	0	2	3
193:	0	1	2	0	1	0	1	1
201:	1	2	0	1	0	2	5	1
209:	1	1	0	1	2	1	2	0
217:	4	1	4	3	2	0	0	1
225:	0	1	1	1	1	2	3	2
233:	4	1	1	0	3	2	1	3
241:	2	2	3	2	1	2	1	0
249:	1	1	2	1	1	0	3	1
257:	0	2	3	0	2	3	1	1
265:	0	1	1	0	3	1	2	1
273:	0	0	0	0	2	2	2	3
281:	0	1	1	1	1	4	2	2
289:	1	2	1	1	5	0	0	1
297:	1	2	1	0	2	2	3	0
305:	1	2	1	0	4	0	2	2
313:	1	0	1	1	1	3	1	4
321:	5	0	2	1	1	1	1	1
329:	1	1	1	1	2	1	3	5
337:	3	2	1	0	1	3	2	1
345:	4	2	0	2	1	1	1	2
353:	1	2	1	1	0	3	1	2
361:	1	0	2	1	5	1	1	3

369:	4	2	4	1	1	2	2	1

Sample Title: 01

Channel								
377:	4	1	1	3	1	0	5	2
385:	3	1	0	2	2	1	2	3
393:	0	0	3	6	3	1	2	0
401:	1	3	2	2	0	2	0	1
409:	2	4	2	0	2	3	1	2
417:	1	2	0	3	1	0	2	0
425:	1	3	2	2	3	1	2	0
433:	2	1	0	4	0	0	1	4
441:	0	0	1	3	1	1	0	0
449:	0	0	0	0	0	1	0	0
457:	0	0	0	0	0	1	1	0
465:	0	0	0	0	0	0	0	1
473:	0	0	0	0	0	0	0	0
481:	0	0	0	0	0	0	1	0
489:	0	0	0	0	0	0	0	0
497:	0	1	0	0	0	0	0	0
505:	0	0	0	0	0	0	1	0
513:	0	1	0	0	0	1	0	0
521:	0	0	0	1	1	0	0	0
529:	0	0	0	0	0	0	0	0
537:	0	0	0	0	0	0	1	0
545:	0	0	0	0	0	0	0	0
553:	0	0	0	0	0	0	0	0
561:	0	1	0	0	0	2	0	0
569:	0	0	0	0	0	0	0	0
577:	0	0	0	1	0	0	1	0
585:	0	0	0	0	0	0	0	1
593:	0	0	0	1	0	0	0	0
601:	0	0	1	0	0	1	0	0
609:	0	0	0	0	1	0	0	0
617:	0	1	0	1	0	0	0	0
625:	0	0	0	0	0	0	0	0
633:	0	0	0	0	0	1	0	0
641:	0	0	0	2	0	1	0	0
649:	0	0	1	0	0	0	0	0
657:	0	0	0	1	0	0	0	0
665:	0	1	0	0	0	0	0	0
673:	0	0	0	0	1	0	0	0
681:	1	0	0	0	0	0	0	0
689:	0	0	0	0	0	0	1	0
697:	0	0	0	0	0	0	0	0
705:	0	0	0	0	0	0	0	0
713:	0	0	0	0	0	0	1	0
721:	0	0	0	0	0	0	0	0
729:	0	0	0	0	0	0	0	0
737:	0	0	1	0	0	0	0	0
745:	0	0	0	0	1	0	0	0
753:	1	0	0	0	0	0	0	0
761:	0	0	0	1	0	0	0	0
769:	0	0	1	1	0	0	0	0
777:	0	0	0	0	0	0	0	0
785:	0	0	0	1	0	0	0	0
793:	0	0	0	1	0	0	0	0

801:	0	0	0	0	0	0	1	0

Sample Title: 01

Channel								
809:	0	0	0	0	0	1	0	0
817:	0	1	0	0	0	0	0	0
825:	0	0	0	1	0	0	0	0
833:	0	1	0	0	0	0	0	0
841:	0	0	0	0	0	0	0	0
849:	0	0	0	0	0	0	0	0
857:	0	0	0	0	0	0	0	0
865:	0	0	0	1	0	0	0	0
873:	0	0	0	0	0	0	1	0
881:	0	0	0	0	0	0	0	0
889:	0	0	0	0	0	0	0	0
897:	0	0	0	0	0	0	0	1
905:	0	0	0	0	0	0	0	0
913:	0	0	0	0	0	0	0	0
921:	0	0	0	0	0	0	0	0
929:	0	0	0	0	1	0	0	0
937:	0	0	0	0	0	0	0	0
945:	0	0	0	0	0	1	0	0
953:	1	0	0	0	0	0	0	0
961:	0	0	0	0	0	0	0	1
969:	0	0	0	0	0	0	0	0
977:	0	0	0	0	0	0	0	0
985:	0	0	0	0	0	0	0	0
993:	0	0	0	0	0	0	0	0
1001:	0	0	0	0	0	0	0	0
1009:	0	0	0	0	0	0	0	0
1017:	0	0	0	0	0	0	0	0

Apex-Alpha™

KP
5/2/19

Sample Description: BLANK
Spectrum File: \\OR-ALPHA1\Canberra\ApexAlpha\Root\Data\00002415
Batch Identification: 1904089A-RA
Sample Identification: 02
Sample Geometry: Shelf 2
Procedure Description: Ra

Detector Name: Alpha_039
Chamber Serial Number: 06027396A
Detector Serial Number: 83109
Env. Background: System Bkgd 243632
Reagent Blank: <not performed>

Sample Size: 1.000E+000 +/- 0.000E+000 liter
Generic Mult. Factor: 3.000E+000 Generic Div. Factor: 1.000E+000
Sample Date/Time: 5/1/2019 3:12:41 PM
Acquisition Date/Time: 5/1/2019 4:25:07 PM
Acquisition Live Time: 170.0 minutes
Acquisition Real Time: 170.0 minutes

Chem. Recovery Factor: 1.0000 +/- 0.0000
Counting Efficiency: 0.1503 +/- 0.0026 on 2/22/2019 8:51:44 AM
Effective Efficiency: 0.1503 +/- 0.0026

Peak Match Tolerance: 0.350 MeV

PEAK AREA REPORT

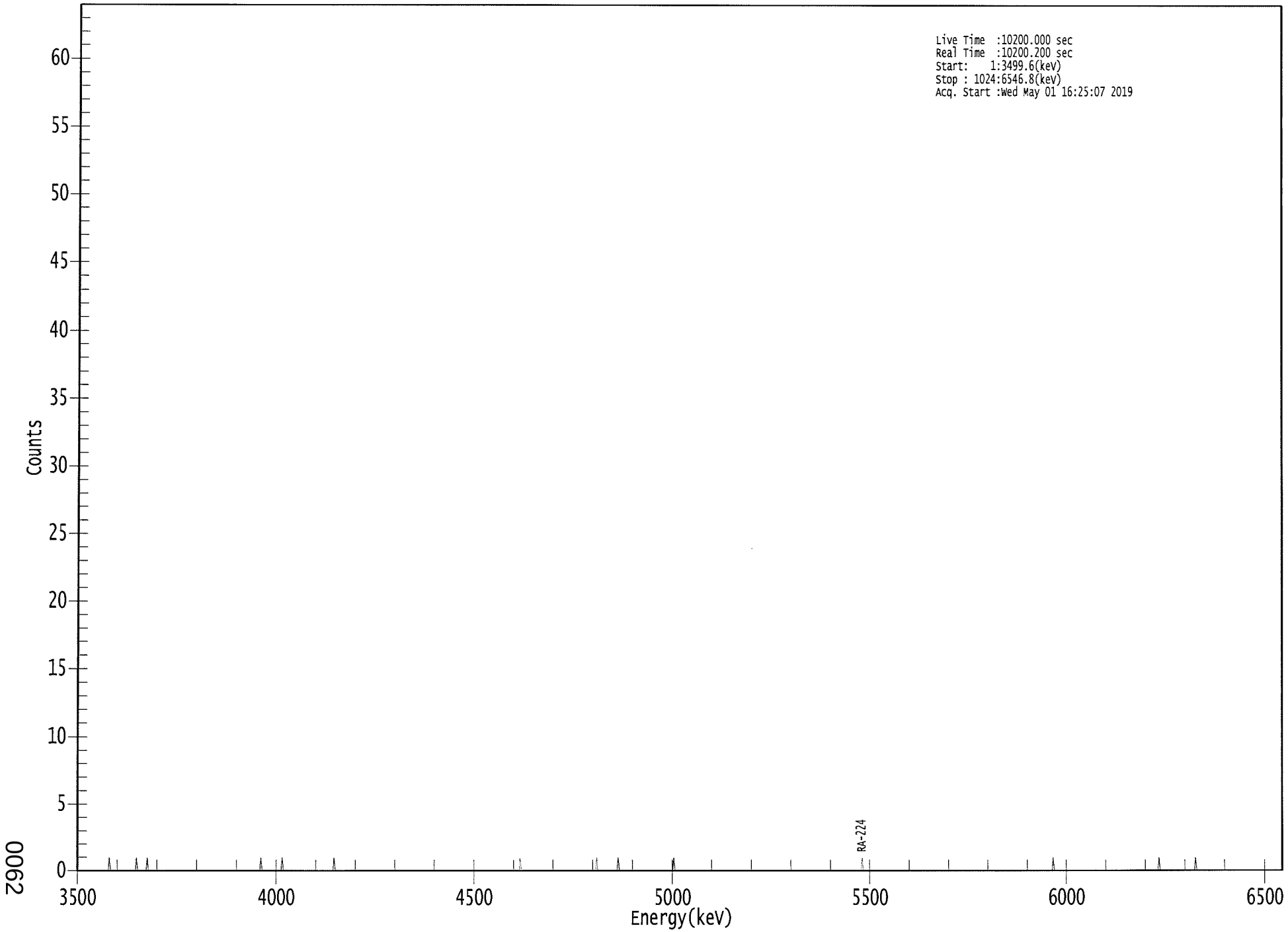
Nuclide	Energy (MeV)	Net Pk Area	Pk Area Error %	Ambient Backgnd	Reagent Backgnd	FWHM (keV)
RA-224	5.480	-0.87	258.63	1.87	0.00E+000	3.0
RA-226	4.713	-1.23	254.42	3.23	0.00E+000	3.0

NUCLIDE ANALYSIS RESULTS

Nuclide	Id Conf.	Energy (keV)	Activity (pCi/liter)	MDA (pCi/liter)
RA-224	0.947	5685.50*	-4.84E-002 +/- 1.25E-001	4.21E-001 +/- 1.45E-002
RA-226	0.993	4785.00*	-6.50E-002 +/- 1.65E-001	4.81E-001 +/- 1.66E-002

AG
5/2/19

0000241535.CNF



ROI Type: 1

2900

****
***** S P E C T R A L D A T A R E P O R T *****
****

Sample Title: 02

Elapsed Live time: 10200
Elapsed Real Time: 10200

Channel								
1:	0	0	0	0	0	0	0	0
9:	0	0	0	0	0	0	0	0
17:	0	0	0	0	0	0	0	0
25:	0	0	0	1	0	0	0	0
33:	0	0	0	0	0	0	0	0
41:	0	0	0	0	0	0	0	0
49:	0	0	1	0	0	0	0	0
57:	0	0	0	1	0	0	0	0
65:	0	0	0	0	0	0	0	0
73:	0	0	0	0	0	0	0	0
81:	0	0	0	0	0	0	0	0
89:	0	0	0	0	0	0	0	0
97:	0	0	0	0	0	0	0	0
105:	0	0	0	0	0	0	0	0
113:	0	0	0	0	0	0	0	0
121:	0	0	0	0	0	0	0	0
129:	0	0	0	0	0	0	0	0
137:	0	0	0	0	0	0	0	0
145:	0	0	0	0	0	0	0	0
153:	0	0	0	1	0	0	0	0
161:	0	0	0	0	0	0	0	0
169:	0	0	0	0	0	1	0	0
177:	0	0	0	0	0	0	0	0
185:	0	0	0	0	0	0	0	0
193:	0	0	0	0	0	0	0	0
201:	0	0	0	0	0	0	0	0
209:	0	0	0	0	0	0	0	0
217:	0	1	0	0	0	0	0	0
225:	0	0	0	0	0	0	0	0
233:	0	0	0	0	0	0	0	0
241:	0	0	0	0	0	0	0	0
249:	0	0	0	0	0	0	0	0
257:	0	0	0	0	0	0	0	0
265:	0	0	0	0	0	0	0	0
273:	0	0	0	0	0	0	0	0
281:	0	0	0	0	0	0	0	0
289:	0	0	0	0	0	0	0	0
297:	0	0	0	0	0	0	0	0
305:	0	0	0	0	0	0	0	0
313:	0	0	0	0	0	0	0	0
321:	0	0	0	0	0	0	0	0
329:	0	0	0	0	0	0	0	0
337:	0	0	0	0	0	0	0	0
345:	0	0	0	0	0	0	0	0
353:	0	0	0	0	0	0	0	0
361:	0	0	0	0	0	0	0	0

369:	0	0	0	0	0	0	0	1

Sample Title: 02

Channel								
377:	0	0	0	0	0	0	0	0
385:	0	0	0	0	0	0	0	0
393:	0	0	0	0	0	0	0	0
401:	0	0	0	0	0	0	0	0
409:	0	0	0	0	0	0	0	0
417:	0	0	0	0	0	0	0	0
425:	0	0	0	0	0	0	0	0
433:	0	0	0	0	0	0	0	0
441:	1	0	0	0	0	0	0	0
449:	0	0	0	0	0	0	0	0
457:	0	0	1	0	0	0	0	0
465:	0	0	0	0	0	0	0	0
473:	0	0	0	0	0	0	0	0
481:	0	0	0	0	0	0	0	0
489:	0	0	0	0	0	0	0	0
497:	0	0	0	0	0	0	0	0
505:	0	1	0	0	0	0	0	0
513:	0	0	0	0	0	0	0	0
521:	0	0	0	0	0	0	0	0
529:	0	0	0	0	0	0	0	0
537:	0	0	0	0	0	0	0	0
545:	0	0	0	0	0	0	0	0
553:	0	0	0	0	0	0	0	0
561:	0	0	0	0	0	0	0	0
569:	0	0	0	0	0	0	0	0
577:	0	0	0	0	0	0	0	0
585:	0	0	0	0	0	0	0	0
593:	0	0	0	0	0	0	0	0
601:	0	0	0	0	0	0	0	0
609:	0	0	0	0	0	0	0	0
617:	0	0	0	0	0	0	0	0
625:	0	0	0	0	0	0	0	0
633:	0	0	0	0	0	0	0	0
641:	0	0	0	0	0	0	0	0
649:	0	0	0	0	0	0	0	0
657:	0	0	0	0	0	0	0	0
665:	0	1	0	0	0	0	0	0
673:	0	0	0	0	0	0	0	0
681:	0	0	0	0	0	0	0	0
689:	0	0	0	0	0	0	0	0
697:	0	0	0	0	0	0	0	0
705:	0	0	0	0	0	0	0	0
713:	0	0	0	0	0	0	0	0
721:	0	0	0	0	0	0	0	0
729:	0	0	0	0	0	0	0	0
737:	0	0	0	0	0	0	0	0
745:	0	0	0	0	0	0	0	0
753:	0	0	0	0	0	0	0	0
761:	0	0	0	0	0	0	0	0
769:	0	0	0	0	0	0	0	0
777:	0	0	0	0	0	0	0	0
785:	0	0	0	0	0	0	0	0
793:	0	0	0	0	0	0	0	0

801:	0	0	0	0	0	0	0	0

Sample Title: 02

Channel								
809:	0	0	0	0	0	0	0	0
817:	0	0	0	0	0	0	0	0
825:	0	0	0	0	1	0	0	0
833:	0	0	0	0	0	0	0	0
841:	0	0	0	0	0	0	0	0
849:	0	0	0	0	0	0	0	0
857:	0	0	0	0	0	0	0	0
865:	0	0	0	0	0	0	0	0
873:	0	0	0	0	0	0	0	0
881:	0	0	0	0	0	0	0	0
889:	0	0	0	0	0	0	0	0
897:	0	0	0	0	0	0	0	0
905:	0	0	0	0	0	0	0	0
913:	0	0	0	0	0	0	1	0
921:	0	0	0	0	0	0	0	0
929:	0	0	0	0	0	0	0	0
937:	0	0	0	0	0	0	0	0
945:	0	0	0	0	0	1	0	0
953:	0	0	0	0	0	0	0	0
961:	0	0	0	0	0	0	0	0
969:	0	0	0	0	0	0	0	0
977:	0	0	0	0	0	0	0	0
985:	0	0	0	0	0	0	0	0
993:	0	0	0	0	0	0	0	0
1001:	0	0	0	0	0	0	0	0
1009:	0	0	0	0	0	0	0	0
1017:	0	0	0	0	0	0	0	0

Apex-Alpha™

KP
5/2/19

Sample Description: BC 22B DUP
Spectrum File: \\OR-ALPHA1\Canberra\ApexAlpha\Root\Data\00002415
Batch Identification: 1904089A-RA
Sample Identification: 03
Sample Geometry: Shelf 2
Procedure Description: Ra

Detector Name: Alpha_040
Chamber Serial Number: 06027396B
Detector Serial Number: 91135
Env. Background: System Bkgd 243633
Reagent Blank: <not performed>

Sample Size: 1.000E+000 +/- 0.000E+000 liter
Generic Mult. Factor: 1.370E+000 Generic Div. Factor: 1.000E+000
Sample Date/Time: 4/9/2019 3:12:41 PM
Acquisition Date/Time: 5/1/2019 4:25:09 PM
Acquisition Live Time: 170.0 minutes
Acquisition Real Time: 170.0 minutes

Chem. Recovery Factor: 1.0000 +/- 0.0000
Counting Efficiency: 0.1606 +/- 0.0028 on 2/22/2019 8:51:43 AM
Effective Efficiency: 0.1606 +/- 0.0028

Peak Match Tolerance: 0.350 MeV

PEAK AREA REPORT

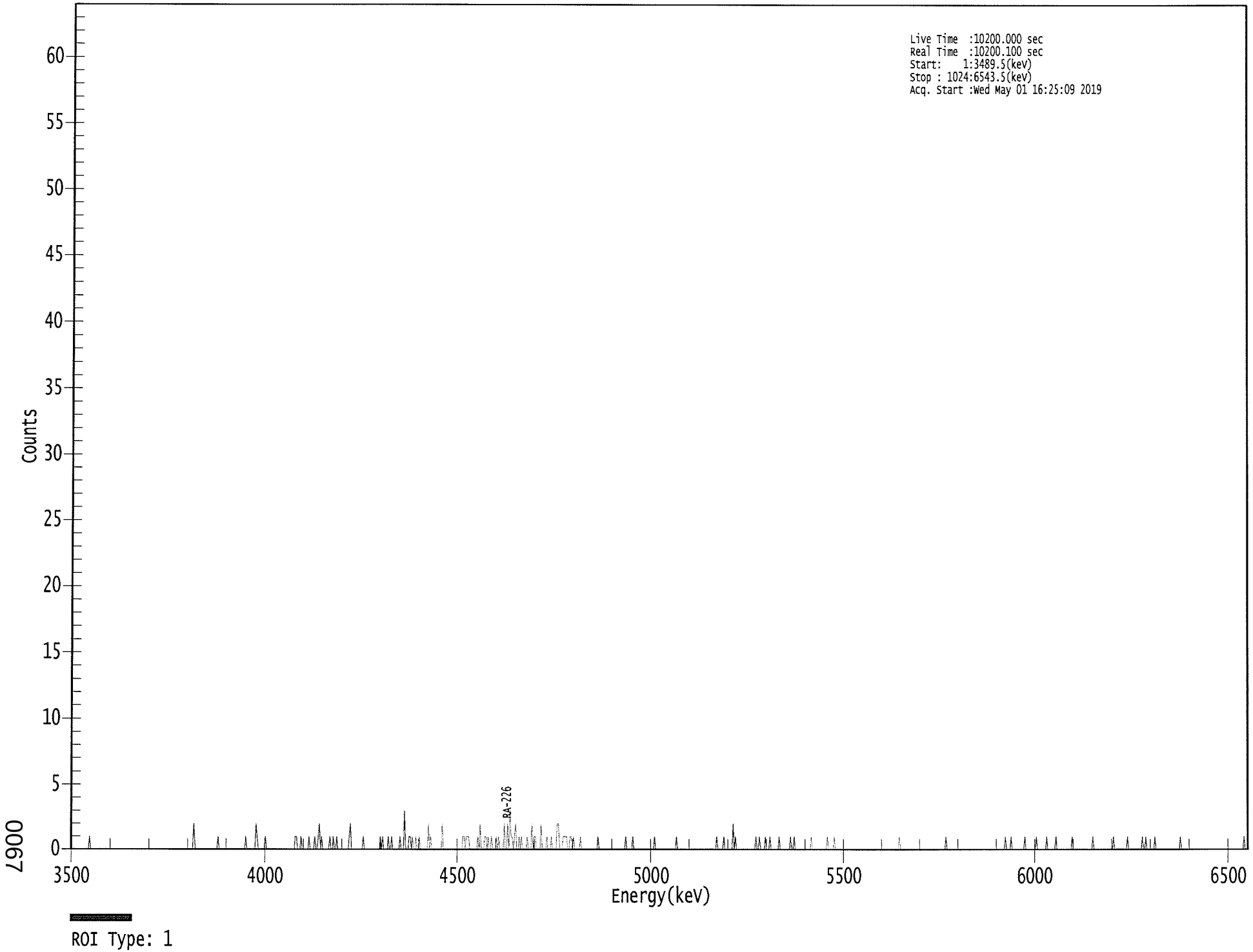
Nuclide	Energy (MeV)	Net Pk Area	Pk Area Error %	Ambient Backgnd	Reagent Backgnd	FWHM (keV)
RA-224	5.489	2.13	191.21	1.87	0.00E+000	3.0
RA-226	4.620	53.60	27.75	3.40	0.00E+000	3.7

NUCLIDE ANALYSIS RESULTS

Nuclide	Id Conf.	Energy (keV)	Activity (pCi/liter)	MDA (pCi/liter)
RA-224	0.951	5685.50*	5.10E-002 +/- 9.75E-002	1.81E-001 +/- 6.20E-003
RA-226	0.965	4785.00*	1.21E+000 +/- 3.39E-001	2.09E-001 +/- 7.14E-003

AG
5/2/19

0000241536.CNF



ROI Type: 1

0067

****
***** S P E C T R A L D A T A R E P O R T *****
****

Sample Title: 03

Elapsed Live time: 10200
Elapsed Real Time: 10200

Channel								
1:	0	0	0	0	0	0	0	0
9:	0	0	0	0	0	0	0	0
17:	1	0	0	0	0	0	0	0
25:	0	0	0	0	0	0	0	0
33:	0	0	0	0	0	0	0	0
41:	0	0	0	0	0	0	0	0
49:	0	0	0	0	0	0	0	0
57:	0	0	0	0	0	0	0	0
65:	0	0	0	0	0	0	0	0
73:	0	0	0	0	0	0	0	0
81:	0	0	0	0	0	0	0	0
89:	0	0	0	0	0	0	0	0
97:	0	0	0	0	0	0	0	0
105:	0	0	2	0	0	0	0	0
113:	0	0	0	0	0	0	0	0
121:	0	0	0	0	0	0	0	1
129:	0	0	0	0	0	0	0	0
137:	0	0	0	0	0	0	0	0
145:	0	0	0	0	0	0	0	1
153:	0	0	0	0	0	0	0	0
161:	2	1	0	0	0	0	0	0
169:	1	0	0	0	0	0	0	0
177:	0	0	0	0	0	0	0	0
185:	0	0	0	0	0	0	0	0
193:	0	0	1	1	0	0	0	1
201:	0	0	0	0	0	0	1	0
209:	0	0	0	1	0	0	1	2
217:	0	1	0	0	0	0	0	0
225:	1	0	0	1	0	0	1	0
233:	0	0	0	0	0	0	0	0
241:	0	1	2	0	0	0	0	0
249:	0	0	0	0	0	1	0	0
257:	0	0	0	0	0	0	0	0
265:	0	0	0	0	1	0	1	0
273:	0	0	0	1	0	0	1	0
281:	0	0	0	0	0	1	0	0
289:	0	3	0	0	0	1	1	0
297:	1	0	0	1	0	0	1	0
305:	0	0	0	0	0	0	2	0
313:	1	0	0	0	0	0	0	0
321:	0	0	2	0	0	0	0	0
329:	0	0	0	0	0	0	0	0
337:	0	0	0	0	1	1	0	1
345:	1	1	0	0	0	0	0	0
353:	0	1	0	2	0	0	0	1
361:	1	0	1	0	0	1	0	0

369:	0	1	0	1	0	0	0	0

Sample Title: 03

Channel								
377:	2	0	0	2	0	3	1	1
385:	0	1	2	0	0	1	0	1
393:	0	0	0	0	1	0	0	0
401:	2	0	1	1	0	0	0	0
409:	2	0	0	0	0	1	0	0
417:	0	1	0	0	0	0	2	2
425:	0	0	0	1	1	1	1	0
433:	0	1	1	0	1	0	0	0
441:	0	0	1	0	0	0	0	0
449:	0	0	0	0	0	0	0	0
457:	0	1	0	0	0	0	0	0
465:	0	0	0	0	0	0	0	0
473:	0	0	0	0	0	0	0	0
481:	0	1	0	0	0	0	0	1
489:	0	0	0	0	0	0	0	0
497:	0	0	0	0	0	0	0	0
505:	0	0	1	0	0	0	0	0
513:	0	0	0	0	0	0	0	0
521:	0	0	0	0	0	1	0	0
529:	0	0	0	0	0	0	0	0
537:	0	0	0	0	0	0	0	0
545:	0	0	0	0	0	0	0	0
553:	0	0	0	0	0	0	0	0
561:	1	0	0	0	0	0	1	0
569:	0	0	0	0	0	0	2	0
577:	1	0	0	0	0	0	0	0
585:	0	0	0	0	0	0	0	0
593:	0	0	1	0	0	1	0	0
601:	0	0	1	0	0	0	1	0
609:	0	0	0	0	0	0	1	0
617:	0	0	0	0	0	0	0	0
625:	1	0	0	1	0	0	0	0
633:	0	0	0	0	0	0	0	0
641:	0	0	1	0	0	0	0	0
649:	0	0	0	0	0	0	0	0
657:	1	0	0	0	0	0	1	0
665:	0	0	0	0	0	0	0	0
673:	0	0	0	0	0	0	0	0
681:	0	0	0	0	0	0	0	0
689:	0	0	0	0	0	0	0	0
697:	0	0	0	0	0	0	0	0
705:	0	0	0	0	0	0	0	0
713:	0	0	0	0	0	0	0	1
721:	0	0	0	0	0	0	0	0
729:	0	0	0	0	0	0	0	0
737:	0	0	0	0	0	0	0	0
745:	0	0	0	0	0	0	0	0
753:	0	0	0	0	0	0	0	0
761:	1	0	0	0	0	0	0	0
769:	0	0	0	0	0	0	0	0
777:	0	0	0	0	0	0	0	0
785:	0	0	0	0	0	0	0	0
793:	0	0	0	0	0	0	0	0

801:	0	0	0	0	0	0	0	0

Sample Title: 03

Channel								
809:	0	0	0	0	1	0	0	0
817:	0	1	0	0	0	0	0	0
825:	0	0	0	0	0	1	0	0
833:	0	0	0	0	0	0	0	1
841:	0	0	0	0	0	0	0	0
849:	1	0	0	0	0	0	0	0
857:	1	0	0	0	0	0	0	0
865:	0	0	0	0	0	0	1	0
873:	0	0	0	0	0	0	0	0
881:	0	0	0	0	0	0	0	0
889:	1	0	0	0	0	0	0	0
897:	0	0	0	0	0	0	0	0
905:	0	0	1	0	0	0	0	0
913:	0	0	0	0	0	0	1	0
921:	0	0	0	0	0	0	0	0
929:	0	0	0	1	0	0	1	0
937:	0	0	0	0	0	0	1	0
945:	0	0	0	0	0	0	0	0
953:	0	0	0	0	0	0	0	0
961:	0	0	0	0	1	0	0	0
969:	0	0	0	0	0	0	0	0
977:	0	0	0	0	0	0	0	0
985:	0	0	0	0	0	0	0	0
993:	0	0	0	0	0	0	0	0
1001:	0	0	0	0	0	0	0	0
1009:	0	0	0	0	0	0	0	0
1017:	0	0	0	1	0	0	0	0

Apex-Alpha™

KP
5/2/19

Sample Description: BC 22B
Spectrum File: \\OR-ALPHA1\Canberra\ApexAlpha\Root\Data\00002415
Batch Identification: 1904089A-RA
Sample Identification: 04
Sample Geometry: Shelf 2
Procedure Description: Ra

Detector Name: Alpha_041
Chamber Serial Number: 05026930A
Detector Serial Number: 91087
Env. Background: System Bkgd 243634
Reagent Blank: <not performed>

Sample Size: 1.000E+000 +/- 0.000E+000 liter
Generic Mult. Factor: 1.810E+000 Generic Div. Factor: 1.000E+000
Sample Date/Time: 4/9/2019 3:12:41 PM
Acquisition Date/Time: 5/1/2019 4:25:11 PM
Acquisition Live Time: 170.0 minutes
Acquisition Real Time: 170.0 minutes

Chem. Recovery Factor: 1.0000 +/- 0.0000
Counting Efficiency: 0.1659 +/- 0.0029 on 2/22/2019 8:51:41 AM
Effective Efficiency: 0.1659 +/- 0.0029

Peak Match Tolerance: 0.350 MeV

PEAK AREA REPORT

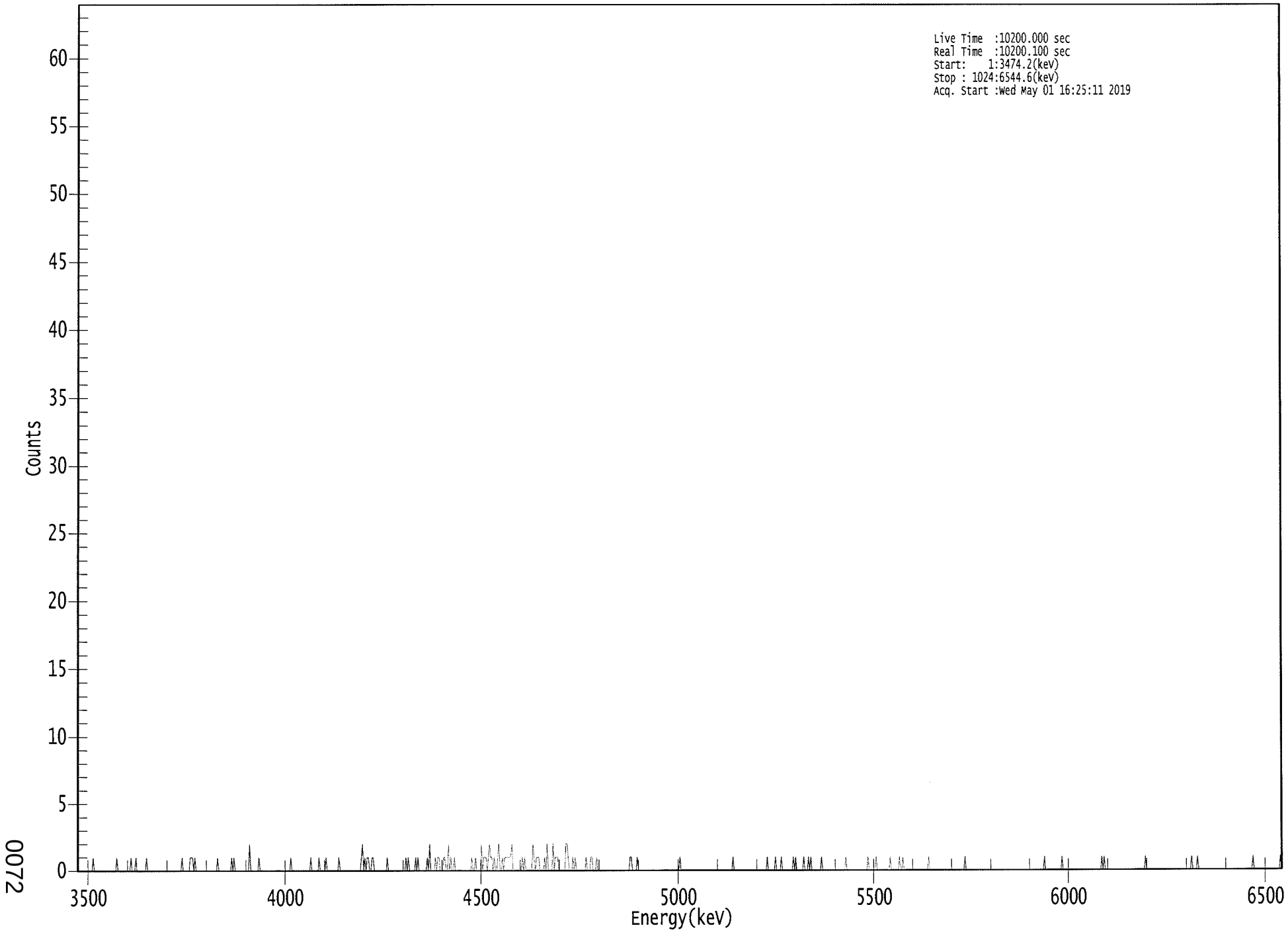
Nuclide	Energy (MeV)	Net Pk Area	Pk Area Error %	Ambient Backgnd	Reagent Backgnd	FWHM (keV)
RA-224	5.535	5.98	87.78	1.02	0.00E+000	3.0
RA-226	4.586	59.64	25.72	1.36	0.00E+000	3.0

NUCLIDE ANALYSIS RESULTS

Nuclide	Id Conf.	Energy (keV)	Activity (pCi/liter)	MDA (pCi/liter)
RA-224	0.971	5685.50*	1.83E-001 +/- 1.61E-001	1.93E-001 +/- 6.57E-003
RA-226	0.950	4785.00*	1.72E+000 +/- 4.47E-001	1.98E-001 +/- 6.73E-003

AG
5/2/19

0000241530.CNF



0072

ROI Type: 1

****
***** S P E C T R A L D A T A R E P O R T *****
****

Sample Title: 04

Elapsed Live time: 10200
Elapsed Real Time: 10200

Channel								
1:	0	0	0	0	0	0	0	0
9:	0	0	0	0	0	1	0	0
17:	0	0	0	0	0	0	0	0
25:	0	0	0	0	0	0	0	0
33:	0	1	0	0	0	0	0	0
41:	0	0	0	0	0	1	0	0
49:	0	1	0	0	0	0	0	0
57:	0	0	1	0	0	0	0	0
65:	0	0	0	0	0	0	0	0
73:	0	0	0	0	0	0	0	0
81:	0	0	0	0	0	0	0	0
89:	1	0	0	0	0	0	0	1
97:	1	1	0	1	0	0	0	0
105:	0	0	0	0	0	0	0	0
113:	0	0	0	0	0	0	1	0
121:	0	0	0	0	0	0	0	0
129:	0	0	1	0	1	0	0	0
137:	0	0	0	0	0	0	0	0
145:	0	2	0	0	0	0	0	0
153:	0	1	0	0	0	0	0	0
161:	0	0	0	0	0	0	0	0
169:	0	0	0	0	0	0	0	0
177:	0	0	0	0	1	0	0	0
185:	0	0	0	0	0	0	0	0
193:	0	0	0	0	0	1	0	0
201:	0	0	0	0	1	0	0	0
209:	0	0	1	0	0	0	0	0
217:	0	0	0	0	0	1	0	0
225:	0	0	0	0	0	0	0	0
233:	0	0	0	0	0	0	0	0
241:	1	2	0	1	0	1	1	0
249:	0	1	1	0	0	0	0	0
257:	0	0	0	0	0	0	1	0
265:	0	0	0	0	0	0	0	0
273:	0	0	0	0	0	0	1	0
281:	1	0	0	0	0	0	1	0
289:	1	0	0	0	0	0	0	0
297:	1	0	2	0	0	0	0	1
305:	0	1	1	0	0	0	1	1
313:	0	0	2	0	1	0	0	1
321:	0	0	0	0	0	0	0	0
329:	0	0	0	0	0	0	1	0
337:	0	1	0	0	0	0	2	0
345:	1	1	1	0	1	2	1	1
353:	0	1	0	0	1	2	0	0
361:	1	0	1	1	1	1	1	1

369:	2	0	0	0	0	0	0	0

Sample Title: 04

Channel							
377:	0	1	0	1	0	0	0	0
385:	0	0	2	1	0	1	1	1
393:	0	0	0	0	1	0	2	0
401:	0	0	0	2	0	1	1	1
409:	0	0	0	0	0	0	2	2
417:	1	0	0	0	1	0	1	0
425:	0	0	0	0	0	0	0	1
433:	0	0	0	1	1	0	0	0
441:	1	0	0	0	0	0	0	0
449:	0	0	0	0	0	0	0	0
457:	0	0	0	0	0	0	0	0
465:	0	0	0	0	1	1	0	0
473:	0	0	1	0	0	0	0	0
481:	0	0	0	0	0	0	0	0
489:	0	0	0	0	0	0	0	0
497:	0	0	0	0	0	0	0	0
505:	0	0	0	0	0	0	1	0
513:	0	0	0	0	0	0	0	0
521:	0	0	0	0	0	0	0	0
529:	0	0	0	0	0	0	0	0
537:	0	0	0	0	0	0	0	0
545:	0	0	0	0	0	0	0	0
553:	0	0	0	1	0	0	0	0
561:	0	0	0	0	0	0	0	0
569:	0	0	0	0	0	0	0	0
577:	0	0	0	0	0	0	0	0
585:	1	0	0	0	0	0	0	1
593:	0	0	0	0	1	0	0	0
601:	0	0	0	0	0	0	1	0
609:	1	0	0	0	0	0	0	1
617:	0	0	0	1	0	1	0	0
625:	0	0	0	0	0	0	1	0
633:	0	0	0	0	0	0	0	0
641:	0	0	0	0	0	0	0	0
649:	0	0	0	1	0	0	0	0
657:	0	0	0	0	0	0	0	0
665:	0	0	0	0	0	0	1	0
673:	0	0	0	0	0	1	0	0
681:	0	0	0	0	0	0	0	0
689:	0	1	0	0	0	0	0	0
697:	0	1	0	0	1	0	0	0
705:	0	0	0	0	0	0	0	0
713:	0	0	0	0	0	0	0	0
721:	0	0	1	0	0	0	0	0
729:	0	0	0	0	0	0	0	0
737:	0	0	0	0	0	0	0	0
745:	0	0	0	0	0	0	0	0
753:	0	1	0	0	0	0	0	0
761:	0	0	0	0	0	0	0	0
769:	0	0	0	0	0	0	0	0
777:	0	0	0	0	0	0	0	0
785:	0	0	0	0	0	0	0	0
793:	0	0	0	0	0	0	0	0

801:	0	0	0	0	0	0	0	0

Sample Title: 04

Channel								
809:	0	0	0	0	0	0	0	0
817:	0	0	0	0	0	1	0	0
825:	0	0	0	0	0	0	0	0
833:	0	0	0	0	1	0	0	0
841:	0	0	0	0	0	0	0	0
849:	0	0	0	0	0	0	0	0
857:	0	0	0	0	0	0	0	0
865:	0	0	0	0	0	0	1	0
873:	1	0	0	0	0	0	0	0
881:	0	0	0	0	0	0	0	0
889:	0	0	0	0	0	0	0	0
897:	0	0	0	0	0	0	0	0
905:	0	0	0	1	0	0	0	0
913:	0	0	0	0	0	0	0	0
921:	0	0	0	0	0	0	0	0
929:	0	0	0	0	0	0	0	0
937:	0	0	0	0	0	0	0	0
945:	0	0	1	0	0	0	0	1
953:	0	0	0	0	0	0	0	0
961:	0	0	0	0	0	0	0	0
969:	0	0	0	0	0	0	0	0
977:	0	0	0	0	0	0	0	0
985:	0	0	0	0	0	0	0	0
993:	0	0	0	0	0	0	1	0
1001:	0	0	0	0	0	0	0	0
1009:	0	0	0	0	0	0	0	0
1017:	0	0	0	0	0	1	0	0

KP
5/2/19

Apex-Alpha™

Sample Description: BC 9
Spectrum File: \\OR-ALPHA1\Canberra\ApexAlpha\Root\Data\00002415
Batch Identification: 1904089A-RA
Sample Identification: 05
Sample Geometry: Shelf 2
Procedure Description: Ra

Detector Name: Alpha_042
Chamber Serial Number: 05026930B
Detector Serial Number: 84185
Env. Background: System Bkgd 243635
Reagent Blank: <not performed>

Sample Size: 1.000E+000 +/- 0.000E+000 liter
Generic Mult. Factor: 2.080E+000 Generic Div. Factor: 1.000E+000
Sample Date/Time: 4/9/2019 3:12:41 PM
Acquisition Date/Time: 5/1/2019 4:25:13 PM
Acquisition Live Time: 170.0 minutes
Acquisition Real Time: 170.0 minutes

Chem. Recovery Factor: 1.0000 +/- 0.0000
Counting Efficiency: 0.1620 +/- 0.0028 on 2/22/2019 8:51:39 AM
Effective Efficiency: 0.1620 +/- 0.0028

Peak Match Tolerance: 0.350 MeV

PEAK AREA REPORT

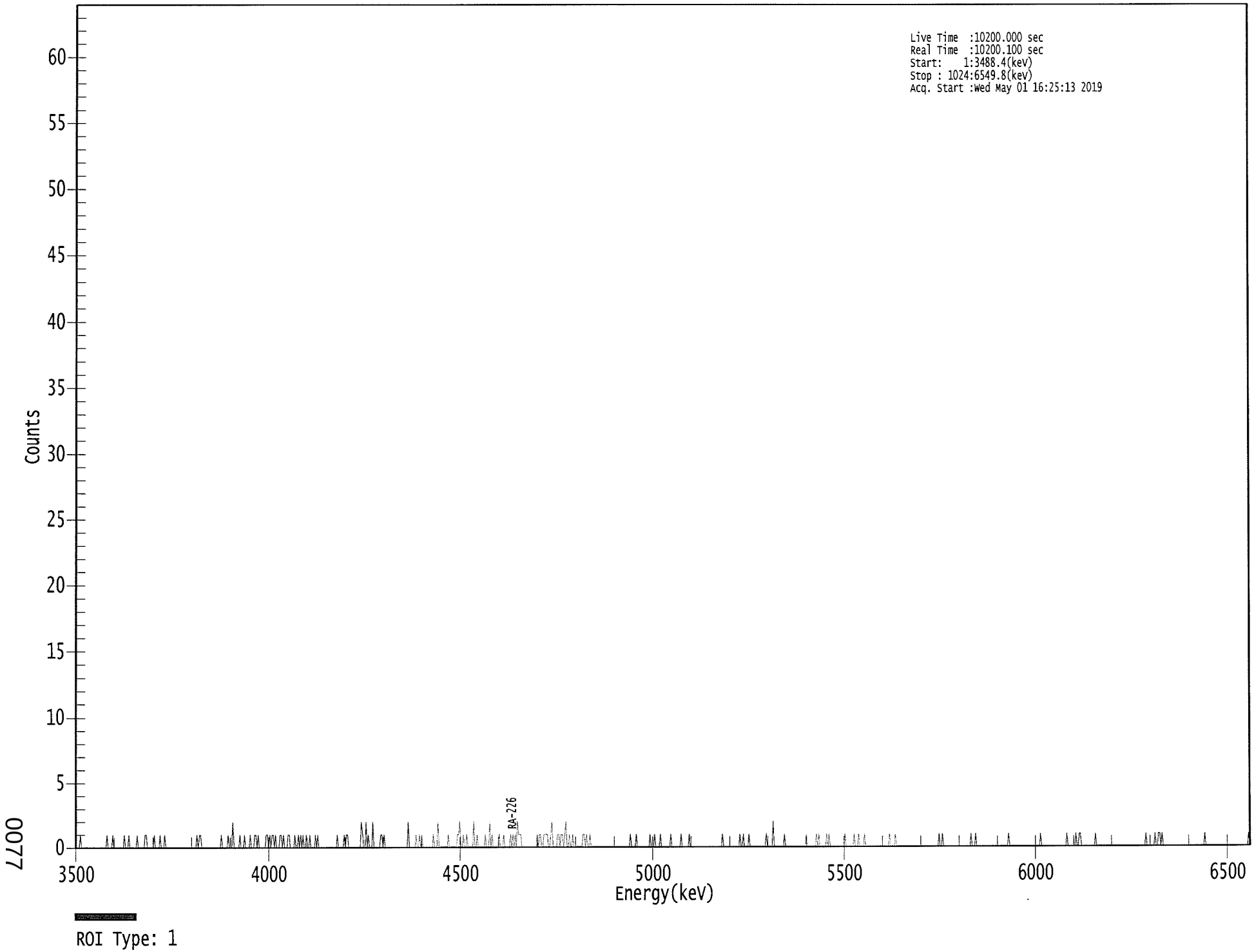
Nuclide	Energy (MeV)	Net Pk Area	Pk Area Error %	Ambient Backgnd	Reagent Backgnd	FWHM (keV)
RA-224	5.493	10.32	63.32	0.68	0.00E+000	3.0
RA-226	4.625	51.64	27.69	1.36	0.00E+000	3.0

NUCLIDE ANALYSIS RESULTS

Nuclide	Id Conf.	Energy (keV)	Activity (pCi/liter)	MDA (pCi/liter)
RA-224	0.953	5685.50*	3.72E-001 +/- 2.36E-001	2.03E-001 +/- 6.93E-003
RA-226	0.967	4785.00*	1.76E+000 +/- 4.90E-001	2.33E-001 +/- 7.94E-003

AG
5/2/19

0000241531.CNF



****
***** S P E C T R A L D A T A R E P O R T *****
****

Sample Title: 05

Elapsed Live time: 10200
Elapsed Real Time: 10200

Channel								
1:	0	0	0	0	1	0	0	0
9:	0	0	0	0	0	0	0	0
17:	0	0	0	0	0	0	0	0
25:	0	0	0	1	0	0	0	0
33:	1	0	0	0	0	0	0	0
41:	0	0	1	0	0	0	1	0
49:	0	0	0	0	0	1	0	0
57:	0	0	0	0	1	1	0	0
65:	0	0	0	0	1	0	0	0
73:	0	1	0	0	0	1	0	0
81:	0	0	0	0	0	0	0	0
89:	0	0	0	0	0	0	0	0
97:	0	0	0	0	0	0	0	0
105:	0	1	0	1	1	0	0	0
113:	0	0	0	0	0	0	0	0
121:	0	0	0	0	0	0	1	0
129:	0	0	0	0	1	0	0	0
137:	2	0	0	0	0	0	1	0
145:	0	0	1	0	0	0	0	1
153:	0	0	0	1	1	0	1	0
161:	0	0	0	0	0	1	1	0
169:	1	0	1	1	0	1	0	0
177:	0	1	1	0	1	0	0	0
185:	1	1	0	0	0	0	1	0
193:	0	1	0	1	0	1	0	0
201:	1	0	0	1	0	0	0	0
209:	1	0	1	0	0	0	0	0
217:	0	0	0	0	0	0	0	0
225:	0	0	0	1	0	0	0	0
233:	0	1	0	1	1	0	0	0
241:	0	0	0	0	0	0	0	0
249:	2	1	0	0	2	0	1	0
257:	0	0	2	0	0	0	0	0
265:	0	1	1	0	1	0	0	0
273:	0	0	0	0	0	0	0	0
281:	0	0	0	0	0	0	0	0
289:	0	2	0	0	0	0	0	0
297:	1	0	0	1	0	1	0	0
305:	0	0	0	0	0	0	0	1
313:	0	0	0	2	0	0	0	0
321:	0	0	0	0	1	0	0	0
329:	0	0	0	0	1	1	2	0
337:	0	1	0	0	1	0	0	0
345:	0	0	2	0	0	1	0	0
353:	0	0	0	0	1	0	0	0
361:	2	0	1	0	0	0	0	0

369:	1	0	0	0	1	0	0	0

Sample Title: 05

Channel								
377:	0	0	1	0	1	0	1	0
385:	2	1	1	1	0	0	0	0
393:	0	0	0	0	0	0	0	0
401:	0	1	0	1	1	0	0	1
409:	1	1	1	0	0	1	2	0
417:	0	0	0	1	1	0	1	1
425:	0	1	2	0	0	1	0	0
433:	1	0	0	0	0	0	0	0
441:	0	1	1	0	1	0	0	1
449:	0	0	0	0	0	0	0	0
457:	0	0	0	0	0	0	0	0
465:	0	0	0	0	0	0	0	0
473:	0	0	0	0	0	0	0	0
481:	0	0	1	0	0	0	0	1
489:	0	0	0	0	0	0	0	0
497:	0	0	0	1	0	0	0	1
505:	0	0	0	0	1	0	0	0
513:	0	0	0	0	0	1	0	0
521:	0	0	0	0	0	0	1	0
529:	0	0	0	0	0	1	0	0
537:	0	0	0	0	0	0	0	0
545:	0	0	0	0	0	0	0	0
553:	0	0	0	0	0	0	0	0
561:	0	0	1	0	0	0	0	0
569:	0	0	0	0	0	0	0	0
577:	0	1	0	0	1	0	0	0
585:	0	1	0	0	0	0	0	0
593:	0	0	0	0	0	0	0	0
601:	1	0	0	0	0	0	2	0
609:	0	0	0	0	0	0	0	0
617:	1	0	0	0	0	0	0	0
625:	0	0	0	0	0	0	0	0
633:	0	0	0	1	0	0	0	0
641:	0	0	0	0	1	0	1	0
649:	0	0	0	0	0	1	0	1
657:	0	0	0	0	0	0	0	0
665:	0	0	0	0	0	1	0	0
673:	0	0	0	0	0	1	0	0
681:	0	1	0	0	0	0	1	0
689:	0	0	0	0	0	0	0	0
697:	0	0	0	0	0	0	0	0
705:	0	0	0	0	1	0	0	0
713:	0	1	0	0	0	0	0	0
721:	0	0	0	0	0	0	0	0
729:	0	0	0	0	0	0	0	0
737:	0	0	0	0	0	0	0	0
745:	0	0	0	0	0	0	0	1
753:	0	0	1	0	0	0	0	0
761:	0	0	0	0	0	0	0	0
769:	0	0	0	0	0	0	0	0
777:	0	0	0	1	0	0	0	1
785:	0	0	0	0	0	0	0	0
793:	0	0	0	0	0	0	0	0

801:	0	0	0	0	0	0	0	0

Sample Title: 05

Channel								
809:	0	0	0	0	1	0	0	0
817:	0	0	0	0	0	0	0	0
825:	0	0	0	0	0	0	0	0
833:	0	0	0	0	0	0	0	0
841:	1	0	0	0	0	0	0	0
849:	0	0	0	0	0	0	0	0
857:	0	0	0	0	0	0	0	1
865:	0	0	0	0	0	0	0	1
873:	0	0	1	1	0	0	0	0
881:	0	0	0	0	0	0	0	0
889:	1	0	0	0	0	0	0	0
897:	0	0	0	0	0	0	0	0
905:	0	0	0	0	0	0	0	0
913:	0	0	0	0	0	0	0	0
921:	0	0	0	0	0	0	0	0
929:	0	0	0	0	1	0	0	0
937:	0	0	0	0	1	0	0	1
945:	1	0	1	0	0	0	0	0
953:	0	0	0	0	0	0	0	0
961:	0	0	0	0	0	0	0	0
969:	0	0	0	0	0	0	0	0
977:	0	0	0	0	0	0	0	1
985:	0	0	0	0	0	0	0	0
993:	0	0	0	0	0	0	0	0
1001:	0	0	0	0	0	0	0	0
1009:	0	0	0	0	0	0	0	0
1017:	0	0	0	0	0	1	0	0

Apex-Alpha™

LP
5/2/19

Sample Description: BC 10
Spectrum File: \\OR-ALPHA1\Canberra\ApexAlpha\Root\Data\00002415
Batch Identification: 1904089A-RA
Sample Identification: 06
Sample Geometry: Shelf 2
Procedure Description: Ra

Detector Name: Alpha_043
Chamber Serial Number: 04026481A
Detector Serial Number: 91088
Env. Background: System Bkgd 243636
Reagent Blank: <not performed>

Sample Size: 5.000E-001 +/- 0.000E+000 liter
Generic Mult. Factor: 2.640E+000 Generic Div. Factor: 1.000E+000
Sample Date/Time: 4/9/2019 3:12:41 PM
Acquisition Date/Time: 5/1/2019 4:25:16 PM
Acquisition Live Time: 170.0 minutes
Acquisition Real Time: 170.0 minutes

Chem. Recovery Factor: 0.9496 +/- 0.0000
Counting Efficiency: 0.1494 +/- 0.0026 on 2/22/2019 8:51:38 AM
Effective Efficiency: 0.1418 +/- 0.0025

Peak Match Tolerance: 0.350 MeV

PEAK AREA REPORT

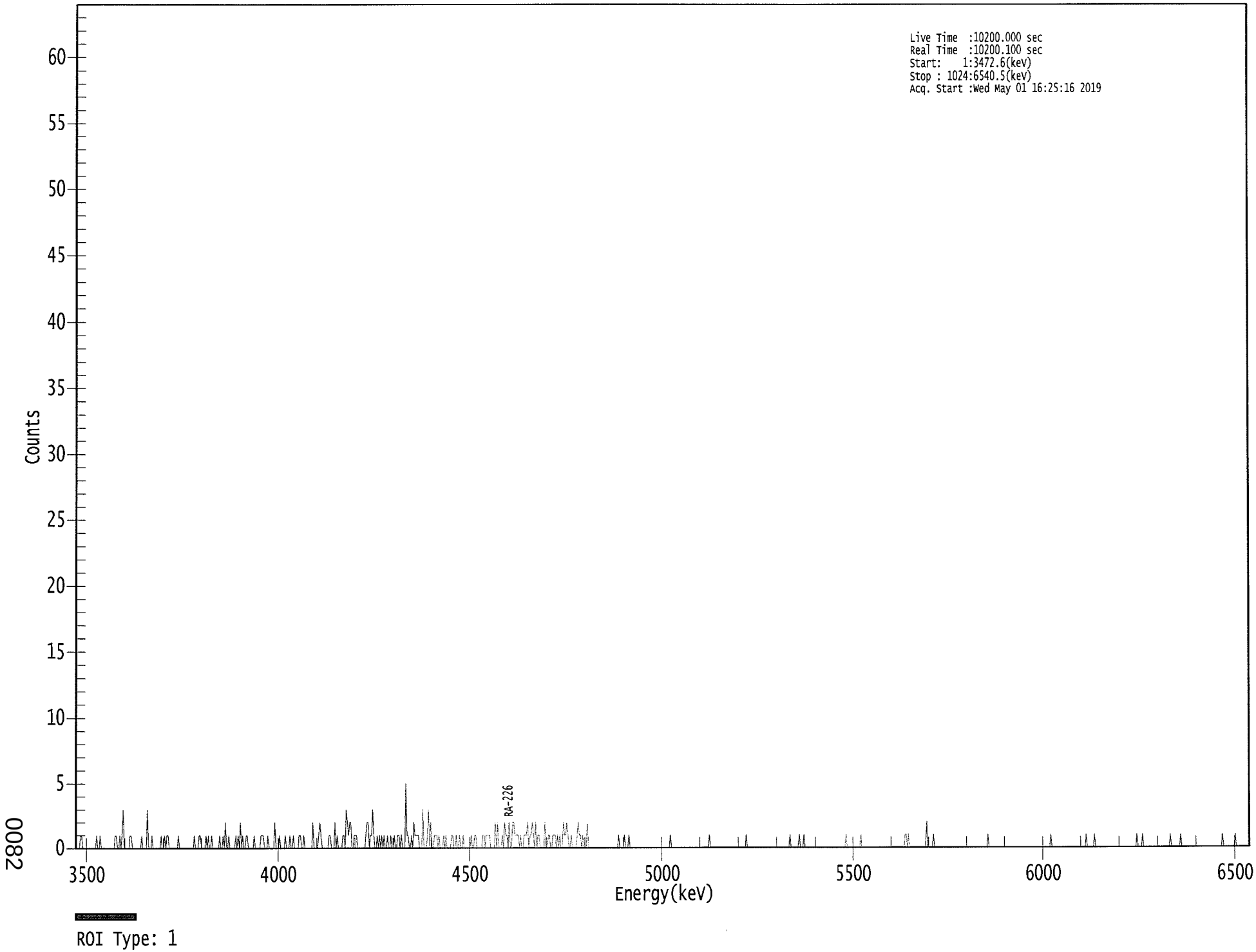
Nuclide	Energy (MeV)	Net Pk Area	Pk Area Error %	Ambient Backgnd	Reagent Backgnd	FWHM (keV)
RA-224	5.586	4.32	102.62	0.68	0.00E+000	3.0
RA-226	4.605	86.13	21.39	1.87	0.00E+000	3.0

NUCLIDE ANALYSIS RESULTS

Nuclide	Id Conf.	Energy (keV)	Activity (pCi/liter)	MDA (pCi/liter)
RA-224	0.987	5685.50*	4.51E-001 +/- 4.63E-001	5.89E-001 +/- 2.04E-002
RA-226	0.958	4785.00*	8.50E+000 +/- 1.84E+000	7.47E-001 +/- 2.58E-002

AG
5/2/19

0000241533.CNF



****
***** S P E C T R A L D A T A R E P O R T *****
****

Sample Title: 06

Elapsed Live time: 10200
Elapsed Real Time: 10200

Channel								
1:	0	0	0	0	1	1	0	0
9:	0	0	0	0	0	0	0	0
17:	0	0	1	0	0	1	0	0
25:	0	0	0	0	0	0	0	0
33:	0	0	1	1	0	0	1	0
41:	1	3	0	0	0	0	0	1
49:	1	0	0	0	0	0	0	0
57:	0	1	0	0	0	0	3	0
65:	0	0	1	0	0	0	0	0
73:	0	0	1	0	0	1	0	1
81:	1	0	0	0	0	0	0	0
89:	0	1	0	0	0	0	0	0
97:	0	0	0	0	0	0	0	1
105:	0	0	0	1	1	0	0	0
113:	0	1	0	1	0	0	1	0
121:	0	0	0	0	0	1	0	0
129:	1	0	2	0	0	1	0	0
137:	0	0	0	1	0	1	0	2
145:	0	1	0	0	1	1	0	0
153:	0	0	0	1	0	0	0	0
161:	0	1	1	1	0	0	0	1
169:	0	0	0	0	0	2	0	0
177:	0	1	0	0	0	0	1	0
185:	0	0	1	0	0	1	0	0
193:	0	0	1	1	0	0	1	0
201:	0	0	0	0	0	0	2	0
209:	0	0	0	1	2	1	0	0
217:	0	0	0	0	1	1	0	0
225:	0	2	0	1	0	0	0	0
233:	1	1	0	3	2	1	2	2
241:	0	0	1	1	1	0	0	0
249:	0	0	0	0	1	2	2	0
257:	1	1	3	1	0	0	1	0
265:	1	0	1	0	1	0	0	1
273:	0	0	1	0	0	1	0	0
281:	1	1	0	1	0	0	0	5
289:	1	1	0	0	1	0	2	1
297:	1	1	1	0	0	0	3	0
305:	0	0	1	3	0	2	0	0
313:	1	1	1	0	1	0	0	0
321:	1	0	1	0	0	0	0	1
329:	1	0	0	1	0	0	1	0
337:	0	1	0	0	0	0	0	0
345:	1	0	0	1	1	0	0	0
353:	0	0	1	1	0	1	1	1
361:	1	0	0	0	0	2	0	2

369:	0	0	0	1	0	2	1	1

Sample Title: 06

Channel								
377:	0	2	0	0	2	2	1	1
385:	1	1	0	1	0	0	1	1
393:	1	2	0	1	1	2	1	0
401:	2	0	1	1	0	0	0	0
409:	2	0	0	1	1	0	0	1
417:	1	1	0	1	0	1	0	0
425:	2	1	1	2	1	0	0	1
433:	0	0	0	0	1	2	1	1
441:	0	1	0	0	0	2	0	0
449:	0	0	0	0	0	0	0	0
457:	0	0	0	0	0	0	0	0
465:	0	0	0	0	0	0	0	0
473:	1	0	0	0	0	1	0	0
481:	0	1	0	0	0	0	0	0
489:	0	0	0	0	0	0	0	0
497:	0	0	0	0	0	0	0	0
505:	0	0	0	0	0	0	0	0
513:	0	0	0	0	0	1	0	0
521:	0	0	0	0	0	0	0	0
529:	0	0	0	0	0	0	0	0
537:	0	0	0	0	0	0	0	0
545:	0	0	0	0	0	0	0	1
553:	0	0	0	0	0	0	0	0
561:	0	0	0	0	0	0	0	0
569:	0	0	0	0	0	0	0	0
577:	0	0	0	0	0	0	0	1
585:	0	0	0	0	0	0	0	0
593:	0	0	0	0	0	0	0	0
601:	0	0	0	0	0	0	0	0
609:	0	0	0	0	0	0	0	0
617:	0	0	0	0	0	1	0	0
625:	0	0	0	0	0	1	0	0
633:	0	1	0	0	0	0	0	0
641:	0	0	0	0	0	0	0	0
649:	0	0	0	0	0	0	0	0
657:	0	0	0	0	0	0	0	0
665:	0	0	0	0	0	0	1	0
673:	0	0	0	0	0	0	0	0
681:	0	0	0	1	0	0	0	0
689:	0	0	0	0	0	0	0	0
697:	0	0	0	0	0	0	0	0
705:	0	0	0	0	0	0	0	0
713:	0	0	0	0	0	0	0	0
721:	0	0	1	1	0	1	0	0
729:	0	0	0	0	0	0	0	0
737:	0	0	0	0	0	2	0	0
745:	0	0	0	1	0	0	0	0
753:	0	0	0	0	0	0	0	0
761:	0	0	0	0	0	0	0	0
769:	0	0	0	0	0	0	0	0
777:	0	0	0	0	0	0	0	0
785:	0	0	0	0	0	0	0	0
793:	0	0	0	1	0	0	0	0

801:	0	0	0	0	0	0	0	0

Sample Title: 06

Channel								
809:	0	0	0	0	0	0	0	0
817:	0	0	0	0	0	0	0	0
825:	0	0	0	0	0	0	0	0
833:	0	0	0	0	0	0	0	0
841:	0	0	0	0	0	0	0	0
849:	0	0	1	0	0	0	0	0
857:	0	0	0	0	0	0	0	0
865:	0	0	0	0	0	0	0	0
873:	0	0	0	0	0	0	0	0
881:	0	1	0	0	0	0	0	0
889:	1	0	0	0	0	0	0	0
897:	0	0	0	0	0	0	0	0
905:	0	0	0	0	0	0	0	0
913:	0	0	0	0	0	0	0	0
921:	0	0	0	0	0	1	0	0
929:	0	0	1	0	0	0	0	0
937:	0	0	0	0	0	0	0	0
945:	0	0	0	0	0	0	0	0
953:	0	0	1	0	0	0	0	0
961:	0	0	0	1	0	0	0	0
969:	0	0	0	0	0	0	0	0
977:	0	0	0	0	0	0	0	0
985:	0	0	0	0	0	0	0	0
993:	0	0	0	0	0	0	0	1
1001:	0	0	0	0	0	0	0	0
1009:	0	0	1	0	0	0	0	0
1017:	0	0	0	0	0	0	0	0

Apex-Alpha™

KP
5/2/19

Sample Description: BC 23
Spectrum File: \\OR-ALPHA1\Canberra\ApexAlpha\Root\Data\00002415
Batch Identification: 1904089A-RA
Sample Identification: 07
Sample Geometry: Shelf 2
Procedure Description: Ra

Detector Name: Alpha_044
Chamber Serial Number: 04026481B
Detector Serial Number: 84168
Env. Background: System Bkgd 243637
Reagent Blank: <not performed>

Sample Size: 5.000E-001 +/- 0.000E+000 liter
Generic Mult. Factor: 3.000E+000 Generic Div. Factor: 1.000E+000
Sample Date/Time: 4/9/2019 3:12:41 PM
Acquisition Date/Time: 5/1/2019 4:25:19 PM
Acquisition Live Time: 170.0 minutes
Acquisition Real Time: 170.0 minutes

Chem. Recovery Factor: 1.0000 +/- 0.0000
Counting Efficiency: 0.1711 +/- 0.0030 on 2/22/2019 8:51:36 AM
Effective Efficiency: 0.1711 +/- 0.0030

Peak Match Tolerance: 0.350 MeV

PEAK AREA REPORT

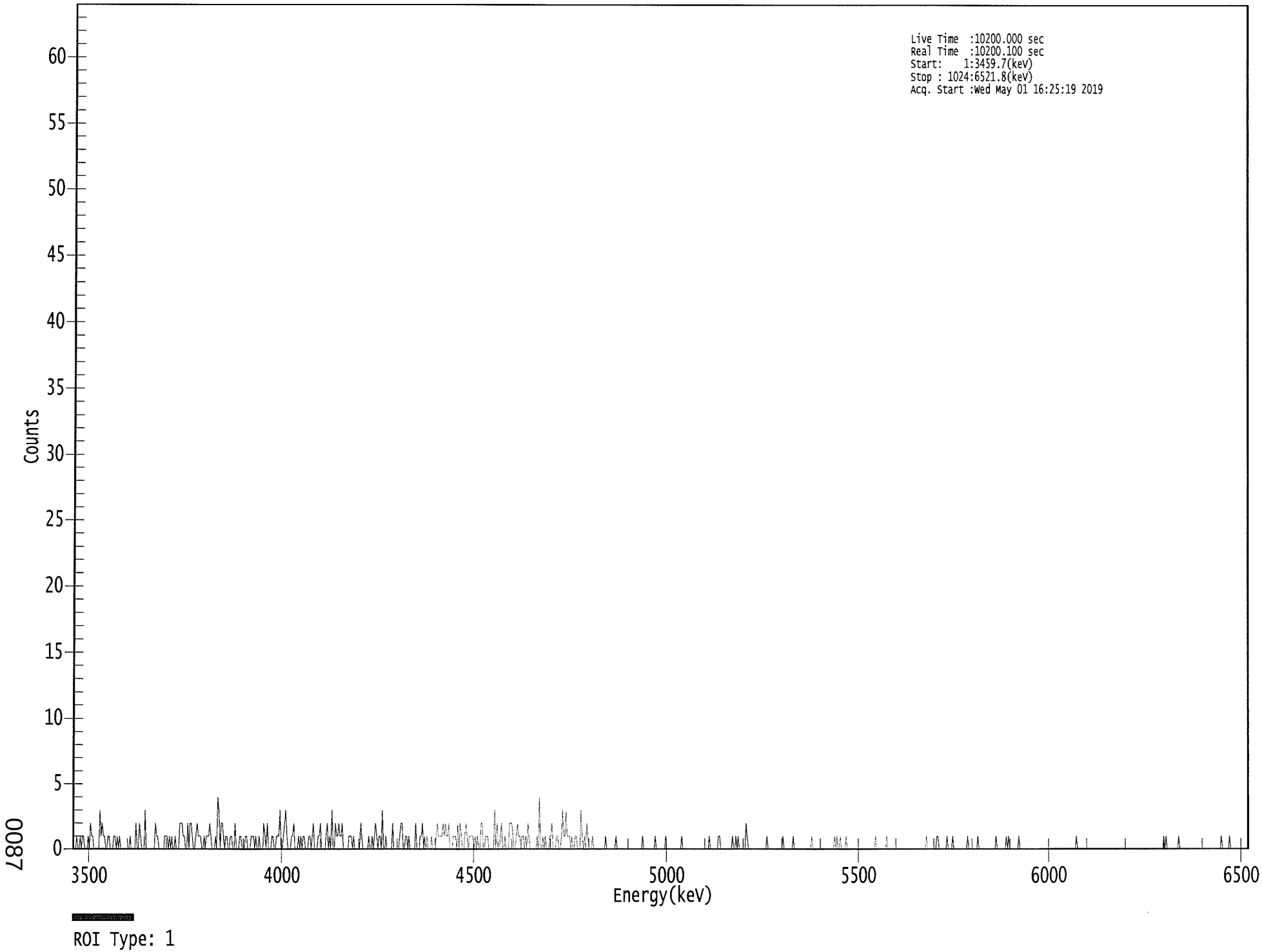
Nuclide	Energy (MeV)	Net Pk Area	Pk Area Error %	Ambient Backgnd	Reagent Backgnd	FWHM (keV)
RA-224	5.498	7.32	76.28	0.68	0.00E+000	3.0
RA-226	4.588	107.32	18.99	0.68	0.00E+000	3.0

NUCLIDE ANALYSIS RESULTS

Nuclide	Id Conf.	Energy (keV)	Activity (pCi/liter)	MDA (pCi/liter)
RA-224	0.955	5685.50*	7.21E-001 +/- 5.50E-001	5.55E-001 +/- 1.89E-002
RA-226	0.951	4785.00*	9.98E+000 +/- 1.92E+000	5.24E-001 +/- 1.78E-002

AG
5/2/19

0000241534.CNF



0087

****
***** S P E C T R A L D A T A R E P O R T *****
****

Sample Title: 07

Elapsed Live time: 10200
Elapsed Real Time: 10200

Channel							
1:	0	0	0	1	0	0	1	0
9:	1	1	0	0	0	1	0	2
17:	1	1	0	0	0	0	0	3
25:	1	2	1	1	0	0	1	1
33:	0	0	0	1	1	0	1	0
41:	1	0	0	0	0	0	0	0
49:	0	1	0	0	0	0	2	0
57:	0	2	1	0	0	0	3	0
65:	0	0	0	0	0	0	0	2
73:	1	1	0	0	0	0	0	1
81:	1	1	0	1	0	1	0	0
89:	1	0	0	0	2	2	2	1
97:	1	0	0	2	0	2	2	1
105:	0	0	1	2	1	1	1	0
113:	0	1	0	1	1	1	2	1
121:	0	0	0	1	0	4	3	0
129:	2	2	1	0	1	1	0	0
137:	1	1	0	0	2	0	0	0
145:	1	1	0	0	0	1	1	0
153:	0	0	1	1	1	0	1	0
161:	0	1	0	0	0	2	1	0
169:	2	0	0	0	1	1	0	0
177:	1	1	1	3	0	0	1	2
185:	3	1	0	0	0	1	1	2
193:	0	0	0	1	0	1	0	1
201:	1	0	0	0	1	1	0	1
209:	2	0	0	0	1	1	2	0
217:	0	0	0	1	2	0	1	0
225:	3	0	0	2	1	1	2	1
233:	1	2	0	0	0	0	0	1
241:	1	1	0	1	0	0	0	0
249:	0	2	1	0	0	0	0	0
257:	1	0	0	1	0	1	2	1
265:	0	1	1	0	3	0	0	1
273:	0	0	0	0	0	2	0	0
281:	0	0	0	1	2	2	0	0
289:	1	1	0	1	0	0	0	0
297:	0	2	0	0	0	1	1	2
305:	0	1	0	1	0	0	0	1
313:	0	0	0	1	2	1	1	1
321:	1	2	1	2	1	1	2	0
329:	0	0	1	1	1	0	2	0
337:	2	1	0	0	1	2	1	0
345:	1	1	1	1	0	1	0	1
353:	0	0	2	2	0	0	1	1
361:	1	0	0	0	0	0	3	0

369:	2	0	0	1	2	0	0	1

Sample Title: 07

Channel								
377:	0	0	0	2	2	2	1	0
385:	0	1	2	1	1	0	1	1
393:	0	1	0	2	1	0	0	0
401:	0	0	0	1	0	4	0	0
409:	1	0	1	0	0	0	1	1
417:	2	0	0	0	1	1	0	0
425:	1	3	1	1	3	1	1	1
433:	0	1	0	0	1	1	0	0
441:	0	3	1	0	1	0	2	1
449:	0	0	0	1	0	0	0	0
457:	0	0	0	0	0	0	1	0
465:	0	0	0	0	0	0	0	1
473:	0	0	0	0	0	0	0	0
481:	0	0	0	0	0	0	0	0
489:	0	0	0	0	0	0	1	0
497:	0	0	0	0	0	0	0	0
505:	0	1	0	0	0	0	0	0
513:	0	0	1	0	0	0	0	0
521:	0	0	0	0	0	0	0	0
529:	1	0	0	0	0	0	0	0
537:	0	0	0	0	0	0	0	0
545:	0	0	0	0	0	0	0	0
553:	1	0	0	0	0	0	0	0
561:	1	1	0	0	0	0	0	0
569:	0	0	0	0	1	0	0	1
577:	0	1	0	0	0	0	0	0
585:	2	1	0	0	0	0	0	0
593:	0	0	0	0	0	0	0	0
601:	0	0	1	0	0	0	0	0
609:	0	0	0	0	0	0	0	0
617:	1	0	0	0	0	0	0	0
625:	0	1	0	0	0	0	0	0
633:	0	0	0	0	0	0	0	0
641:	0	1	0	0	0	0	0	0
649:	0	0	0	0	0	0	0	0
657:	0	0	0	0	0	1	0	1
665:	0	0	1	0	0	0	0	1
673:	0	0	0	0	0	0	0	0
681:	0	0	0	0	0	0	0	0
689:	0	0	0	0	0	0	0	0
697:	0	1	0	0	0	0	0	0
705:	0	0	0	1	0	0	0	0
713:	0	0	0	0	0	0	0	0
721:	0	0	0	0	0	0	0	0
729:	0	0	0	0	0	0	0	0
737:	0	0	0	0	0	0	1	0
745:	0	0	0	0	0	0	0	1
753:	1	0	0	0	0	0	0	0
761:	1	0	0	0	0	1	0	0
769:	0	0	0	0	0	0	0	0
777:	0	0	1	0	0	0	0	0
785:	0	0	0	1	0	0	0	0
793:	0	0	0	0	0	0	0	0

801:	0	0	0	1	0	0	0	0

Sample Title: 07

Channel								
809:	0	0	0	0	1	0	1	0
817:	0	0	0	0	0	0	0	1
825:	0	0	0	0	0	0	0	0
833:	0	0	0	0	0	0	0	0
841:	0	0	0	0	0	0	0	0
849:	0	0	0	0	0	0	0	0
857:	0	0	0	0	0	0	0	0
865:	0	0	0	0	0	0	0	0
873:	0	1	0	0	0	0	0	0
881:	0	0	0	0	0	0	0	0
889:	0	0	0	0	0	0	0	0
897:	0	0	0	0	0	0	0	0
905:	0	0	0	0	0	0	0	0
913:	0	0	0	0	0	0	0	0
921:	0	0	0	0	0	0	0	0
929:	0	0	0	0	0	0	0	0
937:	0	0	0	0	0	0	0	0
945:	0	0	0	0	0	1	0	1
953:	0	0	0	0	0	0	0	0
961:	0	0	1	0	0	0	0	0
969:	0	0	0	0	0	0	0	0
977:	0	0	0	0	0	0	0	0
985:	0	0	0	0	0	0	0	0
993:	0	0	0	0	0	0	0	1
1001:	0	0	0	0	0	0	1	0
1009:	0	0	0	0	0	0	0	0
1017:	0	0	0	0	0	0	0	0

5/1/2019 6:10:57 AM

Apex-Alpha™

QA SUMMARY REPORT

Review Of QA Results - Pulser Check

Date : 5/1/2019
Time : 6:10:57 AM

CHAMBER	DEVICE	PARAMETER	FLAG	DATE
Alpha_001	21f	ALL	Not Done	
Alpha_002	21f	ALL	Not Done	
Alpha_003	21f	ALL	Passed	5/1/2019 5:16:11 AM
Alpha_004	21f	ALL	Passed	5/1/2019 5:16:12 AM
Alpha_005	21f	ALL	Not Done	
Alpha_006	21f	ALL	Not Done	
Alpha_007	21f	ALL	Not Done	
Alpha_008	21f	ALL	Not Done	
Alpha_009	21f	ALL	Not Done	
Alpha_010	21f	ALL	Passed	5/1/2019 5:16:13 AM
Alpha_011	21f	ALL	Passed	5/1/2019 5:16:14 AM
Alpha_012	21f	ALL	Passed	5/1/2019 5:16:14 AM
Alpha_013	21f	ALL	Not Done	
Alpha_014	21f	ALL	Passed	5/1/2019 5:16:15 AM
Alpha_015	21f	ALL	Not Done	
Alpha_016	21f	ALL	Not Done	
Alpha_033	Alpha Analyst100DC	ALL	Passed	5/1/2019 5:16:16 AM
Alpha_034	Alpha Analyst100DC	ALL	Passed	5/1/2019 5:16:18 AM
Alpha_035	Alpha Analyst100DC	Peak CPS	Action	5/1/2019 5:16:19 AM
Alpha_036	Alpha Analyst100DC	ALL	Passed	5/1/2019 5:16:21 AM
Alpha_037	Alpha Analyst100DC	ALL	Not Done	
Alpha_038	Alpha Analyst100DC	Peak Energy	Action	5/1/2019 5:16:23 AM
Alpha_039	Alpha Analyst100DC	Peak FWHM	Action	5/1/2019 5:16:24 AM
Alpha_040	Alpha Analyst100DC	ALL	Passed	5/1/2019 5:16:26 AM
Alpha_041	Alpha Analyst100DC	ALL	Passed	5/1/2019 5:16:28 AM
Alpha_042	Alpha Analyst100DC	ALL	Passed	5/1/2019 5:16:30 AM
Alpha_043	Alpha Analyst100DC	ALL	Passed	5/1/2019 5:16:33 AM
Alpha_044	Alpha Analyst100DC	ALL	Passed	5/1/2019 5:16:35 AM
Alpha_045	Alpha Analyst100DC	ALL	Passed	5/1/2019 5:16:37 AM
Alpha_046	Alpha Analyst100DC	ALL	Passed	5/1/2019 5:16:40 AM
Alpha_047	Alpha Analyst100DC	ALL	Passed	5/1/2019 5:16:42 AM
Alpha_048	Alpha Analyst100DC	ALL	Passed	5/1/2019 5:16:45 AM
Alpha_049	Alpha Analyst100DC	ALL	Passed	5/1/2019 5:16:47 AM
Alpha_050	Alpha Analyst100DC	ALL	Passed	5/1/2019 5:16:50 AM
Alpha_051	Alpha Analyst100DC	ALL	Not Done	
Alpha_052	Alpha Analyst100DC	ALL	Not Done	
Alpha_053	Alpha Analyst100DC	ALL	Passed	5/1/2019 5:16:53 AM
Alpha_054	Alpha Analyst100DC	ALL	Passed	5/1/2019 5:16:56 AM
Alpha_055	Alpha Analyst100DC	ALL	Passed	5/1/2019 5:16:58 AM
Alpha_056	Alpha Analyst100DC	ALL	Passed	5/1/2019 5:17:01 AM
Alpha_057	Alpha Analyst100DC	ALL	Passed	5/1/2019 5:17:04 AM
Alpha_058	Alpha Analyst100DC	ALL	Passed	5/1/2019 5:17:06 AM

CHAMBER	DEVICE	PARAMETER	FLAG	DATE
Alpha_059	Alpha Analyst100DC	ALL	Passed	5/1/2019 5:17:09 AM
Alpha_060	Alpha Analyst100DC	ALL	Passed	5/1/2019 5:17:13 AM

APPROVED BY: KP

APPROVAL DATE: 5/1/19

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

Nuclide Library Title: Radium

Nuclide Library Description: Ra-226, Po-218, Rn-222

Nuclide Name	Half-Life (Seconds)	Energy (keV)	Energy Uncert. (keV)	Yield (%)	Yield Uncert.(Abs.+-)
PO-218	5.049E+010	6003.000*	0.000	99.9800	0.0000
RN-222	5.049E+010	5490.000*	0.000	99.9200	0.0000
RA-226	5.049E+010	4785.000*	0.000	100.0000	0.0000

* = key line

TOTALS: 3 Nuclides 3 Energy Lines

SECTION IX

ANALYTICAL DATA (RADIUM-228)

19-04089
Ra228
Run 1

Work Order	19-04089
Analysis Code	Ra228
Run	1
Date Received	4/17/2019
Lab Deadline	4/30/2019
Client	Michael Pisani & Associates, Inc.
Project	HERO LANDS
Report Level	4
Activity Units	pCi
Aliquot Units	l
Matrix	WA
Method	EPA 904.0
Instrument Type	Alpha/Beta GPC
Radiometric Tracer	Ba-133
Radiometric Sol#	Ba-6a
Tracer Act (dpm/g)	455.17
Carrier	Yttrium
Carrier Conc (mg/ml)	30.6333

Internal Fraction	Sample Desc	Client ID	Login CPM	Sample Date	Sample Aliquot
01	LCS	LCS		04/18/19 00:00	1.0000E+00
02	MBL	BLANK		04/18/19 00:00	1.0000E+00
03	DUP	BC 22B	30	04/09/19 10:00	1.0000E+00
04	DO	BC 22B	30	04/09/19 10:00	1.0000E+00
05	TRG	BC 9	29	04/09/19 12:10	1.0000E+00
06	TRG	BC 10	33	04/09/19 14:55	1.0000E+00
07	TRG	BC 23	34	04/09/19 16:50	1.0000E+00

0095

* SAF1 is used for Gross Alpha and all other radionuclides. SAF2 is used for Gross Beta only. ^ Indicates estimated SAF value.
** Actual mass exceeded the calibration curve range. Results should be qualified as appropriate.

Internal Fraction	Sample Desc	Tracer Aliquot (g)	Tracer Total ACT (dpm)	Radiometric Tracer (pCi)	Radiometric % Rec	Grav Carrier Added (ml)	Grav Filter Tare (g)	Grav Filter Final (g)	Grav Filter Net (g)	Grav % Rec	Mean % Rec	SAF 1*	SAF 2*
01	LCS	2.2045	1003.4	668.0	147.79	2.050	0.0713	0.1340	0.0627	99.84	109.83	1.00	1.00
02	MBL	2.2033	1002.9	569.0	125.96	2.100	0.0708	0.1338	0.0630	97.93	107.73	1.00	1.00
03	DUP	2.2045	1003.4	682.0	150.89	2.100	0.0704	0.1337	0.0633	98.40	108.24	1.00	1.00
04	DO	2.1975	1000.2	693.0	153.81	2.050	0.0704	0.1323	0.0619	98.57	108.43	1.00	1.00
05	TRG	2.2000	1001.4	505.0	111.96	2.050	0.0702	0.1324	0.0622	99.05	108.95	1.00	1.00
06	TRG	2.1968	999.9	428.0	95.02	2.100	0.0697	0.1334	0.0637	99.02	94.09	1.00	1.00
07	TRG	2.1945	998.9	652.0	144.91	2.100	0.0692	0.1328	0.0636	98.87	108.75	1.00	1.00

9600

* SAF1 is used for Gross Alpha and all other radionuclides. SAF2 is used for Gross Beta only. ^ Indicates estimated SAF value.
** Actual mass exceeded the calibration curve range. Results should be qualified as appropriate.

19-04089
Ra228
Run 1

Internal Fraction	Sample Desc	Rough Prep Date	Rough Prep By	Prep Date	Prep By	Sep t0 Date/Time	Sep t0 By	Sep t1 Date/Time	Sep t1 By
01	LCS			05/03/19 09:49	DBUSH	05/01/19 08:59	DBUSH	05/03/19 10:20	DBUSH
02	MBL			05/03/19 09:49	DBUSH	05/01/19 08:59	DBUSH	05/03/19 10:20	DBUSH
03	DUP			05/03/19 09:49	DBUSH	05/01/19 08:59	DBUSH	05/03/19 10:20	DBUSH
04	DO			05/03/19 09:49	DBUSH	05/01/19 08:59	DBUSH	05/03/19 10:20	DBUSH
05	TRG			05/03/19 09:49	DBUSH	05/01/19 08:59	DBUSH	05/03/19 10:20	DBUSH
06	TRG			05/03/19 09:49	DBUSH	05/01/19 13:35	DBUSH	05/03/19 10:20	DBUSH
07	TRG			05/03/19 09:49	DBUSH	05/01/19 13:35	DBUSH	05/03/19 10:20	DBUSH

0097

* SAF1 is used for Gross Alpha and all other radionuclides. SAF2 is used for Gross Beta only. ^ Indicates estimated SAF value.
** Actual mass exceeded the calibration curve range. Results should be qualified as appropriate.

Preliminary Data Report & Analytical Calculations

Work Order: 19-04089-Ra228-1

Client: Michael Pisani & Associates, Inc.
Eberline Analytical Work Order: 19-04089
Analysis Code: Ra228
Run: 1

Lab Fraction	Nuclide	Sample Desc	Client Identification	Activity Units	Results	Error Estimate	MDA	LCS Known	LCS %R	LCS Flag	RPD Flag	MDA Flag	Blank Flag
01	RA-228	LCS	LCS	pCi/l	8.93E+00	7.37E-01	8.63E-01	8.98E+00	99.46	OK		OK	
02	RA-228	MBL	BLANK	pCi/l	5.67E-01	4.00E-01	7.92E-01					OK	OK
03	RA-228	DUP	BC 22B	pCi/l	1.11E+00	4.70E-01	8.92E-01				INV	OK	
04	RA-228	DO	BC 22B	pCi/l	7.01E-01	4.40E-01	8.66E-01					OK	
05	RA-228	TRG	BC 9	pCi/l	1.38E+00	4.76E-01	8.82E-01					OK	
06	RA-228	TRG	BC 10	pCi/l	2.98E+00	6.12E-01	1.03E+00					OK	
07	RA-228	TRG	BC 23	pCi/l	5.45E+00	5.74E-01	6.97E-01					OK	

8600

Work Order: 19-04089-Ra228-1

Client: Michael Pisani & Associates, Inc.
Eberline Analytical Work Order: 19-04089
Analysis Code: Ra228
Run: 1

Lab Fraction	Nuclide	Sample Desc	Sample Date	Sample Aliquot	Radiometric % Rec	Grav % Rec	Mean % Rec	SAF	Sep t0 Date/Time	Sep t1 Date/Time
01	RA-228	LCS	04/18/19 00:00	1.00E+00	147.79	99.84	109.83	1.00	5/1/2019 8:59	5/3/2019 10:20
02	RA-228	MBL	04/18/19 00:00	1.00E+00	125.96	97.93	107.73	1.00	5/1/2019 8:59	5/3/2019 10:20
03	RA-228	DUP	04/09/19 10:00	1.00E+00	150.89	98.40	108.24	1.00	5/1/2019 8:59	5/3/2019 10:20
04	RA-228	DO	04/09/19 10:00	1.00E+00	153.81	98.57	108.43	1.00	5/1/2019 8:59	5/3/2019 10:20
05	RA-228	TRG	04/09/19 12:10	1.00E+00	111.96	99.05	108.95	1.00	5/1/2019 8:59	5/3/2019 10:20
06	RA-228	TRG	04/09/19 14:55	1.00E+00	95.02	99.02	94.09	1.00	5/1/2019 13:35	5/3/2019 10:20
07	RA-228	TRG	04/09/19 16:50	1.00E+00	144.91	98.87	108.75	1.00	5/1/2019 13:35	5/3/2019 10:20

6600

Preliminary Data Report & Analytical Calculations

Work Order: 19-04089-Ra228-1

Run	Analysis Code	Eberline Analytical Work Order	Client
1	Ra228	19-04089	Michael Pisani & Associates, Inc.

Lab Fraction	Nuclide	Sample Desc	Counting Date/Time	Halflife (days)	Detect	Carrier	Count Time	Counts	Bkg CPM	Eff
01	RA-228	LCS	05/03/19 12:24		LB4110A	A1	120	976	1.433333333	0.4803
02	RA-228	MBL	05/03/19 12:24		LB4110A	A3	120	216	1.35	0.4719
03	RA-228	DUP	05/03/19 12:24		LB4110A	A4	120	296	1.616666667	0.4548
04	RA-228	DO	05/03/19 12:24		LB4110A	B3	120	242	1.483333333	0.449
05	RA-228	TRG	05/03/19 12:24		LB4110A	B4	120	328	1.65	0.4619
06	RA-228	TRG	05/03/19 12:24		LB4110A	C1	120	451	1.716666667	0.4667
07	RA-228	TRG	05/03/19 12:24		LB4110A	C2	120	625	0.983333333	0.4578

0100

Count Room Report
Client: Michael Pisani Associat

19-04089-Ra228-1 (pCi/l) in WA
Tracer ID: Ba-6a

Internal Fraction	Sample Desc	Client ID	Sample Date	Sample Aliquot	Tracer Aliquot (g)	Tracer ACT (dpm)	Radiometric Tracer (pCi)	Radiometric % Rec	SAF 1*	SAF 2*
01	LCS	LCS	04/18/19 00:00	1.0000	2.2045	1003.4223	668.0000	147.79	1.00	1.00
02	MBL	BLANK	04/18/19 00:00	1.0000	2.2033	1002.8761	569.0000	125.96	1.00	1.00
03	DUP	BC 22B	04/09/19 10:00	1.0000	2.2045	1003.4223	682.0000	150.89	1.00	1.00
04	DO	BC 22B	04/09/19 10:00	1.0000	2.1975	1000.2361	693.0000	153.81	1.00	1.00
05	TRG	BC 9	04/09/19 12:10	1.0000	2.2000	1001.3740	505.0000	111.96	1.00	1.00
06	TRG	BC 10	04/09/19 14:55	1.0000	2.1968	999.9175	428.0000	95.02	1.00	1.00
07	TRG	BC 23	04/09/19 16:50	1.0000	2.1945	998.8706	652.0000	144.91	1.00	1.00

0101

Spike and Tracer Worksheet

Internal Work Order	Run	Analysis Code	Date	Technician	Technician Initials	Witness Initials
19-04089	1	Ra228	5/3/2019 9:48	DBUSH	DB	

LCS & Matrix Spikes					LCS	MS	LCSD	MSD	LCS		MS		LCSD		MSD	
Isotope	*Sol #*	*Activity dpm/g*	*Solution Date*	*Approx Addition*	*Volume Used (g)*	*Volume Used (g)*	*Volume Used (g)*	*Volume Used (g)*	*Known pCi*	*Error Estimate*	*Added pCi*	*Error Estimate*	*Known pCi*	*Error Estimate*	*Added pCi*	*Error Estimate*
Ra-228	Ra-12	49.460	5/3/2019	0.400	0.4029				8.98	0.458	0.00	0.000	0.00	0.000	0.00	0.000

Tracers

fraction	*Isotope*	*Sol #*	*Activity dpm/g*	*Solution Date*	*Volume Used (g)*	*Approx Addition*
01	Ba-133	Ba-6a	455.170	5/3/2019	2.2045	2.2300
02	Ba-133	Ba-6a	455.170	5/3/2019	2.2033	2.2300
03	Ba-133	Ba-6a	455.170	5/3/2019	2.2045	2.2300
04	Ba-133	Ba-6a	455.170	5/3/2019	2.1975	2.2300
05	Ba-133	Ba-6a	455.170	5/3/2019	2.2000	2.2300
06	Ba-133	Ba-6a	455.170	5/3/2019	2.1968	2.2300
07	Ba-133	Ba-6a	455.170	5/3/2019	2.1945	2.2300

Balance Printer Tapes

Tracer	LCS

Matrix Spike

01102

Eberline Analytical
Oak Ridge Laboratory

Aliquot Worksheet

Printed: 4/29/2019 10:32 AM

Work Order	Run	Analysis Code	Rpt Units	Lab Deadline	Technician
19-04089	1	Ra228	liters	4/30/2019	JHARVEY

Lab Fraction	Michael Pisani & Associates, Inc. Client ID	Sample Type	Muffle Data Ratio Post/Pre	Dilution Data No of Dils	Dil Factor	Ratio	Aliquot Data Aliquot	Net Equiv	MS Aliquot Data Aliquot	Net Equiv	H-3 Solids Only Water Added (ml)	H3 Dist Aliq
01	LCS	LCS					1.0000E+00	1.0000E+00				
02	BLANK	MBL					1.0000E+00	1.0000E+00				
03	BC 22B	DUP					1.0000E+00	1.0000E+00				
04	BC 22B	DO					1.0000E+00	1.0000E+00				
05	BC 9	TRG					1.0000E+00	1.0000E+00				
06	BC 10	TRG					1.0000E+00	1.0000E+00				
07	BC 23	TRG					1.0000E+00	1.0000E+00				

Comments	

0103

Technician: _____ Date: 4/29/19

Gravimetric Worksheet

Work Order	Run	Analysis Code	Gravimetric Carrier	Carrier Conc (mg/ml)	Technician
19-04089	1	Ra228	Yttrium	30.6333	DBUSH

TRetec	Michael Pisani & Associates, Inc.	Sample	Carrier Data	Filter Data			Gravimetric
Fraction	Client ID	Type	Carrier Added (ml)	Filter Tare (g)	Filter Final (g)	Filter Net (g)	% Recovery
01	LCS	LCS	2.0500	0.0713	0.1340	0.0627	99.84
02	BLANK	MBL	2.1000	0.0708	0.1338	0.0630	97.93
03	DUP	DUP	2.1000	0.0704	0.1337	0.0633	98.40
04	BC 22B	DO	2.0500	0.0704	0.1323	0.0619	98.57
05	BC 9	TRG	2.0500	0.0702	0.1324	0.0622	99.05
06	BC 10	TRG	2.1000	0.0697	0.1334	0.0637	99.02
07	BC 23	TRG	2.1000	0.0692	0.1328	0.0636	98.87

01104

Technician: _____ Date: 5 / 3 / 19

Detector ID	Sample ID	Alpha	Beta	Count Time	Voltage	TOD
A1	1904089-01	44	976	120	1410	5/3/2019 12:24:56 PM
A3	1904089-02	22	216	120	1410	5/3/2019 12:24:56 PM
A4	1904089-03	23	296	120	1410	5/3/2019 12:24:56 PM
B3	1904089-04	17	242	120	1410	5/3/2019 12:24:56 PM
B4	1904089-05	20	328	120	1410	5/3/2019 12:24:56 PM
C1	1904089-06	16	451	120	1410	5/3/2019 12:24:56 PM
C2	1904089-07	33	625	120	1410	5/3/2019 12:24:56 PM

LD
5/3/19

GPC Detector Report
(ALL Backgrounds)

KP
5/3/19

Detector	Alpha/Beta	Calibration Date	Count Date	Bkg CPM	PFW	LCL	Mean	UCL
LB4110A - A1	Alpha	11/2/2017	5/3/2019	1.33E-01	P	-4.08E-02	1.02E-01	2.46E-01
LB4110A - A2	Alpha	11/2/2017	5/3/2019	2.17E-01	P	-4.08E-02	1.12E-01	2.64E-01
LB4110A - A3	Alpha	11/2/2017	5/3/2019	8.33E-02	P	-3.22E-02	1.09E-01	2.51E-01
LB4110A - A4	Alpha	11/2/2017	5/3/2019	1.83E-01	P	-4.27E-02	1.10E-01	2.62E-01
LB4110A - B1	Alpha	11/2/2017	5/3/2019	2.50E-01	P	-3.80E-02	1.32E-01	3.02E-01
LB4110A - B2	Alpha	11/2/2017	5/3/2019	1.50E-01	P	-2.65E-02	1.44E-01	3.15E-01
LB4110A - B3	Alpha	11/2/2017	5/3/2019	1.17E-01	P	-5.04E-02	8.37E-02	2.18E-01
LB4110A - B4	Alpha	11/2/2017	5/3/2019	1.33E-01	P	-4.35E-02	8.86E-02	2.21E-01
LB4110A - C1	Alpha	11/2/2017	5/3/2019	1.83E-01	P	-2.74E-02	8.64E-02	2.00E-01
LB4110A - C2	Alpha	11/2/2017	5/3/2019	1.33E-01	P	-3.65E-02	7.04E-02	1.77E-01
LB4110A - C3	Alpha	11/2/2017	5/3/2019	6.67E-02	P	-4.86E-02	6.85E-02	1.86E-01
LB4110A - C4	Alpha	11/2/2017	5/3/2019	2.17E-01	P	-4.25E-02	9.97E-02	2.42E-01
LB4110A - D1	Alpha	11/2/2017	5/3/2019	2.17E-01	P	-1.81E-02	1.54E-01	3.26E-01
LB4110A - D2	Alpha	11/2/2017	5/3/2019	1.50E-01	P	-2.87E-02	1.15E-01	2.58E-01
LB4110A - D3	Alpha	11/2/2017	5/3/2019	8.33E-02	P	-3.05E-02	1.07E-01	2.45E-01
LB4110A - D4	Alpha	11/2/2017	5/3/2019	2.00E-01	P	-4.68E-03	1.56E-01	3.16E-01
LB4110A - E1	Alpha	11/2/2017	3/23/2018	0.00E+00	P	-4.29E-02	1.10E-01	2.62E-01
LB4110A - E2	Alpha	11/2/2017	3/23/2018	0.00E+00	P	-3.09E-02	6.37E-02	1.58E-01
LB4110A - E3	Alpha	11/2/2017	3/23/2018	0.00E+00	P	-8.81E-02	9.11E-02	2.70E-01
LB4110A - E4	Alpha	11/2/2017	3/23/2018	0.00E+00	P	-4.55E-02	7.04E-02	1.86E-01
LB4110A - F1	Alpha	11/2/2017	5/3/2019	6.67E-02	P	-3.83E-02	7.07E-02	1.80E-01
LB4110A - F2	Alpha	11/2/2017	5/3/2019	3.33E-02	P	-4.10E-02	4.95E-02	1.40E-01
LB4110A - F3	Alpha	11/2/2017	5/3/2019	3.33E-02	P	-4.19E-02	5.89E-02	1.60E-01
LB4110A - F4	Alpha	11/2/2017	5/3/2019	5.00E-02	P	-3.83E-02	6.46E-02	1.68E-01
LB4110A - G1	Alpha	11/2/2017	5/3/2019	1.33E-01	P	-4.52E-02	6.43E-02	1.74E-01
LB4110A - G2	Alpha	11/2/2017	5/3/2019	1.17E-01	P	-3.91E-02	7.77E-02	1.94E-01
LB4110A - G3	Alpha	11/2/2017	5/3/2019	1.67E-02	P	-4.22E-02	8.12E-02	2.05E-01
LB4110A - G4	Alpha	11/2/2017	5/3/2019	1.50E-01	P	-3.93E-02	8.42E-02	2.08E-01

GPC Detector Report
(ALL Backgrounds)

KP
5/3/19

Detector	Alpha/Beta	Calibration Date	Count Date	Bkg CPM	PFW	LCL	Mean	UCL
_B4110A - A1	Beta	11/2/2017	5/3/2019	1.43E+00	P	8.82E-01	1.37E+00	1.86E+00
_B4110A - A2	Beta	11/2/2017	5/3/2019	1.62E+00	P	9.69E-01	1.54E+00	2.10E+00
_B4110A - A3	Beta	11/2/2017	5/3/2019	1.35E+00	P	1.01E+00	1.48E+00	1.96E+00
_B4110A - A4	Beta	11/2/2017	5/3/2019	1.62E+00	P	9.81E-01	1.43E+00	1.87E+00
_B4110A - B1	Beta	11/2/2017	5/3/2019	1.57E+00	P	1.04E+00	1.52E+00	1.99E+00
_B4110A - B2	Beta	11/2/2017	5/3/2019	1.53E+00	P	6.66E-01	1.45E+00	2.23E+00
_B4110A - B3	Beta	11/2/2017	5/3/2019	1.48E+00	P	9.18E-01	1.36E+00	1.80E+00
_B4110A - B4	Beta	11/2/2017	5/3/2019	1.65E+00	P	7.53E-01	1.33E+00	1.91E+00
_B4110A - C1	Beta	11/2/2017	5/3/2019	1.72E+00	P	8.38E-01	1.27E+00	1.70E+00
_B4110A - C2	Beta	11/2/2017	5/3/2019	9.83E-01	P	-1.41E-01	1.19E+00	2.53E+00
_B4110A - C3	Beta	11/2/2017	5/3/2019	2.20E+00	F	2.45E-01	1.79E+00	3.34E+00
_B4110A - C4	Beta	11/2/2017	5/3/2019	1.50E+00	P	8.25E-01	1.24E+00	1.66E+00
_B4110A - D1	Beta	11/2/2017	5/3/2019	1.43E+00	P	8.91E-01	1.33E+00	1.76E+00
_B4110A - D2	Beta	11/2/2017	5/3/2019	1.92E+00	P	-2.47E+01	3.05E+00	3.08E+01
_B4110A - D3	Beta	11/2/2017	5/3/2019	1.20E+00	P	7.95E-01	1.27E+00	1.74E+00
_B4110A - D4	Beta	11/2/2017	5/3/2019	1.45E+00	P	9.68E-01	1.45E+00	1.94E+00
_B4110A - E1	Beta	11/2/2017	3/23/2018	3.33E-02	P	7.66E-01	1.32E+00	1.88E+00
_B4110A - E2	Beta	11/2/2017	3/23/2018	1.67E-02	P	5.45E-01	9.58E-01	1.37E+00
_B4110A - E3	Beta	11/2/2017	3/23/2018	6.67E-02	P	4.98E-01	1.20E+00	1.91E+00
_B4110A - E4	Beta	11/2/2017	3/23/2018	0.00E+00	P	5.67E-01	1.04E+00	1.50E+00
_B4110A - F1	Beta	11/2/2017	5/3/2019	1.22E+00	P	7.38E-01	1.29E+00	1.85E+00
_B4110A - F2	Beta	11/2/2017	5/3/2019	7.17E-01	P	4.54E-01	8.78E-01	1.30E+00
_B4110A - F3	Beta	11/2/2017	5/3/2019	1.25E+00	P	2.27E-01	1.16E+00	2.08E+00
_B4110A - F4	Beta	11/2/2017	5/3/2019	1.23E+00	P	5.46E-01	1.08E+00	1.62E+00
_B4110A - G1	Beta	11/2/2017	5/3/2019	1.10E+00	P	5.86E-01	1.26E+00	1.94E+00
_B4110A - G2	Beta	11/2/2017	5/3/2019	1.50E+00	P	1.03E+00	1.75E+00	2.46E+00
_B4110A - G3	Beta	11/2/2017	5/3/2019	1.28E+00	P	6.28E-01	1.37E+00	2.12E+00
_B4110A - G4	Beta	11/2/2017	5/3/2019	1.45E+00	P	-1.63E+00	1.46E+00	4.55E+00

0107

GPC Detector Report
(ALL Efficiencies)

LP
5/3/19

Detector	Alpha/Beta	Calibration Date	Count Date	Eff	PFW	LCL	Mean	UCL
LB4110A - A1	Alpha	11/2/2017	5/3/2019	0.2317	P	0.2122	0.2262	0.2402
LB4110A - A2	Alpha	11/2/2017	5/3/2019	0.1959	P	0.1900	0.2093	0.2287
LB4110A - A3	Alpha	11/2/2017	5/3/2019	0.1963	P	0.1823	0.1988	0.2154
LB4110A - A4	Alpha	11/2/2017	5/3/2019	0.2241	P	0.2036	0.2253	0.2470
LB4110A - B1	Alpha	11/2/2017	5/3/2019	0.2195	P	0.2067	0.2239	0.2411
LB4110A - B2	Alpha	11/2/2017	5/3/2019	0.1949	P	0.1858	0.2003	0.2148
LB4110A - B3	Alpha	11/2/2017	5/3/2019	0.2385	P	0.2200	0.2351	0.2501
LB4110A - B4	Alpha	11/2/2017	5/3/2019	0.2259	P	0.2058	0.2231	0.2404
LB4110A - C1	Alpha	11/2/2017	5/3/2019	0.2084	P	0.1950	0.2070	0.2190
LB4110A - C2	Alpha	11/2/2017	5/3/2019	0.2244	P	-0.0294	0.2220	0.4735
LB4110A - C3	Alpha	11/2/2017	5/3/2019	0.2361	P	0.2245	0.2408	0.2572
LB4110A - C4	Alpha	11/2/2017	5/3/2019	0.2182	P	0.2001	0.2157	0.2313
LB4110A - D1	Alpha	11/2/2017	5/3/2019	0.2187	P	0.2094	0.2214	0.2335
LB4110A - D2	Alpha	11/2/2017	5/3/2019	0.2304	P	0.2199	0.2461	0.2723
LB4110A - D3	Alpha	11/2/2017	5/3/2019	0.2564	P	0.2299	0.2487	0.2676
LB4110A - D4	Alpha	11/2/2017	5/3/2019	0.1899	P	0.1712	0.1940	0.2169
LB4110A - E1	Alpha	11/2/2017	3/23/2018	0.0000	F	0.1687	0.2258	0.2830
LB4110A - E2	Alpha	11/2/2017	3/23/2018	0.0000	F	0.1518	0.2051	0.2584
LB4110A - E3	Alpha	11/2/2017	3/23/2018	0.0000	F	0.1547	0.2075	0.2603
LB4110A - E4	Alpha	11/2/2017	3/23/2018	0.0000	F	0.1747	0.2355	0.2963
LB4110A - F1	Alpha	11/2/2017	5/3/2019	0.2174	P	0.1574	0.2127	0.2680
LB4110A - F2	Alpha	11/2/2017	5/3/2019	0.1810	P	0.1432	0.1819	0.2206
LB4110A - F3	Alpha	11/2/2017	5/3/2019	0.2330	P	0.1786	0.2313	0.2839
LB4110A - F4	Alpha	11/2/2017	5/3/2019	0.2166	P	0.1623	0.2105	0.2586
LB4110A - G1	Alpha	11/2/2017	5/3/2019	0.1878	P	0.1780	0.1947	0.2115
LB4110A - G2	Alpha	11/2/2017	5/3/2019	0.1852	P	0.1802	0.1981	0.2159
LB4110A - G3	Alpha	11/2/2017	5/3/2019	0.2236	P	0.2026	0.2204	0.2383
LB4110A - G4	Alpha	11/2/2017	5/3/2019	0.1845	P	0.1693	0.1926	0.2159

0108

GPC Detector Report
(ALL Efficiencies)

KP
5/3/19

Detector	Alpha/Beta	Calibration Date	Count Date	Eff	PFW	LCL	Mean	UCL
LB4110A - A1	Beta	11/2/2017	5/3/2019	0.5540	P	0.5047	0.5417	0.5788
LB4110A - A2	Beta	11/2/2017	5/3/2019	0.4382	P	0.4003	0.4595	0.5187
LB4110A - A3	Beta	11/2/2017	5/3/2019	0.4631	P	0.4330	0.4782	0.5234
LB4110A - A4	Beta	11/2/2017	5/3/2019	0.5539	P	0.4971	0.5417	0.5862
LB4110A - B1	Beta	11/2/2017	5/3/2019	0.5296	P	0.5054	0.5417	0.5779
LB4110A - B2	Beta	11/2/2017	5/3/2019	0.4705	W	0.4675	0.4997	0.5319
LB4110A - B3	Beta	11/2/2017	5/3/2019	0.5731	P	0.5506	0.5837	0.6167
LB4110A - B4	Beta	11/2/2017	5/3/2019	0.5406	P	0.5067	0.5481	0.5896
LB4110A - C1	Beta	11/2/2017	5/3/2019	0.4757	P	0.4471	0.4787	0.5102
LB4110A - C2	Beta	11/2/2017	5/3/2019	0.5314	P	0.4875	0.5201	0.5527
LB4110A - C3	Beta	11/2/2017	5/3/2019	0.5778	P	0.5494	0.5948	0.6402
LB4110A - C4	Beta	11/2/2017	5/3/2019	0.5236	P	0.4861	0.5237	0.5612
LB4110A - D1	Beta	11/2/2017	5/3/2019	0.6414	P	0.6103	0.6397	0.6691
LB4110A - D2	Beta	11/2/2017	5/3/2019	0.5800	P	0.5369	0.6263	0.7156
LB4110A - D3	Beta	11/2/2017	5/3/2019	0.6598	P	0.5904	0.6402	0.6900
LB4110A - D4	Beta	11/2/2017	5/3/2019	0.4822	P	0.4515	0.5001	0.5487
LB4110A - E1	Beta	11/2/2017	3/23/2018	0.0436	F	0.4162	0.5409	0.6655
LB4110A - E2	Beta	11/2/2017	3/23/2018	0.0428	F	0.3730	0.4913	0.6097
LB4110A - E3	Beta	11/2/2017	3/23/2018	0.0551	F	0.3852	0.4994	0.6137
LB4110A - E4	Beta	11/2/2017	3/23/2018	0.0569	F	0.4534	0.5890	0.7247
LB4110A - F1	Beta	11/2/2017	5/3/2019	0.5410	P	0.4365	0.5313	0.6260
LB4110A - F2	Beta	11/2/2017	5/3/2019	0.4580	P	0.4079	0.4562	0.5046
LB4110A - F3	Beta	11/2/2017	5/3/2019	0.5918	P	0.4760	0.5964	0.7168
LB4110A - F4	Beta	11/2/2017	5/3/2019	0.5538	P	0.4418	0.5337	0.6257
LB4110A - G1	Beta	11/2/2017	5/3/2019	0.4539	P	0.4277	0.4544	0.4811
LB4110A - G2	Beta	11/2/2017	5/3/2019	0.4417	P	0.4277	0.4741	0.5205
LB4110A - G3	Beta	11/2/2017	5/3/2019	0.5303	P	0.4842	0.5313	0.5785
LB4110A - G4	Beta	11/2/2017	5/3/2019	0.4537	P	0.4041	0.4673	0.5305

0109

SECTION X

BARIUM-133 ANALYTICAL TRACER DATA

CB 5/2/19

Apex-Gamma

Analysis Report for 1904089-01
SPIKE

GAMMA SPECTRUM ANALYSIS

Sample Identification	: 1904089-01
Sample Description	: SPIKE
Sample Type	: RA RECOVERY
Sample Size	: 1.000E+00 units
Facility	: Countroom
Sample Taken On	: 5/1/2019 3:11:02PM
Acquisition Started	: 5/1/2019 3:16:01PM
Procedure	: BAFIL
Operator	: Administrator
Detector Name	: GE1
Geometry	: BAFIL
Live Time	: 900.0 seconds
Real Time	: 900.4 seconds
Dead Time	: 0.04 %
Peak Locate Threshold	: 2.50
Peak Locate Range (in channels)	: 1 - 4096
Peak Area Range (in channels)	: 19 - 4096
Identification Energy Tolerance	: 1.000FWHM
Energy Calibration Used Done On	: 6/16/2018
Efficiency Calibration Used Done On	: 2/17/2018
Efficiency Calibration Description	:
Sample Number	: 81209

PEAK ANALYSIS REPORT

Peak Analysis Performed on : 5/1/2019 3:31:05PM

Peak Analysis From Channel : 1
Peak Analysis To Channel : 4096

Peak No.	Energy (keV)	ROI start	ROI end	Peak Centroid	Net Peak Area	Net Area Uncertainty	Continuum Counts	FWHM (keV)

Analysis Report for 1904089-01

SPIKE

	Peak No.	Energy (keV)	ROI start	ROI end	Peak Centroid	Net Peak Area	Net Area Uncertainty	Continuum Counts	FWHM (keV)
M	1	30.76	26 -	40	31.14	2.64E+03	129.13	7.03E+02	3.02
m	2	34.88	26 -	40	35.25	7.05E+02	133.67	7.75E+02	3.50
	3	52.56	48 -	57	52.93	8.11E+01	50.68	3.22E+02	3.52
	4	63.32	58 -	73	63.69	5.23E+02	91.35	6.31E+02	4.10
	5	80.93	76 -	88	81.29	1.09E+03	95.26	5.65E+02	3.19
M	6	108.85	107 -	120	109.20	4.44E+01	25.77	1.12E+02	2.79
m	7	111.80	107 -	120	112.16	2.48E+02	52.19	2.45E+02	2.80
m	8	115.31	107 -	120	115.67	5.22E+01	40.44	2.05E+02	1.92
	9	276.27	272 -	280	276.59	6.72E+01	30.69	1.04E+02	3.58
M	10	297.69	297 -	310	298.00	1.14E+01	4.74	7.14E+00	1.72
m	11	302.89	297 -	310	303.20	2.11E+02	42.73	1.21E+02	3.36
m	12	307.52	297 -	310	307.83	2.63E+01	26.50	1.07E+02	1.90
M	13	333.59	328 -	342	333.90	9.89E+01	32.10	5.92E+01	3.73
m	14	336.13	328 -	342	336.43	4.21E+01	29.97	3.86E+01	3.09
M	15	356.05	350 -	370	356.35	7.91E+02	60.33	6.84E+01	3.11
m	16	364.06	350 -	370	364.36	4.12E+01	25.13	4.70E+01	3.12
	17	385.66	380 -	391	385.95	3.68E+02	63.18	3.07E+02	3.88
	18	415.61	410 -	422	415.89	8.00E+01	29.57	6.61E+01	5.65
	19	436.67	431 -	441	436.94	1.26E+02	26.67	2.78E+01	2.63
M	20	467.55	462 -	476	467.82	1.19E+01	13.23	2.17E+01	1.99
m	21	470.91	462 -	476	471.18	1.21E+01	13.82	1.98E+01	2.00
	22	499.59	497 -	502	499.86	7.00E+00	5.29	0.00E+00	1.66
	23	718.28	715 -	721	718.50	8.00E+00	5.66	0.00E+00	2.70

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 2.000sigma

BACKGROUND SUBTRACT REPORT

Peak Analysis Performed on : 5/1/2019 3:31:05PM

Env. Background File : \\OR-GAMMA1\ApexRoot\Countroom\Data\0000080014.CNF

	Peak No.	Energy (keV)	Original Area	Orig. Area Uncertainty	Ambient Background	Backgr. Uncert.	Subtracted Area	Subtracted Uncert.
M	1	30.76	2.64E+03	129.13			2.64E+03	1.29E+02
m	2	34.88	7.05E+02	133.67			7.05E+02	1.34E+02
	3	52.56	8.11E+01	50.68			8.11E+01	5.07E+01
	4	63.32	5.23E+02	91.35	2.07E+01	2.02E+00	5.02E+02	9.14E+01
	5	80.93	1.09E+03	95.26			1.09E+03	9.53E+01
M	6	108.85	4.44E+01	25.77			4.44E+01	2.58E+01

Analysis Report for 1904089-01

SPIKE

	Peak No.	Energy (keV)	Original Area	Orig. Area Uncertainty	Ambient Background	Backgr. Uncert.	Subtracted Area	Subtracted Uncert.
m	7	111.80	2.48E+02	52.19			2.48E+02	5.22E+01
m	8	115.31	5.22E+01	40.44			5.22E+01	4.04E+01
	9	276.27	6.72E+01	30.69			6.72E+01	3.07E+01
M	10	297.69	1.14E+01	4.74			1.14E+01	4.74E+00
m	11	302.89	2.11E+02	42.73			2.11E+02	4.27E+01
m	12	307.52	2.63E+01	26.50			2.63E+01	2.65E+01
M	13	333.59	9.89E+01	32.10			9.89E+01	3.21E+01
m	14	336.13	4.21E+01	29.97			4.21E+01	3.00E+01
M	15	356.05	7.91E+02	60.33			7.91E+02	6.03E+01
m	16	364.06	4.12E+01	25.13			4.12E+01	2.51E+01
	17	385.66	3.68E+02	63.18			3.68E+02	6.32E+01
	18	415.61	8.00E+01	29.57			8.00E+01	2.96E+01
	19	436.67	1.26E+02	26.67			1.26E+02	2.67E+01
M	20	467.55	1.19E+01	13.23			1.19E+01	1.32E+01
m	21	470.91	1.21E+01	13.82			1.21E+01	1.38E+01
	22	499.59	7.00E+00	5.29			7.00E+00	5.29E+00
	23	718.28	8.00E+00	5.66			8.00E+00	5.66E+00

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 2.000sigma

NUCLIDE IDENTIFICATION REPORT

Nuclide Library Used : \\OR-GAMMA1\ApexRoot\Countroom\Library\WSRC.NLB

IDENTIFIED NUCLIDES

Nuclide Name	Id Confidence	Energy (keV)		Yield(%)	Activity (pCi/units)	Activity Uncertainty
I-125	0.98	35.49	*	6.49	6.27E+00	1.19E+00
BA-133	1.00	30.80	*	97.60	4.86E-01	2.37E-02
		302.84	*	17.80	9.32E+02	4.51E+02
		356.01	*	60.00	6.68E+02	8.90E+01
PA-231	1.00	9.28		42.00		
		10.11		20.20		
		283.67		1.60		
		302.67	*	2.30	7.21E+03	3.49E+03
TH-234	1.00	63.29	*	3.80	6.39E+02	1.17E+02

Analysis Report for 1904089-01

SPIKE

* = Energy line found in the spectrum.
\- = Manually added nuclide.
? = Manually edited nuclide.
@ = Energy line not used for Weighted Mean Activity
Energy Tolerance : 2.000FWHM
Nuclide confidence index threshold = 0.30
Errors quoted at 2.000sigma

INTERFERENCE CORRECTED REPORT

	Nuclide Name	Nuclide Id Confidence	Wt mean Activity (pCi/units)	Wt mean Activity Uncertainty	Comments
	I-125	0.989	6.27E+00	1.19E+00	
X	I-129	0.921			
	BA-133	1.000	4.86E-01	2.37E-02	
	PA-231	1.000	7.21E+03	3.49E+03	
	TH-234	1.000	6.39E+02	1.17E+02	
X	NP-237	0.939			

? = 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 2.000sigma

Analysis Report for 1904089-01

SPIKE

UNIDENTIFIED PEAKS

Peak Locate Performed on : 5/1/2019 3:31:05PM
Peak Locate From Channel : 1
Peak Locate To Channel : 4096

	Peak No.	Energy (keV)	Peak Size (CPS)	Peak CPS (%) Uncertainty	Peak Type	Tolerance Nuclide
	3	52.56	9.01469E-02	31.23		
	5	80.93	1.20920E+00	4.38		
M	6	108.85	4.92946E-02	29.04		
m	7	111.80	2.75857E-01	10.51		
m	8	115.31	5.79893E-02	38.74	Tol.	U-237
	9	276.27	7.46265E-02	22.85		
M	10	297.69	1.26722E-02	20.80		
m	12	307.52	2.92479E-02	50.33		
M	13	333.59	1.09935E-01	16.22	Sum	
m	14	336.13	4.67555E-02	35.62	Sum	
m	16	364.06	4.57433E-02	30.53		
	17	385.66	4.08604E-01	8.59	Sum	
	18	415.61	8.88446E-02	18.49		
	19	436.67	1.40107E-01	10.57		
M	20	467.55	1.31686E-02	55.81		
m	21	470.91	1.34985E-02	56.88		
	22	499.59	7.77778E-03	37.80		
	23	718.28	8.88889E-03	35.36		

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 2.000sigma

NUCLIDE MDA REPORT

Nuclide Library Used : \\OR-GAMMA1\ApexRoot\Countroom\Library\WSRC.NLB

Analysis Report for 1904089-01

SPIKE

	Nuclide Name	Energy (keV)		Yield(%)	Line MDA (pCi/units)	Nuclide MDA (pCi/units)	Activity (pCi/units)	Dec. Level (pCi/units)
	FE-55	5.89		24.50	1.90E-13	1.90E-13	0.00E+00	0.00E+00
	CO-57	122.06		85.51	4.01E+01	4.01E+01	8.82E+00	1.89E+01
		136.48		10.60	3.88E+02		4.43E+00	1.82E+02
	NI-59	6.92		29.80	2.77E-12	2.77E-12	0.00E+00	0.00E+00
	MO-93	16.59		52.90	1.01E-05	1.01E-05	-1.30E-06	4.61E-06
		18.60		10.00	4.13E-04		-1.11E-04	1.97E-04
	NB-93M	16.57		9.43	5.58E-05	5.58E-05	-7.20E-06	2.55E-05
	CD-109	88.03		3.72	3.60E+02	3.60E+02	1.27E+01	1.71E+02
	SN-113	255.12		1.93	2.09E+03	3.36E+01	1.18E+03	9.68E+02
		391.69		61.90	3.36E+01		7.02E+00	1.60E+01
	SN-119M	23.87		16.10	7.65E-03	7.65E-03	1.14E-02	3.72E-03
		25.10		22.70	8.87E-03		1.02E-02	4.30E-03
+	I-125	35.49	*	6.49	1.51E+00	1.51E+00	6.27E+00	7.43E-01
	I-129	29.78	*	57.00	5.31E-02	5.31E-02	8.32E-01	2.61E-02
		33.60	*	13.20	7.43E-01		3.08E+00	3.65E-01
		39.58		7.52	1.69E+00		-2.29E-03	8.12E-01
+	BA-133	30.80	*	97.60	3.10E-02	3.10E-02	4.86E-01	1.52E-02
		302.84	*	17.80	2.95E+02		9.32E+02	1.42E+02
		356.01	*	60.00	6.11E+01		6.68E+02	2.94E+01
	CE-139	165.85		80.35	6.67E+01	6.67E+01	-2.32E+01	3.13E+01
	CE-144	133.54		10.80	3.45E+02	3.45E+02	2.90E+00	1.61E+02
	HG-203	279.19		77.30	5.48E+01	5.48E+01	4.25E+00	2.58E+01
	PB-210	46.50		4.25	6.15E+00	6.15E+00	-1.38E+00	2.88E+00
+	PA-231	9.28		42.00	2.61E-10	2.61E-10	0.00E+00	0.00E+00
		10.11		20.20	2.08E-09		0.00E+00	0.00E+00
		283.67		1.60	2.05E+03		-2.83E+01	9.49E+02
		302.67	*	2.30	2.28E+03		7.21E+03	1.10E+03
	TH-231	25.64		14.70	1.45E-02	1.45E-02	-1.65E-02	6.98E-03
		84.21		6.40	2.83E+02		-1.74E+02	1.37E+02
	PA-234M	9.89		89.00	3.36E-10	3.36E-10	0.00E+00	0.00E+00
		21.72		64.90	6.76E-04		1.61E-03	3.28E-04
		37.93		23.75	5.51E-01		5.84E-01	2.69E-01
		131.42		20.40	1.65E+02		-7.91E+00	7.65E+01
+	TH-234	63.29	*	3.80	1.70E+02	1.70E+02	6.39E+02	8.34E+01
	NP-237	29.37	*	14.00	2.16E-01	2.16E-01	3.39E+00	1.06E-01
		86.50		12.60	1.02E+02		-3.43E+02	4.85E+01
	U-237	97.08		16.30	1.05E+02	7.13E+01	-4.95E+01	4.97E+01
		101.07		26.30	7.13E+01		-1.09E+01	3.34E+01
		114.00		12.30	4.24E+02		6.71E+02	2.05E+02
		208.01		22.00	2.15E+02		-6.37E+01	9.97E+01
	AM-241	59.54		35.90	7.61E+00	7.61E+00	2.88E+00	3.68E+00
	AM-243	74.67		66.00	9.01E+00	9.01E+00	-1.54E-01	4.26E+00

\+ = 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

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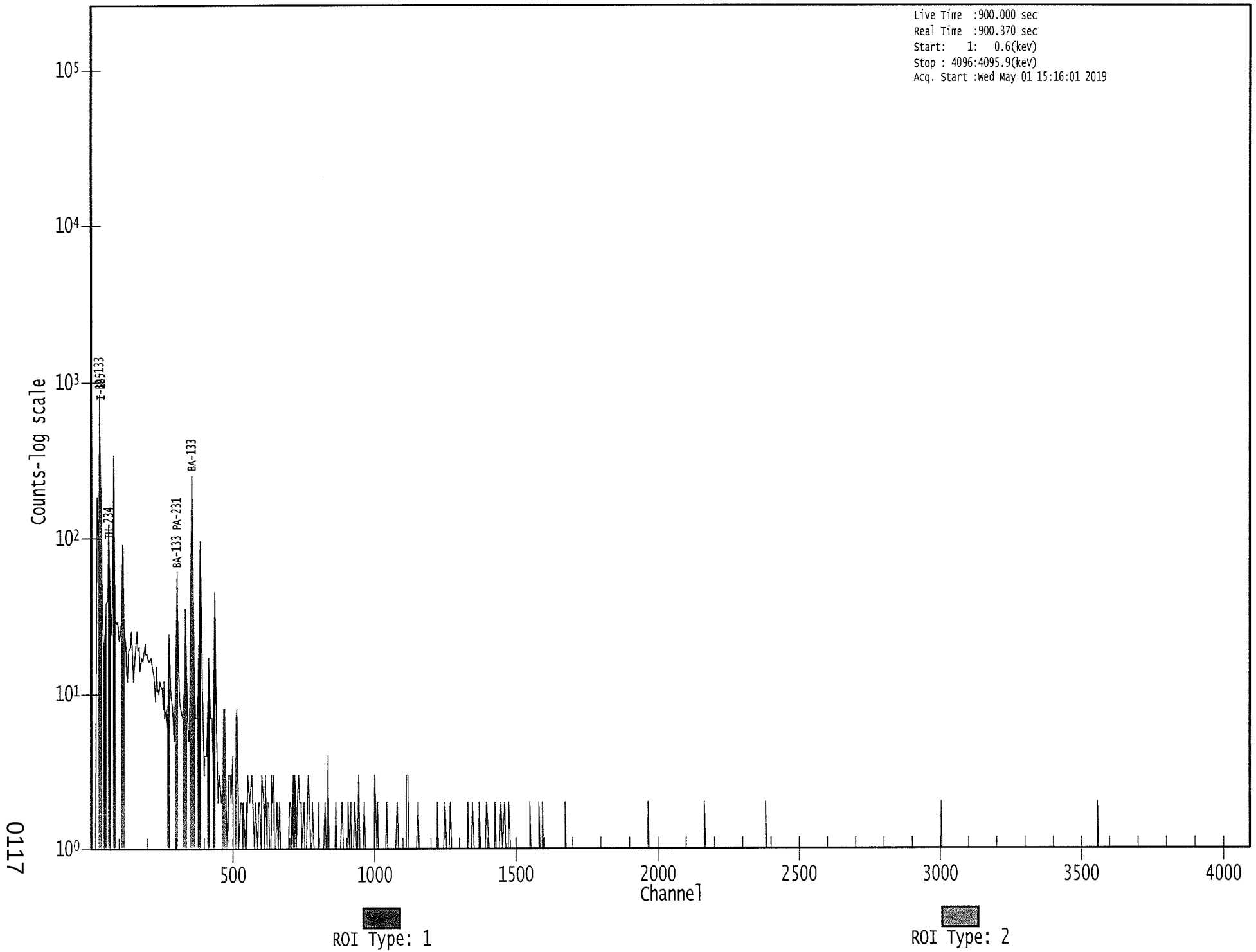

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Apex-Gamma

Analysis Report for 1904089-02
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GAMMA SPECTRUM ANALYSIS

Sample Identification	: 1904089-02
Sample Description	: BLANK
Sample Type	: RA RECOVERY
Sample Size	: 1.000E+00 units
Facility	: Countroom
Sample Taken On	: 5/1/2019 3:11:13PM
Acquisition Started	: 5/1/2019 3:16:09PM
Procedure	: BAFIL
Operator	: Administrator
Detector Name	: GE3
Geometry	: BAFIL
Live Time	: 900.0 seconds
Real Time	: 901.9 seconds
Dead Time	: 0.21 %
Peak Locate Threshold	: 2.50
Peak Locate Range (in channels)	: 1 - 4096
Peak Area Range (in channels)	: 9 - 4096
Identification Energy Tolerance	: 1.000FWHM
Energy Calibration Used Done On	: 7/21/2018
Efficiency Calibration Used Done On	: 7/21/2018
Efficiency Calibration Description	:
Sample Number	: 81210

PEAK ANALYSIS REPORT

Peak Analysis Performed on : 5/1/2019 3:31:20PM

Peak Analysis From Channel : 1
Peak Analysis To Channel : 4096

Peak No.	Energy (keV)	ROI start	ROI end	Peak Centroid	Net Peak Area	Net Area Uncertainty	Continuum Counts	FWHM (keV)

Analysis Report for 1904089-02

BLANK

	Peak No.	Energy (keV)	ROI start	ROI end	Peak Centroid	Net Peak Area	Net Area Uncertainty	Continuum Counts	FWHM (keV)
M	1	21.05	18 -	44	21.42	1.60E+02	42.80	2.37E+02	2.19
m	2	30.99	18 -	44	31.35	2.89E+03	113.85	1.85E+02	1.86
m	3	35.24	18 -	44	35.60	7.32E+02	94.99	2.01E+02	2.24
M	4	52.07	49 -	70	52.43	7.31E+01	42.66	2.73E+02	2.46
m	5	61.84	49 -	70	62.19	3.48E+02	51.17	2.34E+02	2.08
m	6	66.00	49 -	70	66.34	1.85E+02	51.96	2.73E+02	2.49
	7	81.15	77 -	86	81.49	1.15E+03	83.62	3.38E+02	2.18
	8	101.96	100 -	105	102.29	2.68E+01	27.95	1.34E+02	3.35
M	9	111.88	106 -	120	112.21	3.65E+02	48.44	1.48E+02	2.33
m	10	115.69	106 -	120	116.01	6.88E+01	41.50	1.42E+02	2.34
	11	167.57	165 -	171	167.87	2.69E+01	30.04	1.46E+02	4.65
M	12	272.97	272 -	282	273.22	1.59E+01	10.90	2.73E+01	2.95
m	13	276.42	272 -	282	276.68	6.59E+01	27.42	7.54E+01	2.81
M	14	303.06	298 -	309	303.31	2.16E+02	32.86	5.28E+01	2.43
m	15	307.05	298 -	309	307.30	2.09E+01	17.60	2.68E+01	2.48
M	16	333.53	328 -	345	333.77	9.94E+01	26.95	4.77E+01	3.08
m	17	337.69	328 -	345	337.92	3.89E+01	28.26	4.12E+01	3.00
	18	356.02	351 -	361	356.24	6.55E+02	55.43	6.02E+01	2.12
	19	364.50	362 -	367	364.72	1.46E+01	15.49	3.67E+01	1.97
M	20	384.04	379 -	396	384.25	1.44E+02	37.58	2.85E+01	2.51
m	21	386.92	379 -	396	387.14	2.51E+02	39.27	1.75E+01	2.03
m	22	391.14	379 -	396	391.35	7.09E+01	34.76	1.78E+01	2.60
M	23	414.94	409 -	430	415.15	5.99E+01	22.66	2.70E+01	2.87
m	24	418.06	409 -	430	418.26	2.72E+01	20.43	2.10E+01	2.40
m	25	421.82	409 -	430	422.02	1.35E+01	18.15	2.70E+01	2.87
m	26	427.80	409 -	430	427.99	8.64E+00	9.03	1.50E+01	2.87
	27	436.80	432 -	441	436.99	9.10E+01	23.96	3.00E+01	1.63
	28	467.57	464 -	471	467.75	2.48E+01	14.00	1.64E+01	2.12
	29	619.81	617 -	622	619.94	5.50E+00	6.08	3.00E+00	2.37

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 2.000sigma

BACKGROUND SUBTRACT REPORT

Peak Analysis Performed on : 5/1/2019 3:31:20PM

Env. Background File : \\OR-GAMMA1\ApexRoot\Countroom\Data\0000080016.CNF

Peak No.	Energy (keV)	Original Area	Orig. Area Uncertainty	Ambient Background	Backgr. Uncert.	Subtracted Area	Subtracted Uncert.

Analysis Report for 1904089-02

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	Peak No.	Energy (keV)	Original Area	Orig. Area Uncertainty	Ambient Background	Backgr. Uncert.	Subtracted Area	Subtracted Uncert.
M	1	21.05	1.60E+02	42.80			1.60E+02	4.28E+01
m	2	30.99	2.89E+03	113.85			2.89E+03	1.14E+02
m	3	35.24	7.32E+02	94.99			7.32E+02	9.50E+01
M	4	52.07	7.31E+01	42.66			7.31E+01	4.27E+01
m	5	61.84	3.48E+02	51.17	1.56E+01	2.88E+00	3.32E+02	5.12E+01
m	6	66.00	1.85E+02	51.96			1.85E+02	5.20E+01
	7	81.15	1.15E+03	83.62			1.15E+03	8.36E+01
	8	101.96	2.68E+01	27.95			2.68E+01	2.79E+01
M	9	111.88	3.65E+02	48.44			3.65E+02	4.84E+01
m	10	115.69	6.88E+01	41.50			6.88E+01	4.15E+01
	11	167.57	2.69E+01	30.04			2.69E+01	3.00E+01
M	12	272.97	1.59E+01	10.90			1.59E+01	1.09E+01
m	13	276.42	6.59E+01	27.42			6.59E+01	2.74E+01
M	14	303.06	2.16E+02	32.86			2.16E+02	3.29E+01
m	15	307.05	2.09E+01	17.60			2.09E+01	1.76E+01
M	16	333.53	9.94E+01	26.95			9.94E+01	2.70E+01
m	17	337.69	3.89E+01	28.26			3.89E+01	2.83E+01
	18	356.02	6.55E+02	55.43			6.55E+02	5.54E+01
	19	364.50	1.46E+01	15.49			1.46E+01	1.55E+01
M	20	384.04	1.44E+02	37.58			1.44E+02	3.76E+01
m	21	386.92	2.51E+02	39.27			2.51E+02	3.93E+01
m	22	391.14	7.09E+01	34.76			7.09E+01	3.48E+01
M	23	414.94	5.99E+01	22.66			5.99E+01	2.27E+01
m	24	418.06	2.72E+01	20.43			2.72E+01	2.04E+01
m	25	421.82	1.35E+01	18.15			1.35E+01	1.82E+01
m	26	427.80	8.64E+00	9.03			8.64E+00	9.03E+00
	27	436.80	9.10E+01	23.96			9.10E+01	2.40E+01
	28	467.57	2.48E+01	14.00			2.48E+01	1.40E+01
	29	619.81	5.50E+00	6.08			5.50E+00	6.08E+00

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 2.000sigma

NUCLIDE IDENTIFICATION REPORT

Nuclide Library Used : \\OR-GAMMA1\ApexRoot\Countroom\Library\WSRC.NLB

IDENTIFIED NUCLIDES

Nuclide Name	Id Confidence	Energy (keV)	Yield(%)	Activity (pCi/units)	Activity Uncertainty

Analysis Report for 1904089-02

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Nuclide Name	Id Confidence	Energy (keV)		Yield(%)	Activity (pCi/units)	Activity Uncertainty
SN-113	0.95	255.12		1.93		
		391.69	*	61.90	4.94E+01	2.47E+01
I-125	0.99	35.49	*	6.49	3.40E+01	4.41E+00
BA-133	1.00	30.80	*	97.60	3.86E+00	1.52E-01
		302.84	*	17.80	8.12E+02	3.20E+02
		356.01	*	60.00	5.69E+02	8.07E+01
CE-139	0.94	165.85	*	80.35	2.57E+01	3.06E+01
TH-234	0.96	63.29	*	3.80	5.20E+02	8.20E+01

* = Energy line found in the spectrum.
\- = Manually added nuclide.
? = Manually edited nuclide.
@ = Energy line not used for Weighted Mean Activity
Energy Tolerance : 2.000FWHM
Nuclide confidence index threshold = 0.30
Errors quoted at 2.000sigma

INTERFERENCE CORRECTED REPORT

	Nuclide Name	Nuclide Id Confidence	Wt mean Activity (pCi/units)	Wt mean Activity Uncertainty	Comments
	SN-113	0.959	4.94E+01	2.47E+01	
	I-125	0.999	3.40E+01	4.41E+00	
X	I-129	0.903			
	BA-133	1.000	3.86E+00	1.52E-01	
	CE-139	0.949	2.57E+01	3.06E+01	
	TH-234	0.963	5.20E+02	8.20E+01	
X	NP-237	0.886			

? = 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 2.000sigma

Analysis Report for 1904089-02

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UNIDENTIFIED PEAKS

Peak Locate Performed on : 5/1/2019 3:31:20PM
Peak Locate From Channel : 1
Peak Locate To Channel : 4096

	Peak No.	Energy (keV)	Peak Size (CPS)	Peak CPS (%) Uncertainty	Peak Type	Tolerance Nuclide
M	1	21.05	1.77492E-01	13.40		
M	4	52.07	8.12565E-02	29.16		
m	6	66.00	2.05140E-01	14.07	Sum	
	7	81.15	1.27558E+00	3.64		
	8	101.96	2.97754E-02	52.14	Tol.	U-237
M	9	111.88	4.05702E-01	6.63		
m	10	115.69	7.64962E-02	30.14	Tol.	U-237
M	12	272.97	1.76379E-02	34.32		
m	13	276.42	7.32450E-02	20.80		
m	15	307.05	2.31969E-02	42.15		
M	16	333.53	1.10400E-01	13.56	Sum	
m	17	337.69	4.32758E-02	36.28	Sum	
	19	364.50	1.62626E-02	52.92	Sum	
M	20	384.04	1.60204E-01	13.03		
m	21	386.92	2.78672E-01	7.83	Sum	
M	23	414.94	6.65133E-02	18.93		
m	24	418.06	3.02632E-02	37.51	Sum	
m	25	421.82	1.50404E-02	67.05	Sum	
m	26	427.80	9.59445E-03	52.27	Sum	
	27	436.80	1.01111E-01	13.16		
	28	467.57	2.75421E-02	28.24		
	29	619.81	6.11111E-03	55.30		

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 2.000sigma

Analysis Report for 1904089-02

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NUCLIDE MDA REPORT

Nuclide Library Used : \\OR-GAMMA1\ApexRoot\Countroom\Library\WSRC.NLB

	Nuclide Name	Energy (keV)		Yield(%)	Line MDA (pCi/units)	Nuclide MDA (pCi/units)	Activity (pCi/units)	Dec. Level (pCi/units)
	FE-55	5.89		24.50	5.37E-09	5.37E-09	-1.85E-08	1.90E-09
	CO-57	122.06		85.51	2.83E+01	2.83E+01	-7.26E+00	1.34E+01
		136.48		10.60	2.54E+02		-5.11E+01	1.20E+02
	NI-59	6.92		29.80	1.03E-07	1.03E-07	-1.42E-08	4.68E-08
	MO-93	16.59		52.90	1.09E-03	1.09E-03	-1.24E-04	5.21E-04
		18.60		10.00	2.04E-02		4.87E-04	9.86E-03
	NB-93M	16.57		9.43	6.06E-03	6.06E-03	-6.90E-04	2.89E-03
	CD-109	88.03		3.72	2.90E+02	2.90E+02	-1.50E+02	1.37E+02
+	SN-113	255.12		1.93	1.44E+03	2.81E+01	-3.52E+02	6.66E+02
		391.69	*	61.90	2.81E+01		4.94E+01	1.31E+01
	SN-119M	23.87		16.10	1.01E-01	9.83E-02	-9.95E-02	4.87E-02
		25.10		22.70	9.83E-02		-1.07E+00	4.74E-02
+	I-125	35.49	*	6.49	8.39E+00	8.39E+00	3.40E+01	4.13E+00
	I-129	29.78	*	57.00	4.13E-01	4.13E-01	6.61E+00	2.03E-01
		33.60	*	13.20	4.13E+00		1.67E+01	2.03E+00
		39.58		7.52	5.99E+00		-2.22E+01	2.89E+00
+	BA-133	30.80	*	97.60	2.41E-01	2.41E-01	3.86E+00	1.19E-01
		302.84	*	17.80	1.67E+02		8.12E+02	7.85E+01
		356.01	*	60.00	3.28E+01		5.69E+02	1.52E+01
+	CE-139	165.85	*	80.35	4.68E+01	4.68E+01	2.57E+01	2.21E+01
	CE-144	133.54		10.80	2.52E+02	2.52E+02	8.07E+01	1.19E+02
	HG-203	279.19		77.30	4.54E+01	4.54E+01	4.47E+01	2.14E+01
	PB-210	46.50		4.25	1.97E+01	1.97E+01	7.87E+00	9.36E+00
	PA-231	9.28		42.00	4.07E-06	4.07E-06	5.68E-06	1.94E-06
		10.11		20.20	2.14E-05		2.99E-05	1.02E-05
		283.67		1.60	1.38E+03		-2.39E+02	6.30E+02
		302.67		2.30	2.11E+03		3.95E+03	1.01E+03
	TH-231	25.64		14.70	1.80E-01	1.80E-01	-6.27E+00	8.71E-02
		84.21		6.40	3.68E+02		1.56E+01	1.80E+02
	PA-234M	9.89		89.00	3.84E-06	3.84E-06	5.35E-06	1.83E-06
		21.72		64.90	1.18E-02		1.60E-02	5.70E-03
		37.93		23.75	2.63E+00		1.07E+01	1.29E+00
		131.42		20.40	1.30E+02		-2.31E+01	6.13E+01
+	TH-234	63.29	*	3.80	2.61E+02	2.61E+02	5.20E+02	1.29E+02
	NP-237	29.37	*	14.00	1.68E+00	1.68E+00	2.69E+01	8.28E-01
		86.50		12.60	8.26E+01		-2.16E+01	3.91E+01
	U-237	97.08		16.30	9.24E+01	6.38E+01	-2.12E+01	4.38E+01
		101.07		26.30	6.38E+01		-5.20E+00	3.02E+01
		114.00		12.30	3.69E+02		1.24E+03	1.80E+02
		208.01		22.00	1.86E+02		4.07E+01	8.76E+01
	AM-241	59.54		35.90	1.45E+01	1.45E+01	3.70E+01	7.08E+00
	AM-243	74.67		66.00	1.06E+01	1.06E+01	2.92E+00	5.04E+00

Analysis Report for 1904089-02

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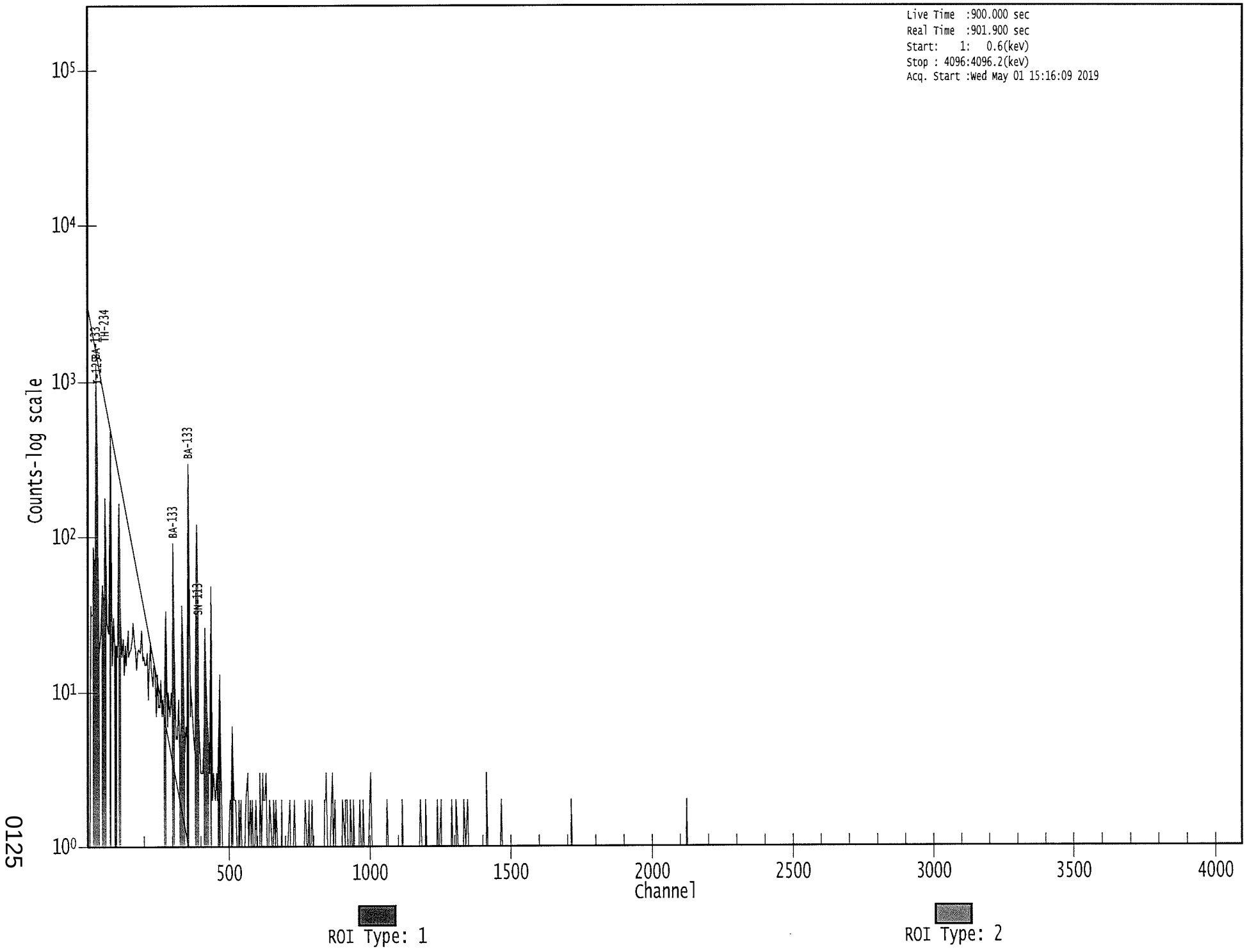
+	=	Nuclide identified during the nuclide identification
*	=	Energy line found in the spectrum
>	=	MDA value not calculated
@	=	Half-life too short to be able to perform the decay correction

0000081210.CNF



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Apex-Gamma

Analysis Report for 1904089-03

BC 22B

GAMMA SPECTRUM ANALYSIS

Sample Identification	: 1904089-03
Sample Description	: BC 22B
Sample Type	: RA RECOVERY
Sample Size	: 1.000E+00 units
Facility	: Countroom
Sample Taken On	: 5/1/2019 3:11:26PM
Acquisition Started	: 5/1/2019 3:16:16PM
Procedure	: BAFIL
Operator	: Administrator
Detector Name	: GE4
Geometry	: BAFIL
Live Time	: 900.0 seconds
Real Time	: 900.4 seconds
Dead Time	: 0.05 %
Peak Locate Threshold	: 2.50
Peak Locate Range (in channels)	: 1 - 4096
Peak Area Range (in channels)	: 9 - 4096
Identification Energy Tolerance	: 1.000FWHM
Energy Calibration Used Done On	: 2/24/2018
Efficiency Calibration Used Done On	: 11/9/2014
Efficiency Calibration Description	:
Sample Number	: 81211

PEAK ANALYSIS REPORT

Peak Analysis Performed on : 5/1/2019 3:31:32PM

Peak Analysis From Channel : 1

Peak Analysis To Channel : 4096

Peak No.	Energy (keV)	ROI start	ROI end	Peak Centroid	Net Peak Area	Net Area Uncertainty	Continuum Counts	FWHM (keV)

Analysis Report for 1904089-03

BC 22B

	Peak No.	Energy (keV)	ROI start	ROI end	Peak Centroid	Net Peak Area	Net Area Uncertainty	Continuum Counts	FWHM (keV)
	1	20.46	15 -	23	19.51	1.08E+02	52.57	3.66E+02	2.31
M	2	30.93	24 -	41	29.99	2.49E+03	106.91	2.02E+02	2.24
m	3	35.17	24 -	41	34.23	6.00E+02	77.71	1.58E+02	2.24
	4	53.12	46 -	57	52.19	5.34E+01	56.46	3.71E+02	1.95
M	5	61.82	57 -	69	60.90	2.18E+02	45.59	1.95E+02	2.31
m	6	65.76	57 -	69	64.85	1.18E+02	47.44	2.04E+02	2.32
	7	81.09	75 -	85	80.19	1.00E+03	79.14	2.99E+02	2.23
	8	112.50	106 -	117	111.63	2.24E+02	57.41	3.00E+02	2.09
	9	160.77	158 -	164	159.93	2.38E+01	29.77	1.44E+02	2.62
	10	275.97	271 -	280	275.23	4.97E+01	26.96	7.65E+01	2.00
M	11	303.13	298 -	314	302.41	1.72E+02	29.19	3.66E+01	2.62
m	12	310.72	298 -	314	310.00	1.68E+01	16.31	1.59E+01	2.31
M	13	333.82	328 -	341	333.12	5.07E+01	23.07	6.26E+01	2.73
m	14	338.15	328 -	341	337.45	2.49E+01	19.79	3.16E+01	2.45
	15	356.15	349 -	360	355.47	4.34E+02	45.56	4.32E+01	2.38
	16	365.63	361 -	370	364.96	1.79E+01	17.86	3.62E+01	1.32
	17	376.40	373 -	378	375.74	1.54E+01	8.77	3.24E+00	3.17
M	18	384.38	380 -	395	383.73	1.30E+02	32.56	8.00E+00	2.62
m	19	387.65	380 -	395	387.00	1.33E+02	33.47	7.00E+00	2.35
	20	417.14	409 -	425	416.52	5.54E+01	21.93	2.13E+01	5.08
	21	437.23	431 -	441	436.62	7.05E+01	22.07	2.69E+01	2.15
	22	446.27	442 -	449	445.67	1.20E+01	6.93	0.00E+00	1.67
M	23	468.73	463 -	476	468.15	2.21E+01	10.77	0.00E+00	3.18
m	24	473.08	463 -	476	472.50	7.45E+00	9.80	0.00E+00	2.89

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 2.000sigma

BACKGROUND SUBTRACT REPORT

Peak Analysis Performed on : 5/1/2019 3:31:32PM

Env. Background File : \\OR-GAMMA1\ApexRoot\Countroom\Data\0000080017.CNF

	Peak No.	Energy (keV)	Original Area	Orig. Area Uncertainty	Ambient Background	Backgr. Uncert.	Subtracted Area	Subtracted Uncert.
	1	20.46	1.08E+02	52.57			1.08E+02	5.26E+01
M	2	30.93	2.49E+03	106.91			2.49E+03	1.07E+02
m	3	35.17	6.00E+02	77.71			6.00E+02	7.77E+01
	4	53.12	5.34E+01	56.46			5.34E+01	5.65E+01
M	5	61.82	2.18E+02	45.59	1.28E+01	1.96E+00	2.05E+02	4.56E+01

Analysis Report for 1904089-03

BC 22B

	Peak No.	Energy (keV)	Original Area	Orig. Area Uncertainty	Ambient Background	Backgr. Uncert.	Subtracted Area	Subtracted Uncert.
m	6	65.76	1.18E+02	47.44			1.18E+02	4.74E+01
	7	81.09	1.00E+03	79.14			1.00E+03	7.91E+01
	8	112.50	2.24E+02	57.41			2.24E+02	5.74E+01
	9	160.77	2.38E+01	29.77			2.38E+01	2.98E+01
	10	275.97	4.97E+01	26.96			4.97E+01	2.70E+01
M	11	303.13	1.72E+02	29.19			1.72E+02	2.92E+01
m	12	310.72	1.68E+01	16.31			1.68E+01	1.63E+01
M	13	333.82	5.07E+01	23.07			5.07E+01	2.31E+01
m	14	338.15	2.49E+01	19.79			2.49E+01	1.98E+01
	15	356.15	4.34E+02	45.56			4.34E+02	4.56E+01
	16	365.63	1.79E+01	17.86			1.79E+01	1.79E+01
	17	376.40	1.54E+01	8.77			1.54E+01	8.77E+00
M	18	384.38	1.30E+02	32.56			1.30E+02	3.26E+01
m	19	387.65	1.33E+02	33.47			1.33E+02	3.35E+01
	20	417.14	5.54E+01	21.93			5.54E+01	2.19E+01
	21	437.23	7.05E+01	22.07			7.05E+01	2.21E+01
	22	446.27	1.20E+01	6.93			1.20E+01	6.93E+00
M	23	468.73	2.21E+01	10.77			2.21E+01	1.08E+01
m	24	473.08	7.45E+00	9.80			7.45E+00	9.80E+00

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 2.000sigma

NUCLIDE IDENTIFICATION REPORT

Nuclide Library Used : \\OR-GAMMA1\ApexRoot\Countroom\Library\WSRC.NLB

IDENTIFIED NUCLIDES

Nuclide Name	Id Confidence	Energy (keV)		Yield(%)	Activity (pCi/units)	Activity Uncertainty
I-125	0.99	35.49	*	6.49	5.32E+02	7.02E+01
BA-133	1.00	30.80	*	97.60	1.13E+02	5.29E+00
		302.84	*	17.80	8.47E+02	2.98E+02
		356.01	*	60.00	6.82E+02	1.14E+02
TH-234	0.95	63.29	*	3.80	8.73E+02	2.03E+02

Analysis Report for 1904089-03

BC 22B

* = Energy line found in the spectrum.
\- = Manually added nuclide.
? = Manually edited nuclide.
@ = Energy line not used for Weighted Mean Activity
Energy Tolerance : 2.000FWHM
Nuclide confidence index threshold = 0.30
Errors quoted at 2.000sigma

INTERFERENCE CORRECTED REPORT

	Nuclide Name	Nuclide Id Confidence	Wt mean Activity (pCi/units)	Wt mean Activity Uncertainty	Comments
	I-125	0.998	5.32E+02	7.02E+01	
X	I-129	0.852			
	BA-133	1.000	1.14E+02	5.28E+00	
	TH-234	0.959	8.73E+02	2.03E+02	
X	NP-237	0.565			

? = 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 2.000sigma

Analysis Report for 1904089-03

BC 22B

UNIDENTIFIED PEAKS

Peak Locate Performed on : 5/1/2019 3:31:32PM
Peak Locate From Channel : 1
Peak Locate To Channel : 4096

	Peak No.	Energy (keV)	Peak Size (CPS)	Peak CPS (%) Uncertainty	Peak Type	Tolerance Nuclide
	1	20.46	1.20164E-01	24.31	Tol.	MO-93 PA-234M
	4	53.12	5.93259E-02	52.87		
m	6	65.76	1.30890E-01	20.13	Sum	
	7	81.09	1.11160E+00	3.96		
	8	112.50	2.48889E-01	12.81	Tol.	U-237
	9	160.77	2.64525E-02	62.52		
	10	275.97	5.52588E-02	27.11		
m	12	310.72	1.86787E-02	48.51		
M	13	333.82	5.62852E-02	22.77	Sum	
m	14	338.15	2.76983E-02	39.69	Sum	
	16	365.63	1.99074E-02	49.84	Sum	
	17	376.40	1.70915E-02	28.52		
M	18	384.38	1.44947E-01	12.48		
m	19	387.65	1.48103E-01	12.56	Sum	
	20	417.14	6.15152E-02	19.80	Sum	
	21	437.23	7.83862E-02	15.64		
	22	446.27	1.33333E-02	28.87		
M	23	468.73	2.45999E-02	24.32		
m	24	473.08	8.27987E-03	65.74		

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 2.000sigma

NUCLIDE MDA REPORT

Nuclide Library Used : \\OR-GAMMA1\ApexRoot\Countroom\Library\WSRC.NLB

Analysis Report for 1904089-03

BC 22B

	Nuclide Name	Energy (keV)		Yield(%)	Line MDA (pCi/units)	Nuclide MDA (pCi/units)	Activity (pCi/units)	Dec. Level (pCi/units)
	FE-55	5.89		24.50	5.43E-03	5.43E-03	0.00E+00	0.00E+00
	CO-57	122.06		85.51	2.07E+01	2.07E+01	-3.84E+00	9.72E+00
		136.48		10.60	2.05E+02		6.77E+01	9.67E+01
	NI-59	6.92		29.80	3.34E-02	3.34E-02	-5.84E-02	1.29E-02
	MO-93	16.59		52.90	1.34E+00	1.34E+00	-4.36E-02	6.42E-01
		18.60		10.00	1.06E+01		1.71E+01	5.12E+00
	NB-93M	16.57		9.43	7.47E+00	7.47E+00	-2.44E-01	3.59E+00
	CD-109	88.03		3.72	3.53E+02	3.53E+02	-1.63E+02	1.67E+02
	SN-113	255.12		1.93	1.16E+03	8.83E+01	-3.51E+02	5.26E+02
		391.69		61.90	8.83E+01		6.27E+01	4.20E+01
	SN-119M	23.87		16.10	1.12E+01	8.47E+00	-3.57E+01	5.37E+00
		25.10		22.70	8.47E+00		-1.68E+02	4.07E+00
+	I-125	35.49	*	6.49	1.05E+02	1.05E+02	5.32E+02	5.12E+01
	I-129	29.78	*	57.00	9.23E+00	9.23E+00	1.93E+02	4.51E+00
		33.60	*	13.20	5.16E+01		2.62E+02	2.52E+01
		39.58		7.52	5.16E+01		-3.83E+02	2.45E+01
+	BA-133	30.80	*	97.60	5.39E+00	5.39E+00	1.13E+02	2.63E+00
		302.84	*	17.80	2.20E+02		8.47E+02	1.03E+02
		356.01	*	60.00	5.17E+01		6.82E+02	2.37E+01
	CE-139	165.85		80.35	3.20E+01	3.20E+01	1.51E+01	1.50E+01
	CE-144	133.54		10.80	1.88E+02	1.88E+02	-3.13E+01	8.84E+01
	HG-203	279.19		77.30	4.49E+01	4.49E+01	2.14E+01	2.10E+01
	PB-210	46.50		4.25	1.09E+02	1.09E+02	-2.61E+00	5.15E+01
	PA-231	9.28		42.00	1.80E-01	1.80E-01	9.65E-02	8.34E-02
		10.11		20.20	5.58E-01		3.37E-01	2.61E-01
		283.67		1.60	1.58E+03		1.12E+02	7.18E+02
		302.67		2.30	2.47E+03		4.98E+03	1.19E+03
	TH-231	25.64		14.70	1.58E+01	1.58E+01	-4.64E+02	7.65E+00
		84.21		6.40	5.65E+02		2.84E+03	2.77E+02
	PA-234M	9.89		89.00	1.19E-01	1.19E-01	7.18E-02	5.56E-02
		21.72		64.90	2.37E+00		1.70E+00	1.14E+00
		37.93		23.75	3.14E+01		1.06E+02	1.53E+01
		131.42		20.40	1.00E+02		4.67E+01	4.71E+01
+	TH-234	63.29	*	3.80	3.85E+02	3.85E+02	8.73E+02	1.87E+02
	NP-237	29.37	*	14.00	3.76E+01	3.76E+01	7.86E+02	1.84E+01
		86.50		12.60	1.05E+02		-3.04E+01	4.98E+01
	U-237	97.08		16.30	8.83E+01	6.53E+01	-1.16E+02	4.15E+01
		101.07		26.30	6.53E+01		3.68E+01	3.09E+01
		114.00		12.30	2.59E+02		6.27E+02	1.25E+02
		208.01		22.00	1.33E+02		-1.41E+01	6.21E+01
	AM-241	59.54		35.90	3.69E+01	3.69E+01	5.83E+01	1.79E+01
	AM-243	74.67		66.00	1.79E+01	1.79E+01	1.86E+00	8.48E+00

\+ = 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

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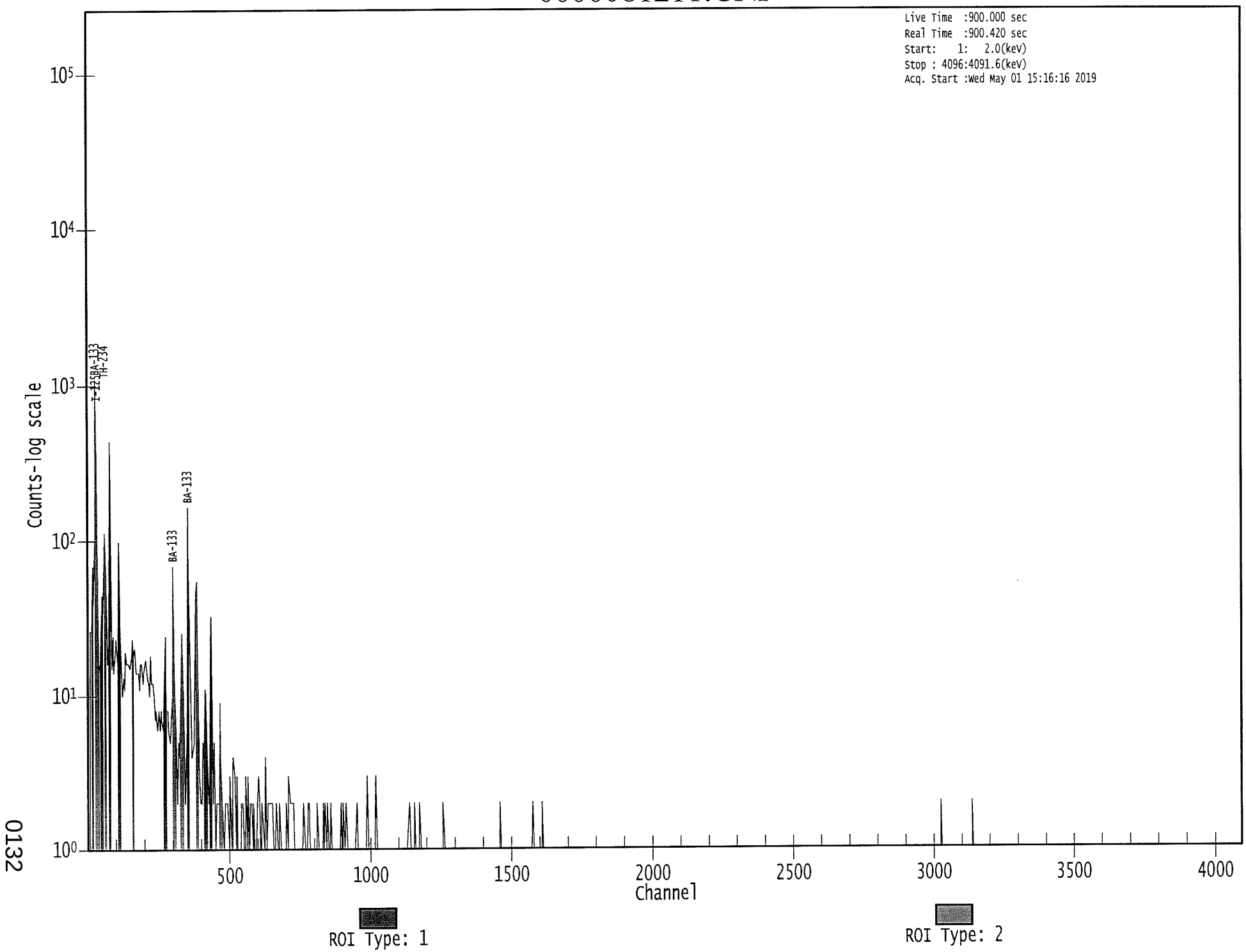

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KB 5/1/19

Apex-Gamma

Analysis Report for 1904089-04

BC 22B

GAMMA SPECTRUM ANALYSIS

Sample Identification	: 1904089-04
Sample Description	: BC 22B
Sample Type	: RA RECOVERY
Sample Size	: 1.000E+00 units
Facility	: Countroom
Sample Taken On	: 5/1/2019 3:11:40PM
Acquisition Started	: 5/1/2019 3:37:19PM
Procedure	: BAFIL
Operator	: Administrator
Detector Name	: GE4
Geometry	: BAFIL
Live Time	: 900.0 seconds
Real Time	: 900.4 seconds
Dead Time	: 0.04 %
Peak Locate Threshold	: 2.50
Peak Locate Range (in channels)	: 1 - 4096
Peak Area Range (in channels)	: 9 - 4096
Identification Energy Tolerance	: 1.000FWHM
Energy Calibration Used Done On	: 2/24/2018
Efficiency Calibration Used Done On	: 11/9/2014
Efficiency Calibration Description	:
Sample Number	: 81212

PEAK ANALYSIS REPORT

Peak Analysis Performed on : 5/1/2019 3:52:22PM

Peak Analysis From Channel : 1

Peak Analysis To Channel : 4096

Peak No.	Energy (keV)	ROI start	ROI end	Peak Centroid	Net Peak Area	Net Area Uncertainty	Continuum Counts	FWHM (keV)

Analysis Report for 1904089-04

BC 22B

	Peak No.	Energy (keV)	ROI start	ROI end	Peak Centroid	Net Peak Area	Net Area Uncertainty	Continuum Counts	FWHM (keV)
	1	20.71	16 -	23	19.76	8.27E+01	49.19	3.49E+02	1.99
M	2	30.93	24 -	42	29.99	2.36E+03	101.82	1.94E+02	2.14
m	3	35.35	24 -	42	34.41	6.08E+02	77.30	1.35E+02	2.43
	4	53.06	49 -	55	52.14	6.36E+01	34.94	1.77E+02	1.28
M	5	61.78	57 -	68	60.87	2.14E+02	44.66	1.84E+02	2.31
m	6	65.70	57 -	68	64.79	6.54E+01	44.53	2.33E+02	2.32
	7	81.02	74 -	86	80.12	9.52E+02	78.99	2.85E+02	2.22
M	8	111.88	104 -	122	111.00	1.53E+02	36.11	9.97E+01	2.61
m	9	115.99	104 -	122	115.11	5.83E+01	34.58	8.40E+01	2.62
	10	161.60	156 -	168	160.76	7.96E+01	41.38	1.69E+02	2.62
	11	276.89	272 -	280	276.15	4.43E+01	24.73	6.55E+01	1.87
	12	303.00	297 -	307	302.28	1.38E+02	38.73	1.26E+02	1.85
	13	334.50	329 -	341	333.80	6.32E+01	24.28	4.15E+01	2.95
	14	356.10	351 -	359	355.42	4.42E+02	44.06	2.65E+01	2.11
	15	377.40	374 -	379	376.74	1.30E+01	9.06	6.00E+00	2.84
	16	385.59	380 -	389	384.93	1.86E+02	36.57	8.32E+01	5.09
	17	436.85	433 -	440	436.24	5.83E+01	16.85	9.37E+00	2.33
	18	466.94	462 -	470	466.36	1.69E+01	9.81	4.21E+00	5.71
	19	509.48	503 -	513	508.93	2.75E+01	12.26	5.00E+00	4.05
	20	962.92	959 -	965	962.80	5.00E+00	4.47	0.00E+00	2.40

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 2.000sigma

BACKGROUND SUBTRACT REPORT

Peak Analysis Performed on : 5/1/2019 3:52:22PM

Env. Background File : \\OR-GAMMA1\ApexRoot\Countroom\Data\0000080017.CNF

	Peak No.	Energy (keV)	Original Area	Orig. Area Uncertainty	Ambient Background	Backgr. Uncert.	Subtracted Area	Subtracted Uncert.
	1	20.71	8.27E+01	49.19			8.27E+01	4.92E+01
M	2	30.93	2.36E+03	101.82			2.36E+03	1.02E+02
m	3	35.35	6.08E+02	77.30			6.08E+02	7.73E+01
	4	53.06	6.36E+01	34.94			6.36E+01	3.49E+01
M	5	61.78	2.14E+02	44.66	1.28E+01	1.96E+00	2.01E+02	4.47E+01
m	6	65.70	6.54E+01	44.53			6.54E+01	4.45E+01
	7	81.02	9.52E+02	78.99			9.52E+02	7.90E+01
M	8	111.88	1.53E+02	36.11			1.53E+02	3.61E+01
m	9	115.99	5.83E+01	34.58			5.83E+01	3.46E+01

Analysis Report for 1904089-04

BC 22B

Peak No.	Energy (keV)	Original Area	Orig. Area Uncertainty	Ambient Background	Backgr. Uncert.	Subtracted Area	Subtracted Uncert.
10	161.60	7.96E+01	41.38			7.96E+01	4.14E+01
11	276.89	4.43E+01	24.73			4.43E+01	2.47E+01
12	303.00	1.38E+02	38.73			1.38E+02	3.87E+01
13	334.50	6.32E+01	24.28			6.32E+01	2.43E+01
14	356.10	4.42E+02	44.06			4.42E+02	4.41E+01
15	377.40	1.30E+01	9.06	0.00E+00	0.00E+00	1.30E+01	9.06E+00
16	385.59	1.86E+02	36.57			1.86E+02	3.66E+01
17	436.85	5.83E+01	16.85			5.83E+01	1.69E+01
18	466.94	1.69E+01	9.81			1.69E+01	9.81E+00
19	509.48	2.75E+01	12.26	1.18E+01	1.36E+00	1.57E+01	1.23E+01
20	962.92	5.00E+00	4.47			5.00E+00	4.47E+00

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 2.000sigma

NUCLIDE IDENTIFICATION REPORT

Nuclide Library Used : \\OR-GAMMA1\ApexRoot\Countroom\Library\WSRC.NLB

IDENTIFIED NUCLIDES

Nuclide Name	Id Confidence	Energy (keV)		Yield(%)	Activity (pCi/units)	Activity Uncertainty
I-125	1.00	35.49	*	6.49	5.45E+02	7.06E+01
BA-133	1.00	30.80	*	97.60	1.07E+02	5.03E+00
		302.84	*	17.80	6.79E+02	2.83E+02
		356.01	*	60.00	6.93E+02	1.14E+02
TH-234	0.95	63.29	*	3.80	8.55E+02	1.99E+02

* = Energy line found in the spectrum.
\- = Manually added nuclide.
? = Manually edited nuclide.
@ = Energy line not used for Weighted Mean Activity
Energy Tolerance : 2.000FWHM
Nuclide confidence index threshold = 0.30
Errors quoted at 2.000sigma

Analysis Report for 1904089-04

BC 22B

INTERFERENCE CORRECTED REPORT

	Nuclide Name	Nuclide Id Confidence	Wt mean Activity (pCi/units)	Wt mean Activity Uncertainty	Comments
	I-125	1.000	5.45E+02	7.06E+01	
X	I-129	0.851			
	BA-133	1.000	1.08E+02	5.02E+00	
	TH-234	0.957	8.55E+02	1.99E+02	
X	NP-237	0.565			

? = 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 2.000sigma

Analysis Report for 1904089-04

BC 22B

UNIDENTIFIED PEAKS

Peak Locate Performed on : 5/1/2019 3:52:22PM
Peak Locate From Channel : 1
Peak Locate To Channel : 4096

	Peak No.	Energy (keV)	Peak Size (CPS)	Peak CPS (%) Uncertainty	Peak Type	Tolerance Nuclide
	1	20.71	9.19347E-02	29.73	Tol.	PA-234M
	4	53.06	7.06360E-02	27.48		
m	6	65.70	7.26345E-02	34.06	Sum	
	7	81.02	1.05823E+00	4.15		
M	8	111.88	1.69474E-01	11.84		
m	9	115.99	6.47750E-02	29.66	Tol.	U-237
	10	161.60	8.84384E-02	25.99		
	11	276.89	4.91703E-02	27.95		
	13	334.50	7.02513E-02	19.20	Sum	
	15	377.40	1.44444E-02	34.83		
	16	385.59	2.07098E-01	9.81	Sum	
	17	436.85	6.47972E-02	14.45		
	18	466.94	1.87719E-02	29.03		
	19	509.48	1.73992E-02	39.38		
	20	962.92	5.55556E-03	44.72		

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 2.000sigma

NUCLIDE MDA REPORT

Nuclide Library Used : \\OR-GAMMA1\ApexRoot\Countroom\Library\WSRC.NLB

Nuclide Name	Energy (keV)	Yield(%)	Line MDA (pCi/units)	Nuclide MDA (pCi/units)	Activity (pCi/units)	Dec. Level (pCi/units)

Analysis Report for 1904089-04

BC 22B

	Nuclide Name	Energy (keV)		Yield(%)	Line MDA (pCi/units)	Nuclide MDA (pCi/units)	Activity (pCi/units)	Dec. Level (pCi/units)
	FE-55	5.89		24.50	5.43E-03	5.43E-03	0.00E+00	0.00E+00
	CO-57	122.06		85.51	1.91E+01	1.91E+01	-6.68E-01	8.89E+00
		136.48		10.60	1.93E+02		-5.11E+01	9.05E+01
	NI-59	6.92		29.80	4.18E-02	4.18E-02	-5.29E-02	1.71E-02
	MO-93	16.59		52.90	1.28E+00	1.28E+00	-4.62E-02	6.16E-01
		18.60		10.00	1.04E+01		1.47E+01	5.00E+00
	NB-93M	16.57		9.43	7.18E+00	7.18E+00	-2.58E-01	3.45E+00
	CD-109	88.03		3.72	3.18E+02	3.18E+02	-1.34E+02	1.49E+02
	SN-113	255.12		1.93	1.33E+03	7.85E+01	5.95E+02	6.07E+02
		391.69		61.90	7.85E+01		3.99E+01	3.71E+01
	SN-119M	23.87		16.10	1.09E+01	8.12E+00	-3.89E+01	5.26E+00
		25.10		22.70	8.12E+00		-1.63E+02	3.90E+00
+	I-125	35.49	*	6.49	1.14E+02	1.14E+02	5.45E+02	5.56E+01
	I-129	29.78	*	57.00	9.90E+00	9.90E+00	1.83E+02	4.85E+00
		33.60	*	13.20	5.58E+01		2.68E+02	2.73E+01
		39.58		7.52	5.53E+01		-2.14E+02	2.64E+01
+	BA-133	30.80	*	97.60	5.78E+00	5.78E+00	1.07E+02	2.83E+00
		302.84	*	17.80	2.63E+02		6.79E+02	1.25E+02
		356.01	*	60.00	3.83E+01		6.93E+02	1.70E+01
	CE-139	165.85		80.35	3.05E+01	3.05E+01	-1.70E+01	1.43E+01
	CE-144	133.54		10.80	1.93E+02	1.93E+02	9.03E+00	9.06E+01
	HG-203	279.19		77.30	4.52E+01	4.52E+01	4.94E+01	2.11E+01
	PB-210	46.50		4.25	1.01E+02	1.01E+02	-2.94E+01	4.74E+01
	PA-231	9.28		42.00	1.88E-01	1.88E-01	9.13E-02	8.72E-02
		10.11		20.20	5.92E-01		4.36E-01	2.78E-01
		283.67		1.60	1.40E+03		8.47E+01	6.28E+02
		302.67		2.30	2.44E+03		4.83E+03	1.17E+03
	TH-231	25.64		14.70	1.58E+01	1.58E+01	-4.21E+02	7.62E+00
		84.21		6.40	5.47E+02		2.64E+03	2.68E+02
	PA-234M	9.89		89.00	1.26E-01	1.26E-01	9.27E-02	5.92E-02
		21.72		64.90	2.29E+00		2.13E+00	1.10E+00
		37.93		23.75	3.17E+01		1.15E+02	1.55E+01
		131.42		20.40	1.00E+02		2.49E+01	4.71E+01
+	TH-234	63.29	*	3.80	3.62E+02	3.62E+02	8.55E+02	1.75E+02
	NP-237	29.37	*	14.00	4.03E+01	4.03E+01	7.44E+02	1.97E+01
		86.50		12.60	9.55E+01		-1.05E+01	4.49E+01
	U-237	97.08		16.30	8.74E+01	5.41E+01	-1.12E+01	4.11E+01
		101.07		26.30	5.41E+01		8.33E+00	2.54E+01
		114.00		12.30	2.29E+02		4.88E+02	1.10E+02
		208.01		22.00	1.45E+02		4.83E+01	6.83E+01
	AM-241	59.54		35.90	3.55E+01	3.55E+01	5.67E+01	1.72E+01
	AM-243	74.67		66.00	1.66E+01	1.66E+01	1.10E+00	7.87E+00

\+ = 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

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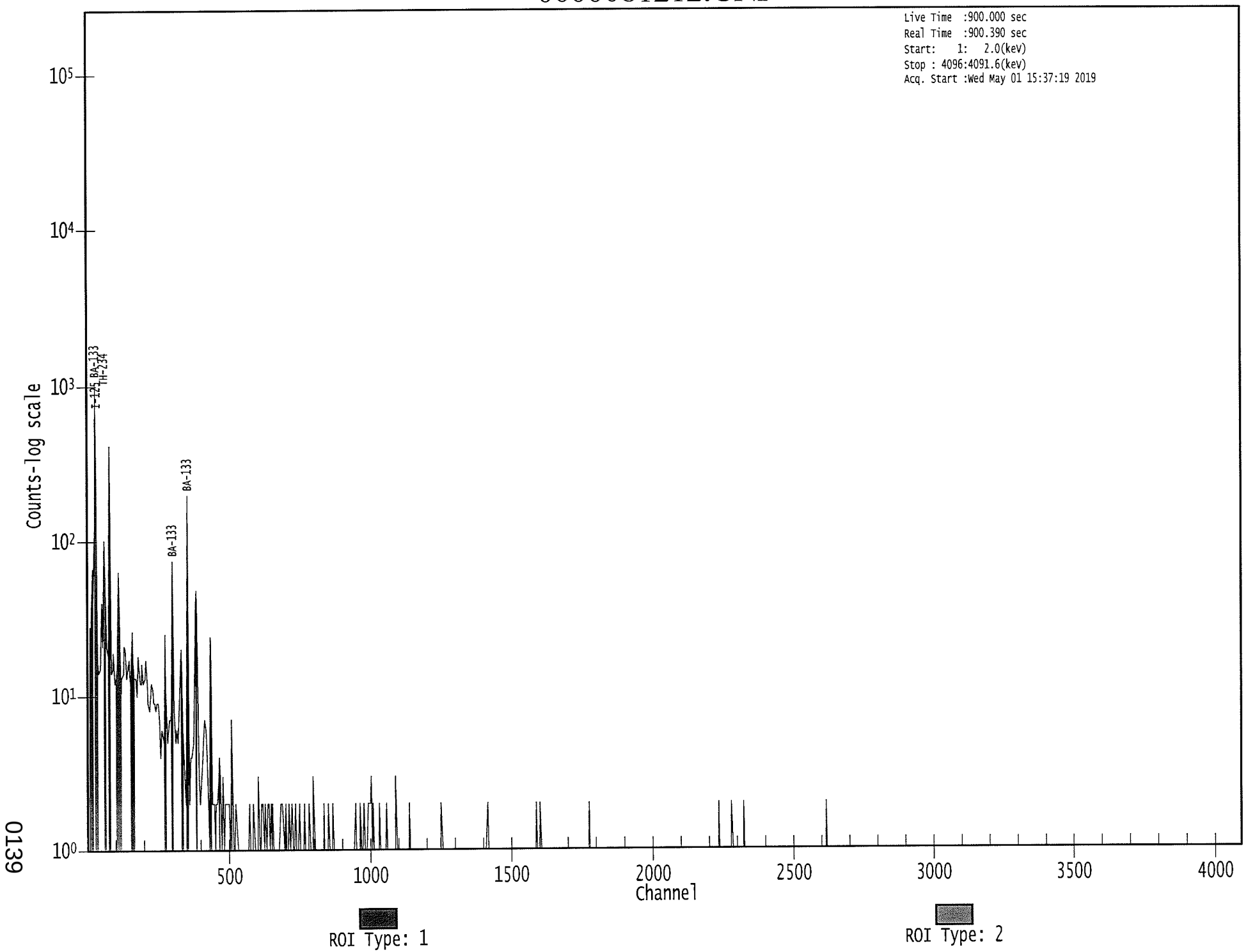

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Analysis Report for 1904089-05

BC 9

GAMMA SPECTRUM ANALYSIS

Sample Identification	: 1904089-05
Sample Description	: BC 9
Sample Type	: RA RECOVERY
Sample Size	: 1.000E+00 units
Facility	: Countroom
Sample Taken On	: 5/1/2019 3:11:51PM
Acquisition Started	: 5/1/2019 3:37:27PM
Procedure	: BAFIL
Operator	: Administrator
Detector Name	: GE1
Geometry	: BAFIL
Live Time	: 900.0 seconds
Real Time	: 900.3 seconds
Dead Time	: 0.04 %
Peak Locate Threshold	: 2.50
Peak Locate Range (in channels)	: 1 - 4096
Peak Area Range (in channels)	: 19 - 4096
Identification Energy Tolerance	: 1.000FWHM
Energy Calibration Used Done On	: 6/16/2018
Efficiency Calibration Used Done On	: 2/17/2018
Efficiency Calibration Description	:
Sample Number	: 81213

PEAK ANALYSIS REPORT

Peak Analysis Performed on : 5/1/2019 3:52:37PM

Peak Analysis From Channel : 1

Peak Analysis To Channel : 4096

Peak No.	Energy (keV)	ROI start	ROI end	Peak Centroid	Net Peak Area	Net Area Uncertainty	Continuum Counts	FWHM (keV)

Analysis Report for 1904089-05

BC 9

	Peak No.	Energy (keV)	ROI start	ROI end	Peak Centroid	Net Peak Area	Net Area Uncertainty	Continuum Counts	FWHM (keV)
M	1	30.85	26 -	40	31.23	2.37E+03	123.03	7.16E+02	3.38
m	2	35.40	26 -	40	35.77	4.78E+02	95.87	5.32E+02	2.74
M	3	61.44	57 -	71	61.81	2.92E+02	62.42	3.26E+02	3.31
m	4	65.86	57 -	71	66.23	1.24E+02	63.56	3.59E+02	3.28
	5	81.09	76 -	87	81.45	8.93E+02	84.43	4.47E+02	3.24
M	6	111.92	107 -	122	112.28	2.14E+02	50.77	2.48E+02	2.97
m	7	115.90	107 -	122	116.26	6.27E+01	49.25	2.24E+02	3.11
M	8	275.23	272 -	281	275.54	2.65E+01	26.95	9.50E+01	2.27
m	9	277.85	272 -	281	278.17	3.38E+01	27.02	7.26E+01	2.27
	10	303.21	298 -	309	303.52	1.91E+02	46.48	1.75E+02	2.61
M	11	334.48	328 -	347	334.78	6.04E+01	26.00	3.43E+01	2.55
m	12	338.12	328 -	347	338.42	3.05E+01	23.15	2.44E+01	2.55
	13	356.06	350 -	365	356.36	5.98E+02	71.69	2.86E+02	3.33
M	14	385.81	379 -	397	386.10	3.54E+02	49.17	7.37E+01	4.59
m	15	390.75	379 -	397	391.04	6.64E+01	38.14	2.74E+01	3.06
	16	418.05	410 -	430	418.33	6.73E+01	41.09	1.03E+02	7.92
	17	437.22	431 -	443	437.50	1.23E+02	28.66	3.90E+01	3.41
	18	469.27	464 -	477	469.55	3.10E+01	19.39	2.80E+01	4.67
	19	969.58	966 -	972	969.75	8.00E+00	5.66	0.00E+00	3.70
	20	1002.45	999 -	1005	1002.62	5.36E+00	6.34	3.29E+00	1.24
	21	1459.16	1456 -	1461	1459.26	4.42E+00	5.74	3.17E+00	1.88

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 2.000sigma

BACKGROUND SUBTRACT REPORT

Peak Analysis Performed on : 5/1/2019 3:52:37PM

Env. Background File : \\OR-GAMMA1\ApexRoot\Countroom\Data\0000080014.CNF

	Peak No.	Energy (keV)	Original Area	Orig. Area Uncertainty	Ambient Background	Backgr. Uncert.	Subtracted Area	Subtracted Uncert.
M	1	30.85	2.37E+03	123.03			2.37E+03	1.23E+02
m	2	35.40	4.78E+02	95.87			4.78E+02	9.59E+01
M	3	61.44	2.92E+02	62.42			2.92E+02	6.24E+01
m	4	65.86	1.24E+02	63.56			1.24E+02	6.36E+01
	5	81.09	8.93E+02	84.43			8.93E+02	8.44E+01
M	6	111.92	2.14E+02	50.77			2.14E+02	5.08E+01
m	7	115.90	6.27E+01	49.25			6.27E+01	4.92E+01
M	8	275.23	2.65E+01	26.95			2.65E+01	2.69E+01

Analysis Report for 1904089-05

BC 9

	Peak No.	Energy (keV)	Original Area	Orig. Area Uncertainty	Ambient Background	Backgr. Uncert.	Subtracted Area	Subtracted Uncert.
m	9	277.85	3.38E+01	27.02			3.38E+01	2.70E+01
	10	303.21	1.91E+02	46.48			1.91E+02	4.65E+01
M	11	334.48	6.04E+01	26.00			6.04E+01	2.60E+01
m	12	338.12	3.05E+01	23.15			3.05E+01	2.32E+01
	13	356.06	5.98E+02	71.69			5.98E+02	7.17E+01
M	14	385.81	3.54E+02	49.17			3.54E+02	4.92E+01
m	15	390.75	6.64E+01	38.14			6.64E+01	3.81E+01
	16	418.05	6.73E+01	41.09			6.73E+01	4.11E+01
	17	437.22	1.23E+02	28.66			1.23E+02	2.87E+01
	18	469.27	3.10E+01	19.39			3.10E+01	1.94E+01
	19	969.58	8.00E+00	5.66			8.00E+00	5.66E+00
	20	1002.45	5.36E+00	6.34			5.36E+00	6.34E+00
	21	1459.16	4.42E+00	5.74			4.42E+00	5.74E+00

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 2.000sigma

NUCLIDE IDENTIFICATION REPORT

Nuclide Library Used : \\OR-GAMMA1\ApexRoot\Countroom\Library\WSRC.NLB

IDENTIFIED NUCLIDES

Nuclide Name	Id Confidence	Energy (keV)		Yield(%)	Activity (pCi/units)	Activity Uncertainty
SN-113	0.94	255.12		1.93		
		391.69	*	61.90	3.97E+01	2.30E+01
I-125	1.00	35.49	*	6.49	4.85E+00	9.73E-01
BA-133	1.00	30.80	*	97.60	4.48E-01	2.32E-02
		302.84	*	17.80	8.45E+02	4.22E+02
		356.01	*	60.00	5.05E+02	8.19E+01
HG-203	0.94	279.19	*	77.30	4.12E+01	3.94E+01
PA-231	1.00	9.28		42.00		
		10.11		20.20		
		283.67		1.60		
		302.67	*	2.30	6.54E+03	3.27E+03

Analysis Report for 1904089-05

BC 9

* = Energy line found in the spectrum.
\- = Manually added nuclide.
? = Manually edited nuclide.
@ = Energy line not used for Weighted Mean Activity
Energy Tolerance : 2.000FWHM
Nuclide confidence index threshold = 0.30
Errors quoted at 2.000sigma

INTERFERENCE CORRECTED REPORT

	Nuclide Name	Nuclide Id Confidence	Wt mean Activity (pCi/units)	Wt mean Activity Uncertainty	Comments
	SN-113	0.946	3.97E+01	2.30E+01	
	I-125	1.000	4.85E+00	9.73E-01	
X	I-129	0.746			
	BA-133	1.000	4.48E-01	2.32E-02	
	HG-203	0.948	4.12E+01	3.94E+01	
	PA-231	1.000	6.53E+03	3.27E+03	

? = 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 2.000sigma

Analysis Report for 1904089-05

BC 9

UNIDENTIFIED PEAKS

Peak Locate Performed on : 5/1/2019 3:52:37PM
Peak Locate From Channel : 1
Peak Locate To Channel : 4096

	Peak No.	Energy (keV)	Peak Size (CPS)	Peak CPS (%) Uncertainty	Peak Type	Tolerance Nuclide
M	3	61.44	3.24363E-01	10.69	Sum	
m	4	65.86	1.38081E-01	25.57	Sum	
	5	81.09	9.91673E-01	4.73		
M	6	111.92	2.37516E-01	11.87		
m	7	115.90	6.96159E-02	39.30	Tol.	U-237
M	8	275.23	2.94655E-02	50.81		
M	11	334.48	6.70946E-02	21.53	Sum	
m	12	338.12	3.38412E-02	38.01	Sum	
M	14	385.81	3.93452E-01	6.94	Sum	
	16	418.05	7.47432E-02	30.54		
	17	437.22	1.36111E-01	11.70		
	18	469.27	3.44444E-02	31.28		
	19	969.58	8.88889E-03	35.36		
	20	1002.45	5.95238E-03	59.21		
	21	1459.16	4.90741E-03	65.03		

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 2.000sigma

NUCLIDE MDA REPORT

Nuclide Library Used : \\OR-GAMMA1\ApexRoot\Countroom\Library\WSRC.NLB

Nuclide Name	Energy (keV)	Yield(%)	Line MDA (pCi/units)	Nuclide MDA (pCi/units)	Activity (pCi/units)	Dec. Level (pCi/units)

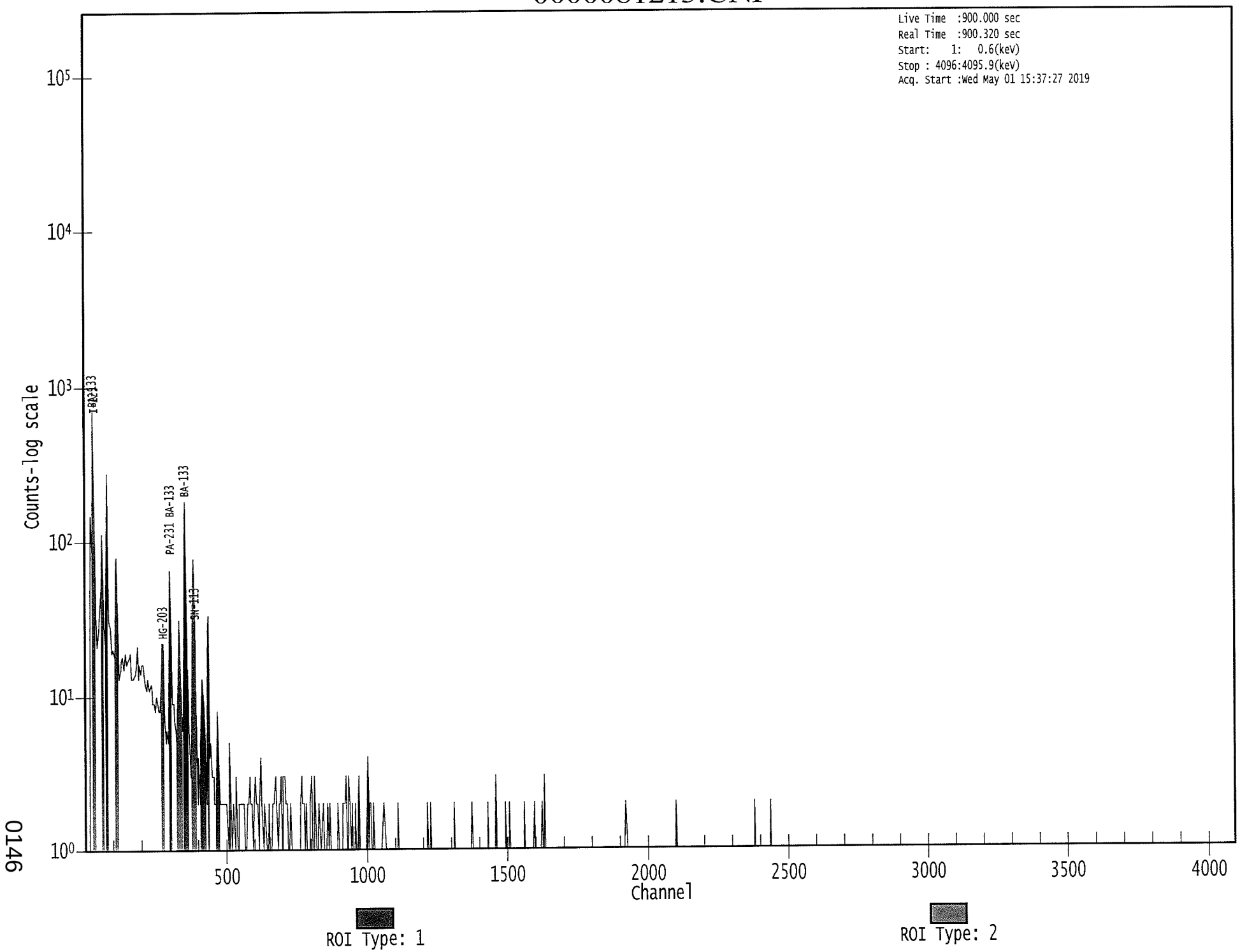
Analysis Report for 1904089-05

BC 9

	Nuclide Name	Energy (keV)		Yield(%)	Line MDA (pCi/units)	Nuclide MDA (pCi/units)	Activity (pCi/units)	Dec. Level (pCi/units)
	FE-55	5.89		24.50	1.90E-13	1.90E-13	0.00E+00	0.00E+00
	CO-57	122.06		85.51	3.08E+01	3.08E+01	-5.23E+00	1.42E+01
		136.48		10.60	3.41E+02		-1.53E+02	1.58E+02
	NI-59	6.92		29.80	2.77E-12	2.77E-12	0.00E+00	0.00E+00
	MO-93	16.59		52.90	9.04E-06	9.04E-06	-3.58E-06	4.08E-06
		18.60		10.00	3.84E-04		6.22E-05	1.82E-04
	NB-93M	16.57		9.43	4.99E-05	4.99E-05	-1.98E-05	2.25E-05
	CD-109	88.03		3.72	3.60E+02	3.60E+02	7.41E+01	1.71E+02
+	SN-113	255.12		1.93	1.82E+03	3.20E+01	-7.59E+02	8.36E+02
		391.69	*	61.90	3.20E+01		3.97E+01	1.52E+01
	SN-119M	23.87		16.10	7.01E-03	7.01E-03	1.08E-02	3.40E-03
		25.10		22.70	8.38E-03		1.11E-02	4.05E-03
+	I-125	35.49	*	6.49	1.61E+00	1.61E+00	4.85E+00	7.92E-01
	I-129	29.78	*	57.00	5.23E-02	5.23E-02	7.67E-01	2.57E-02
		33.60		13.20	5.74E-01		4.67E-01	2.83E-01
		39.58		7.52	1.51E+00		3.26E-01	7.23E-01
+	BA-133	30.80	*	97.60	3.06E-02	3.06E-02	4.48E-01	1.50E-02
		302.84	*	17.80	2.83E+02		8.45E+02	1.36E+02
		356.01	*	60.00	7.51E+01		5.05E+02	3.64E+01
	CE-139	165.85		80.35	5.85E+01	5.85E+01	-1.09E+01	2.72E+01
	CE-144	133.54		10.80	3.48E+02	3.48E+02	2.21E+01	1.63E+02
+	HG-203	279.19	*	77.30	5.89E+01	5.89E+01	4.12E+01	2.78E+01
	PB-210	46.50		4.25	6.03E+00	6.03E+00	-7.21E+00	2.82E+00
+	PA-231	9.28		42.00	2.61E-10	2.61E-10	0.00E+00	0.00E+00
		10.11		20.20	2.08E-09		0.00E+00	0.00E+00
		283.67		1.60	1.60E+03		-2.19E+02	7.21E+02
		302.67	*	2.30	2.19E+03		6.54E+03	1.05E+03
	TH-231	25.64		14.70	1.45E-02	1.45E-02	-9.15E-03	6.99E-03
		84.21		6.40	2.72E+02		-1.35E+02	1.32E+02
	PA-234M	9.89		89.00	3.36E-10	3.36E-10	0.00E+00	0.00E+00
		21.72		64.90	6.15E-04		1.07E-03	2.98E-04
		37.93		23.75	5.16E-01		6.70E-01	2.51E-01
		131.42		20.40	1.86E+02		4.72E+01	8.74E+01
	TH-234	63.29		3.80	1.16E+02	1.16E+02	1.35E+02	5.63E+01
	NP-237	29.37		14.00	1.77E-01	1.77E-01	1.03E+00	8.72E-02
		86.50		12.60	1.02E+02		1.11E+01	4.85E+01
	U-237	97.08		16.30	1.03E+02	6.70E+01	-3.96E+01	4.86E+01
		101.07		26.30	6.70E+01		-1.31E+01	3.13E+01
		114.00		12.30	3.86E+02		4.50E+02	1.86E+02
		208.01		22.00	2.42E+02		9.43E+01	1.13E+02
	AM-241	59.54		35.90	7.54E+00	7.54E+00	8.55E+00	3.64E+00
	AM-243	74.67		66.00	8.97E+00	8.97E+00	-4.61E-01	4.24E+00

\+ = 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

0000081213.CNF



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VB 5/1/19

Apex-Gamma

Analysis Report for 1904089-06

BC 10

GAMMA SPECTRUM ANALYSIS

Sample Identification	: 1904089-06
Sample Description	: BC 10
Sample Type	: RA RECOVERY
Sample Size	: 1.000E+00 units
Facility	: Countroom
Sample Taken On	: 5/1/2019 3:12:02PM
Acquisition Started	: 5/1/2019 3:37:33PM
Procedure	: BAFIL
Operator	: Administrator
Detector Name	: GE3
Geometry	: BAFIL
Live Time	: 900.0 seconds
Real Time	: 902.2 seconds
Dead Time	: 0.24 %
Peak Locate Threshold	: 2.50
Peak Locate Range (in channels)	: 1 - 4096
Peak Area Range (in channels)	: 9 - 4096
Identification Energy Tolerance	: 1.000FWHM
Energy Calibration Used Done On	: 7/21/2018
Efficiency Calibration Used Done On	: 7/21/2018
Efficiency Calibration Description	:
Sample Number	: 81214

PEAK ANALYSIS REPORT

Peak Analysis Performed on : 5/1/2019 3:52:49PM

Peak Analysis From Channel : 1

Peak Analysis To Channel : 4096

Peak No.	Energy (keV)	ROI start	ROI end	Peak Centroid	Net Peak Area	Net Area Uncertainty	Continuum Counts	FWHM (keV)

Analysis Report for 1904089-06

BC 10

	Peak No.	Energy (keV)	ROI start	ROI end	Peak Centroid	Net Peak Area	Net Area Uncertainty	Continuum Counts	FWHM (keV)
	1	20.77	18 -	25	21.14	8.62E+01	50.24	3.70E+02	2.20
M	2	31.01	27 -	40	31.38	2.23E+03	102.34	2.84E+02	1.87
m	3	35.27	27 -	40	35.64	5.43E+02	63.32	2.30E+02	1.88
	4	52.77	48 -	58	53.13	1.16E+02	51.71	2.88E+02	2.32
M	5	61.74	58 -	72	62.09	2.81E+02	45.46	1.88E+02	2.12
m	6	66.18	58 -	72	66.52	1.40E+02	48.66	2.54E+02	2.56
	7	81.19	77 -	87	81.53	9.41E+02	74.87	2.41E+02	2.14
M	8	111.94	108 -	120	112.27	2.36E+02	44.65	1.98E+02	2.31
m	9	116.23	108 -	120	116.55	4.42E+01	42.38	1.82E+02	2.57
	10	222.06	215 -	228	222.34	5.05E+01	40.63	1.61E+02	3.52
	11	276.25	272 -	280	276.51	8.60E+01	26.36	5.40E+01	2.19
M	12	302.94	298 -	312	303.19	1.66E+02	29.52	4.52E+01	2.33
m	13	307.93	298 -	312	308.17	2.54E+01	25.14	5.51E+01	2.53
M	14	333.72	330 -	342	333.95	7.72E+01	23.56	4.66E+01	2.49
m	15	338.05	330 -	342	338.28	2.58E+01	28.51	6.22E+01	3.39
	16	356.07	352 -	360	356.30	4.94E+02	47.61	4.50E+01	2.35
M	17	384.12	381 -	395	384.33	1.45E+02	34.60	1.40E+01	2.44
m	18	386.96	381 -	395	387.17	2.01E+02	36.66	1.20E+01	1.94
m	19	391.06	381 -	395	391.27	4.56E+01	30.94	1.80E+01	3.03
M	20	414.85	410 -	424	415.05	5.38E+01	22.05	3.60E+01	2.87
m	21	418.30	410 -	424	418.50	2.89E+01	22.58	3.60E+01	2.87
	22	436.80	432 -	440	437.00	1.14E+02	22.64	7.97E+00	2.19
	23	467.65	463 -	473	467.83	1.71E+01	16.59	2.78E+01	1.89
	24	618.47	614 -	620	618.60	5.00E+00	4.47	0.00E+00	1.70
	25	636.05	634 -	638	636.17	6.00E+00	4.90	0.00E+00	1.98

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 2.000sigma

BACKGROUND SUBTRACT REPORT

Peak Analysis Performed on : 5/1/2019 3:52:49PM

Env. Background File : \\OR-GAMMA1\ApexRoot\Countroom\Data\0000080016.CNF

	Peak No.	Energy (keV)	Original Area	Orig. Area Uncertainty	Ambient Background	Backgr. Uncert.	Subtracted Area	Subtracted Uncert.
	1	20.77	8.62E+01	50.24			8.62E+01	5.02E+01
M	2	31.01	2.23E+03	102.34			2.23E+03	1.02E+02
m	3	35.27	5.43E+02	63.32			5.43E+02	6.33E+01
	4	52.77	1.16E+02	51.71			1.16E+02	5.17E+01

Analysis Report for 1904089-06

BC 10

	Peak No.	Energy (keV)	Original Area	Orig. Area Uncertainty	Ambient Background	Backgr. Uncert.	Subtracted Area	Subtracted Uncert.
M	5	61.74	2.81E+02	45.46	1.56E+01	2.88E+00	2.66E+02	4.56E+01
m	6	66.18	1.40E+02	48.66			1.40E+02	4.87E+01
	7	81.19	9.41E+02	74.87			9.41E+02	7.49E+01
M	8	111.94	2.36E+02	44.65			2.36E+02	4.47E+01
m	9	116.23	4.42E+01	42.38			4.42E+01	4.24E+01
	10	222.06	5.05E+01	40.63			5.05E+01	4.06E+01
	11	276.25	8.60E+01	26.36			8.60E+01	2.64E+01
M	12	302.94	1.66E+02	29.52			1.66E+02	2.95E+01
m	13	307.93	2.54E+01	25.14			2.54E+01	2.51E+01
M	14	333.72	7.72E+01	23.56			7.72E+01	2.36E+01
m	15	338.05	2.58E+01	28.51			2.58E+01	2.85E+01
	16	356.07	4.94E+02	47.61			4.94E+02	4.76E+01
M	17	384.12	1.45E+02	34.60			1.45E+02	3.46E+01
m	18	386.96	2.01E+02	36.66			2.01E+02	3.67E+01
m	19	391.06	4.56E+01	30.94			4.56E+01	3.09E+01
M	20	414.85	5.38E+01	22.05			5.38E+01	2.20E+01
m	21	418.30	2.89E+01	22.58			2.89E+01	2.26E+01
	22	436.80	1.14E+02	22.64			1.14E+02	2.26E+01
	23	467.65	1.71E+01	16.59			1.71E+01	1.66E+01
	24	618.47	5.00E+00	4.47			5.00E+00	4.47E+00
	25	636.05	6.00E+00	4.90			6.00E+00	4.90E+00

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 2.000sigma

NUCLIDE IDENTIFICATION REPORT

Nuclide Library Used : \\OR-GAMMA1\ApexRoot\Countroom\Library\WSRC.NLB

IDENTIFIED NUCLIDES

Nuclide Name	Id Confidence	Energy (keV)		Yield(%)	Activity (pCi/units)	Activity Uncertainty
SN-113	0.95	255.12		1.93		
		391.69	*	61.90	3.18E+01	2.18E+01
I-125	0.99	35.49	*	6.49	2.54E+01	2.96E+00
BA-133	1.00	30.80	*	97.60	2.99E+00	1.37E-01
		302.84	*	17.80	6.24E+02	2.53E+02
		356.01	*	60.00	4.28E+02	6.40E+01
TH-234	0.95	63.29	*	3.80	4.13E+02	7.21E+01

Analysis Report for 1904089-06

BC 10

* = Energy line found in the spectrum.
\- = Manually added nuclide.
? = Manually edited nuclide.
@ = Energy line not used for Weighted Mean Activity
Energy Tolerance : 2.000FWHM
Nuclide confidence index threshold = 0.30
Errors quoted at 2.000sigma

INTERFERENCE CORRECTED REPORT

	Nuclide Name	Nuclide Id Confidence	Wt mean Activity (pCi/units)	Wt mean Activity Uncertainty	Comments
	SN-113	0.957	3.18E+01	2.18E+01	
	I-125	0.999	2.54E+01	2.96E+00	
X	I-129	0.902			
	BA-133	1.000	2.99E+00	1.37E-01	
	TH-234	0.958	4.13E+02	7.21E+01	
X	NP-237	0.885			

? = 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 2.000sigma

Analysis Report for 1904089-06

BC 10

UNIDENTIFIED PEAKS

Peak Locate Performed on : 5/1/2019 3:52:49PM
Peak Locate From Channel : 1
Peak Locate To Channel : 4096

	Peak No.	Energy (keV)	Peak Size (CPS)	Peak CPS (%) Uncertainty	Peak Type	Tolerance Nuclide
	1	20.77	9.57401E-02	29.15	Tol.	PA-234M
	4	52.77	1.28889E-01	22.29		
m	6	66.18	1.55463E-01	17.39	Sum	
	7	81.19	1.04510E+00	3.98		
M	8	111.94	2.62736E-01	9.44		
m	9	116.23	4.91004E-02	47.95		
	10	222.06	5.61620E-02	40.19		
	11	276.25	9.55556E-02	15.33		
m	13	307.93	2.82068E-02	49.51		
M	14	333.72	8.57312E-02	15.27	Sum	
m	15	338.05	2.86571E-02	55.28	Sum	
M	17	384.12	1.61499E-01	11.90		
m	18	386.96	2.23604E-01	9.11	Sum	
M	20	414.85	5.97301E-02	20.50		
m	21	418.30	3.21108E-02	39.07	Sum	
	22	436.80	1.26686E-01	9.93		
	23	467.65	1.89785E-02	48.57		
	24	618.47	5.55556E-03	44.72		
	25	636.05	6.66667E-03	40.82		

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 2.000sigma

NUCLIDE MDA REPORT

Nuclide Library Used : \\OR-GAMMA1\ApexRoot\Countroom\Library\WSRC.NLB

Analysis Report for 1904089-06

BC 10

	Nuclide Name	Energy (keV)		Yield(%)	Line MDA (pCi/units)	Nuclide MDA (pCi/units)	Activity (pCi/units)	Dec. Level (pCi/units)
	FE-55	5.89		24.50	4.26E-09	4.26E-09	-2.00E-08	1.35E-09
	CO-57	122.06		85.51	2.48E+01	2.48E+01	-2.06E+00	1.16E+01
		136.48		10.60	2.74E+02		1.36E+02	1.29E+02
	NI-59	6.92		29.80	1.16E-07	1.16E-07	3.71E-08	5.32E-08
	MO-93	16.59		52.90	1.12E-03	1.12E-03	9.00E-05	5.36E-04
		18.60		10.00	1.98E-02		8.48E-04	9.52E-03
	NB-93M	16.57		9.43	6.23E-03	6.23E-03	5.00E-04	2.98E-03
	CD-109	88.03		3.72	2.74E+02	2.74E+02	-2.54E+02	1.29E+02
+	SN-113	255.12		1.93	1.30E+03	2.04E+01	-3.14E+02	5.95E+02
		391.69	*	61.90	2.04E+01		3.18E+01	9.27E+00
	SN-119M	23.87		16.10	9.56E-02	9.22E-02	-5.85E-03	4.61E-02
		25.10		22.70	9.22E-02		-8.13E-01	4.44E-02
+	I-125	35.49	*	6.49	5.60E+00	5.60E+00	2.54E+01	2.74E+00
	I-129	29.78	*	57.00	2.78E-01	2.78E-01	5.12E+00	1.36E-01
		33.60	*	13.20	2.75E+00		1.25E+01	1.34E+00
		39.58		7.52	5.49E+00		1.16E-01	2.63E+00
+	BA-133	30.80	*	97.60	1.63E-01	1.63E-01	2.99E+00	7.95E-02
		302.84	*	17.80	1.87E+02		6.24E+02	8.86E+01
		356.01	*	60.00	2.68E+01		4.28E+02	1.22E+01
	CE-139	165.85		80.35	4.33E+01	4.33E+01	-2.31E+01	2.04E+01
	CE-144	133.54		10.80	2.68E+02	2.68E+02	1.64E+02	1.26E+02
	HG-203	279.19		77.30	4.56E+01	4.56E+01	-3.12E+00	2.15E+01
	PB-210	46.50		4.25	2.03E+01	2.03E+01	1.69E+00	9.65E+00
	PA-231	9.28		42.00	3.97E-06	3.97E-06	4.68E-06	1.89E-06
		10.11		20.20	2.09E-05		2.46E-05	9.94E-06
		283.67		1.60	1.29E+03		-6.33E+01	5.84E+02
		302.67		2.30	1.89E+03		3.43E+03	9.04E+02
	TH-231	25.64		14.70	1.63E-01	1.63E-01	-5.36E+00	7.85E-02
		84.21		6.40	3.26E+02		8.51E+02	1.59E+02
	PA-234M	9.89		89.00	3.75E-06	3.75E-06	4.41E-06	1.78E-06
		21.72		64.90	1.13E-02		1.21E-02	5.44E-03
		37.93		23.75	2.41E+00		8.37E+00	1.18E+00
		131.42		20.40	1.29E+02		-2.00E+01	6.09E+01
+	TH-234	63.29	*	3.80	1.66E+02	1.66E+02	4.13E+02	8.07E+01
	NP-237	29.37	*	14.00	1.13E+00	1.13E+00	2.09E+01	5.54E-01
		86.50		12.60	8.14E+01		-2.51E+01	3.85E+01
	U-237	97.08		16.30	8.30E+01	6.22E+01	-1.11E+02	3.91E+01
		101.07		26.30	6.22E+01		5.21E+01	2.94E+01
		114.00		12.30	3.18E+02		9.17E+02	1.54E+02
		208.01		22.00	1.78E+02		1.15E+02	8.36E+01
	AM-241	59.54		35.90	1.29E+01	1.29E+01	2.91E+01	6.26E+00
	AM-243	74.67		66.00	9.53E+00	9.53E+00	-5.42E-01	4.51E+00

\+ = 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

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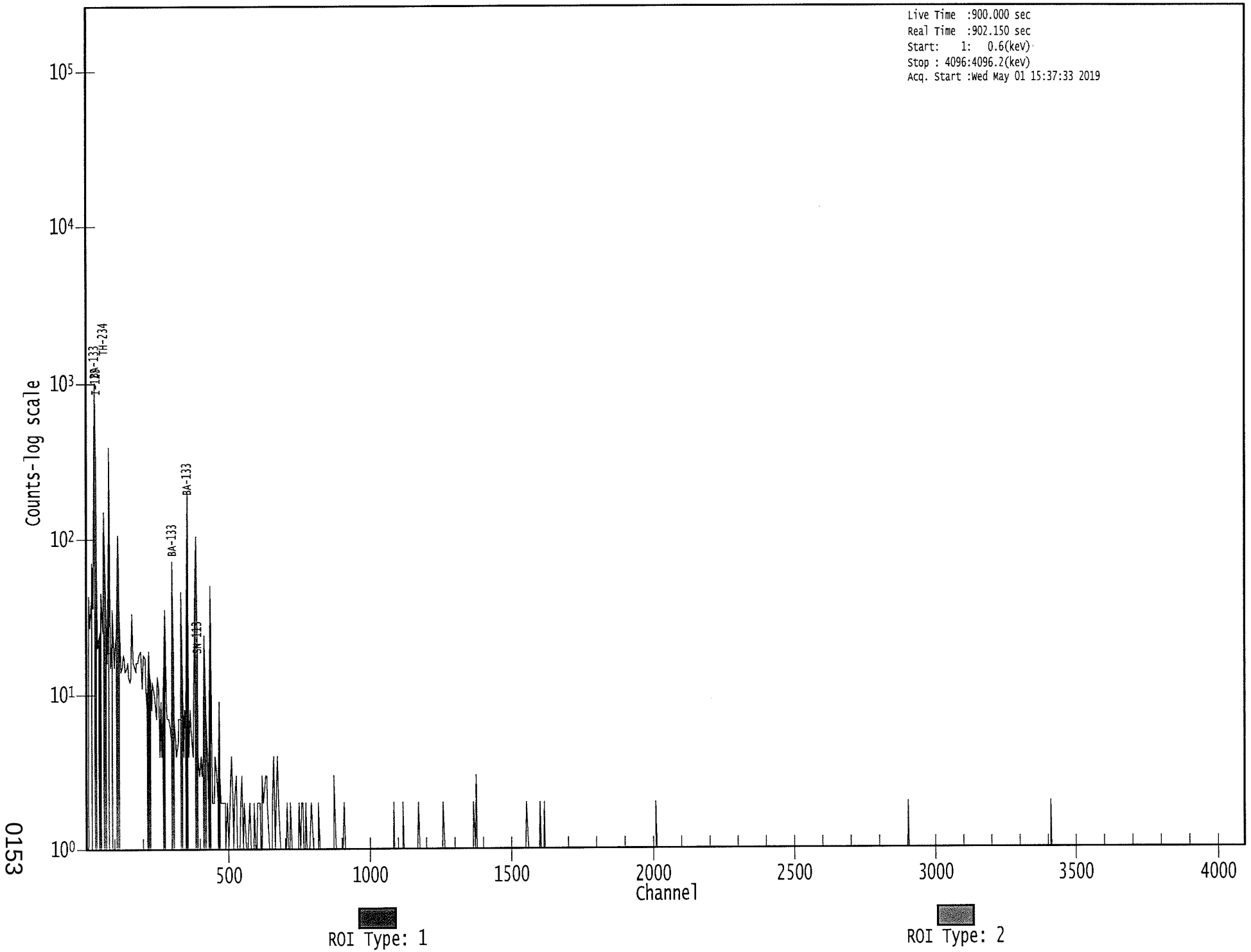


0153

KB 5/1/19

Apex-Gamma

Analysis Report for 1904089-07
BC 23

GAMMA SPECTRUM ANALYSIS

Sample Identification	: 1904089-07
Sample Description	: BC 23
Sample Type	: RA RECOVERY
Sample Size	: 1.000E+00 units
Facility	: Countroom
Sample Taken On	: 5/1/2019 3:12:13PM
Acquisition Started	: 5/1/2019 3:53:44PM
Procedure	: BAFIL
Operator	: Administrator
Detector Name	: GE4
Geometry	: BAFIL
Live Time	: 900.0 seconds
Real Time	: 900.6 seconds
Dead Time	: 0.07 %
Peak Locate Threshold	: 2.50
Peak Locate Range (in channels)	: 1 - 4096
Peak Area Range (in channels)	: 9 - 4096
Identification Energy Tolerance	: 1.000FWHM
Energy Calibration Used Done On	: 2/24/2018
Efficiency Calibration Used Done On	: 11/9/2014
Efficiency Calibration Description	:
Sample Number	: 81216

PEAK ANALYSIS REPORT

Peak Analysis Performed on : 5/1/2019 4:08:47PM

Peak Analysis From Channel : 1
Peak Analysis To Channel : 4096

Peak No.	Energy (keV)	ROI start	ROI end	Peak Centroid	Net Peak Area	Net Area Uncertainty	Continuum Counts	FWHM (keV)

Analysis Report for 1904089-07

BC 23

	Peak No.	Energy (keV)	ROI start	ROI end	Peak Centroid	Net Peak Area	Net Area Uncertainty	Continuum Counts	FWHM (keV)
M	1	30.98	24 -	44	30.04	1.94E+03	96.80	1.99E+02	2.26
m	2	35.14	24 -	44	34.21	4.94E+02	72.98	1.65E+02	2.27
	3	52.39	48 -	55	51.47	6.18E+01	36.82	1.86E+02	1.95
M	4	61.82	56 -	72	60.90	1.97E+02	41.55	1.63E+02	2.31
m	5	65.91	56 -	72	64.99	8.02E+01	38.09	1.36E+02	2.32
m	6	69.76	56 -	72	68.85	3.37E+01	34.62	1.27E+02	2.32
m	7	81.06	73 -	86	80.16	8.35E+02	63.50	1.19E+02	2.17
	8	101.93	98 -	104	101.04	2.20E+01	26.53	1.12E+02	2.00
M	9	111.72	105 -	118	110.85	1.91E+02	39.12	1.17E+02	3.16
m	10	116.61	105 -	118	115.74	3.05E+01	28.46	6.84E+01	2.18
	11	168.19	164 -	171	167.36	3.02E+01	27.35	1.06E+02	3.36
	12	244.57	240 -	247	243.80	2.36E+01	21.07	5.48E+01	2.22
M	13	276.52	271 -	285	275.77	6.81E+01	22.24	4.17E+01	2.30
m	14	281.97	271 -	285	281.23	1.49E+01	19.08	2.96E+01	2.52
M	15	303.08	291 -	319	302.36	1.50E+02	26.29	2.16E+01	2.09
m	16	307.56	291 -	319	306.84	2.93E+01	16.67	2.22E+01	2.18
m	17	313.65	291 -	319	312.94	1.27E+01	19.89	3.39E+01	3.72
M	18	333.93	327 -	342	333.23	6.47E+01	21.07	4.15E+01	2.55
m	19	337.93	327 -	342	337.23	2.40E+01	21.17	3.54E+01	2.55
M	20	351.68	350 -	361	351.00	1.60E+01	7.00	3.08E+00	2.33
m	21	356.17	350 -	361	355.49	4.15E+02	41.58	1.40E+01	2.28
	22	365.13	362 -	367	364.46	1.20E+01	11.75	1.80E+01	1.46
M	23	384.43	379 -	395	383.78	9.94E+01	32.82	3.22E+01	3.12
m	24	386.97	379 -	395	386.32	1.46E+02	30.94	1.37E+01	2.13
m	25	391.30	379 -	395	390.65	3.57E+01	27.81	4.59E+00	3.13
M	26	415.39	409 -	425	414.76	2.05E+01	14.83	1.33E+01	2.60
m	27	418.64	409 -	425	418.01	1.41E+01	15.36	1.75E+01	2.60
m	28	421.86	409 -	425	421.24	1.14E+01	13.71	2.07E+01	2.60
	29	437.01	431 -	442	436.40	5.36E+01	20.20	2.48E+01	2.23
	30	467.48	463 -	471	466.90	1.06E+01	12.69	1.88E+01	1.99
	31	485.97	481 -	488	485.40	1.00E+01	6.32	0.00E+00	3.59
	32	565.37	561 -	568	564.88	8.00E+00	5.66	0.00E+00	3.40
	33	590.95	587 -	593	590.48	5.29E+00	6.34	3.43E+00	2.69
	34	608.92	604 -	612	608.46	8.86E+00	8.02	4.27E+00	2.73

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 2.000sigma

BACKGROUND SUBTRACT REPORT

Peak Analysis Performed on : 5/1/2019 4:08:47PM

Env. Background File : \\OR-GAMMA1\ApexRoot\Countroom\Data\0000080017.CNF

Analysis Report for 1904089-07

BC 23

	Peak No.	Energy (keV)	Original Area	Orig. Area Uncertainty	Ambient Background	Backgr. Uncert.	Subtracted Area	Subtracted Uncert.
M	1	30.98	1.94E+03	96.80			1.94E+03	9.68E+01
m	2	35.14	4.94E+02	72.98			4.94E+02	7.30E+01
	3	52.39	6.18E+01	36.82			6.18E+01	3.68E+01
M	4	61.82	1.97E+02	41.55	1.28E+01	1.96E+00	1.84E+02	4.16E+01
m	5	65.91	8.02E+01	38.09			8.02E+01	3.81E+01
m	6	69.76	3.37E+01	34.62			3.37E+01	3.46E+01
m	7	81.06	8.35E+02	63.50			8.35E+02	6.35E+01
	8	101.93	2.20E+01	26.53			2.20E+01	2.65E+01
M	9	111.72	1.91E+02	39.12			1.91E+02	3.91E+01
m	10	116.61	3.05E+01	28.46			3.05E+01	2.85E+01
	11	168.19	3.02E+01	27.35			3.02E+01	2.73E+01
	12	244.57	2.36E+01	21.07			2.36E+01	2.11E+01
M	13	276.52	6.81E+01	22.24			6.81E+01	2.22E+01
m	14	281.97	1.49E+01	19.08			1.49E+01	1.91E+01
M	15	303.08	1.50E+02	26.29			1.50E+02	2.63E+01
m	16	307.56	2.93E+01	16.67			2.93E+01	1.67E+01
m	17	313.65	1.27E+01	19.89			1.27E+01	1.99E+01
M	18	333.93	6.47E+01	21.07			6.47E+01	2.11E+01
m	19	337.93	2.40E+01	21.17			2.40E+01	2.12E+01
M	20	351.68	1.60E+01	7.00	3.01E+00	1.41E+00	1.30E+01	7.14E+00
m	21	356.17	4.15E+02	41.58			4.15E+02	4.16E+01
	22	365.13	1.20E+01	11.75			1.20E+01	1.17E+01
M	23	384.43	9.94E+01	32.82			9.94E+01	3.28E+01
m	24	386.97	1.46E+02	30.94			1.46E+02	3.09E+01
m	25	391.30	3.57E+01	27.81			3.57E+01	2.78E+01
M	26	415.39	2.05E+01	14.83			2.05E+01	1.48E+01
m	27	418.64	1.41E+01	15.36			1.41E+01	1.54E+01
m	28	421.86	1.14E+01	13.71			1.14E+01	1.37E+01
	29	437.01	5.36E+01	20.20			5.36E+01	2.02E+01
	30	467.48	1.06E+01	12.69			1.06E+01	1.27E+01
	31	485.97	1.00E+01	6.32			1.00E+01	6.32E+00
	32	565.37	8.00E+00	5.66			8.00E+00	5.66E+00
	33	590.95	5.29E+00	6.34			5.29E+00	6.34E+00
	34	608.92	8.86E+00	8.02	1.76E+00	8.81E-01	7.11E+00	8.06E+00

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 2.000sigma

Analysis Report for 1904089-07

BC 23

NUCLIDE IDENTIFICATION REPORT

Nuclide Library Used : \\OR-GAMMA1\ApexRoot\Countroom\Library\WSRC.NLB

IDENTIFIED NUCLIDES

Nuclide Name	Id Confidence	Energy (keV)		Yield(%)	Activity (pCi/units)	Activity Uncertainty
SN-113	0.94	255.12		1.93		
		391.69	*	61.90	5.61E+01	4.44E+01
I-125	0.99	35.49	*	6.49	4.38E+02	6.56E+01
BA-133	0.99	30.80	*	97.60	8.79E+01	4.70E+00
		302.84	*	17.80	7.38E+02	2.62E+02
		356.01	*	60.00	6.52E+02	1.07E+02
TH-234	0.95	63.29	*	3.80	7.84E+02	1.85E+02

* = Energy line found in the spectrum.
\- = Manually added nuclide.
? = Manually edited nuclide.
@ = Energy line not used for Weighted Mean Activity
Energy Tolerance : 2.000FWHM
Nuclide confidence index threshold = 0.30
Errors quoted at 2.000sigma

INTERFERENCE CORRECTED REPORT

	Nuclide Name	Nuclide Id Confidence	Wt mean Activity (pCi/units)	Wt mean Activity Uncertainty	Comments
	SN-113	0.944	5.61E+01	4.44E+01	
	I-125	0.998	4.38E+02	6.56E+01	
X	I-129	0.851			
	BA-133	0.999	8.92E+01	4.69E+00	
	TH-234	0.959	7.84E+02	1.85E+02	
X	NP-237	0.564			

Analysis Report for 1904089-07

BC 23

? = 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 2.000sigma

Analysis Report for 1904089-07

BC 23

UNIDENTIFIED PEAKS

Peak Locate Performed on : 5/1/2019 4:08:47PM
Peak Locate From Channel : 1
Peak Locate To Channel : 4096

	Peak No.	Energy (keV)	Peak Size (CPS)	Peak CPS (%) Uncertainty	Peak Type	Tolerance Nuclide
	3	52.39	6.86237E-02	29.81		
m	5	65.91	8.91174E-02	23.74	Sum	
m	6	69.76	3.74052E-02	51.42	Sum	
m	7	81.06	9.27556E-01	3.80		
	8	101.93	2.44444E-02	60.30		
M	9	111.72	2.11929E-01	10.25		
m	10	116.61	3.39062E-02	46.64		
	11	168.19	3.35877E-02	45.24		
	12	244.57	2.62309E-02	44.63		
M	13	276.52	7.56898E-02	16.33		
m	14	281.97	1.65976E-02	63.86	Tol.	PA-231
m	16	307.56	3.25828E-02	28.42		
m	17	313.65	1.41269E-02	78.23		
M	18	333.93	7.18603E-02	16.29	Sum	
m	19	337.93	2.66607E-02	44.11	Sum	
M	20	351.68	1.44617E-02	27.43		
	22	365.13	1.33333E-02	48.95	Sum	
M	23	384.43	1.10480E-01	16.50		
m	24	386.97	1.62514E-01	10.58	Sum	
M	26	415.39	2.28255E-02	36.10		
m	27	418.64	1.56960E-02	54.37	Sum	
m	28	421.86	1.26594E-02	60.17	Sum	
	29	437.01	5.95623E-02	18.84		
	30	467.48	1.17778E-02	59.85		
	31	485.97	1.11111E-02	31.62		
	32	565.37	8.88889E-03	35.36		
	33	590.95	5.87302E-03	60.01		
	34	608.92	7.89810E-03	56.72		

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 2.000sigma

Analysis Report for 1904089-07

BC 23

NUCLIDE MDA REPORT

Nuclide Library Used : \\OR-GAMMA1\ApexRoot\Countroom\Library\WSRC.NLB

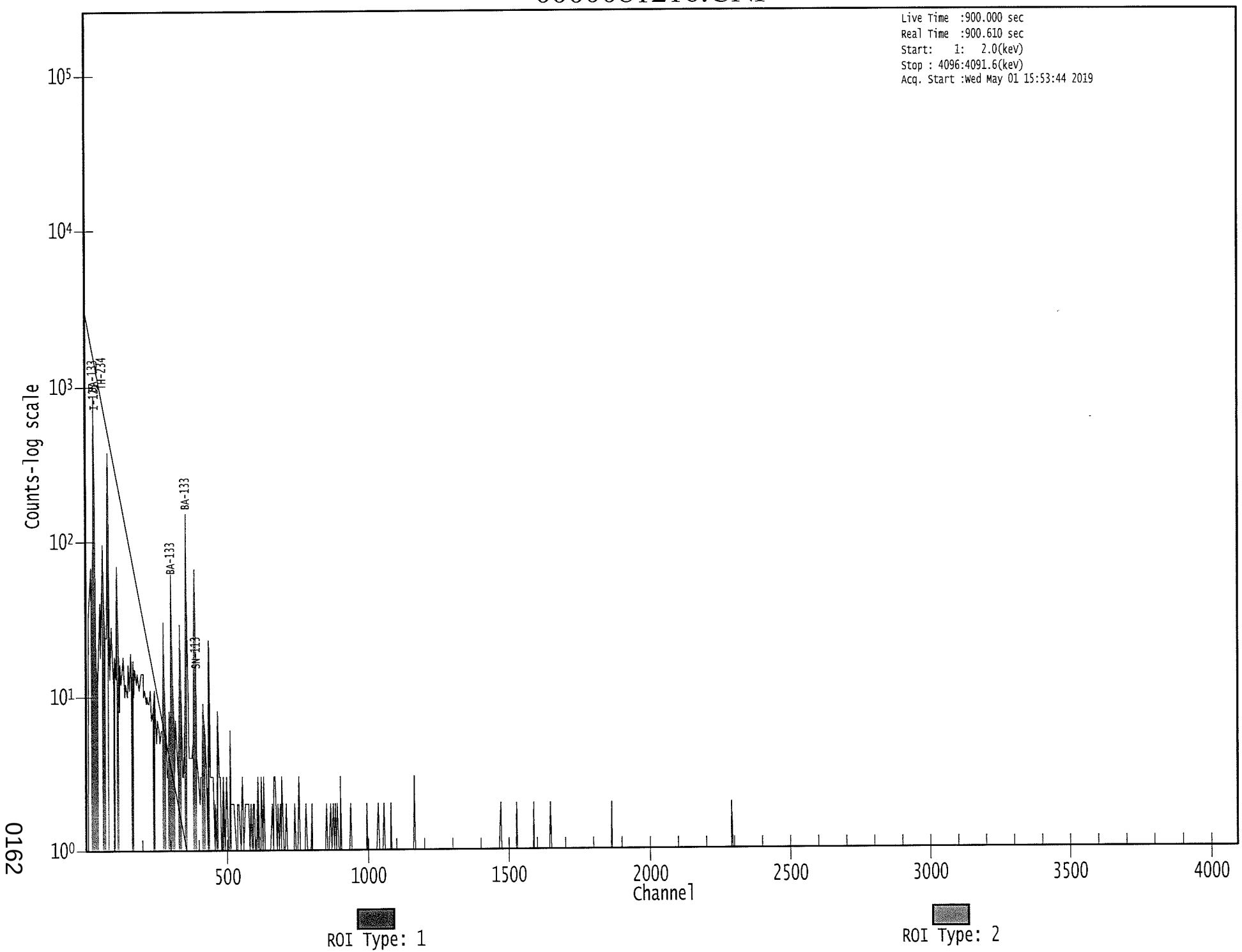
	Nuclide Name	Energy (keV)		Yield(%)	Line MDA (pCi/units)	Nuclide MDA (pCi/units)	Activity (pCi/units)	Dec. Level (pCi/units)
	FE-55	5.89		24.50	5.43E-03	5.43E-03	0.00E+00	0.00E+00
	CO-57	122.06		85.51	1.82E+01	1.82E+01	4.28E-01	8.45E+00
		136.48		10.60	1.80E+02		-2.90E+01	8.38E+01
	NI-59	6.92		29.80	4.42E-02	4.42E-02	-6.68E-02	1.83E-02
	MO-93	16.59		52.90	1.31E+00	1.31E+00	-1.33E+00	6.31E-01
		18.60		10.00	9.98E+00		9.97E+00	4.80E+00
	NB-93M	16.57		9.43	7.35E+00	7.35E+00	-7.43E+00	3.53E+00
	CD-109	88.03		3.72	3.18E+02	3.18E+02	-2.24E+02	1.49E+02
+	SN-113	255.12		1.93	1.21E+03	5.40E+01	3.31E+02	5.51E+02
		391.69	*	61.90	5.40E+01		5.61E+01	2.49E+01
	SN-119M	23.87		16.10	1.03E+01	7.56E+00	3.58E+00	4.95E+00
		25.10		22.70	7.56E+00		-4.74E+00	3.61E+00
+	I-125	35.49	*	6.49	1.20E+02	1.20E+02	4.38E+02	5.88E+01
	I-129	29.78	*	57.00	1.06E+01	1.06E+01	1.50E+02	5.18E+00
		33.60	*	13.20	5.89E+01		2.15E+02	2.89E+01
		39.58		7.52	5.65E+01		-2.35E+02	2.69E+01
+	BA-133	30.80	*	97.60	6.17E+00	6.17E+00	8.79E+01	3.02E+00
		302.84	*	17.80	3.29E+02		7.38E+02	1.58E+02
		356.01	*	60.00	3.81E+01		6.52E+02	1.69E+01
	CE-139	165.85		80.35	2.98E+01	2.98E+01	-1.78E-01	1.39E+01
	CE-144	133.54		10.80	1.87E+02	1.87E+02	1.50E+02	8.79E+01
	HG-203	279.19		77.30	4.98E+01	4.98E+01	5.26E+01	2.34E+01
	PB-210	46.50		4.25	1.04E+02	1.04E+02	8.01E+00	4.86E+01
	PA-231	9.28		42.00	2.06E-01	2.06E-01	1.44E-01	9.63E-02
		10.11		20.20	6.21E-01		2.87E-01	2.93E-01
		283.67		1.60	1.45E+03		4.96E+02	6.52E+02
		302.67		2.30	2.35E+03		3.93E+03	1.12E+03
	TH-231	25.64		14.70	1.50E+01	1.50E+01	-5.49E+00	7.25E+00
		84.21		6.40	5.16E+02		2.36E+03	2.52E+02
	PA-234M	9.89		89.00	1.32E-01	1.32E-01	6.11E-02	6.23E-02
		21.72		64.90	2.16E+00		1.75E+00	1.04E+00
		37.93		23.75	3.01E+01		9.41E+01	1.47E+01
		131.42		20.40	9.45E+01		3.59E+01	4.42E+01
+	TH-234	63.29	*	3.80	4.25E+02	4.25E+02	7.84E+02	2.07E+02
	NP-237	29.37	*	14.00	4.30E+01	4.30E+01	6.13E+02	2.11E+01
		86.50		12.60	9.55E+01		-1.79E+01	4.49E+01
	U-237	97.08		16.30	8.14E+01	5.49E+01	-3.14E+01	3.81E+01
		101.07		26.30	5.49E+01		9.77E+00	2.57E+01
		114.00		12.30	2.28E+02		4.68E+02	1.10E+02
		208.01		22.00	1.23E+02		-1.49E+01	5.73E+01
	AM-241	59.54		35.90	3.42E+01	3.42E+01	5.98E+01	1.65E+01
	AM-243	74.67		66.00	1.57E+01	1.57E+01	-1.11E+02	7.42E+00

Analysis Report for 1904089-07

BC 23

+	=	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

0000081216.CNF



0162

SECTION XI

ANALYTICAL DATA (TOTAL DISSOLVED SOLIDS)

TDS / TSS Worksheet

Work Order	Run	Analysis Code	Technician
19-04089	1	TDS	JPACHELLA

TRetec	Michael Pisani & Associates, Inc.		Filter Data			TDS/TSS	Maximum Aliq
Fraction	Client ID	Aliquot ml	Filter Tare (g)	Filter Final (g)	Filter Net (g)	(mg/L)	(mL)
04	BC 22B	100.0000	112.9068	114.7642	1.8574	18574.0000	5.38
05	BC 9	100.0000	121.9510	123.0535	1.1025	11025.0000	9.07
06	BC 10	100.0000	95.0504	99.1558	4.1054	41054.0000	2.44
07	BC 23	100.0000	94.9259	101.2148	6.2889	62889.0000	1.59

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Technician: J Pachella Date: 4/23/19

Eberline Analytical
Oak Ridge Laboratory

Aliquot Worksheet

Printed: 4/22/2019 9:56 AM

Work Order	Run	Analysis Code	Rpt Units	Lab Deadline	Technician
19-04089	1	TDS	liters	4/30/2019	JPACHELLA

Lab Fraction	Michael Pisani & Associates, Inc. Client ID	Sample Type	Muffle Data	Dilution Data			Aliquot Data		MS Aliquot Data		H-3 Solids Only	
			Ratio Post/Pre	No of Dils	Dil Factor	Ratio	Aliquot	Net Equiv	Aliquot	Net Equiv	Water Added (ml)	H3 Dist Aliq
01	LCS	LCS					1.0000E+00	1.0000E+00				
02	BLANK	MBL					1.0000E+00	1.0000E+00				
03	DUP	DUP					1.0000E-01	1.0000E-01				
04	BC 22B	TRG					1.0000E-01	1.0000E-01				
05	BC 9	TRG					1.0000E-01	1.0000E-01				
06	BC 10	TRG					1.0000E-01	1.0000E-01				
07	BC 23	TRG					1.0000E-01	1.0000E-01				

Comments	

0165

Technician: JPachella Date: 4/22/19