FEEZOR ENGINEERING, INC.

FEE/BRI

Water

STANDARD LEVEL IV
REPORT OF ANALYSIS

WORK ORDER #14-11095-OR

December 4, 2014

EBERLINE ANALYTICAL/OAK RIDGE LABORATORY
OAK RIDGE, TN

001

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Eberline Services – Oak Ridge Laboratory

LABORATORY DATA SUPPORT CHECKLIST

MP-001-3

Eberline Services Work Order # 14-11095

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

Date for Partial	Initials	Date	Initials	Checklist Items
		11/18/14	KC	Sample Log-In
		11/24/14	JG	Data Compilation
		11/24/14	MLT	First Technical Data Review
		11/25/14	MLT	Second Technical Data Review
		12/02/14	EJT	Data Entry/Electronic Deliverable
		12/02/14	EJT	Case Narrative
		12/3/14	KBS	Electronic Deliverable Proof
		12/3/14	MLT	Samples Analyzed within Holding Time Yes? [X] No? [ ]
		12/3/14	MLT	QA/QC Review
		11/24/14	EJT	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: _____ 12/4/14

Laboratory Manager Date

Copy No. _____

Radiochemistry Services

SECTION I

CHAIN OF CUSTODY
&
pH CHECK SHEET

WLLFOIA4312 - 001 - 0030421

14-11095

REC'D NOV 18 2014

Auxier & Associates, Inc.
9821 Cogdill Road
Suite 1
Knoxville, TN 37932
(423) 675-3669

Radiological Health, Safety and Environmental Services
A USA Environment, L.P. Company

CHAIN OF CUSTODY FORM

Project Name:	FEE/BRI	Project Manager:	Beth Jansen
Location:	Bridgeton, MO	Telephone No.:	865-675-3669
Sample Custodian:		Fax No.:	865-675-3677

SAMPLE IDENTIFICATION	DATE OF COLLECTION	SAMPLE DESCRIPTION	SAMPLE IDENTIFICATION	DATE OF COLLECTION	SAMPLE DESCRIPTION
FEE-BRI-W FADW29206L >4	11-13-14	(1) GALLON WATER			
FEE-BRI-W FADW29206L	11-13-14	(1) GALLON WATER			

Relinquished By: ALEX LUNA	Received In Good Condition By: Kristen Carlot	Time: 930	Date: 11/18/14
Method Of Shipment: FEDEX			
Relinquished By:	Received In Good Condition By:	Time:	Date:
Method Of Shipment:			

g:\marsha\forms\COC 08/13/99

005

WLLFOIA4312 - 001 - 0030422

EBERLINE SERVICES Oak Ridge Laboratory	Internal Chain of Custody	Work Order #	14-11095
		Lab Deadline	11/24/2014
		Analysis	UUISO - Level 4
		Sample Matrix	Water

Comments	Sample Fraction	HP 210 / 270 Detector Activity	Storage Location
	04	39	01.2

	Location (circle one)					Initials	Date
Received by	Sample Storage	Rough Prep	Prep	Separations	Count Room	JGN	11/18/14 1530
Relinquished by	Sample Storage	Rough Prep	Prep	Separations	Count Room	[illegible]	11/19/14 1045
Received by	Sample Storage	Rough Prep	Prep	Separations	Count Room	[illegible]	11/19/14 1045
Relinquished by	Sample Storage	Rough Prep	Prep	Separations	Count Room	[illegible]	[illegible]
Received by	Sample Storage	Rough Prep	Prep	Separations	Count Room	[illegible]	[illegible]
Relinquished by	Sample Storage	Rough Prep	Prep	Separations	Count Room	KB	11/21/14 1144
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		

006

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EBERLINE SERVICES Oak Ridge Laboratory	Internal Chain of Custody	Work Order #	14-11095
		Lab Deadline	11/24/2014
		Analysis	ThISO - Level 4
		Sample Matrix	Water

Comments	Sample Fraction	HP 210 / 270 Detector Activity	Storage Location
	04	39	O1.2

	Location (circle one)					Initials	Date
Received by	Sample Storage	Rough Prep	Prep	Separations	Count Room	JW	11/18/14 1530
Relinquished by	Sample Storage	Rough Prep	Prep	Separations	Count Room	[illegible]	11/19/14 1045
Received by	Sample Storage	Rough Prep	Prep	Separations	Count Room	[illegible]	11-19-14 1045
Relinquished by	Sample Storage	Rough Prep	Prep	Separations	Count Room	[illegible]	11-21-14 0800
Received by	Sample Storage	Rough Prep	Prep	Separations	Count Room	[illegible]	
Relinquished by	Sample Storage	Rough Prep	Prep	Separations	Count Room	KB	11/21/14 1145
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		

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EBERLINE SERVICES Oak Ridge Laboratory	Internal Chain of Custody	Work Order #	14-11095
		Lab Deadline	11/24/2014
		Analysis	Ra226 - Level 4
		Sample Matrix	Water

Comments	Sample Fraction	HP 210 / 270 Detector Activity	Storage Location
	04	39	01.2

	Location (circle one)					Initials	Date
Received by	Sample Storage	Rough Prep	Prep	Separations	Count Room	LW	11/18/14 1530
Relinquished by	Sample Storage	Rough Prep	Prep	Separations	Count Room	[illegible]	11/19/14 0515
Received by	Sample Storage	Rough Prep	Prep	Separations	Count Room	0600 RM	11/19/14
Relinquished by	Sample Storage	Rough Prep	Prep	Separations	Count Room	0740 RM	11/20/14
Received by	Sample Storage	Rough Prep	Prep	Separations	Count Room	0740 [illegible]	
Relinquished by	Sample Storage	Rough Prep	Prep	Separations	Count Room	KB	11/20/14 1447
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		

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EBERLINE SERVICES Oak Ridge Laboratory	Internal Chain of Custody	Work Order #	14-11095
		Lab Deadline	11/24/2014
		Analysis	Ra228 - Level 4
		Sample Matrix	Water

Comments	Sample Fraction	HP 210 / 270 Detector Activity	Storage Location
	04	39	01.2

	Location (circle one)					Initials	Date
Received by	Sample Storage	Rough Prep	Prep	Separations	Count Room	JW	11/18/14 1530
Relinquished by	Sample Storage	Rough Prep	Prep	Separations	Count Room	[illegible]	11/19/14 0515
Received by	Sample Storage	Rough Prep	Prep	Separations	Count Room	0000 RM	11/19/14
Relinquished by	Sample Storage	Rough Prep	Prep	Separations	Count Room	0740 RM	11/20/14
Received by	Sample Storage	Rough Prep	Prep	Separations	Count Room	0740	[illegible]
Relinquished by	Sample Storage	Rough Prep	Prep	Separations	Count Room	KB 11/20/14	MYR
Received by	Sample Storage	Rough Prep	Prep	Separations	Count Room	0000 RM	11/21/14
Relinquished by	Sample Storage	Rough Prep	Prep	Separations	Count Room	0825 RM	11/24/14
Received by	Sample Storage	Rough Prep	Prep	Separations	Count Room	0825	[illegible] 11/24
Relinquished by	Sample Storage	Rough Prep	Prep	Separations	Count Room	1020	[illegible] 11/24
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		

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EBERLINE SERVICES Oak Ridge Laboratory	Internal Chain of Custody	Work Order #	14-11095
		Lab Deadline	11/24/2014
		Analysis	GaGbT_ThSr - Level 4
		Sample Matrix	Water

Comments	Sample Fraction	HP 210 / 270 Detector Activity	Storage Location
	04	39	01.2

	Location (circle one)					Initials	Date
Received by	Sample Storage	Rough Prep	Prep	Separations	Count Room	MR	20Nov14
Relinquished by	Sample Storage	Rough Prep	Prep	Separations	Count Room	MR	20Nov14 0815
Received by	Sample Storage	Rough Prep	Prep	Separations	Count Room	[illegible]	[illegible]
Relinquished by	Sample Storage	Rough Prep	Prep	Separations	Count Room	KB	11/20/14 1202
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		

010

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EBERLINE SERVICES

Sample Receiving Report
(Volumes, pH, & CPM)

Internal Work Order: **14-11095**

Received By: KCOULSTON

FR	ClientID	# Btls	Comments	Matrix	Storage	Rec Vol Ttl	CPM Max
01	LCS	0		WA	O1.2		
02	BLANK	0		WA	O1.2		
03	DUP	0		WA	O1.2		
04	FEE-BRI-W-FADW29206L i	2		WA	O1.2	8.00	39
			Container Number	pH Orig	pH Final	Volume (L)	CPM
			1	12	12	4.0000	36
			2	12	12	4.0000	39

KEJ
11/18/14

011

Received by: Kristen Coulston Date: 11/18/14

MP-001, Rev 5
Effective: 11/22/02

SECTION II

SAMPLE ACKNOWLEDGEMENT

WLLFOIA4312 - 001 - 0030429

Client Name	Contract/PO	Project Type	Date Received	Required Turnaround Days	Eberline Services Work Order
Feezor Engineering, Inc.	BT-026-PO1	Environmental	11/18/2014	7	14-11095
Project Name	**Client WO**	**Sample Disp**	**Lab Deadline**	**Internal Deadline**	**Client Deadline**
FEEBRI	FEE/BRI Bridgeton, MO	W	11/24/2014	11/25/2014	11/25/2014

Internal ID	Client ID	Sample Date	Matrix	Storage	GaGbT_	Ra226	Ra228	ThISO	UUISO																			Ttl
01	LCS	11/18/14	WA	O1.2	X	X	X	X	X																			5
02	BLANK	11/18/14	WA	O1.2	X	X	X	X	X																			5
03	DUP	11/18/14	WA	O1.2	X	X	X	X	X																			5
04	FEE-BRI-W-FADW29206L	11/13/14 00:00	WA	O1.2	X	X	X	X	X																			5
																												0
																												0
																												0
																												0
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																												0
																												0
																												0
																												0
																												0
				Totals Per Analysis (non QA samples)	1	1	1	1	1	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
Feezor Engineering, Inc.
406 East Walnut Street
Chatham, IL 62629
Voice 217-483-3118
Fax

Contact Mike Bollenbacher
Voice 865-675-0379
Fax 865-675-3677

Report Data
Dan Feezor
Feezor Engineering, Inc.
406 East Walnut Street
Chatham, IL 62629
Voice 217-483-3118
Fax

Printed: 11/18/2014 3:06 PM

WLLFOIA4312 - 001 - 0030430

Eberline Services – Oak Ridge Laboratory

SAMPLE RECEIPT CHECKLIST
MP-001-2

WORK ORDER # 14-11095

SAMPLE MATRIX/MATRICES: (CIRCLE ONE OR BOTH)

(AQUEOUS) NON-AQUEOUS

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

WERE SAMPLES:

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: Kristen Coulston DATE: 11/18/14

SECTION III

CASE NARRATIVE

WLLFOIA4312 - 001 - 0030432

EBERLINE SERVICES

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

EBS-OR-38233

December 4, 2014

Dan Feezor
Feezor Engineering, Inc.
406 East Walnut Street
Chatham, IL 62629

CASE NARRATIVE
Work Order # 14-11095-OR

SAMPLE RECEIPT

This work order contains one water sample received 11/18/2014. This sample was analyzed for Isotopic Uranium, Isotopic Thorium, Radium-226/228 and Gross Alpha/Beta.

CLIENT ID	LAB ID
FEE-BRI-W-FADW29206L	14-11095-04

ANALYTICAL METHODS

Isotopic Uranium was analyzed using Method EML U-02 Modified. Isotopic Thorium was analyzed using Method EML Th-01 Modified. Radium-226 was analyzed using EPA Method 903.0 Modified. Radium-228 was analyzed using EPA Method 904.0 Modified. Gross Alpha/Beta was analyzed using EPA Method 900.0.

ANALYTICAL RESULTS

Combined Standard Uncertainty is reported at 2-sigma value.

ISOTOPIC URANIUM

Sample was prepared by removing a representative aliquot followed by mixed acid digestions as appropriate. Uranium was selectively extracted by ion exchange. Uranium was eluted, micro-precipitated and mounted on micro-porous filter media. Sample activities were then determined by alpha spectroscopy using energy specific regions of interest for Uranium-234, Uranium-235 and Uranium-238. Chemical recovery was determined by the use of a Uranium-232 tracer. Activity of the Uranium-232 tracer was determined by alpha spectroscopy using an energy specific region of interest.

Sample demonstrated acceptable results for all Uranium analyses. Chemical recovery was acceptable for all samples. The Uranium-234, Uranium-235 and Uranium-238 method blank demonstrated acceptable results. Results for the Uranium-234, Uranium-235 and Uranium-238 duplicate demonstrated a high relative percent difference; however, normalized difference is within acceptable limits for the analytical technique. Results for the Uranium-234 and Uranium-238 laboratory control sample demonstrated an acceptable percent recovery.

ANALYTICAL RESULTS CONTINUED

ISOTOPIC THORIUM

Sample was prepared by removing a representative aliquot followed by mixed acid digestions as appropriate. Thorium was selectively extracted by ion exchange. Thorium was eluted, micro-precipitated and mounted on micro-porous filter media. Sample activities were then determined by alpha spectroscopy using energy specific regions of interest for Thorium-228, Thorium-230 and Thorium-232. Chemical recovery was determined by the use of a Thorium-229 tracer. Activity of the Thorium-229 tracer was determined by alpha spectroscopy using an energy specific region of interest.

Sample demonstrated acceptable results for all Thorium analyses. Chemical recovery was acceptable for all samples. The Thorium-228, Thorium-230 and Thorium-232 method blank demonstrated acceptable results. Results for the Thorium-228, Thorium-230 and Thorium-232 duplicate demonstrated an acceptable relative percent difference and normalized difference. Results for the Thorium-228, Thorium-230 and Thorium-232 laboratory control sample demonstrated an acceptable percent recovery.

RADIUM-226

Sample was prepared by removing a representative aliquot followed by mixed acid digestions as appropriate. This was followed by selective sulfate precipitations of the Radium. Sample was then mounted by semi-micro-precipitations onto micro-porous filters. Sample was counted by alpha spectroscopy using an energy specific region of interest for Radium-226. Chemical recovery was calculated by the use of a Barium-133 tracer, which was determined by HPGe gamma spectroscopy.

Sample demonstrated acceptable results for all Radium-226 analyses. Chemical recovery was acceptable for all samples. The Radium-226 method blank demonstrated acceptable results. Results for the Radium-226 duplicate demonstrated an acceptable relative percent difference and normalized difference. 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 re-dissolved and time 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.

Sample demonstrated acceptable results for all Radium-228 analyses. Chemical recovery was acceptable for all samples. The Radium-228 method blank demonstrated acceptable results. 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.

GROSS ALPHA & BETA

Sample was prepared by evaporation of a representative volumetric aliquot acidified with HNO_3. Reduced sample was then transferred to a steel planchet for final evaporation to dryness and flaming. Sample was then counted on a gas proportional counter. Results were corrected as required for inherent self-absorption based on residual mass present.

ANALYTICAL RESULTS CONTINUED

GROSS ALPHA & BETA CONTINUED

Sample demonstrated acceptable results for all Gross Alpha and Beta analyses. The Gross Alpha and Beta method blank demonstrated acceptable results. Results for the Gross Alpha and Beta duplicate demonstrated an acceptable relative percent difference and normalized difference. Results for the Gross Alpha and Beta laboratory control sample demonstrated an acceptable percent recovery.

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: 12/4/2014

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

SECTION IV

ANALYTICAL RESULTS SUMMARY

WLLFOIA4312 - 001 - 0030436

Eberline Analytical
Final Report of Analysis

Report To:

Dan Feezor
Feezor Engineering, Inc.
406 East Walnut Street
Chatham, IL 62629

Work Order Details:

SDG: **14-11095**
Purchase Order: BT-026-PO1
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	CV	Report Units
14-11095-01	LCS	KNOWN	11/18/14 00:00	11/18/2014	11/20/2014	14-11095	Gross Alpha	EPA 900.0 Modified	2.69E+02	1.16E+01				pCi/l
14-11095-01	LCS	SPIKE	11/18/14 00:00	11/18/2014	11/20/2014	14-11095	Gross Alpha	EPA 900.0 Modified	2.64E+02	3.66E+00	2.91E+01	2.52E-01	4.84E+00	pCi/l
14-11095-02	MBL	BLANK	11/18/14 00:00	11/18/2014	11/20/2014	14-11095	Gross Alpha	EPA 900.0 Modified	3.94E-02	6.81E-02	6.83E-02	1.45E-01	4.74E+00	pCi/l
14-11095-03	DUP	FEE-BRI-W-FADW29206L	11/13/14 00:00	11/18/2014	11/20/2014	14-11095	Gross Alpha	EPA 900.0 Modified	3.05E+01	7.77E+00	8.46E+00	5.36E+00	3.52E+01	pCi/l
14-11095-04	DO	FEE-BRI-W-FADW29206L	11/13/14 00:00	11/18/2014	11/20/2014	14-11095	Gross Alpha	EPA 900.0 Modified	3.37E+01	8.91E+00	9.64E+00	7.82E+00	3.70E+01	pCi/l
14-11095-01	LCS	KNOWN	11/18/14 00:00	11/18/2014	11/20/2014	14-11095	Gross Beta	EPA 900.0 Modified	3.00E+02	8.99E+00				pCi/l
14-11095-01	LCS	SPIKE	11/18/14 00:00	11/18/2014	11/20/2014	14-11095	Gross Beta	EPA 900.0 Modified	2.83E+02	3.14E+00	3.93E+01	5.57E-01	1.88E+00	pCi/l
14-11095-02	MBL	BLANK	11/18/14 00:00	11/18/2014	11/20/2014	14-11095	Gross Beta	EPA 900.0 Modified	1.65E-02	2.51E-01	2.51E-01	5.39E-01	1.79E+00	pCi/l
14-11095-03	DUP	FEE-BRI-W-FADW29206L	11/13/14 00:00	11/18/2014	11/20/2014	14-11095	Gross Beta	EPA 900.0 Modified	6.29E+01	8.23E+00	1.20E+01	1.18E+01	3.20E+01	pCi/l
14-11095-04	DO	FEE-BRI-W-FADW29206L	11/13/14 00:00	11/18/2014	11/20/2014	14-11095	Gross Beta	EPA 900.0 Modified	6.02E+01	7.88E+00	1.15E+01	1.08E+01	2.80E+01	pCi/l
14-11095-01	LCS	KNOWN	11/18/14 00:00	11/18/2014	11/20/2014	14-11095	Radium-226	EPA 903.0 Modified	9.98E+00	4.59E-01				pCi/l
14-11095-01	LCS	SPIKE	11/18/14 00:00	11/18/2014	11/20/2014	14-11095	Radium-226	EPA 903.0 Modified	1.10E+01	1.26E+00	2.65E+00	2.15E-01	1.84E-02	pCi/l
14-11095-02	MBL	BLANK	11/18/14 00:00	11/18/2014	11/20/2014	14-11095	Radium-226	EPA 903.0 Modified	2.46E-02	7.50E-02	7.52E-02	1.78E-01	7.27E-03	pCi/l
14-11095-03	DUP	FEE-BRI-W-FADW29206L	11/13/14 00:00	11/18/2014	11/20/2014	14-11095	Radium-226	EPA 903.0 Modified	1.80E+00	7.50E-01	8.41E-01	3.80E-01	1.41E-02	pCi/l
14-11095-04	DO	FEE-BRI-W-FADW29206L	11/13/14 00:00	11/18/2014	11/20/2014	14-11095	Radium-226	EPA 903.0 Modified	1.70E+00	7.38E-01	8.21E-01	4.50E-01	2.19E-02	pCi/l
14-11095-01	LCS	KNOWN	11/18/14 00:00	11/18/2014	11/24/2014	14-11095	Radium-228	EPA 904.0 Modified	7.38E+00	3.76E-01				pCi/l
14-11095-01	LCS	SPIKE	11/18/14 00:00	11/18/2014	11/24/2014	14-11095	Radium-228	EPA 904.0 Modified	7.82E+00	9.59E-01	2.01E+00	1.38E+00	1.13E-01	pCi/l
14-11095-02	MBL	BLANK	11/18/14 00:00	11/18/2014	11/24/2014	14-11095	Radium-228	EPA 904.0 Modified	6.86E-01	6.48E-01	6.66E-01	1.31E+00	1.11E-01	pCi/l
14-11095-03	DUP	FEE-BRI-W-FADW29206L	11/13/14 00:00	11/18/2014	11/24/2014	14-11095	Radium-228	EPA 904.0 Modified	2.82E+00	5.89E-01	8.69E-01	9.50E-01	9.48E-02	pCi/l
14-11095-04	DO	FEE-BRI-W-FADW29206L	11/13/14 00:00	11/18/2014	11/24/2014	14-11095	Radium-228	EPA 904.0 Modified	2.10E+00	6.93E-01	8.40E-01	1.27E+00	1.09E-01	pCi/l
14-11095-01	LCS	KNOWN	11/18/14 00:00	11/18/2014	11/21/2014	14-11095	Thorium-228	EML Th-01 Modified	5.10E+00	1.84E-01				pCi/l
14-11095-01	LCS	SPIKE	11/18/14 00:00	11/18/2014	11/21/2014	14-11095	Thorium-228	EML Th-01 Modified	5.04E+00	8.42E-01	9.67E-01	1.20E-01	3.52E-02	pCi/l
14-11095-02	MBL	BLANK	11/18/14 00:00	11/18/2014	11/21/2014	14-11095	Thorium-228	EML Th-01 Modified	-2.12E-02	5.74E-02	5.74E-02	1.46E-01	7.56E-02	pCi/l
14-11095-03	DUP	FEE-BRI-W-FADW29206L	11/13/14 00:00	11/18/2014	11/21/2014	14-11095	Thorium-228	EML Th-01 Modified	1.01E+00	4.42E-01	4.53E-01	2.72E-01	6.38E-02	pCi/l
14-11095-04	DO	FEE-BRI-W-FADW29206L	11/13/14 00:00	11/18/2014	11/21/2014	14-11095	Thorium-228	EML Th-01 Modified	9.39E-01	3.64E-01	3.74E-01	1.89E-01	3.81E-02	pCi/l

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (2-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample; MBL=Blank; DUP=Duplicate; TRG=Normal Sample; DO=Duplicate Original; CV=Critical Value

EBERLINE SERVICES

EBERLINE ANALYTICAL CORPORATION
601 SCARBORO ROAD OAK RIDGE, TN 37830 865/481-0683 FAX 865/483-4621

WLLFOIA4312 - 001 - 0030437

Eberline Analytical
Final Report of Analysis

Report To:

Dan Feezor
Feezor Engineering, Inc.
406 East Walnut Street
Chatham, IL 62629

Work Order Details:

SDG: **14-11095**
Purchase Order: BT-026-PO1
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	CV	Report Units
14-11095-01	LCS	KNOWN	11/18/14 00:00	11/18/2014	11/21/2014	14-11095	Thorium-230	EML Th-01 Modified	5.37E+00	1.45E-01				pCi/l
14-11095-01	LCS	SPIKE	11/18/14 00:00	11/18/2014	11/21/2014	14-11095	Thorium-230	EML Th-01 Modified	5.21E+00	8.65E-01	1.08E+00	8.98E-02	3.02E-03	pCi/l
14-11095-02	MBL	BLANK	11/18/14 00:00	11/18/2014	11/21/2014	14-11095	Thorium-230	EML Th-01 Modified	1.38E-01	9.30E-02	9.45E-02	9.35E-02	2.27E-02	pCi/l
14-11095-03	DUP	FEE-BRI-W-FADW29206L	11/13/14 00:00	11/18/2014	11/21/2014	14-11095	Thorium-230	EML Th-01 Modified	1.82E+00	6.21E-01	6.60E-01	1.59E-01	1.41E-02	pCi/l
14-11095-04	DO	FEE-BRI-W-FADW29206L	11/13/14 00:00	11/18/2014	11/21/2014	14-11095	Thorium-230	EML Th-01 Modified	1.60E+00	4.98E-01	5.36E-01	1.70E-01	2.99E-02	pCi/l
14-11095-01	LCS	KNOWN	11/18/14 00:00	11/18/2014	11/21/2014	14-11095	Thorium-232	EML Th-01 Modified	5.10E+00	1.84E-01				pCi/l
14-11095-01	LCS	SPIKE	11/18/14 00:00	11/18/2014	11/21/2014	14-11095	Thorium-232	EML Th-01 Modified	5.00E+00	8.36E-01	9.45E-01	7.85E-02	8.65E-02	pCi/l
14-11095-02	MBL	BLANK	11/18/14 00:00	11/18/2014	11/21/2014	14-11095	Thorium-232	EML Th-01 Modified	1.51E-02	3.78E-02	3.78E-02	7.86E-02	8.06E-02	pCi/l
14-11095-03	DUP	FEE-BRI-W-FADW29206L	11/13/14 00:00	11/18/2014	11/21/2014	14-11095	Thorium-232	EML Th-01 Modified	6.07E-01	3.27E-01	3.32E-01	2.27E-01	2.01E-01	pCi/l
14-11095-04	DO	FEE-BRI-W-FADW29206L	11/13/14 00:00	11/18/2014	11/21/2014	14-11095	Thorium-232	EML Th-01 Modified	6.53E-01	2.93E-01	2.99E-01	1.70E-01	1.50E-01	pCi/l
14-11095-01	LCS	KNOWN	11/18/14 00:00	11/18/2014	11/21/2014	14-11095	Uranium-234	EML U-02 Modified	7.94E+00	2.86E-01				pCi/l
14-11095-01	LCS	SPIKE	11/18/14 00:00	11/18/2014	11/21/2014	14-11095	Uranium-234	EML U-02 Modified	7.24E+00	9.22E-01	1.06E+00	6.23E-02	1.64E-02	pCi/l
14-11095-02	MBL	BLANK	11/18/14 00:00	11/18/2014	11/21/2014	14-11095	Uranium-234	EML U-02 Modified	1.73E-03	2.42E-02	2.42E-02	6.91E-02	1.91E-02	pCi/l
14-11095-03	DUP	FEE-BRI-W-FADW29206L	11/13/14 00:00	11/18/2014	11/21/2014	14-11095	Uranium-234	EML U-02 Modified	9.44E-01	3.12E-01	3.19E-01	1.86E-01	7.22E-02	pCi/l
14-11095-04	DO	FEE-BRI-W-FADW29206L	11/13/14 00:00	11/18/2014	11/21/2014	14-11095	Uranium-234	EML U-02 Modified	1.35E+00	3.93E-01	4.04E-01	1.43E-01	3.77E-02	pCi/l
14-11095-01	LCS	KNOWN	11/18/14 00:00	11/18/2014	11/21/2014	14-11095	Uranium-235	EML U-02 Modified						pCi/l
14-11095-01	LCS	SPIKE	11/18/14 00:00	11/18/2014	11/21/2014	14-11095	Uranium-235	EML U-02 Modified	4.97E-01	1.70E-01	1.74E-01	7.15E-02	6.63E-03	pCi/l
14-11095-02	MBL	BLANK	11/18/14 00:00	11/18/2014	11/21/2014	14-11095	Uranium-235	EML U-02 Modified	-4.84E-03	2.87E-02	2.87E-02	6.81E-02	4.97E-03	pCi/l
14-11095-03	DUP	FEE-BRI-W-FADW29206L	11/13/14 00:00	11/18/2014	11/21/2014	14-11095	Uranium-235	EML U-02 Modified	1.02E-01	1.26E-01	1.26E-01	1.92E-01	3.29E-02	pCi/l
14-11095-04	DO	FEE-BRI-W-FADW29206L	11/13/14 00:00	11/18/2014	11/21/2014	14-11095	Uranium-235	EML U-02 Modified	1.56E-01	1.51E-01	1.51E-01	1.87E-01	2.31E-03	pCi/l
14-11095-01	LCS	KNOWN	11/18/14 00:00	11/18/2014	11/21/2014	14-11095	Uranium-238	EML U-02 Modified	7.74E+00	2.79E-01				pCi/l
14-11095-01	LCS	SPIKE	11/18/14 00:00	11/18/2014	11/21/2014	14-11095	Uranium-238	EML U-02 Modified	7.77E+00	9.77E-01	1.12E+00	5.77E-02	6.90E-03	pCi/l
14-11095-02	MBL	BLANK	11/18/14 00:00	11/18/2014	11/21/2014	14-11095	Uranium-238	EML U-02 Modified	7.36E-03	3.37E-02	3.37E-02	7.88E-02	1.70E-02	pCi/l
14-11095-03	DUP	FEE-BRI-W-FADW29206L	11/13/14 00:00	11/18/2014	11/21/2014	14-11095	Uranium-238	EML U-02 Modified	8.27E-01	2.87E-01	2.93E-01	1.55E-01	3.34E-02	pCi/l
14-11095-04	DO	FEE-BRI-W-FADW29206L	11/13/14 00:00	11/18/2014	11/21/2014	14-11095	Uranium-238	EML U-02 Modified	1.25E+00	3.74E-01	3.85E-01	1.32E-01	1.58E-02	pCi/l

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (2-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample; MBL=Blank; DUP=Duplicate; TRG=Normal Sample; DO=Duplicate Original; CV=Critical Value

021

EBERLINE SERVICES

EBERLINE ANALYTICAL CORPORATION
601 SCARBORO ROAD OAK RIDGE, TN 37830 865/481-0683 FAX 865/483-4621

WLLFOIA4312 - 001 - 0030438

SECTION V

ANALYTICAL STANDARDS

WLLFOIA4312 - 001 - 0030439

QA/QC REVIEWED
Date 1/16/95 Initials VA

U-8

CERTIFICATE OF CALIBRATION
ALPHA STANDARD SOLUTION

Radionuclide:	U-238NAT	Customer:	TMA EBERLINE
Half Life:	(4.468 ± 0.005) x 10^9 years	P.O.No.:	OR2778
Catalog No.:	7338	Reference Date:	January 1 1995 12:00 PST.
Source No.:	479-50	Contained Radioactivity:	(Total U) 8.016 μCi
		Contained Radioactivity:	(Total U) 297 kBq

Description of Solution

a. Mass of solution: 65.2896 g in a 50 ml flame sealed ampoule

b. Chemical form: Uranyl Nitrate in H2O

c. Carrier content: None

d. Density: Approximately 1.3202 g/ml @ 20°C.

Radioimpurities: Refer to attached technical data sheet

Radioactive Daughters: Refer to attached technical data sheet

Radionuclide Concentration

(Total U) 0.1228 μCi/g.

Method of Calibration

Activity calculations are based upon known specific activity and mass.

Uncertainty of Measurement

a. Systematic uncertainty in instrument calibration: ±3.0%

b. Random uncertainty in assay: ±0.0%

c. Random uncertainty in weighing(s): ±2.0%

d. Total uncertainty at the 99% confidence level: ±3.6%

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).

ERIC ALLAS
QUALITY CONTROL

29 DECEMBER 1994
Date Signed

ISOTOPE PRODUCTS LABORATORIES
3017 N. SAN FERNANDO BLVD.
BURBANK, CALIFORNIA 91504
818·843·7000 FAX 818·843·6168

WLLFOIA4312 - 001 - 0030440

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: 9/2/2014 0:00

SOLUTION REFERENCE #: IPL 479-50

SOLUTION #: U-8

Principal Radionuclide	Half Life, Years	Half Life, Days
$^{234,235,238}U$	4.468E+09	1.632E+12

Radionuclide: $^{234,235,238}U$

Reference Date: 1/1/1995 0:00

Certified Activity: 8.016E+00 µCi

Certified Concentration: µCi per gram

Ampoule /Solution Gross	97.6400	Weight, Grams
Empty Ampoule	32.5020	Weight, Grams
Solution Net	65.1380	Weight, Grams
Total Activity in Ampoule	8.0160	µCi

Chemical Composition of Standard Solution

Uranyl nitrate in dilute HNO_3

Dilution Instructions:

Dilution Solvent Used: 1M HNO_3

Dilute to a volume of 1000.00 milliliters

Certified Total Activity of 8.0160 µCi Which Equals 1.780E+07 dpm at the date listed above

And after dilution the activity of this solution is 1.77955E+04 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: July 30, 2015

Verified & Approved By _____ Date: 9/2/2014 0:00

QC Approval _____ Date: 9/3/14

024

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
Solution Reference # IPL 479-50

Date 9/2/2014 0:00
Solution # U-8a

Principal Radionuclide	Half Life, Years	Half Life, Days
$^{234,235,238}U$	4.468E+09	1.632E+12

Radionuclide of Interest $^{234,235,238}U$
Parent Solution Conc. 1.7796E+04 dpm/ml

Reference Date 1/1/1995 0:00

Chemical Composition of Standard Solution
Uranly Nitrate in 1M HNO_3

Dilution Instructions:

Dilution Solvent Used 1M HNO_3

SECONDARY VOLUMETRIC DILUTION

Vol. Parent Solution: 4.0000 ml
Total Activity: 7.1182E+04 dpm
Final Volume: 1000.00 ml

Final Activity Concentration: 7.1182E+01 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.

NOTES:

Isotopic Distribution as:
U-238 Atom % = 48.239 U-238 = 71.182 dpm/ml X 0.48249 = 34.345 dpm/ml
U-235 Atom % = 2.25 U-235 = 71.182 dpm/ml X 0.0225 = 1.602 dpm/ml
U-234 Atom % = 49.501 U-238 = 71.182 dpm/ml X 0.49501 = 35.236 dpm/ml
All values +/- 3.6%

Isotopic ratios from manufacturer's data sheet

Expiration Date: July 30, 2015

Verified & Approved By _____ Date: 9/2/2014 0:00

QC Approval _____ Date: 9/3/14

025

RECORD COPY

Tracer Solution for Environmental Analysis & Disequilibrium Studies

Product Description & Measurement Certificate

Description	Principal radionuclide:	**uranium 232** (U-232)	Product code: **UDP10050**
	Daughter Nuclide:	Th-228	Batch Number: 92/232/67

Measurement	Reference date:	01 March 2000
	Radioactive concentration U-232	6.739E+03 becquerels per gram of solution
	which is equivalent to	1.821E-01 microcuries per gram of solution
	Mass of solution	5.356 grams
	Volume of solution	5.035 millilitres
	Total activity of U-232	3.61E+04 becquerels
	which is equivalent to	9.76E-01 microcuries

Accuracy

Method of measurement (see reverse of this certificate)
Random uncertainty is: ± 0.7% Systematic uncertainty: ± 0.5%
Overall uncertainty in the radioactive concentration quoted above: ± 1.7%
Overall uncertainty is defined on the reverse of this certificate.

Radionuclidic Purity

Any radioactive impurities measured are listed below, expressed as percentages of the activity of the principle radionuclide at the reference date .

Th-228 and daughter activity removed 2 Feb 2000
U-232 daughters activity will increase with time. By alpha 88% U-232, 12% daughters on 1/3/00

Isotopic Purity

The isotopic composition, expressed as atom per cent at the reference date .

Not measured

Chemical Composition

Calculated weight of U-232, 4.42E-08 grams, as 2M HNO3 solution in a flame sealed glass vial.
This Tracer solution has been produced 'carrier free'.

Physical Data

Recommended half life of uranium 232: 6.980E+01 years
Principle energies of alpha emissions (MeV): 5.263 31.7%, 5.320 68.0%
Branching ratio for alpha emission: 100%
Calculated specific activity of uranium 232: 8.167E+05 Bq per microgram U-232.

Remarks

For safety information and notes to ensure correct usage by all persons handling this radioactive Tracer solution please read the instructions accompanying the package.

AEA Technology operates a quality management system which has been independently audited and approved to ISO 9001.

Approved Signatory

Roger Wiltshire

Project Ref. AE2315

Roger Wiltshire

Prepared and characterised in the UK, for world wide distribution by **Isotrak, AEA Technology, QSA.**

026

AEA Technology is the trading name of AEA Technology plc

WLLFOIA4312 - 001 - 0030443

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: 11/11/2014 0:00

SOLUTION REFERENCE #: AEA/Amersham 92/232/67

SOLUTION #: U-10

Principal Radionuclide	Half Life, Years	Half Life, Days
^{232}U	7.200E+01	2.630E+04

Radionuclide: ^{232}U

Reference Date: 3/1/2000 0:00

Certified Activity: 9.760E-01 µCi

Certified Concentration: µCi per gram

Ampoule /Solution Gross: Weight, Grams

Empty Ampoule: Weight, Grams

Solution Net: Weight, Grams

Total Activity in Ampoule: 0.9760 µCi

Chemical Composition of Standard Solution

$^{232}U(NO_3)_6$ in 2M HNO_3

Dilution Instructions:

Dilution Solvent Used: 2M HNO_3

Dilute to a volume of 1000.00 milliliters

Certified Total Activity of 0.9760 µCi Which Equals 2.167E+06 dpm at the date listed above

And after dilution the activity of this solution is 2.167E+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: November 4, 2015

Verified & Approved By _____ Date: 11/11/2014 0:00

QC Approval _____ Date: 11/3/14

027

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
Solution Reference # AEA/Amersham 92/232/67

Date 11/11/2014 0:00
Solution # U-10a

Principal Radionuclide	Half Life, Years	Half Life, Days
^{232}U	7.200E+01	2.630E+04

Radionuclide of Interest ^{232}U
Parent Solution Conc. 2.167E+03 dpm/ml

Reference Date 3/1/2000 0:00

Chemical Composition of Standard Solution
$^{232}U(NO_3)_6$ in 2M HNO_3

Dilution Instructions:

Dilution Solvent Used 2M HNO_3

SECONDARY VOLUMETRIC DILUTION

Vol. Parent Solution: 10.0000 ml
Total Activity: 2.1670E+04 dpm
Final Volume: 1000.00 ml

Final Activity Concentration: 2.1670E+01 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: November 4, 2015

Verified & Approved By _____ Date: 11/11/2014 0:00

QC Approval _____ Date: 11/13/14

028

QA/QC REVIEWED
Date 10/14/91 Initials WT

CERTIFICATE OF CALIBRATION
ALPHA STANDARD SOLUTION

Received
OCT 14 1991
TMA/Eberline
Oak Ridge Lab

Radionuclide	Th-230	Customer:	TMA EBERLINE
Half Life:	(7.54 ± 0.03) x 10^4 years	P.O.No.:	TT4944
Catalog No.:	7230	Reference Date:	November 1 1991 12:00 PST.
Source No.:	388-116	Contained Radioactivity:	1.036 µCi.

Description of Solution

a. Mass of solution: 5.0042 grams.
b. Chemical form: Th(NO3)4 in 0.1N HNO3
c. Carrier content: None added
d. Density: 1.0016 gram/ml @ 20°C.

Radioimpurities

See attached technical data sheet

Radioactive Daughters

See attached technical data sheet

Radionuclide Concentration

0.207 µCi/gram.

Method of Calibration

Weighed aliquots of the solution were assayed using a liquid scintillation counter.

Uncertainty of Measurement

a. Systematic uncertainty in instrument calibration: ±2.0%
b. Random uncertainty in assay: ±0.5%
c. Random uncertainty in weighing(s): ±0.2%
d. Total uncertainty at the 99% confidence level: ±2.7%

NIST Traceability

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

Notes

1. Nuclear data were taken from "Table of Isotopes", Seventh Edition, edited by Virginia S. Shirley.
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)

QUALITY CONTROL

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EBERLINE SERVICES

QUALITY CONTROL PROGRAM

MP-009

Rev.14; 10/10/2012
Title: Radioactive Reference Standards Solutions & Records

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

CURRENT DATE: 3/1/2014 0:00

SOLUTION REFERENCE #: IPL 388-116

SOLUTION #: Th-1

Principal Radionuclide	Half Life, Years	Half Life, Days
^{230}Th	7.540E+04	2.754E+07

Radionuclide: ^{230}Thorium

Reference Date: 11/1/1991 0:00

Certified Activity: 1.036E+00 µCi

Certified Concentration: µCi per gram

Ampoule /Solution Gross: 9.2660 Weight, Grams

Empty Ampoule: 4.6218 Weight, Grams

Solution Net: 4.6442 Weight, Grams

Total Activity in Ampoule: 1.0360 µCi

Chemical Composition of Standard Solution

$^{230}Th(NO_3)_4$ in 0.1N HNO_3

Dilution Instructions:

Dilution Solvent Used: 0.1N HNO_3

Dilute to a volume of 1000.00 milliliters

Certified Total Activity of 1.0360 µCi Which Equals 2.300E+06 dpm at the date listed above

And after dilution the activity of this solution is 2.300E+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: February 24, 2015

Recertified By _____ Date: 3/1/2014 0:00

QC Approval _____ Date: 3/6/14

030

EBERLINE SERVICES

QUALITY CONTROL PROGRAM
MP-009

Rev.14; 10/10/2012
Title: Radioactive Reference Standards Solutions & Records

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

MP-009
Solution Reference # IPL 388-116

Date 3/1/2014 0:00
Solution # Th-1b

Principal Radionuclide	Half Life, Years	Half Life, Days
^{230}Th	7.540E+04	2.754E+07

Radionuclide of Interest ^{230}Thonum
Parent Solution Conc. 2.30E+03 dpm/ml

Reference Date 11/1/1991 0:00

Chemical Composition of Standard Solution
$^{230}Th(NO_3)_4$ in 0.1N HNO_3

Dilution Instructions:

Dilution Solvent Used 0.1N HNO_3

SECONDARY VOLUMETRIC DILUTION

Vol. Parent Solution: 10.0000 ml
Total Activity: 2.2999E+04 dpm
Final Volume: 1000.00 ml

Final Activity Concentration: 2.2999E+01 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: February 24, 2015

Recertified By _____ Date: 3/1/2014 0:00

Verified & Approved By _____ Date: 3/1/14

QC Approval _____ Date: 3/10/14

031

Th-8

CERTIFICATE OF CALIBRATION
ALPHA STANDARD SOLUTION

Radionuclide:	Th-232	Customer:	TMA EBERLINE
Half Life:	(1.405± 0.006) x 10^10 years	P.O.No.:	VH1632
Catalog No.:	7232	Reference Date:	November 1 1993 12:00 PST.
Source No.:	435-104-2	Contained Radioactivity:	(Th-232) 0.0933 µCi.
		Contained Radioactivity:	(Th-232) 3.45 kBq.

Description of Solution

a. Mass of solution: 11.9712 g (in a 10 ml flame sealed ampoule)

b. Chemical form: Th(NO3)4 in water

c. Carrier content: None added

d. Density: Approx. 1.21 g/ml @ 20°C.

Radioimpurities None detected (other than daughters).

Radioactive Daughters

Ra-228, Ac-228, Th-228, Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Po-212, Tl-208

Radionuclide Concentration

(Th-232) 0.00779 µCi/g.

Method of Calibration

Activity calculations are based upon known specific activity and mass.

Uncertainty of Measurement

a. Systematic uncertainty in instrument calibration: ±3.0%

b. Random uncertainty in assay: ±0.0%

c. Random uncertainty in weighing(s): ±2.0%

d. Total uncertainty at the 99% confidence level: ±3.6%

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).

Anna U. Mra

QUALITY CONTROL

Nov. 8, 1993

Date Signed

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

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
PRIMARY DILUTION RECERTIFICATION
MP 009

CURRENT DATE: 9/2/2014 0:00

SOLUTION REFERENCE #: IPL 435-104-2

SOLUTION #: Th-8

Principal Radionuclide	Half Life, Years	Half Life, Days
^{232}Th, ^{228}Th	1.405E+10	5.132E+12

Radionuclide: $^{232\&228}Th$

Reference Date: 11/1/1993 0:00

Certified Activity: 9.330E-02 µCi

Certified Concentration: µCi per gram

Ampoule /Solution Gross: 18.8415 Weight, Grams

Empty Ampoule: 6.9296 Weight, Grams

Solution Net: 11.9119 Weight, Grams

Total Activity in Ampoule: 0.0933 µCi

Chemical Composition of Standard Solution

$Th(NO_3)_4$ in H_2O

Dilution Instructions:

Dilution Solvent Used: 1% Nitric Acid

Dilute to a volume of 1000.00 milliliters

Certified Total Activity of 0.0933 µCi Which Equals 2.071E+05 dpm at the date listed above

And after dilution the activity of this solution is 2.071E+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: August 28, 2015

Verified & Approved By _____ Date: 9/2/2014 0:00

QC Approval _____ Date: 9/3/14

033

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 STANDARD SOLUTIONS
SECONDARY DILUTION RECERTIFICATION

MP-009
Solution Reference # IPL 435-104-2

Date 9/2/2014 0:00
Solution # Th-8b

Principal Radionuclide	Half Life, Years	Half Life, Days
$^{228\&232}Th$	1.405E+10	5.132E+12

Radionuclide of Interest $^{228\&232}Th$
Parent Solution Conc. 2.07E+02 dpm/ml

Reference Date 11/1/1993 0:00

Chemical Composition of Standard Solution
$Th(NO_3)_4$ in 1% HNO_3

Dilution Instructions:

Dilution Solvent Used 1% Nitric Acid

SECONDARY VOLUMETRIC DILUTION

Vol. Parent Solution: 500.0000 ml
Total Activity: 1.0355E+05 dpm
Final Volume: 1000.00 ml

Final Activity Concentration: 1.0355E+02 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: August 28, 2015

Verified & Approved By _____ Date: 9/2/2014 0:00

QC Approval _____ Date: 9/3/14

034

Th-18

Isotope Products Laboratories
An Eckert & Ziegler Company

24937 Avenue Tibbitts
Valencia, California 91355

Tel 661•309•1010
Fax 661•257•8303

CERTIFICATE OF CALIBRATION
ALPHA STANDARD SOLUTION

Radionuclide:	Th-229	**Customer:**	EBERLINE SERVICES
Half-life:	7340 ± 160 years	**P.O. No.:**	00009633
Catalog No.:	7229	**Reference Date:**	15-Jan-02 12:00 PST
Source No.:	867-54	**Contained Radioactivity: (Th-229 only)**	1.013 µCi 37.48 kBq

Physical Description:

A. Mass of solution: 5.0147 g in 5 mL flame-sealed ampoule
B. Chemical form: $Th(NO_3)_4$ in 0.1M HNO_3
C. Carrier content: 10µg Th/mL
D. Density: 1.0016 g/mL @ 20°C.

Radioimpurities:

None detected (daughters in equilibrium)

Radionuclide Concentration: 0.2020 µCi/g, 7.474 kBq/g

Method of Calibration:

This source was prepared from a weighed aliquot of solution whose activity in µCi/g was determined using gamma ray spectrometry.

Peak energy used for integration: 193.5 keV
Branching ratio used: 0.0441 gammas per decay

Uncertainty of Measurement:

A. Type A (random) uncertainty: ± 0.7 %
B. Type B (systematic) uncertainty: ± 3.0 %
C. Uncertainty in aliquot weighing: ± 0.0 %
D. Total uncertainty at the 99% confidence level: ± 3.1 %

Notes:

- See reverse side for leak test(s) performed on this source.
- IPL participates in a 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).
- Nuclear data was taken from IAEA Technical Report Series No. 261.
- This solution has a working life of 5 years.

Quality Control — 9-Jan-02 Date Signed — IPL Ref. No.: 867-54

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
PRIMARY DILUTION RECERTIFICATION
MP 009

CURRENT DATE: 9/2/2014 0:00

SOLUTION REFERENCE #: IPL 867-54

SOLUTION #: Th-18

Principal Radionuclide	Half Life, Years	Half Life, Days
^{229}Th	7.340E+03	2.681E+06

Reference Date: 1/15/2002 0:00

Radionuclide: ^{229}Th
Certified Activity: 1.013E+00 µCi
Certified Concentration: µCi per gram

Ampoule /Solution Gross: 8.7752 Weight, Grams
Empty Ampoule: 3.7591 Weight, Grams
Solution Net: 5.0161 Weight, Grams
Total Activity in Ampoule: 1.0130 µCi

Chemical Composition of Standard Solution

$^{229}Th(NO_3)_4$ in 0.1M HNO_3

Dilution Instructions:

Dilution Solvent Used: 0.1 M HNO_3

Dilute to a volume of 1000.00 milliliters

Certified Total Activity of 1.0130 µCi Which Equals 2.249E+06 dpm at the date listed above

And after dilution the activity of this solution is 2.249E+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: August 28, 2015

Verified & Approved By _____ Date: 9/2/2014 0:00

QC Approval _____ Date: 9/3/14

036

EBERLINE SERVICES

QUALITY CONTROL PROGRAM
MP-009

Rev.7; 9/29/99
Title: Radioactive Reference Standards Solutions & Records

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

MP-009
Solution Reference # IPL 867-54

Date 9/2/2014 0:00
Solution # Th-18a

Principal Radionuclide	Half Life, Years	Half Life, Days
^{229}Th	7.340E+03	2.681E+06

Radionuclide of Interest ^{229}Th
Parent Solution Conc. 2.25E+03 dpm/ml

Reference Date 1/15/2002 0:00

Chemical Composition of Standard Solution
$TH(NO_3)_4$ in 0.1M HNO_3

Dilution Instructions:

Dilution Solvent Used 0.1M HNO_3

SECONDARY VOLUMETRIC DILUTION

Vol. Parent Solution: 10.0000 ml
Total Activity: 2.2490E+04 dpm
Final Volume: 1000.00 ml

Final Activity Concentration: 2.2490E+01 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.

NOTES:

Expiration Date: August 28, 2015

Verified & Approved By _____ Date: 9/2/2014 0:00

QC Approval _____ Date: 9/3/14

037

CERTIFICATE OF CALIBRATION
ALPHA STANDARD SOLUTION

Ra-5
QA/QC REVIEWED
Date 2/8/94 Initials MT

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. Kuen
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: 11/11/2014 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

Reference Date: 2/1/1994 0:00

Certified Activity: 1.001E+00 µCi

Certified Concentration: µCi per gram

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

$^{226}Ra(NO_3)_2$ 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: October 24, 2015

Verified & Approved By _____ Date: 11/11/2014

QC Approval _____ Date: 11/13/14

039

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
Solution Reference # IPL-453-26

Date 11/11/2014 0:00
Solution # Ra-5b

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

Radionuclide of Interest ^{226}Radium
Parent Solution Conc. 2.22E+03 dpm/ml

Reference Date 2/1/1994 0:00

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
Total Activity: 4.4440E+04 dpm
Final Volume: 1000.00 ml

Final Activity Concentration: 4.4440E+01 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.

NOTES:

Expiration Date: October 24, 2015

Verified & Approved By _____ Date: 11/11/2014 0:00

QC Approval _____ Date: 11/13/14

010

RA-11

ANALYTICS

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

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

CERTIFICATE OF CALIBRATION

Standard Radionuclide Source

62680-416

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):	2.585 E3
HALF-LIFE:	5.75 years
CALIBRATION DATE:	November 7, 2001 12:00 EST
TOTAL UNCERTAINTY*:	4.0%
SYSTEMATIC:	3.0%
RANDOM:	1.0%

*99% Confidence Level

Impurities: γ-impurities (other than decay products) <0.1%

5.07198 grams 0.1M HCl solution with 50 μg/g Ba carrier.

P O NUMBER 9508, Item 1 (Part #4339A)

SOURCE PREPARED BY: M. D. Currie
M. D. Currie, Radiochemist

Q A APPROVED: 11/7/01

New vial from the 6/11/01 Shipment.
P.S. Different activity Level
8/9/11

011

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: 3/30/2014 0:00

SOLUTION REFERENCE #: Analytics 62680-416

SOLUTION #: Ra-11

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

Radionuclide: ^{228}Ra

Reference Date: 11/7/2001 0:00

Certified Activity: 6.986E-02 µCi

Certified Concentration: µCi per gram

Ampoule /Solution Gross	9.4982	Weight, Grams
Empty Ampoule	4.4895	Weight, Grams
Solution Net	5.0087	Weight, Grams
Total Activity in Ampoule	0.0699	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 1000.00 milliliters

Certified Total Activity of 0.0699 µCi Which Equals 1.551E+05 dpm at the date listed above

And after dilution the activity of this solution is 1.551E+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: March 11, 2015

Recertified By _____ Date: 3/30/14

QC Approval _____ Date: 3/31/14

042

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.

013

WLLFOIA4312 - 001 - 0030460

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 SOLUTIONS
PRIMARY DILUTION RECERTIFICATION
QCP 009-1

CURRENT DATE: 5/31/2014 0:00

SOLUTION REFERENCE #: NIST SRM4251C

SOLUTION #: Ba-6

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

Radionuclide: ^{133}Barium

Reference Date: 9/1/1993 0:00

Certified Activity: µCi

Certified Concentration: 1.318E+01 µCi per gram

Ampoule /Solution Gross	9.3081	Weight, Grams
Empty Ampoule	4.2582	Weight, Grams
Solution Net	5.0499	Weight, Grams
Total Activity in Ampoule	66.5577	µCi

Chemical Composition of Standard Solution

$^{133}BaCl_2$ in 1M HCl

Dilution Instructions:

Dilution Solvent Used: 1M HCl

Dilute to a volume of 1000.00 milliliters

Certified Total Activity of 66.5577 µCi Which Equals 1.478E+08 dpm at the date listed above

And after dilution the activity of this solution is 1.478E+05 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: May 22, 2015

Verified & Approved By _____ Date: 5/31/14

QC Approval _____ Date: 6/2/14

044

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

Solution Reference # NIST SRM4251C

Date 5/31/14

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: May 22, 2015

Verified & Approved By _____ Date: 5/31/14

QC Approval _____ Date: 6/2/14

045

ANALYTICS

QA/QC REVIEWED
Date 4/30/96 Initials MT

Am-4

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

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

CERTIFICATE OF CALIBRATION

Standard Radionuclide Source

52094-416

Am-241 10 mL Liquid in Flame Sealed Vial

This standard radionuclide source was prepared gravimetrically from a calibrated master liquid radionuclide solution source. The master source was calibrated by liquid scintillation counting.

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:	Am-241
ACTIVITY (dps):	1.975 E+05
HALF-LIFE:	432.2 years
CALIBRATION DATE:	March 19, 1996 12:00 EST
TOTAL ERROR:	3.0%
SYSTEMATIC ERROR:	2.37%
RANDOM ERROR:	0.63%

10.01177 grams of solution 1M HCl.

P O NUMBER OR3830, Item 1

SOURCE PREPARED BY: Kare O'Brie Beverly
K. O. Beverly, Radiochemist

Q A APPROVED: D M. Mal 4-26-96

046

EBERLINE SERVICES

QUALITY CONTROL PROGRAM
RM09

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

EBERLINE SERVICES - OAK RIDGE LABORATORY
RADIOACTIVE REFERENCE STANDARD SOLUTIONS
SECONDARY DILUTION (RE-CERTIFICATION)

Date: 9/2/2014 0:00
Solution Reference #: Analytics 52094-416
Solution #: A/B-7 (alpha)

Principal Radionuclide	Half Life, Years	Half Life, Days
^{241}Americium	4.322E+02	1.579E+05

Radionuclide of Interest: ^{241}Am
Reference Date: 3/19/1996 0:00
Parent Solution Conc.: 1.19E+04 dpm/ml

Chemical Composition of Standard Solution
$^{241}AmCl_3$ in 1M HCL

Dilution Instructions:
Dilution Solvent Used: 1 M HNO_3

SECONDARY VOLUMETRIC DILUTION

Vol. Parent Solution: 60.0000 ml
Total Activity: 7.1100E+05 dpm
Final Volume: 1000.00 ml

Final Activity Concentration: 7.1100E+02 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: August 15, 2015

Verified & Approved By: _____ Date: 9/2/14

QC Approval: _____ Date: 9/2/14

017

Sr-90
13 uCi

National Institute of Standards & Technology

Certificate

Standard Reference Material 4234A
Strontium-90 Radioactivity Standard

This Standard Reference Material (SRM) consists of radioactive strontium-90 chloride, non-radioactive strontium chloride, non-radioactive yttrium 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 beta-particle counting instruments and for the monitoring of radiochemical procedures.

Radiological Hazard

The SRM ampoule contains strontium-90 with a total activity of approximately 13 MBq. Strontium-90 decays by beta-particle emission to yttrium-90, which also decays by beta-particle emission. None of the beta particles escape from the SRM ampoule. The beta particles emitted from strontium-90 and yttrium-90 produce bremsstrahlung photons with energies up to 2 MeV. 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 March 2005.

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
May 1995 (Text only revised November 1997)

Thomas E. Gills, Chief
Standard Reference Materials Program

*Notes and references are on pages 5 and 6.

048

WLLFOIA4312 - 001 - 0030465

EBERLINE SERVICES

QUALITY CONTROL PROGRAM
QCP-009

Rev.7; 9/29/99
Title: Radioactive Reference Standards Solutions & Records

EBERLINE SERVICES - OAK RIDGE LABORATORY
RADIOACTIVE REFERENCE STANDARD SOLUTIONS
SECONDARY DILUTION (RE-CERTIFICATION)

QCP-009-1-A

Solution Reference # NIST 4234A

Date 9/2/2014 0:00

Solution # A/B-7 (beta)

Principal Radionuclide	Half Life, Years	Half Life, Days
^{90}Strontium	2.878E+01	1.051E+04

Radionuclide of interest ^{90}Sr

Parent Solution Conc. 1.52E+06 dpm/ml

Reference Date 3/13/1995 0:00

The beta activity of solution reflects the original ^{90}Strontium concentration and an equal concentration of ^{90}Yttrium.

Chemical Composition of Standard Solution
$^{90}SrCl_2$ in 1 M HCl

Dilution Instructions:

Dilution Solvent Used 1 M HNO_3

SECONDARY VOLUMETRIC DILUTION

Vol. Parent Solution: 0.5000 ml
Total Activity: 7.5764E+05 dpm
Final Volume: 1000.00 ml

Final Activity Concentration: 7.5764E+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.

NOTES:

Expiration Date: August 15, 2015

Verified & Approved By _____ Date: 09/02/14

QC Approval _____ Date: 9/2/14

049

SECTION VI

QUALITY CONTROL SAMPLE RESULTS SUMMARY

WLLFOIA4312 - 001 - 0030467

WO	Analysis	Run	Activity Units	Aliquot Units	Client Name
14-11095	UUISO	1	pCi	I	Feezor Engineering, Inc.

Laboratory Control Sample

Analyte	Normalized Difference	LCS Measured	CSU Measured	LCS Expected	Uncert. Expected	Known	Known Error	Result	CSU	Standard ID	Standard ACT (dpm)	Standard Error	Standard Added (g)
U-234	1.29	91.11%	14.60%	100.00%	3.60%	7.94E+00	2.86E-01	7.24E+00	1.06E+00	U-8a	3.52E+01	3.60E+00	5.01E-01
U-238	0.04	100.33%	14.46%	100.00%	3.60%	7.74E+00	2.79E-01	7.77E+00	1.12E+00	U-8a	3.44E+01	3.60E+00	5.01E-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)

Replicate Sample

Analyte	Normalized Difference	RPD	Original Result	Original CSU	Replicate Result	Replicate CSU
U-234	1.54	35.37	1.35E+00	4.04E-01	9.44E-01	3.19E-01
U-238	1.70	40.47	1.25E+00	3.85E-01	8.27E-01	2.93E-01
U-235	0.54	42.08	1.56E-01	1.51E-01	1.02E-01	1.26E-01

QC Summary

LCS Relative Bias	LCS % R	LCS ND	MS % R	MS ND	Rep RPD	Rep ND
0.91	OK	OK			INV	OK
1.00	OK	OK			INV	OK
	OK	OK			NA	OK

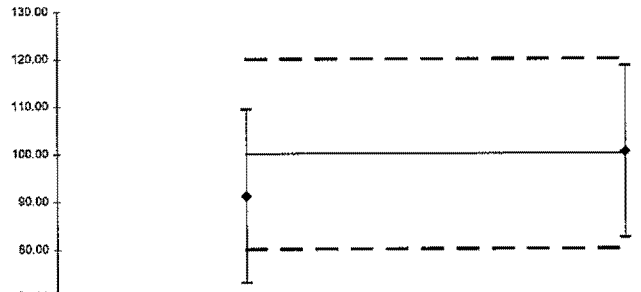
Version

051

WLLFOIA4312 - 001 - 0030468

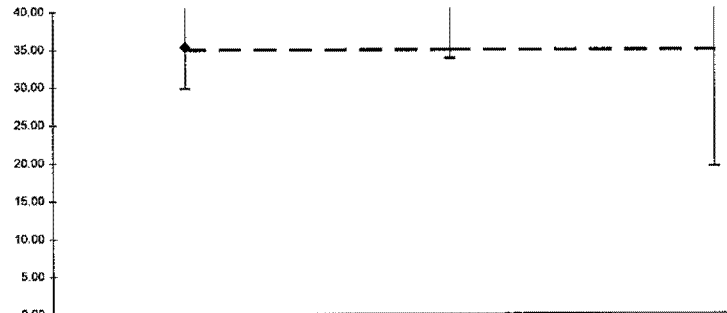
WO	Analysis	Run	Activity Units	Aliquot Units	Client Name
14-11095	UUISO	1	pCi	I	Feezor Engineering, Inc.

LCS % Recovery



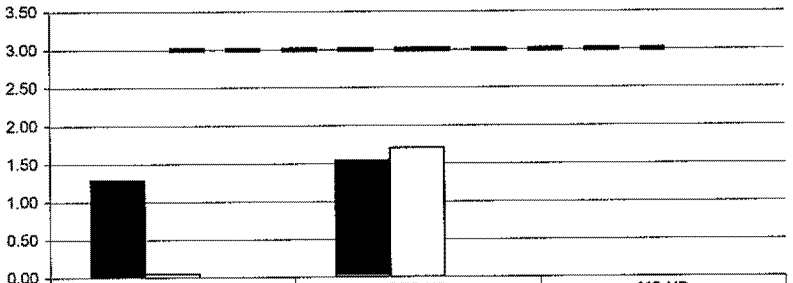
	U-234	U-238
Lower Error	72.90	82.27
Upper Error	109.31	118.39
%R	91.11	100.33
LCL	80	80
Mean	100	100
UCL	120	120

Replicate Sample RPD



	U-234	U-238	U-235
Lower Error	40.95	47.08	64.71
Upper Error	29.79	33.86	19.46
RPD	35.37	40.47	42.08
CL	35	35	35

Normalized Difference



	LCS ND	REP ND	MS ND
U-234	1.29	1.54	0.00
U-238	0.04	1.70	0.00
	0.00	0.00	0.00
UCL	3	3	3

No Matrix Spike

Version

052

WLLFOIA4312 - 001 - 0030469

WO	Analysis	Run	Activity Units	Aliquot Units	Client Name
14-11095	ThISO	1	pCi	I	Feezor Engineering, Inc.

Laboratory Control Sample

Analyte	Normalized Difference	LCS Measured	CSU Measured	LCS Expected	Uncert. Expected	Known	Known Error	Result	CSU	Standard ID	Standard ACT (dpm)	Standard Error	Standard Added (g)
TH-228	0.12	98.83%	19.19%	100.00%	3.60%	5.10E+00	1.84E-01	5.04E+00	9.67E-01	Th-8b	1.04E+02	3.60E+00	1.09E-01
TH-230	0.28	97.15%	20.69%	100.00%	2.70%	5.37E+00	1.45E-01	5.21E+00	1.08E+00	Th-1b	2.35E+01	2.70E+00	5.06E-01
TH-232	0.20	98.09%	18.90%	100.00%	3.60%	5.10E+00	1.84E-01	5.00E+00	9.45E-01	Th-8b	1.04E+02	3.60E+00	1.09E-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)

Replicate Sample

Analyte	Normalized Difference	RPD	Original Result	Original CSU	Replicate Result	Replicate CSU
TH-228	0.24	7.51	9.39E-01	3.74E-01	1.01E+00	4.53E-01
TH-230	0.51	12.93	1.60E+00	5.36E-01	1.82E+00	6.60E-01
TH-232	0.20	7.31	6.53E-01	2.99E-01	6.07E-01	3.32E-01

QC Summary

Analyte	LCS Relative Bias	LCS % R	LCS ND	MS % R	MS ND	Rep RPD	Rep ND
TH-228	0.99	OK	OK			NA	OK
TH-230	0.97	OK	OK			OK	OK
TH-232	0.98	OK	OK			NA	OK

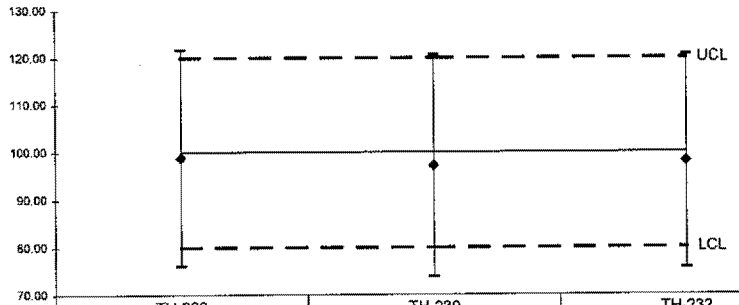
Version

053

WLLFOIA4312 - 001 - 0030470

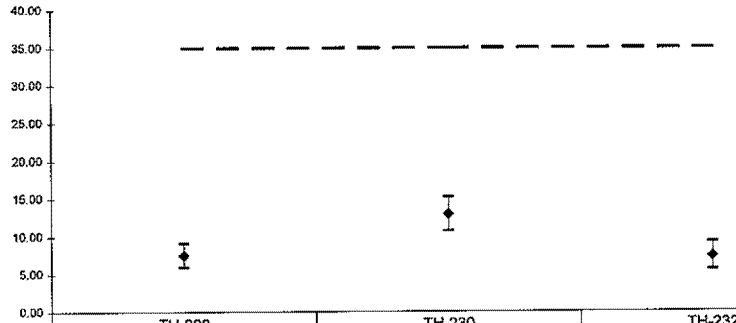
WO	Analysis	Run	Activity Units	Aliquot Units	Client Name
14-11095	ThISO	1	pCi	I	Feezor Engineering, Inc.

LCS % Recovery



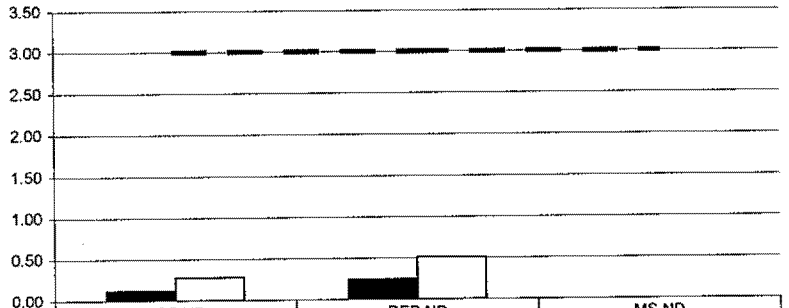
	TH-228	TH-230	TH-232
Lower Error	76.04	73.76	75.58
Upper Error	121.62	120.55	120.59
%R	98.83	97.15	98.09
LCL	80	80	80
Mean	100	100	100
UCL	120	120	120

Replicate Sample RPD



	TH-228	TH-230	TH-232
Lower Error	9.10	15.19	9.14
Upper Error	5.92	10.66	5.48
RPD	7.51	12.93	7.31
CL	35	35	35

Normalized Difference



	LCS ND	REP ND	MS ND
TH-228	0.12	0.24	0.00
TH-230	0.28	0.51	0.00
UCL	3	3	3

No Matrix Spike

Version

WO	Analysis	Run	Activity Units	Aliquot Units	Client Name
14-11095	Ra226	1	pCi	I	Feezor Engineering, Inc.

Laboratory Control Sample

Analyte	Normalized Difference	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	0.76	110.38%	24.04%	100.00%	4.60%	9.98E+00	4.59E-01	1.10E+01	2.65E+00	Ra-5b	4.40E+01	4.60E+00	5.03E-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)

Replicate Sample

Analyte	Normalized Difference	RPD	Original Result	Original CSU	Replicate Result	Replicate CSU
RA-226	0.16	5.62	1.70E+00	8.21E-01	1.80E+00	8.41E-01

QC Summary

LCS Relative Bias	LCS % R	LCS ND	MS % R	MS ND	Rep RPD	Rep ND
1.10	OK	OK			NA	OK

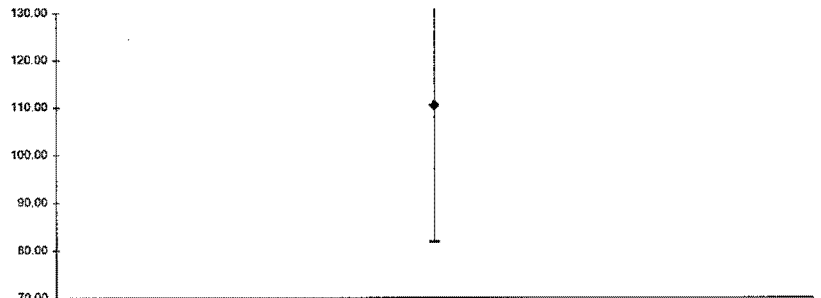
Version

055

WLLFOIA4312 - 001 - 0030472

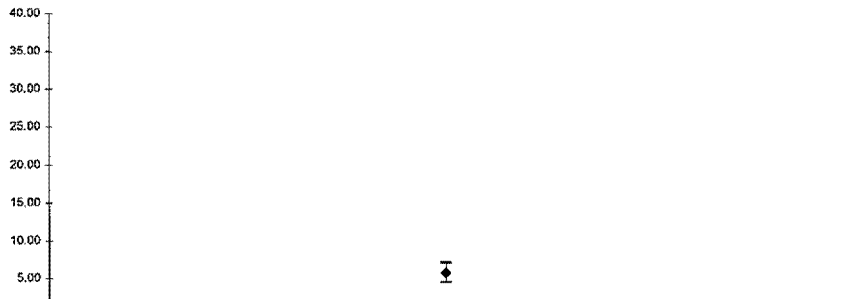
WO	Analysis	Run	Activity Units	Aliquot Units	Client Name
14-11095	Ra226	1	pCi	I	Feezor Engineering, Inc.

LCS % Recovery



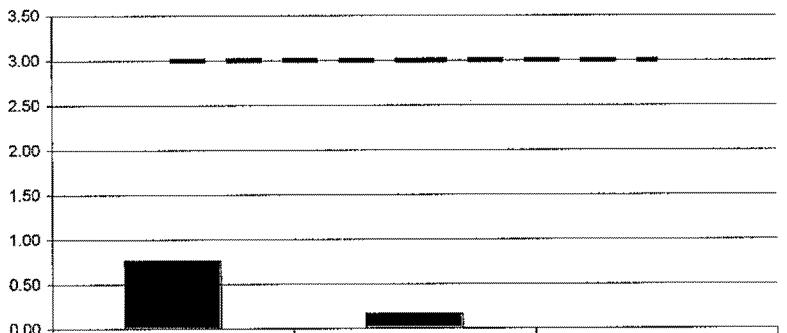
	RA-226
Lower Error	81.73
Upper Error	139.02
%R	110.38
LCL	80
Mean	100
UCL	120

Replicate Sample RPD



	RA-226
Lower Error	6.96
Upper Error	4.29
RPD	5.62
CL	35

Normalized Difference



	LCS ND	REP ND	MS ND
RA-226	0.76	0.16	0.00
*UCL	3	3	3

No Matrix Spike

Version

WLLFOIA4312 - 001 - 0030473

WO	Analysis	Run	Activity Units	Aliquot Units	Client Name
14-11095	Ra228	1	pCi	I	Feezor Engineering, Inc.

Laboratory Control Sample

Analyte	Normalized Difference	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	0.43	105.99%	25.75%	100.00%	5.10%	7.38E+00	3.76E-01	7.82E+00	2.01E+00	Ra-11	3.22E+01	5.10E+00	5.08E-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)

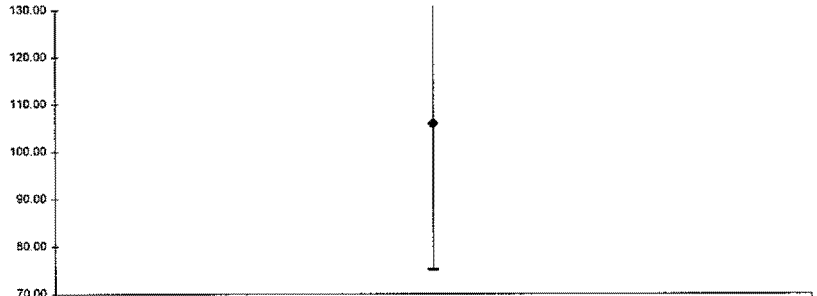
Replicate Sample / QC Summary

Analyte	Normalized Difference	RPD	Original Result	Original CSU	Replicate Result	Replicate CSU	LCS Relative Bias	LCS % R	LCS ND	MS % R	MS ND	Rep RPD	Rep ND
RA-228	1.17	29.41	2.10E+00	8.40E-01	2.82E+00	8.69E-01	1.06	OK	OK			NA	OK

Version

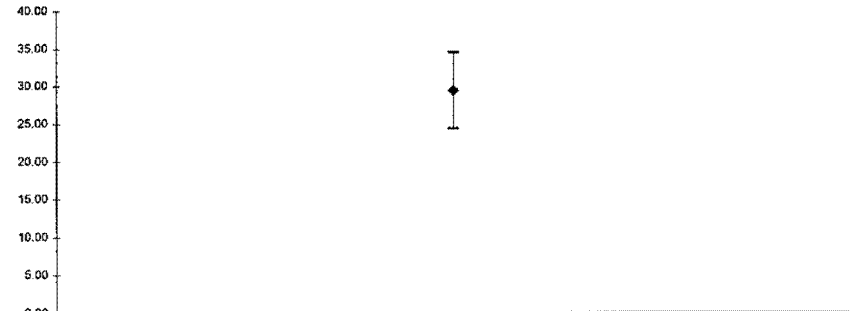
WO	Analysis	Run	Activity Units	Aliquot Units	Client Name
14-11095	Ra228	1	pCi	I	Feezor Engineering, Inc.

LCS % Recovery



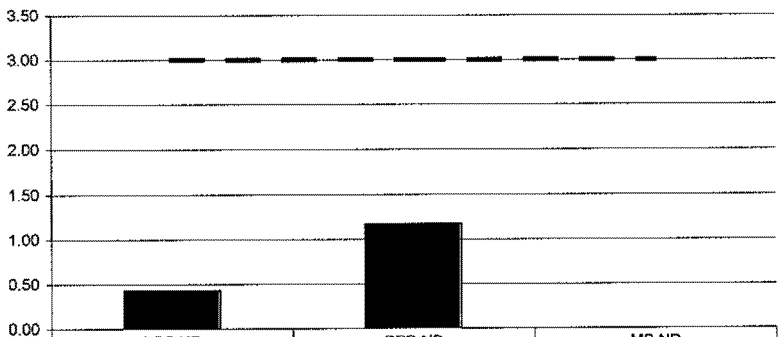
	RA-228
Lower Error	75.14
Upper Error	136.84
%R	105.99
LCL	80
Mean	100
UCL	120

Replicate Sample RPD



	RA-228
Lower Error	34.51
Upper Error	24.30
RPD	29.41
CL	35

Normalized Difference



	LCS ND	REP ND	MS ND
RA-228	0.43	1.17	0.00
UCL	3	3	3

No Matrix Spike

Version

WLLFOIA4312 - 001 - 0030475

Eberline Services
Analysis Control Chart

WO	Analysis	Run	Activity Units	Aliquot Units	Client Name
14-11095	GaGbT_ThSr	1	pCi	I	Feezor Engineering, Inc.

Laboratory Control Sample

Analyte	Normalized Difference	LCS Measured	CSU Measured	LCS Expected	Uncert. Expected	Known	Known Error	Result	CSU	Standard ID	Standard ACT (dpm)	Standard Error	Standard Added (g)
GROSS ALPHA_Th	0.34	98.08%	11.01%	100.00%	4.30%	2.69E+02	1.16E+01	2.64E+02	2.91E+01	A/B-07	5.97E+02	4.30E+00	1.00E+00
GROSS BETA_Sr	0.80	94.58%	13.86%	100.00%	3.00%	3.00E+02	8.99E+00	2.83E+02	3.93E+01	A/B-07	6.64E+02	3.00E+00	1.00E+00

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)

Replicate Sample

Analyte	Normalized Difference	RPD	Original Result	Original CSU	Replicate Result	Replicate CSU
GROSS ALPHA_Th	0.48	9.82	3.37E+01	9.64E+00	3.05E+01	8.46E+00
GROSS BETA_Sr	0.33	4.51	6.02E+01	1.15E+01	6.29E+01	1.20E+01

QC Summary

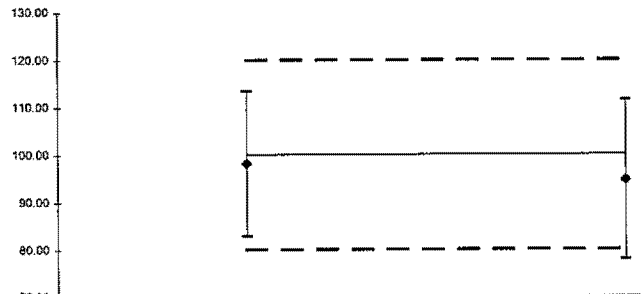
LCS Relative Bias	LCS % R	LCS ND	MS % R	MS ND	Rep RPD	Rep ND
0.98	OK	OK			NA	OK
0.95	OK	OK			OK	OK

Version

WLLFOIA4312 - 001 - 0030476

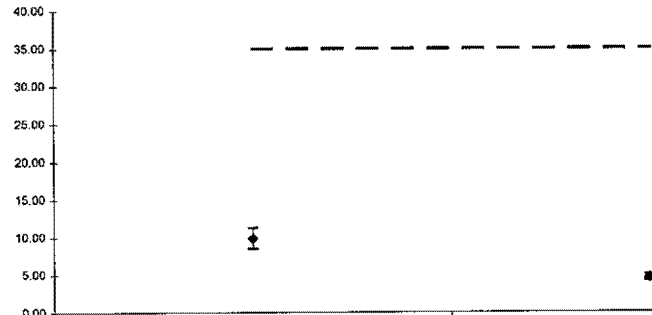
WO	Analysis	Run	Activity Units	Aliquot Units	Client Name
14-11095	GaGbT_ThSr	1	pCi	I	Feezor Engineering, Inc.

LCS % Recovery



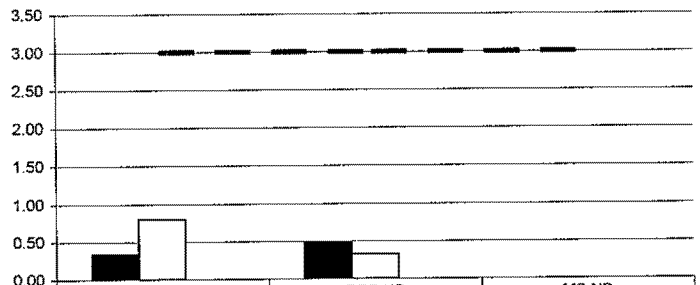
	GROSS ALPHA_Th	GROSS BETA_Sr
Lower Error	82.77	77.71
Upper Error	113.38	111.44
%R	98.08	94.58
LCL	80	80
Mean	100	100
UCL	120	120

Replicate Sample RPD



	GROSS ALPHA_Th	GROSS BETA_Sr
Lower Error	11.21	4.94
Upper Error	8.44	4.08
RPD	9.82	4.51
CL	35	35

Normalized Difference



	LCS ND	REP ND	MS ND
GROSS ALPHA_Th	0.34	0.48	0.00
GROSS BETA_Sr	0.80	0.33	0.00
	0.00	0.00	0.00
UCL	3	3	3

No Matrix Spike

Version

SECTION VII

LABORATORY TECHNICIAN'S NOTES & RUNLOGS

WLLFOIA4312 - 001 - 0030478

ISO-U NOTES

WLLFOIA4312 - 001 - 0030479

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	14-11095
		Analysis Code	UUISO
		Run Number	1

#	Date	Dept	User	Notes
1	11/18/14 16:28	PREP	LWALKER	Spike and trace beakers-aliquot-dry samples down-submit to separations.

LWalker
11/18/14

063

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	14-11095
Analysis Code	UUISO
Run Number	1

#	Date	Dept	User	Notes
1	11/18/14 16:28	PREP	LWALKER	Spike and trace beakers-aliquot-dry samples down-submit to separations.
2	11/19/14 05:48	PREP	JWOLFE	ADDED HNO3 TO ACIDIFY SAMPLES BEFORE DRYING THEM DOWN

JWolfe
11/19/14

064

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	14-11095
		Analysis Code	UUISO
		Run Number	1

#	Date	Dept	User	Notes
1	11/18/14 16:28	PREP	LWALKER	Spike and trace beakers-aliquot-dry samples down-submit to separations.
2	11/19/14 05:48	PREP	JWOLFE	ADDED HNO3 TO ACIDIFY SAMPLES BEFORE DRYING THEM DOWN
3	11/20/14 18:09	CHEM	JDEMELAS	Added concentrated HCl to sample beakers and heated to dryness; Added 20 ml 8N HCL to samples and transferred to new, labeled C-Tubes, rinsing with 8N HCl to bring volume to ~35 ml; Preconditioned resin columns with 35 ml 8N HCl; Centrifuged samples and loaded onto columns; Rinsed C-Tubes with 20 ml 8N HCl, centrifuged as needed and loaded onto columns; Rinsed columns with 35 ml 8N HCl – 0.1N NH4I, 35 ml of 6.5N HCl – 0.04N HF, and 10 ml of 6.5N HCl; Eluted Uranium with 50 ml of 0.5N HCl into clean, labeled 100 ml beakers; Dried-down samples on hotplate; Dissolved samples in ~10 ml of concentrated HCl; Transferred to new, labeled C-Tubes with DI H2O. Set samples aside for later precipitation and filtering.

11/20/14

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	14-11095
Analysis Code	UUISO
Run Number	1

#	Date	Dept	User	Notes
1	11/18/14 16:28	PREP	LWALKER	Spike and trace beakers-aliquot-dry samples down-submit to separations.
2	11/19/14 05:48	PREP	JWOLFE	ADDED HNO3 TO ACIDIFY SAMPLES BEFORE DRYING THEM DOWN
3	11/20/14 18:09	CHEM	JDEMELAS	Added concentrated HCl to sample beakers and heated to dryness; Added 20 ml 8N HCL to samples and transferred to new, labeled C-Tubes, rinsing with 8N HCl to bring volume to ~35 ml; Preconditioned resin columns with 35 ml 8N HCl; Centrifuged samples and loaded onto columns; Rinsed C-Tubes with 20 ml 8N HCl, centrifuged as needed and loaded onto columns; Rinsed columns with 35 ml 8N HCl – 0.1N NH4I, 35 ml of 6.5N HCl – 0.04N HF, and 10 ml of 6.5N HCl; Eluted Uranium with 50 ml of 0.5N HCl into clean, labeled 100 ml beakers; Dried-down samples on hotplate; Dissolved samples in ~10 ml of concentrated HCl; Transferred to new, labeled C-Tubes with DI H2O. Set samples aside for later precipitation and filtering.
4	11/21/14 04:52	CHEM	TSMITH	Followed steps 12.1.7 to 12.4.5 in AP-005 . (Precipitated and filtered samples for Uranium)

11-21-14
[illegible]

EBERLINE SERVICES

Reagents Used in an Analysis

Internal Work Order	
14-11095	
Analysis Code	Run
UUISO	1

Reagent ID	Reagent Name	Reagent Concentration	Analyst ID	Date Recorded
015780P	Nitric Acid	Reagent Grade	JWOLFE	11/19/2014
015696P	Anion Exchange Resin	Reagent Grade	JDEMELAS	11/20/2014
015797S	HCl - HF	6.5N - 0.04N	JDEMELAS	11/20/2014
015818S	HCl - NH4I	8N - 0.1M	JDEMELAS	11/20/2014
015376D07	Hydrochloric Acid	0.5N	JDEMELAS	11/20/2014
015704S	Hydrochloric Acid	6.5N	JDEMELAS	11/20/2014
015811S	Hydrochloric Acid	8N	JDEMELAS	11/20/2014
015553P	Hydrochloric Acid	Reagent Grade	JDEMELAS	11/20/2014
015779S	Carbon substrate	Solution	TSMITH	11/21/2014
015645P	Hydrofluoric Acid	Reagent Grade	TSMITH	11/21/2014
015720S	Neodymium Carrier	1 mg/ml	TSMITH	11/21/2014
014943P	Reagent Alcohol	Reagent Grade	TSMITH	11/21/2014
015660P	Titanous Chloride	Reagent Grade	TSMITH	11/21/2014

Alpha 1

Date	Sampleset	Client	Time Start	CT Time	Analyst	Seal
11/10/14	Daily Pulse	LOA	1120	10 min	NA	AG
11/15/14	1411022A (1-7)	Teledyne	1207	2 hr 50 min	Ra	AG
11/17	Daily Pulse	UAB	0915	1 min	NA	—
11/18	1411040A (1-4)	UCOM	0846	2 hr	Am-241	—
11/18	1411040A (1-7)	UCOM	0846	2 hr	Am-241	—
11/17/14	1411073A (1-4)	ECC	1353	2 hr 50 min	Ra	KB
11/17/14	1411032A (1-4)	TEC	1649	2 hr 50 min	Ra	KB
11/18	Daily Pulse	UAB	0126	1 min	NA	—
11/18	1411073A (1-4)	Envirochem	0844	2 hr	Un-Iso	—
11/18	1411074A (1-7)	Envirochem	0844	2 hr	Un-Iso	—
11/18/14	1411048A (1-3, 11-13)	TN Dept of Health	1144	16.40 hrs	Np	KB
11/19	Daily Pulse	UAB	0527	1 min	NA	—
11/19	1411078A (1-5)	Boston	0840	2 hr	Am-241	—
11/19	1411071A (1,2)	United	0840	2 hr	Un-Iso	—
11/20	Daily Pulse	UAB	0124	1 min	NA	—
11/20	1411049A (1-7)	USA	0831	2h	Th-Iso	—
11/20/14	1411050A (10, 16-20)	USA	1128	2 hr 50 min	Th	KB
11/21	Daily Pulse	UAB	0905	1 min	NA	—
11/21	1411095A (1-4)	Teledyne	0835	2 hr	Un-Iso	—
11/21	1411095A (1-7)	Teledyne	0840	2 hr	Th-Iso	—

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ISO-TH NOTES

WLLFOIA4312 - 001 - 0030486

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	14-11095
Analysis Code	ThISO
Run Number	1

#	Date	Dept	User	Notes
1	11/18/14 16:29	PREP	LWALKER	Spike and trace beakers-aliquot-dry samples down-submit to separations.

L Walker
11/18/14

070

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	14-11095
		Analysis Code	ThISO
		Run Number	1

#	Date	Dept	User	Notes
1	11/18/14 16:29	PREP	LWALKER	Spike and trace beakers-aliquot-dry samples down-submit to separations.
2	11/19/14 05:48	PREP	JWOLFE	ADDED HNO3 TO ACIDIFY SAMPLES BEFORE DRYING THEM DOWN

JWolfe 11/19/14

071

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	14-11095
Analysis Code	ThISO
Run Number	1

#	Date	Dept	User	Notes
1	11/18/14 16:29	PREP	LWALKER	Spike and trace beakers-aliquot-dry samples down-submit to separations.
2	11/19/14 05:48	PREP	JWOLFE	ADDED HNO3 TO ACIDIFY SAMPLES BEFORE DRYING THEM DOWN
3	11/20/14 18:10	CHEM	JDEMELAS	Added concentrated HNO3 to sample beakers and heated to dryness; Added 20 ml 8N HNO3 to samples and transferred to new, labeled C-Tubes, adding 8N HNO3 to bring volume to ~35 ml; Preconditioned resin columns with 50 ml 8N HNO3; Centrifuged samples as needed, and passed through columns; Rinsed C-Tubes with 20 ml 8N HNO3; Centrifuged rinsates and loaded onto columns; Rinsed columns with 40 ml 8N HNO3; Eluted Thorium with 50 ml of 8N HCl into clean, labeled 100-ml beakers; Dried-down samples on hotplate; Dissolved samples in ~10 ml of concentrated HCl; Transferred to new, labeled C-Tubes with deiononized water, bringing volume to ~15ml. Set samples aside for later precipitation and filtering.

11/20/14

072

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	14-11095
Analysis Code	ThISO
Run Number	1

#	Date	Dept	User	Notes
1	11/18/14 16:29	PREP	LWALKER	Spike and trace beakers-aliquot-dry samples down-submit to separations.
2	11/19/14 05:48	PREP	JWOLFE	ADDED HNO3 TO ACIDIFY SAMPLES BEFORE DRYING THEM DOWN
3	11/20/14 18:10	CHEM	JDEMELAS	Added concentrated HNO3 to sample beakers and heated to dryness; Added 20 ml 8N HNO3 to samples and transferred to new, labeled C-Tubes, adding 8N HNO3 to bring volume to ~35 ml; Preconditioned resin columns with 50 ml 8N HNO3; Centrifuged samples as needed, and passed through columns; Rinsed C-Tubes with 20 ml 8N HNO3; Centrifuged rinsates and loaded onto columns; Rinsed columns with 40 ml 8N HNO3; Eluted Thorium with 50 ml of 8N HCl into clean, labeled 100-ml beakers; Dried-down samples on hotplate; Dissolved samples in ~10 ml of concentrated HCl; Transferred to new, labeled C-Tubes with deiononized water, bringing volume to ~15ml. Set samples aside for later precipitation and filtering.
4	11/21/14 04:55	CHEM	TSMITH	Followed steps 12.2.4 to 12.4.5 in AP-005 . (Precipitated and filtered samples for Thorium)

11-21-14
JMR

073

EBERLINE SERVICES

Reagents Used in an Analysis

Internal Work Order	
14-11095	
Analysis Code	Run
ThISO	1

Reagent ID	Reagent Name	Reagent Concentration	Analyst ID	Date Recorded
015780P	Nitric Acid	Reagent Grade	JWOLFE	11/19/2014
015696P	Anion Exchange Resin	Reagent Grade	JDEMELAS	11/20/2014
015811S	Hydrochloric Acid	8N	JDEMELAS	11/20/2014
015553P	Hydrochloric Acid	Reagent Grade	JDEMELAS	11/20/2014
015810S	Nitric Acid	8N	JDEMELAS	11/20/2014
015687P	Nitric Acid	Reagent Grade	JDEMELAS	11/20/2014
015815S	Nitric Acid	8N	JDEMELAS	11/20/2014
015779S	Carbon substrate	Solution	TSMITH	11/21/2014
015645P	Hydrofluoric Acid	Reagent Grade	TSMITH	11/21/2014
014943P	Reagent Alcohol	Reagent Grade	TSMITH	11/21/2014
015789S	Cerrium Carrier	0.1mg/ml	TSMITH	11/21/2014

Alpha #3

Date	Sample	Client	Time	CT Time	Analysis	Tech
11/18/14	1411043A (14-15)	TN Dept. of Health	1144	16.40 hrs	Np	RB
11/18/14	1411048A (1-3, 10-15)	TN Dept of Health	1145	16-40 hrs	Am241	RB
11/18/14	1411037A (5-12)	Shinpei Tanno	1146	2hr50-	UU	RB
11/18/14	1411033A (1-4)	TEC	1147	2hr50-	Ra	RB
11/18/14	1411034A (1-4)	TEC	1208	2hr50-	Ra	RB
11/18/14	1411035A (1-4)	TEC	1443	2hr50-	Ra	RB
11/18/14	1411036A (1-4)	TEC	1444	2hr50-	Ra	RB
11/18	Daily Pulse	UAB	0524	1	[illegible]	C
11/18	1411071A (3-7)	United	0840	2hr-	Un250	C
11/18	1411077A (1-6)	Shinpei	0841	2hr-	Pu250	C
11/18	1411078A (1-4)	Boston	0842	2hr-	Pu250	C
11/18	1411022A (1-7)	TBE	0842	2hr-	Th250	C
11/19	1411022A (8-17)	TBE	1138	2hr-	Th250	C
11/19/14	1411022A (2)	TBE	1534	2hr50-	Th	RB
11/20	Daily Pulse	UAB	0524	1	[illegible]	C
11/20	1411049A (8-20)	USA	0872	2hr-	Th250	C
11/20	1411050A (1-15)	USA	0873	2hr-	Th250	C
11/20/14	1411052A (1-8)	Accutest	1130	2hr50-	Ra	RB
11/20/14	1411095A (1-4)	Feezor	1130	2hr50-	Ra	RB
11/20/14	1411070A (1-4)	TEC	1131	2hr50-	Ra	RB
11/20/14	1411069A (1-4)	Northtrey	1133	2hr50-	Ra	RB
11/20/14	1411075A (1-7)	PCC	1134	2hr50-	Th	RB
11/20/14	1411065A (1-4)	Accutest	1428	2hr50-	Ra	RB
11/20/14	1411057A (1-3, 6)	UCOR	1429	2hr50-	Ra	RB
11/20/14	1411031A (1-8)	United	1434	2hr50-	Pu	RB
11/20	Daily Pulse	UAB	0500	1	[illegible]	C
11/20	SECCAL (7-48)	UAB	0516	2hr-	Am	C
11/20	SECCAL (48-60)	UAB	0757	2hr-	Am	C
11/20	1411085A (4)	Feezor	0840	2hr-	Th250	C
11/20	1411077A (1-7, 9)	Shinpei	0841	2hr-	Am241	C
11/20	1411057A (1-7, 9)	UCOR	0841	2hr-	Pu250	C
11/20/14	1411057ANT (6)	UCOR	0842	2hr-	Pu NT	C
11/20	1411057A (1-7, 6)	UCOR	0842	2hr-	Am241	C
11/20	1411057ANT (6)	UCOR	0843	2hr-	U NT	C

WLLFOIA4312 - 001 - 0030492

Alpha 1

Date	Sampleff	Client	Time	CT Time	Analysis	Tech
11/10/14	Daily Pulse	Lab	1120	10 min	NA	AG
11/10/14	1411022A (1-7)	Teledyne	1207	2 hr 50 min	Ra	AG
11/12	Daily Pulse	UAB	0915	1 min	NA	—
11/12	1411040A (1-4)	UCOM	0846	2 hr	Am-241	C
11/12	1411040A (1-7)	UCOM	0846	2 hr	Am-241	C
11/17/14	1411073A (1-4)	ECC	1353	2 hr 50 min	Ra	KB
11/17/14	1411032A (1-4)	TEC	1649	2 hr 50 min	Ra	KB
11/18	Daily Pulse	UAB	0126	1 min	NA	—
11/18	1411074A (1-4)	Envirochem	0844	2 hr	U-238	—
11/18	1411074A (1-7)	Envirochem	0844	2 hr	U-238	—
11/18/14	1411048A (1-3, 10-13)	TN Dept of Health	1144	16.40 hrs	Np	KB
11/19	Daily Pulse	UAB	0527	1 min	NA	—
11/19	1411078A (1-5)	Boston	0840	2 hr	Am-241	C
11/19	1411031A (1,2)	United	0840	2 hr	U-238	—
11/20	Daily Pulse	UAB	0124	1 min	NA	—
11/20	1411049A (1-7)	USA	0871	2 h	Th-230	—
11/20/14	1411050A (10, 16-20)	USA	1128	2 hr 50 min	Th	KB
11/21	Daily Pulse	UAB	0500	1 min	NA	—
11/21	1411095A (1-4)	Tracor	0875	2 hr	U-238	—
11/21	1411095A (1-7)	Tracor	0840	2 hr	Th-230	—

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RA-226 NOTES

WLLFOIA4312 - 001 - 0030494

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	14-11095
		Analysis Code	Ra226
		Run Number	1

#	Date	Dept	User	Notes
1	11/18/14 16:35	PREP	LWALKER	Spike and trace beakers-aliquot samples-put on stir plate and ph to 2.8-3.0-added Ba and Pb carriers-added 20mls Ammonium Sulfate-let stir and settle. Decant-transfer to c-tubes-centrifuge-pour off supernate and submit precip to separations.

L Walker
11/18/14

078

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	14-11095
		Analysis Code	Ra226
		Run Number	1

#	Date	Dept	User	Notes
1	11/18/14 16:35	PREP	LWALKER	Spike and trace beakers-aliquot samples-put on stir plate and ph to 2.8-3.0-added Ba and Pb carriers-added 20mls Ammonium Sulfate-let stir and settle. Decant-transfer to c-tubes-centrifuge-pour off supernate and submit precip to separations.
2	11/19/14 13:42	CHEM	RMARTZ	ADDED EDTA TO SAMPLES AND LET SIT OVERNIGHT. SYRINGE FILTERED SAMPLES, ADDED AMMONIUM SILFIDE AND ACETIC ACID TO SAMPLES. FILTERED ONTO TARRED FILTER PAPERS, LET DRY UNDER HEAT LAMP, REWEIGHED, AND SUBMITTED TO COUNT.

Oak Ridge Laboratory

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

11/19/14

Oak Ridge Laboratory

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

EBERLINE SERVICES

Reagents Used in an Analysis

Internal Work Order	
14-11095	
Analysis Code	Run
Ra226	1

Reagent ID	Reagent Name	Reagent Concentration	Analyst ID	Date Recorded
015304P	Ammonium Hydroxide	Reagent Grade	LWALKER	11/18/2014
015398D01	Ammonium Sulfate	200 mg/ml	LWALKER	11/18/2014
015186D07	Barium Carrier	1 mg/ml	LWALKER	11/18/2014
015203D01	Lead Carrier	166 mg/ml	LWALKER	11/18/2014
015780P	Nitric Acid	Reagent Grade	LWALKER	11/18/2014
013818P	Acetic Acid	Reagent Grade	RMARTZ	11/19/2014
014409D01	Ammonium Sulfate	200 mg/ml	RMARTZ	11/19/2014
015500S	EDTA	0.25M	RMARTZ	11/19/2014

080

Alphabetic

Date	Alphabetic	Client	Time	CT Time	Analyst	Tech
11/18/14	1411048A (14-15)	TN Dept. of Health	1144	16:40 hrs	Np	KB
11/18/14	1411048A (1-3, 10-15)	TN Dept of Health	1145	16:40 hrs	Am24	KB
11/18/14	1411037A (5-12)	Shinpei Tanno	1146	2hr50-	LLL	KB
11/18/14	1411033A (1-4)	TEC	1147	2hr50-	Rale	KB
11/18/14	1411034A (1-4)	TEC	1208	2hr50-	Rale	KB
11/18/14	1411035A (1-4)	TEC	1443	2hr50-	Rale	KB
11/18/14	1411036A (1-4)	TEC	1444	2hr50-	Rale	KB
11/18	Daily Pull	UAB	0524	1	"	C
11/18	1411031A (1-7)	United	0840	2hr-	LLZ50	C
11/18	1411032A (1-6)	Shinpei	0841	2hr-	PLZ50	C
11/18	1411028A (1-4)	Boston	0842	2hr-	PLZ50	C
11/18	1411022A (1-7)	TBE	0847	2hr-	TLZ50	C
11/18	1411022A (8-17)	TBE	1138	2hr-	TLZ50	C
11/19/14	1411022A (2)	TBE	1534	2hr50-	Th	KB
11/20	Daily Pull	UAB	0524	1	"	C
11/20	1411049A (8-20)	USA	0872	2hr-	TLZ50	C
11/20	1411050A (1-15)	USA	0873	2hr-	TLZ50	C
11/20/14	1411052A (1-9)	Accutest	1130	2hr50-	Rale	KB
11/20/14	1411095A (1-4)	Feezor	1130	2hr50-	Rale	KB
11/20/14	1411070A (1-4)	TEC	1131	2hr50-	Rale	KB
11/20/14	1411069A (1-4)	Northtroy	1133	2hr50-	Rale	KB
11/20/14	1411075A (1-7)	PCC	1134	2hr50-	Th	KB

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RA-228 NOTES

WLLFOIA4312 - 001 - 0030499

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	14-11095
		Analysis Code	Ra228
		Run Number	1

#	Date	Dept	User	Notes
1	11/18/14 16:35	PREP	LWALKER	Spike and trace beakers-aliquot samples-put on stir plate and ph to 2.8-3.0-added Ba and Pb carriers-added 20mls Ammonium Sulfate-let stir and settle. Decant-transfer to c-tubes-centrifuge-pour off supernate and submit precip to separations.

LWalker
11/18/14

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	14-11095
		Analysis Code	Ra228
		Run Number	1

#	Date	Dept	User	Notes
1	11/18/14 16:35	PREP	LWALKER	Spike and trace beakers-aliquot samples-put on stir plate and ph to 2.8-3.0-added Ba and Pb carriers-added 20mls Ammonium Sulfate-let stir and settle. Decant-transfer to c-tubes-centrifuge-pour off supernate and submit precip to separations.
2	11/24/14 06:39	CHEM	RMARTZ	ADDED FILTER PAPERS FROM COUNT ROOM TO LABELED C-TUBES, FILLED WITH EDTA SOLUTION AND LET SIT OVERNIGHT. REMOVED FILTER FROM EDTA-ADDED 13 DROPS CONC HNO3, 2MLS YTTRIUM 9MG/ML CARRIER, 2MLS 1.5MG/ML PB CARRIER, 0.3 MLS AMMONIUM SULFITE, 25 DROPS OF 10M SODIUM HYDROXIDE, SHAKE SAMPLES, CENTRIFUGE, POUR SUPERNATE INTO CLEAN C-TUBE AND ADD 0.3MLS AMMONIUM SULFITE AND 2MLS 1.5MG/ML PB CARRIER, SHAKE SAMPLES, CENTRIFUGE, RINSE OTHER C-TUBES WITH DI-H2O THEN SYRINGE FILTER SUPERNATE BACK INTO RINSED C-TUBES. 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 TARRED FILTER PAPERS. LET DRY UNDER HEAT LAMP, REWEIGHED AND SUBMITTED TO COUNT.

RM 11/24/14

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EBERLINE SERVICES

Reagents Used in an Analysis

Internal Work Order	
14-11095	
Analysis Code	Run
Ra228	1

Reagent ID	Reagent Name	Reagent Concentration	Analyst ID	Date Recorded
015304P	Ammonium Hydroxide	Reagent Grade	LWALKER	11/18/2014
015398D01	Ammonium Sulfate	200 mg/ml	LWALKER	11/18/2014
015186D07	Barium Carrier	1 mg/ml	LWALKER	11/18/2014
015780P	Nitric Acid	Reagent Grade	LWALKER	11/18/2014
015203D01	Lead Carrier	166 mg/ml	LWALKER	11/18/2014

EBERLINE SERVICES

Reagents Used in an Analysis

Internal Work Order	
14-11095	
Analysis Code	Run
Ra228	1

Reagent ID	Reagent Name	Reagent Concentration	Analyst ID	Date Recorded
015304P	Ammonium Hydroxide	Reagent Grade	LWALKER	11/18/2014
015398D01	Ammonium Sulfate	200 mg/ml	LWALKER	11/18/2014
015186D07	Barium Carrier	1 mg/ml	LWALKER	11/18/2014
015780P	Nitric Acid	Reagent Grade	LWALKER	11/18/2014
015203D01	Lead Carrier	166 mg/ml	LWALKER	11/18/2014
013818P	Acetic Acid	Reagent Grade	RMARTZ	11/24/2014
014530S	Ammonium Oxalate	5%	RMARTZ	11/24/2014
014409D01	Ammonium Sulfate	200 mg/ml	RMARTZ	11/24/2014
014594S	Nitric Acid	1N	RMARTZ	11/24/2014
014595S	Nitric Acid	6N	RMARTZ	11/24/2014
014370P	Nitric Acid	Reagent Grade	RMARTZ	11/24/2014
014591S	Sodium Hydroxide	10M	RMARTZ	11/24/2014
014456S	Sodium Hydroxide	18M	RMARTZ	11/24/2014
014466S	Yttrium Carrier	9 mg/ml	RMARTZ	11/24/2014

CB4110 Aqua

Date	Inspect	Clerk	Time	C/Min	Analyst	Tech
11/24	BLC/AC	LAB	0708	6	LB	E
11/24	EZ/AC	LAB	0612	7	LB	
11/24	141105RH(1-4)	Fazor	0877	2L	RHS	C

087

GROSS A/B NOTES

WLLFOIA4312 - 001 - 0030505

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	14-11095
		Analysis Code	GaGbT_ThSr
		Run Number	1

#	Date	Dept	User	Notes
1	11/20/14 08:07	PREP	MHIGHTOWER	Ran TDS/TSS to determine aliquot. Aliquoted samples, dried, nitrated, transferred to tared planchets, dried, flamed, re-weighed, and submitted to count room

MH 20 NOV 14

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EBERLINE SERVICES

Reagents Used in an Analysis

Internal Work Order	
14-11095	
Analysis Code	Run
GaGbT_ThSr	1

Reagent ID	Reagent Name	Reagent Concentration	Analyst ID	Date Recorded
014954D02	Nitric Acid	3N	MHIGHTOWER	11/20/2014

090

CB 4110 Aqua

Date	Sample #	Client	Time Rec'd	Time Out	Analyst	Area
11/17	1411040CL(1-5)	UCON	1112	7	CJG	—
11/17	1410157AB(5-16)	Acoutest	1116	7	LB	—
11/18	Blank	CAS	0721	6	LB	C
11/18	GFTac	CAS	0670	7	LB	
11/18	1411061PB(1-4)	UCON	0717	7	PB210	—
11/18	1411048AB(1-3,11-17)	TN Regs	0808	7	KP272	—
11/19	Blank	CAS	0510	6	LB	C
11/19	GFTac	CAS	0615	7	LB	
11/19	1411025AB(1-7)	Acoutest	0801	7	LB	—
11/19	1411002SR(1-4)	United	0824	7	SR202	—
11/19	1411065AB(1-4)	Acoutest	1115	7	LB	—
11/20	Blank	CAS	0517	6	LB	C
11/20	GFTac	CAS	0622	7	LB	
11/20	1411074AB(1-4)	TEC	0708	7	LB	—
11/20	1411075AB(1-4)	TEC	0710	7	LB	—
11/20	1411073AB(1)	TEC	0712	7	LB	—
11/20	1411076AB(1)	TEC	0744	7	LB	C
11/20	1411076AB(2-4)	TEC	0821	7	LB	—
11/20	1411018SY(1)	UCON	0918	7	SY204	C
11/20	1411019SY(1)	UCON	0918	7	SY204	C
11/20	1411019SY(2-5)	UCON	0955	7	SY204	C
11/20	1411055AB(1-4)	Teledyne	0955	7	LB	—

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SECTION VIII

ANALYTICAL DATA (ISOTOPIC URANIUM)

WLLFOIA4312 - 001 - 0030509

Eberline Services
Oak Ridge Laboratory
Analysis Sheet

14-11095
UUISO
Run 1

Work Order	14-11095
Analysis Code	UUISO
Run	1
Date Received	11/18/2014
Lab Deadline	11/24/2014
Client	Feezor Engineering, Inc.
Project	FEEBRI
Report Level	4
Activity Units	pCi
Aliquot Units	l
Matrix	WA
Method	EML U-02 Modified
Instrument Type	Alpha Spectroscopy
Radiometric Tracer	U-232
Radiometric Sol#	U-10a
Tracer Act (dpm/g)	18.808
Carrier	
Carrier Conc (mg/ml)	

Internal Fraction	Sample Desc	Client ID	Login CPM	Sample Date	Sample Aliquot
01	LCS	LCS		11/18/14 00:00	1.0000E+00
02	MBL	BLANK		11/18/14 00:00	1.0000E+00
03	DUP	FEE-BRI-W-FADW29206L	39	11/13/14 00:00	5.0000E-01
04	DO	FEE-BRI-W-FADW29206L	39	11/13/14 00:00	5.0000E-01

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

Eberline Services
Oak Ridge Laboratory
Analysis Sheet

14-11095
UUISO
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	0.6054	11.4		0.00								
02	MBL	0.6055	11.4		0.00								
03	DUP	0.6057	11.4		0.00								
04	DO	0.6038	11.4		0.00								

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

WLLFOIA4312 - 001 - 0030511

Eberline Services
Oak Ridge Laboratory
Analysis Sheet

14-11095
UUISO
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			11/18/14 16:08	LWALKER				
02	MBL			11/18/14 16:08	LWALKER				
03	DUP			11/18/14 16:08	LWALKER				
04	DO			11/18/14 16:08	LWALKER				

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

WLLFOIA4312 - 001 - 0030512

Eberline Services
Oak Ridge Laboratory

Preliminary Data Report & Analytical Calculations

Work Order: 14-11095-UUISO-1

Client: Feezor Engineering, Inc.
Eberline Services Work Order: 14-11095
Analysis Code: UUISO
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	U-234	LCS	LCS	pCi/l	7.24E+00	9.22E-01	6.23E-02	7.94E+00	91.11	OK		OK	
02	U-234	MBL	BLANK	pCi/l	1.73E-03	2.42E-02	6.91E-02					OK	OK
03	U-234	DUP	FEE-BRI-W-FADW29206L	pCi/l	9.44E-01	3.12E-01	1.86E-01				INV	OK	
04	U-234	DO	FEE-BRI-W-FADW29206L	pCi/l	1.35E+00	3.93E-01	1.43E-01					OK	

Preliminary Data Report & Analytical Calculations
Work Order: 14-11095-UUISO-1

Client: Feezor Engineering, Inc.
Eberline Services Work Order: 14-11095
Analysis Code: UUISO
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	U-234	LCS	11/18/14 00:00	1.00E+00	137.98	0.00	0.00			
02	U-234	MBL	11/18/14 00:00	1.00E+00	121.57	0.00	0.00			
03	U-234	DUP	11/13/14 00:00	5.00E-01	121.91	0.00	0.00			
04	U-234	DO	11/13/14 00:00	5.00E-01	104.70	0.00	0.00			

Preliminary Data Report & Analytical Calculations

Work Order: 14-11095-UUISO-1

Client: Feezor Engineering, Inc.
Eberline Services Work Order: 14-11095
Analysis Code: UUISO
Run: 1

Lab Fraction	Nuclide	Sample Desc	Counting Date/Time	Halflife (days)	Detect	Carrier	Count Time	Counts	Bkg CPM	Eff
01	U-234	LCS	11/21/14 08:39		A_Spec	Alpha_003	170.02	6.55 E+02	4.00 E-03	17.4
02	U-234	MBL	11/21/14 08:39		A_Spec	Alpha_004	170	1.50 E-01	5.00 E-03	18.9
03	U-234	DUP	11/21/14 08:39		A_Spec	Alpha_010	170	4.16 E+01	1.40 E-02	19.2
04	U-234	DO	11/21/14 08:39		A_Spec	Alpha_011	170.02	5.33 E+01	4.00 E-03	20

Eberline Services
Oak Ridge Laboratory

Preliminary Data Report & Analytical Calculations
Work Order: 14-11095-UUISO-1

Client: Feezor Engineering, Inc.
Eberline Services Work Order: 14-11095
Analysis Code: UUISO
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	U-238	LCS	LCS	pCi/l	7.77E+00	9.77E-01	5.77E-02	7.74E+00	100.33	OK		OK	
02	U-238	MBL	BLANK	pCi/l	7.36E-03	3.37E-02	7.88E-02					OK	OK
03	U-238	DUP	FEE-BRI-W-FADW29206L	pCi/l	8.27E-01	2.87E-01	1.55E-01				INV	OK	
04	U-238	DO	FEE-BRI-W-FADW29206L	pCi/l	1.25E+00	3.74E-01	1.32E-01					OK	

Preliminary Data Report & Analytical Calculations
Work Order: 14-11095-UUISO-1

Client	Eberline Services Work Order	Analysis Code	Run
Feezor Engineering, Inc.	14-11095	UUISO	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	U-238	LCS	11/18/14 00:00	1.00E+00	137.98	0.00	0.00			
02	U-238	MBL	11/18/14 00:00	1.00E+00	121.57	0.00	0.00			
03	U-238	DUP	11/13/14 00:00	5.00E-01	121.91	0.00	0.00			
04	U-238	DO	11/13/14 00:00	5.00E-01	104.70	0.00	0.00			

WLLFOIA4312 - 001 - 0030517

Preliminary Data Report & Analytical Calculations
Work Order: 14-11095-UUISO-1

Client: Feezor Engineering, Inc.
Eberline Services Work Order: 14-11095
Analysis Code: UUISO
Run: 1

Lab Fraction	Nuclide	Sample Desc	Counting Date/Time	Halflife (days)	Detect	Carrier	Count Time	Counts	Bkg CPM	Eff
01	U-238	LCS	11/21/14 08:39		A_Spec	Alpha_003	170.02	7.06 E+02	3.00 E-03	17.4
02	U-238	MBL	11/21/14 08:39		A_Spec	Alpha_004	170	6.40 E-01	8.00 E-03	18.9
03	U-238	DUP	11/21/14 08:39		A_Spec	Alpha_010	170	3.66 E+01	8.00 E-03	19.2
04	U-238	DO	11/21/14 08:39		A_Spec	Alpha_011	170.02	4.95 E+01	3.00 E-03	20

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Eberline Services
Oak Ridge Laboratory

Preliminary Data Report & Analytical Calculations

Work Order: 14-11095-UUISO-1

Client: Feezor Engineering, Inc.
Eberline Services Work Order: 14-11095
Analysis Code: UUISO
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	U-235	LCS	LCS	pCi/l	4.97E-01	1.70E-01	7.15E-02					OK	
02	U-235	MBL	BLANK	pCi/l	-4.84E-03	2.87E-02	6.81E-02					OK	OK
03	U-235	DUP	FEE-BRI-W-FADW29206L	pCi/l	1.02E-01	1.26E-01	1.92E-01				NA	OK	
04	U-235	DO	FEE-BRI-W-FADW29206L	pCi/l	1.56E-01	1.51E-01	1.87E-01					OK	

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Preliminary Data Report & Analytical Calculations
Work Order: 14-11095-UUISO-1

Client: Feezor Engineering, Inc.
Eberline Services Work Order: 14-11095
Analysis Code: UUISO
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	U-235	LCS	11/18/14 00:00	1.00E+00	137.98	0.00	0.00			
02	U-235	MBL	11/18/14 00:00	1.00E+00	121.57	0.00	0.00			
03	U-235	DUP	11/13/14 00:00	5.00E-01	121.91	0.00	0.00			
04	U-235	DO	11/13/14 00:00	5.00E-01	104.70	0.00	0.00			

WLLFOIA4312 - 001 - 0030520

Preliminary Data Report & Analytical Calculations
Work Order: 14-11095-UUISO-1

Client: Feezor Engineering, Inc.
Eberline Services Work Order: 14-11095
Analysis Code: UUISO
Run: 1

Lab Fraction	Nuclide	Sample Desc	Counting Date/Time	Halflife (days)	Detect	Carrier	Count Time	Counts	Bkg CPM	Eff
01	U-235	LCS	11/21/14 08:39		A_Spec	Alpha_003	170.02	3.65 E+01	3.00 E-03	17.4
02	U-235	MBL	11/21/14 08:39		A_Spec	Alpha_004	170	-3.40 E-01	2.00 E-03	18.9
03	U-235	DUP	11/21/14 08:39		A_Spec	Alpha_010	170	3.64 E+00	8.00 E-03	19.2
04	U-235	DO	11/21/14 08:39		A_Spec	Alpha_011	170.02	5.00 E+00	0.00 E+00	20

WLLFOIA4312 - 001 - 0030521

Count Room Report
Client: Feezor Engineering, Inc.

14-11095-UUISO-1 (pCi/l) in WA
Tracer ID: U-10a

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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	11/18/14 00:00	1.0000	0.6054	11.3864		0.00		
02	MBL	BLANK	11/18/14 00:00	1.0000	0.6055	11.3882		0.00		
03	DUP	FEE-BRI-W-FADW29206L	11/13/14 00:00	0.5000	0.6057	11.3920		0.00		
04	DO	FEE-BRI-W-FADW29206L	11/13/14 00:00	0.5000	0.6038	11.3563		0.00		

08079
11

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Eberline Services
Oak Ridge Laboratory

Spike and Tracer Worksheet

Printed: 11/18/2014 4:08 PM

Internal Work Order	Run	Analysis Code	Date	Technician	Technician Initials	Witness Initials
14-11095	1	UUISO	11/18/2014 16:03	LWALKER		

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
U-234	U-8a	35.240	11/18/2014	0.500	0.5005				7.94	0.286	0.00	0.000	0.00	0.000	0.00	0.000
U-238	U-8a	34.350	11/18/2014	0.500	0.5005				7.74	0.279	0.00	0.000	0.00	0.000	0.00	0.000
Tc-99 MS	Tc-2a	22043.688	10/16/2013	0.1												

Tracers

fraction	Isotope	Sol #	Activity dpm/g	Solution Date	Volume Used (g)	Approx Addition
01	U-232	U-10a	18.808	11/18/2014	0.6054	0.6400
02	U-232	U-10a	18.808	11/18/2014	0.6055	0.6400
03	U-232	U-10a	18.808	11/18/2014	0.6057	0.6400
04	U-232	U-10a	18.808	11/18/2014	0.6038	0.6400

Balance Printer Tapes

Tracer	LCS
0.6054 g 0.6055 g 0.6057 g 0.6038 g	0.5005 g

Matrix Spike

Version 2.0 08/99

WLLFOIA4312 - 001 - 0030523

Eberline Analytical
Oak Ridge Laboratory

Aliquot Worksheet

Work Order	Run	Analysis Code	Rpt Units	Lab Deadline	Technician
14-11095	1	UUISO	liters	11/24/2014	LWALKER

Lab Fraction	Feezor Engineering, 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	FEE-BRI-W-FADW29206L	DUP					5.0000E-01	5.0000E-01				
04	FEE-BRI-W-FADW29206L	DO					5.0000E-01	5.0000E-01				

Comments	

Technician: L Walker Date: 11/18/14

WLLFOIA4312 - 001 - 0030524

KD 11/21/14

Apex-Alpha™

Sample Description: SPIKE
Spectrum File: \\OR-ALPHA1\Canberra\ApexAlpha\Root\Data\00001030
Batch Identification: 1411095A-UU
Sample Identification: 01
Sample Geometry: Shelf 2
Procedure Description: U iso

Detector Name: Alpha_003
Chamber Serial Number:
Detector Serial Number: 3
Env. Background: System Bkgd 101685
Reagent Blank: <not performed>

Sample Size: 1.000E+000 +/- 0.000E+000 liter
Sample Date/Time: 11/21/2014 6:19:25 AM
Acquisition Date/Time: 11/21/2014 8:39:47 AM
Acquisition Live Time: 170.0 minutes
Acquisition Real Time: 170.0 minutes

Tracer Certificate: U232_UU-10A
Tracer Quantity: 0.605 mL
Effective Efficiency: 0.2404 +/- 0.0125
Counting Efficiency: 0.1742 +/- 0.0031 on 10/25/2014 6:43:48 PM
Chem. Recovery Factor: 1.3798 +/- 0.0757

Control Certificate Name: NatU_U-8A
Chem. Recov. of Control: U-238 0.978035 +/- 0.069248
Peak Match Tolerance: 0.150 MeV

PEAK AREA REPORT

Nuclide		Energy (MeV)	Net Pk Area	Pk Area Error %	Ambient Backgnd	Reagent Backgnd	FWHM (keV)
U-232	T	5.283	462.32	9.12	0.68	0.00E+000	14.9
U-234		4.736	655.32	7.66	0.68	0.00E+000	37.1
U-235		4.385	36.49	32.71	0.51	0.00E+000	5.0
U-238		4.152	706.49	7.38	0.51	0.00E+000	58.4

T = Tracer Peak used for Effective Efficiency

NUCLIDE ANALYSIS RESULTS

Nuclide	Id Conf.	Energy (keV)	Activity (pCi/liter)	MDA (pCi/liter)
U-232	0.997	5302.50*	5.11E+000 +/- 5.20E-001	6.23E-002 +/- 6.34E-003
U-234	0.996	4761.50*	7.24E+000 +/- 9.22E-001	6.23E-002 +/- 6.34E-003
U-235	1.000	4385.50*	4.97E-001 +/- 1.70E-001	7.15E-002 +/- 7.28E-003
U-238	0.992	4184.40*	7.77E+000 +/- 9.77E-001	5.77E-002 +/- 5.87E-003

AG 11/21/14

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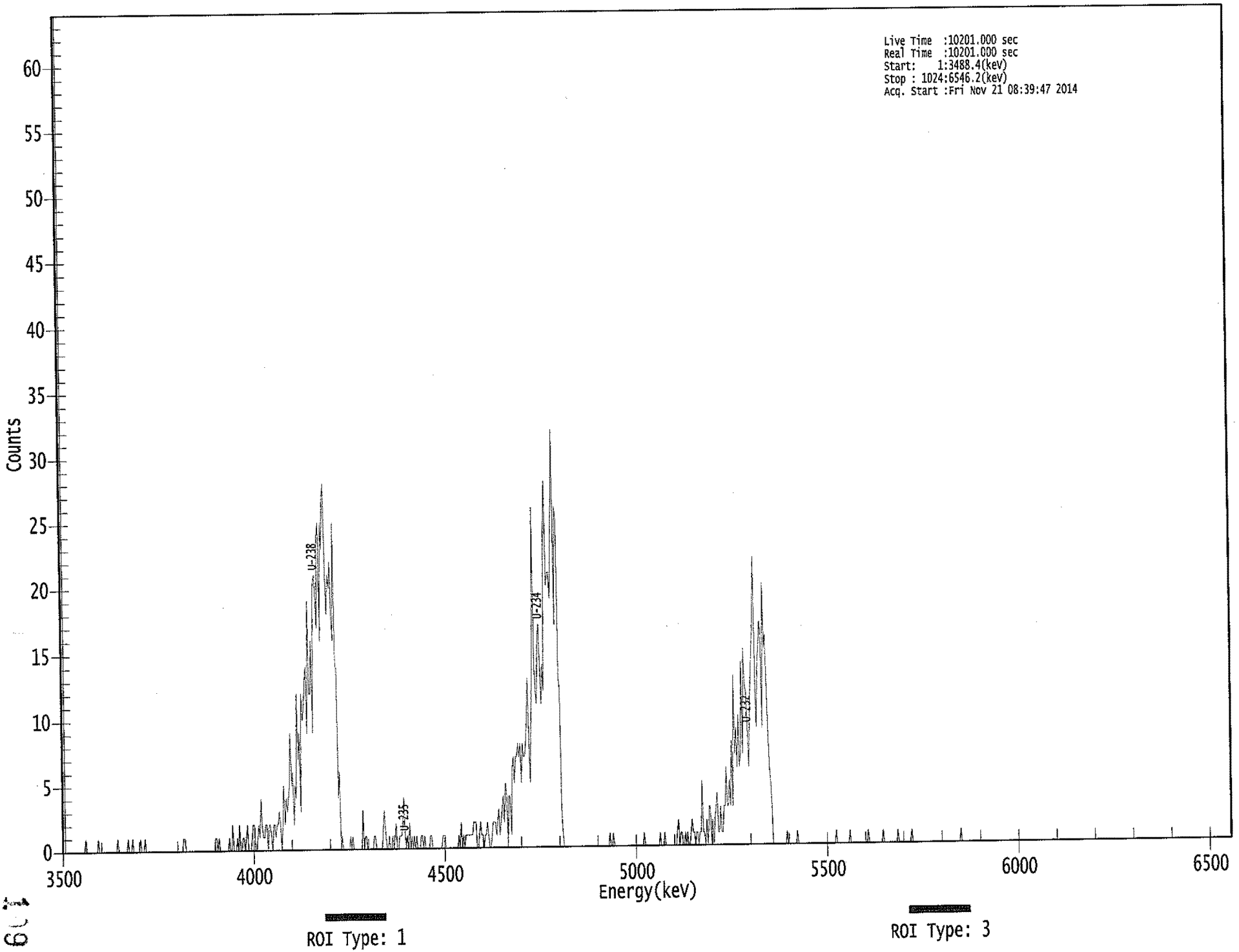
0000103023.CNF



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

Sample Title: 01

Elapsed Live time: 10201
Elapsed Real Time: 10201

Channel								
1:	10201	10201	0	0	0	0	0	0
9:	0	0	0	0	0	0	0	0
17:	0	0	0	0	1	0	0	0
25:	0	0	0	0	0	0	0	1
33:	0	0	0	0	0	0	0	0
41:	0	0	0	0	0	0	0	0
49:	1	0	0	0	0	0	0	0
57:	0	1	0	0	0	1	0	0
65:	0	0	0	0	1	0	0	0
73:	1	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	1	1	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	1	1
137:	0	1	0	0	0	0	0	0
145:	0	0	1	0	0	2	0	0
153:	0	1	0	2	0	0	1	1
161:	0	1	2	0	0	0	1	2
169:	2	0	0	1	2	1	4	2
177:	1	1	2	2	0	2	2	1
185:	0	2	2	1	2	2	3	2
193:	0	2	5	2	4	3	4	5
201:	9	5	6	2	5	4	12	7
209:	9	3	12	10	11	13	14	9
217:	19	12	12	16	9	20	21	20
225:	17	24	25	16	25	23	27	28
233:	21	18	21	20	22	18	16	25
241:	14	14	4	6	0	1	0	0
249:	0	0	0	0	1	0	1	0
257:	0	0	0	0	0	0	0	3
265:	0	1	1	0	0	0	0	0
273:	0	1	1	0	0	0	0	0
281:	0	2	3	1	0	0	1	0
289:	0	1	0	1	2	0	0	1
297:	1	1	2	4	1	0	1	0
305:	2	0	1	0	1	0	1	0
313:	0	0	1	1	0	1	0	0
321:	0	0	1	1	0	0	0	0
329:	0	0	0	0	0	1	1	1
337:	0	0	0	0	0	0	0	0
345:	0	0	0	1	0	2	0	1
353:	0	1	1	1	1	1	1	1
361:	2	2	2	0	0	1	2	1

369:	1	0	1	1	2	1	0	0

Sample Title: 01

Channel								
377:	1	2	2	2	1	2	3	1
385:	2	3	4	2	5	4	0	4
393:	4	1	6	7	5	7	7	8
401:	7	8	5	8	7	7	8	10
409:	13	8	5	10	14	26	14	12
417:	11	16	17	14	11	14	12	24
425:	28	20	21	21	19	23	27	32
433:	17	26	25	13	12	3	1	0
441:	0	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	0	0	0	0
473:	0	0	0	0	0	0	0	1
481:	0	0	1	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	1	0	0
513:	0	0	0	0	0	0	0	0
521:	0	0	0	1	0	0	0	1
529:	0	0	0	0	0	0	0	0
537:	0	0	1	2	0	1	1	0
545:	0	1	0	1	0	0	1	2
553:	1	1	0	1	1	0	1	1
561:	5	1	1	0	2	0	3	3
569:	0	2	0	2	3	4	1	1
577:	3	1	1	3	3	6	3	3
585:	5	3	8	3	13	7	9	6
593:	10	6	7	14	7	15	12	12
601:	9	6	10	13	15	18	22	12
609:	9	14	15	17	16	9	20	15
617:	16	12	9	6	5	3	0	0
625:	0	0	0	0	0	0	0	0
633:	0	0	1	0	0	0	0	0
641:	0	0	0	1	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	0	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	0	0	0	0	0	0	0
705:	0	1	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	1	0	0	0	0
737:	0	0	0	0	0	0	0	1
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	1	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: 01

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	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	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	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	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™

ICB 11/21/14

Sample Description: BLANK
Spectrum File: \\OR-ALPHA1\Canberra\ApexAlpha\Root\Data\00001030
Batch Identification: 1411095A-UU
Sample Identification: 02
Sample Geometry: Shelf 2
Procedure Description: U iso

Detector Name: Alpha_004
Chamber Serial Number:
Detector Serial Number: 4
Env. Background: System Bkgd 101686
Reagent Blank: <not performed>

Sample Size: 1.000E+000 +/- 0.000E+000 liter
Sample Date/Time: 11/21/2014 6:19:25 AM
Acquisition Date/Time: 11/21/2014 8:39:48 AM
Acquisition Live Time: 170.0 minutes
Acquisition Real Time: 170.0 minutes

Tracer Certificate: U232_UU-10A
Tracer Quantity: 0.605 mL
Effective Efficiency: 0.2300 +/- 0.0122
Counting Efficiency: 0.1892 +/- 0.0033 on 10/25/2014 6:43:53 PM
Chem. Recovery Factor: 1.2157 +/- 0.0676

Peak Match Tolerance: 0.150 MeV

PEAK AREA REPORT

Nuclide		Energy (MeV)	Net Pk Area	Pk Area Error %	Ambient Backgnd	Reagent Backgnd	FWHM (keV)
U-232	T	5.279	442.49	9.32	0.51	0.00E+000	24.4
U-234		4.726	0.15	1397.7	0.85	0.00E+000	2.9
U-235		4.397	-0.34	592.91	0.34	0.00E+000	0.0
U-238		4.232	0.64	457.43	1.36	0.00E+000	2.9

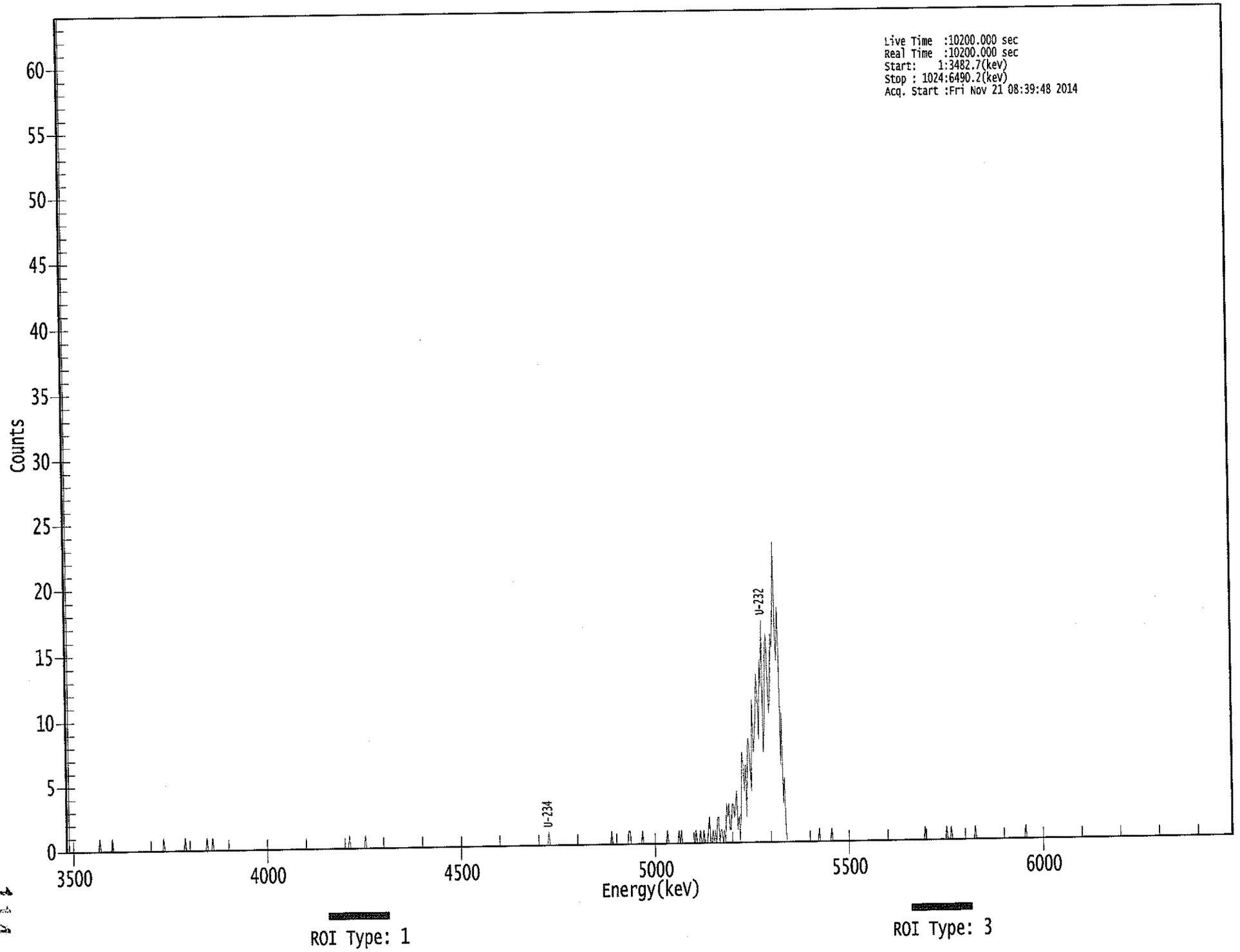
T = Tracer Peak used for Effective Efficiency

NUCLIDE ANALYSIS RESULTS

Nuclide	Id Conf.	Energy (keV)	Activity (pCi/liter)	MDA (pCi/liter)
U-232	0.996	5302.50*	5.11E+000 +/- 5.29E-001	6.06E-002 +/- 6.27E-003
U-234	0.991	4761.50*	1.73E-003 +/- 2.42E-002	6.91E-002 +/- 7.16E-003
U-235	0.999	4385.50*	-4.84E-003 +/- 2.87E-002	6.81E-002 +/- 7.05E-003
U-238	0.984	4184.40*	7.36E-003 +/- 3.37E-002	7.88E-002 +/- 8.16E-003

AG 11/21/14

0000103024.CNF



WLLFOIA4312 - 001 - 0030531

****
***** 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:	10200	10200	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	0	0	1	0	0
33:	0	0	0	0	0	0	0	0
41:	1	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	1	0	0
89:	0	0	0	0	0	0	0	0
97:	0	0	0	0	0	0	0	0
105:	1	0	0	0	0	0	0	0
113:	0	0	0	0	0	0	0	0
121:	0	0	0	1	0	0	0	0
129:	1	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	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	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	0	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:	1	0	0	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	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	0

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	1
425:	0	0	0	0	0	0	0	0
433:	0	0	0	0	0	0	0	0
441:	0	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	0	0	0	0
473:	0	0	0	0	0	0	1	0
481:	0	0	0	0	0	0	0	0
489:	0	0	0	0	0	1	1	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	1
529:	0	0	0	0	0	0	0	0
537:	0	1	0	1	0	0	0	0
545:	0	0	0	0	0	0	0	0
553:	1	0	0	0	1	0	0	1
561:	0	0	0	1	2	0	0	1
569:	0	1	0	2	2	0	1	1
577:	0	1	0	3	2	3	1	1
585:	3	3	2	3	4	1	2	0
593:	3	7	6	4	6	2	8	8
601:	6	4	11	7	8	10	13	11
609:	8	14	12	17	7	9	15	16
617:	13	10	11	16	15	18	23	16
625:	14	18	15	6	10	3	5	1
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	1	0	0	0
665:	0	0	0	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	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	1	0	0	0	0	0	0
761:	0	0	0	0	0	0	0	0
769:	0	0	0	0	1	0	0	0
777:	1	0	0	0	0	0	0	0
785:	0	0	0	0	0	0	0	0
793:	0	0	0	0	0	1	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	0	0	0	0
833:	0	0	0	0	0	0	0	0
841:	0	1	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	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	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	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

WLLFOIA4312 - 001 - 0030534

KB 11/21/14

Apex-Alpha™

Sample Description: FEE-BRI-W-FADW29206L-DUP
Spectrum File: \\OR-ALPHA1\Canberra\ApexAlpha\Root\Data\00001030
Batch Identification: 1411095A-UU
Sample Identification: 03
Sample Geometry: Shelf 2
Procedure Description: U iso

Detector Name: Alpha_010
Chamber Serial Number:
Detector Serial Number: 10
Env. Background: System Bkgd 101687
Reagent Blank: <not performed>

Sample Size: 5.000E-001 +/- 0.000E+000 liter
Sample Date/Time: 11/13/2014 6:19:25 AM
Acquisition Date/Time: 11/21/2014 8:39:45 AM
Acquisition Live Time: 170.0 minutes
Acquisition Real Time: 170.0 minutes

Tracer Certificate: U232_UU-10A
Tracer Quantity: 0.606 mL
Effective Efficiency: 0.2342 +/- 0.0123
Counting Efficiency: 0.1921 +/- 0.0033 on 10/25/2014 6:44:30 PM
Chem. Recovery Factor: 1.2191 +/- 0.0675

Peak Match Tolerance: 0.150 MeV

PEAK AREA REPORT

Nuclide		Energy (MeV)	Net Pk Area	Pk Area Error %	Ambient Backgnd	Reagent Backgnd	FWHM (keV)
U-232	T	5.274	450.60	9.27	3.40	0.00E+000	8.8
U-234		4.724	41.62	31.38	2.38	0.00E+000	4.4
U-235		4.356	3.64	123.16	1.36	0.00E+000	2.9
U-238		4.144	36.64	33.08	1.36	0.00E+000	8.0

T = Tracer Peak used for Effective Efficiency

NUCLIDE ANALYSIS RESULTS

Nuclide	Id Conf.	Energy (keV)	Activity (pCi/liter)	MDA (pCi/liter)
U-232	0.994	5302.50*	1.02E+001 +/- 1.05E+000	2.10E-001 +/- 2.17E-002
U-234	0.990	4761.50*	9.44E-001 +/- 3.12E-001	1.86E-001 +/- 1.92E-002
U-235	0.994	4385.50*	1.02E-001 +/- 1.26E-001	1.92E-001 +/- 1.98E-002
U-238	0.988	4184.40*	8.27E-001 +/- 2.87E-001	1.55E-001 +/- 1.60E-002

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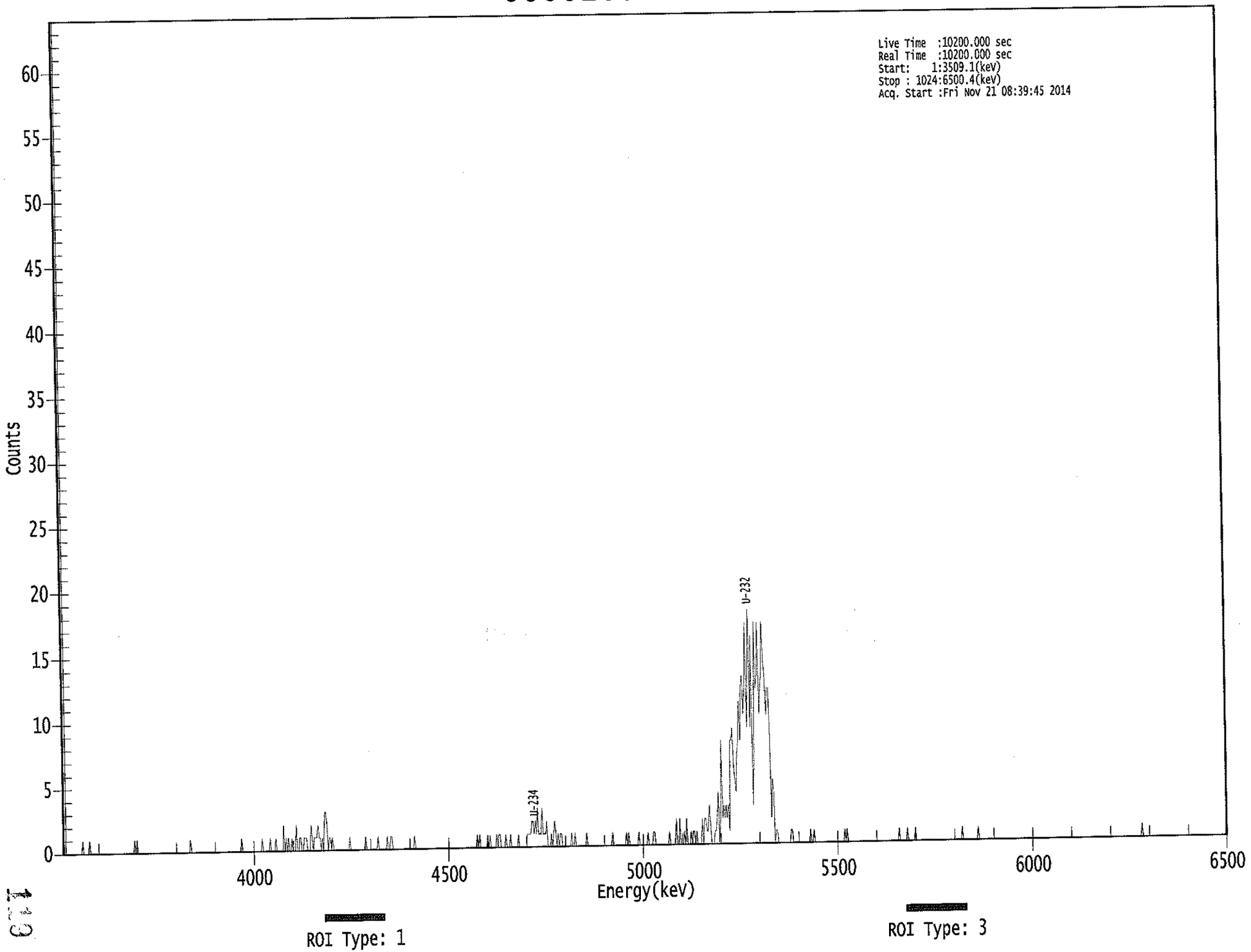
0000103022.CNF



WLLFOIA4312 - 001 - 0030536

****
***** 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:	10200	10200	0	0	0	0	0	0
9:	0	0	0	0	0	0	0	0
17:	0	1	0	0	0	0	0	1
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	1
65:	0	1	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:	1	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	0	0	1	0	0
161:	0	0	0	0	0	0	0	0
169:	0	0	0	0	0	0	0	1
177:	0	0	0	0	0	0	1	0
185:	0	0	0	1	0	0	0	0
193:	0	0	2	0	1	0	1	0
201:	0	1	0	0	0	2	0	0
209:	1	1	0	0	1	1	1	0
217:	0	0	2	1	0	1	1	1
225:	2	1	1	0	1	0	3	3
233:	2	0	1	1	0	1	0	0
241:	0	0	0	0	0	0	0	0
249:	0	0	0	0	1	0	0	0
257:	0	0	0	0	0	0	0	0
265:	0	0	1	0	0	0	0	0
273:	0	0	0	0	0	1	0	0
281:	0	0	0	0	0	1	0	0
289:	1	1	0	0	0	0	0	0
297:	0	0	0	0	0	0	0	0
305:	0	0	0	0	0	1	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	1	0	1	0

369:	0	0	0	0	0	1	0	1

Sample Title: 03

Channel								
377:	0	0	0	0	0	1	0	1
385:	1	0	0	0	0	1	0	0
393:	0	1	0	0	0	0	0	0
401:	1	0	0	0	0	0	0	0
409:	1	1	1	1	2	2	1	2
417:	1	3	1	1	1	3	1	1
425:	1	2	0	0	0	1	0	1
433:	2	1	0	1	0	1	1	0
441:	0	0	0	0	0	0	0	1
449:	0	0	1	0	0	0	0	0
457:	0	0	0	0	1	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	1	0	0	0	0
489:	0	0	0	0	0	0	0	1
497:	0	1	0	0	0	0	0	0
505:	0	0	1	0	0	0	0	0
513:	0	0	1	0	0	0	0	1
521:	1	0	0	0	0	0	0	0
529:	0	0	0	0	0	1	0	0
537:	0	0	0	2	0	0	2	0
545:	0	0	1	0	2	0	0	0
553:	1	0	1	1	0	1	0	0
561:	0	0	2	0	2	2	1	1
569:	3	2	0	0	0	1	1	2
577:	4	0	2	8	2	3	2	3
585:	2	3	1	8	8	9	6	5
593:	4	7	8	11	8	12	13	10
601:	12	17	9	14	18	9	16	3
609:	6	17	12	13	17	10	12	13
617:	17	14	13	10	12	12	9	2
625:	5	4	0	1	1	0	0	0
633:	0	0	0	0	0	0	0	0
641:	1	1	0	0	0	0	0	0
649:	0	0	0	0	0	0	0	0
657:	0	1	0	0	1	0	0	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	1
689:	0	1	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	1
737:	0	0	0	0	0	0	1	0
745:	0	0	0	0	0	1	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	1	0
793:	0	0	0	0	0	0	0	0

801:	0	0	0	0	1	0	0	0

Sample Title: 03

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	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	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	1	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	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™

ICB 11/21/14

Sample Description: FEE-BRI-W-FADW29206L
Spectrum File: \\OR-ALPHA1\Canberra\ApexAlpha\Root\Data\00001030
Batch Identification: 1411095A-UU
Sample Identification: 04
Sample Geometry: Shelf 2
Procedure Description: U iso

Detector Name: Alpha_011
Chamber Serial Number:
Detector Serial Number: 11
Env. Background: System Bkgd 101688
Reagent Blank: <not performed>

Sample Size: 5.000E-001 +/- 0.000E+000 liter
Sample Date/Time: 11/13/2014 6:19:25 AM
Acquisition Date/Time: 11/21/2014 8:39:46 AM
Acquisition Live Time: 170.0 minutes
Acquisition Real Time: 170.0 minutes

Tracer Certificate: U232_UU-10A
Tracer Quantity: 0.604 mL
Effective Efficiency: 0.2098 +/- 0.0115
Counting Efficiency: 0.2004 +/- 0.0035 on 10/25/2014 6:44:33 PM
Chem. Recovery Factor: 1.0470 +/- 0.0603

Peak Match Tolerance: 0.150 MeV

PEAK AREA REPORT

Nuclide		Energy (MeV)	Net Pk Area	Pk Area Error %	Ambient Backgnd	Reagent Backgnd	FWHM (keV)
U-232	T	5.273	402.49	9.78	0.51	0.00E+000	20.3
U-234		4.726	53.32	27.04	0.68	0.00E+000	3.9
U-235		4.421	5.00	96.02	0.00	0.00E+000	2.6
U-238		4.151	49.49	28.03	0.51	0.00E+000	3.1

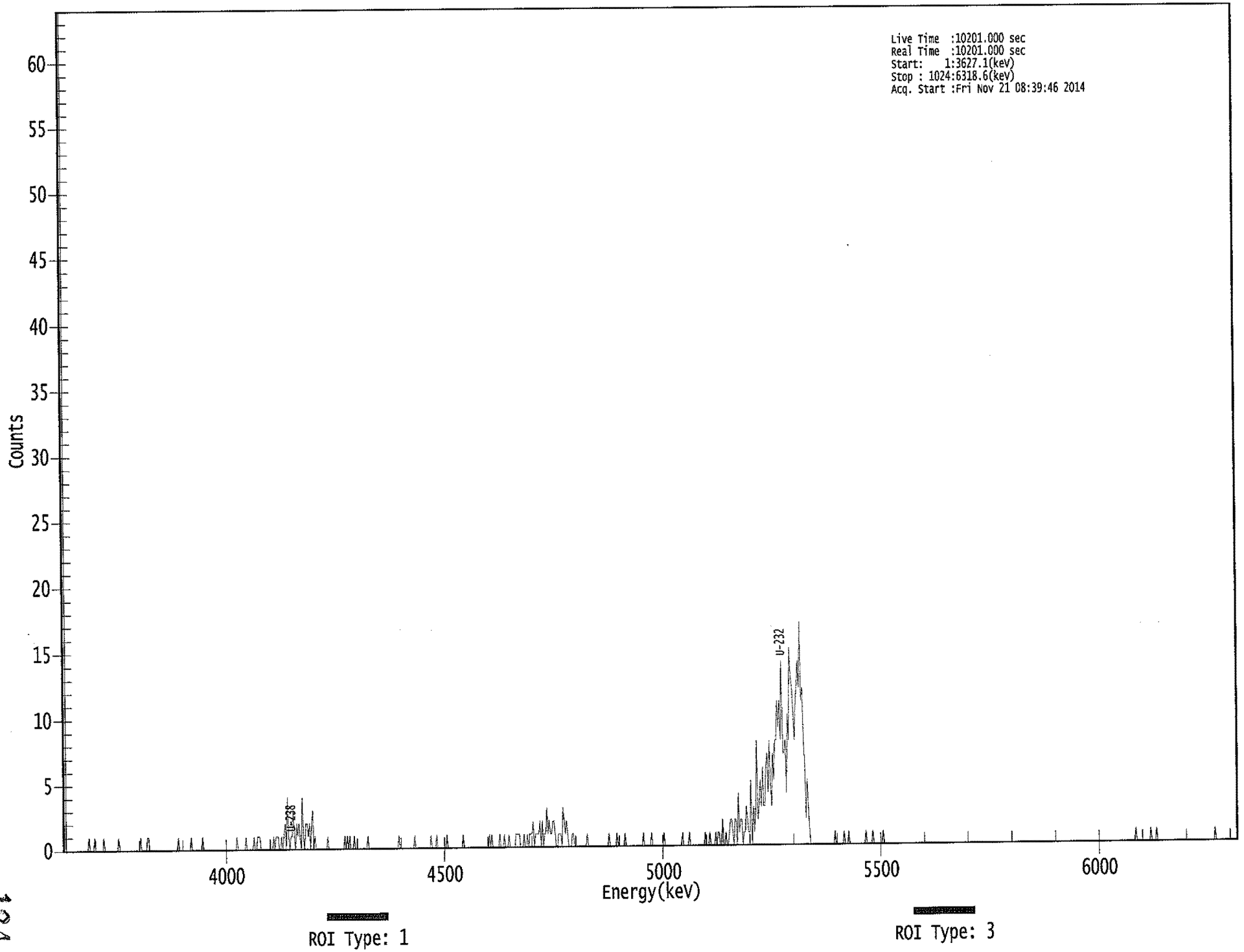
T = Tracer Peak used for Effective Efficiency

NUCLIDE ANALYSIS RESULTS

Nuclide	Id Conf.	Energy (keV)	Activity (pCi/liter)	MDA (pCi/liter)
U-232	0.994	5302.50*	1.02E+001 +/- 1.10E+000	1.33E-001 +/- 1.43E-002
U-234	0.991	4761.50*	1.35E+000 +/- 3.93E-001	1.43E-001 +/- 1.54E-002
U-235	0.991	4385.50*	1.56E-001 +/- 1.51E-001	1.87E-001 +/- 2.02E-002
U-238	0.992	4184.40*	1.25E+000 +/- 3.74E-001	1.32E-001 +/- 1.42E-002

AG 11/21/14

0000103025.CNF



124

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

Sample Title: 04

Elapsed Live time: 10201
Elapsed Real Time: 10201

Channel								
1:	10201	10201	0	0	0	0	0	0
9:	0	0	0	0	0	0	0	0
17:	0	0	0	0	0	0	1	0
25:	0	0	0	1	0	0	0	0
33:	0	0	0	1	0	0	0	0
41:	0	0	0	0	0	0	0	0
49:	1	0	0	0	0	0	0	0
57:	0	0	0	0	0	0	0	0
65:	0	0	0	1	0	0	0	0
73:	0	1	1	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	1	0	0	0
105:	0	0	0	0	0	0	0	1
113:	0	0	0	0	0	0	0	0
121:	0	1	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	1
153:	0	0	0	0	0	0	0	1
161:	0	0	0	0	0	0	1	0
169:	0	1	1	1	0	0	0	0
177:	0	0	0	0	0	0	0	1
185:	0	1	1	1	0	0	1	0
193:	1	2	0	4	1	0	1	1
201:	3	1	0	2	1	2	1	0
209:	4	1	0	2	2	1	2	0
217:	2	3	0	1	0	0	0	0
225:	0	0	0	0	0	0	1	0
233:	0	0	0	0	0	0	0	0
241:	0	0	0	0	0	1	0	1
249:	0	1	0	0	0	1	0	0
257:	0	0	0	0	0	0	0	0
265:	0	1	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	1	0	0	0
297:	0	0	0	0	0	0	0	0
305:	0	0	1	0	0	0	0	0
313:	0	0	0	0	0	0	0	0
321:	1	0	0	0	0	1	0	0
329:	0	0	0	0	0	0	1	0
337:	0	0	0	0	0	0	0	0
345:	0	0	0	0	1	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	1	0	1	0	0

Sample Title: 04

Channel								
377:	0	0	0	0	1	0	0	0
385:	1	0	0	0	1	0	0	0
393:	0	0	1	1	1	1	0	0
401:	0	1	0	0	1	0	1	1
409:	1	2	0	1	1	1	1	2
417:	0	2	0	1	1	3	1	2
425:	1	1	2	2	1	0	0	1
433:	1	1	0	3	2	1	2	1
441:	0	0	0	1	1	0	0	0
449:	0	0	0	0	0	0	0	0
457:	1	0	0	0	0	0	0	0
465:	0	0	0	0	0	0	0	0
473:	0	0	0	1	0	0	0	0
481:	0	0	1	0	0	0	0	0
489:	0	1	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:	1	0	0	0	0	0	0	0
521:	0	0	0	1	0	0	0	0
529:	0	0	0	0	0	0	0	0
537:	0	0	0	1	0	0	0	0
545:	0	1	0	0	0	0	0	0
553:	0	0	0	0	0	0	0	1
561:	0	0	0	1	0	0	0	0
569:	1	0	1	1	0	0	2	0
577:	0	1	0	0	1	2	2	1
585:	0	2	2	0	4	1	2	2
593:	0	1	1	3	2	1	1	5
601:	0	3	1	3	8	2	3	5
609:	3	6	3	3	6	7	4	8
617:	5	3	7	5	8	8	11	9
625:	11	8	14	7	7	8	4	10
633:	8	15	13	12	10	8	11	12
641:	14	12	17	11	12	8	6	2
649:	5	3	1	0	0	0	0	0
657:	0	0	0	0	0	0	0	0
665:	0	0	0	0	0	0	0	0
673:	1	0	0	0	0	0	0	0
681:	1	0	0	0	1	0	0	0
689:	0	0	0	0	0	0	0	0
697:	0	0	0	1	0	0	0	0
705:	0	1	0	0	0	0	0	0
713:	0	0	1	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: 04

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	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	0	0
921:	0	0	0	0	0	0	0	0
929:	0	0	0	0	0	0	1	0
937:	0	0	0	0	0	0	0	0
945:	0	0	0	1	0	0	0	0
953:	1	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	1	0	0	0	0
1009:	0	0	0	0	0	0	0	0
1017:	0	0	0	0	0	0	0	0

11/21/2014 5:20:12 AM

Apex-Alpha™

QA SUMMARY REPORT

Review Of QA Results - Pulser Check

Date : 11/21/2014
Time : 5:20:12 AM

CHAMBER	DEVICE	PARAMETER	FLAG	DATE
Alpha_001	21f	ALL	Not Done	
Alpha_002	21f	ALL	Not Done	
Alpha_003	21f	ALL	Passed	11/21/2014 5:00:18 AM
Alpha_004	21f	ALL	Passed	11/21/2014 5:00:19 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	11/21/2014 5:00:20 AM
Alpha_011	21f	ALL	Passed	11/21/2014 5:00:21 AM
Alpha_012	21f	ALL	Passed	11/21/2014 5:00:21 AM
Alpha_013	21f	ALL	Not Done	
Alpha_014	21f	ALL	Passed	11/21/2014 5:00:22 AM
Alpha_015	21f	Peak FWHM	Action	11/21/2014 5:00:23 AM
Alpha_016	21f	ALL	Not Done	
Alpha_033	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:00:24 AM
Alpha_034	Alpha Analyst100DC	Peak FWHM	Action	11/21/2014 5:00:26 AM
Alpha_035	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:00:27 AM
Alpha_036	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:00:29 AM
Alpha_037	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:00:30 AM
Alpha_038	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:00:32 AM
Alpha_039	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:00:33 AM
Alpha_040	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:00:35 AM
Alpha_041	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:00:37 AM
Alpha_042	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:00:39 AM
Alpha_043	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:00:40 AM
Alpha_044	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:00:42 AM
Alpha_045	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:00:43 AM
Alpha_046	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:00:45 AM
Alpha_047	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:00:47 AM
Alpha_048	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:00:49 AM
Alpha_049	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:00:50 AM
Alpha_050	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:00:52 AM
Alpha_051	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:00:53 AM
Alpha_052	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:00:56 AM
Alpha_053	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:00:58 AM
Alpha_054	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:01:00 AM
Alpha_055	Alpha Analyst100DC	Peak FWHM	Action	11/21/2014 5:01:03 AM
Alpha_056	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:01:06 AM
Alpha_057	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:01:08 AM
Alpha_058	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:01:11 AM

OK AL

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Review of QA Results - Pulser Check

11/21/2014 5:20:12 AM

CHAMBER	DEVICE	PARAMETER	FLAG	DATE
Alpha_059	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:01:14 AM
Alpha_060	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:01:17 AM

APPROVED BY: _____

APPROVAL DATE: 11/21

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

Nuclide Library Title: Uranium

Nuclide Library Description: U-232,-234,-235,-238

Nuclide Name	Half-Life (Seconds)	Energy (keV)	Energy Uncert. (keV)	Yield (%)	Yield Uncert.(Abs.+-)
U-232	2.174E+009	5302.500*	0.000	99.8000	0.0000
U-234	7.731E+012	4761.500*	0.000	99.8000	0.0000
U-235	2.221E+016	4385.500*	0.000	80.9000	0.0000
U-238	1.410E+017	4184.400*	0.000	100.2300	0.0000

* = key line

TOTALS: 4 Nuclides 4 Energy Lines

SECTION IX

ANALYTICAL DATA (ISOTOPIC THORIUM)

WLLFOIA4312 - 001 - 0030548

Eberline Services
Oak Ridge Laboratory
Analysis Sheet

14-11095
ThISO
Run 1

Work Order	14-11095
Analysis Code	ThISO
Run	1
Date Received	11/18/2014
Lab Deadline	11/24/2014
Client	Feezor Engineering, Inc.
Project	FEEBRI
Report Level	4
Activity Units	pCi
Aliquot Units	l
Matrix	WA
Method	EML Th-01 Modified
Instrument Type	Alpha Spectroscopy
Radiometric Tracer	Th-229
Radiometric Sol#	Th-18a
Tracer Act (dpm/g)	22.464
Carrier	
Carrier Conc (mg/ml)	

Internal Fraction	Sample Desc	Client ID	Login CPM	Sample Date	Sample Aliquot
01	LCS	LCS		11/18/14 00:00	1.0000E+00
02	MBL	BLANK		11/18/14 00:00	1.0000E+00
03	DUP	FEE-BRI-W-FADW29206L	39	11/13/14 00:00	5.0000E-01
04	DO	FEE-BRI-W-FADW29206L	39	11/13/14 00:00	5.0000E-01

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

Eberline Services
Oak Ridge Laboratory
Analysis Sheet

14-11095
ThISO
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	0.4455	10.0		0.00								
02	MBL	0.2237	5.0		0.00								
03	DUP	0.2239	5.0		0.00								
04	DO	0.2239	5.0		0.00								

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

14-11095
ThISO
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			11/18/14 15:59	LWALKER				
02	MBL			11/18/14 15:59	LWALKER				
03	DUP			11/18/14 15:59	LWALKER				
04	DO			11/18/14 15:59	LWALKER				

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

WLLFOIA4312 - 001 - 0030551

Eberline Services
Oak Ridge Laboratory

Preliminary Data Report & Analytical Calculations

Work Order: 14-11095-ThISO-1

Client: Feezor Engineering, Inc.
Eberline Services Work Order: 14-11095
Analysis Code: ThISO
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	TH-228	LCS	LCS	pCi/l	5.04E+00	8.42E-01	1.20E-01	5.10E+00	98.83	OK		OK	
02	TH-228	MBL	BLANK	pCi/l	-2.12E-02	5.74E-02	1.46E-01					OK	OK
03	TH-228	DUP	FEE-BRI-W-FADW29206L	pCi/l	1.01E+00	4.42E-01	2.72E-01				NA	OK	
04	TH-228	DO	FEE-BRI-W-FADW29206L	pCi/l	9.39E-01	3.64E-01	1.89E-01					OK	

WLLFOIA4312 - 001 - 0030552

Preliminary Data Report & Analytical Calculations

Work Order: 14-11095-ThISO-1

Client	Eberline Services Work Order	Analysis Code	Run
Feezor Engineering, Inc.	14-11095	ThISO	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	TH-228	LCS	11/18/14 00:00	1.00E+00	91.51	0.00	0.00			
02	TH-228	MBL	11/18/14 00:00	1.00E+00	109.68	0.00	0.00			
03	TH-228	DUP	11/13/14 00:00	5.00E-01	96.88	0.00	0.00			
04	TH-228	DO	11/13/14 00:00	5.00E-01	103.47	0.00	0.00			

WLLFOIA4312 - 001 - 0030553

Preliminary Data Report & Analytical Calculations

Work Order: 14-11095-ThISO-1

Client: Feezor Engineering, Inc.

Eberline Services Work Order: 14-11095

Analysis Code: ThISO

Run: 1

Lab Fraction	Nuclide	Sample Desc	Counting Date/Time	Halflife (days)	Detect	Carrier	Count Time	Counts	Bkg CPM	Eff
01	TH-228	LCS	11/21/14 08:40		A_Spec	Alpha_012	170.02	3.37 E+02	1.30 E-02	19.4
02	TH-228	MBL	11/21/14 08:40		A_Spec	Alpha_014	170.02	-1.61 E+00	3.30 E-02	18.4
03	TH-228	DUP	11/21/14 08:40		A_Spec	Alpha_015	170	2.65 E+01	9.00 E-03	14.4
04	TH-228	DO	11/21/14 08:40		A_Spec	Alpha_033	170	3.28 E+01	7.00 E-03	18

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Eberline Services
Oak Ridge Laboratory

Preliminary Data Report & Analytical Calculations
Work Order: 14-11095-ThISO-1

Run: 1
Analysis Code: ThISO
Eberline Services Work Order: 14-11095
Client: Feezor Engineering, Inc.

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	TH-230	LCS	LCS	pCi/l	5.21E+00	8.65E-01	8.98E-02	5.37E+00	97.15	OK		OK	
02	TH-230	MBL	BLANK	pCi/l	1.38E-01	9.30E-02	9.35E-02					OK	OK
03	TH-230	DUP	FEE-BRI-W-FADW29206L	pCi/l	1.82E+00	6.21E-01	1.59E-01				OK	OK	
04	TH-230	DO	FEE-BRI-W-FADW29206L	pCi/l	1.60E+00	4.98E-01	1.70E-01					OK	

WLLFOIA4312 - 001 - 0030555

Preliminary Data Report & Analytical Calculations
Work Order: 14-11095-ThISO-1

Client	Eberline Services Work Order	Analysis Code	Run
Feezor Engineering, Inc.	14-11095	ThISO	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	TH-230	LCS	11/18/14 00:00	1.00E+00	91.51	0.00	0.00			
02	TH-230	MBL	11/18/14 00:00	1.00E+00	109.68	0.00	0.00			
03	TH-230	DUP	11/13/14 00:00	5.00E-01	96.88	0.00	0.00			
04	TH-230	DO	11/13/14 00:00	5.00E-01	103.47	0.00	0.00			

WLLFOIA4312 - 001 - 0030556

Preliminary Data Report & Analytical Calculations
Work Order: 14-11095-ThISO-1

Client: Feezor Engineering, Inc.
Eberline Services Work Order: 14-11095
Analysis Code: ThISO
Run: 1

Lab Fraction	Nuclide	Sample Desc	Counting Date/Time	Halflife (days)	Detect	Carrier	Count Time	Counts	Bkg CPM	Eff
01	TH-230	LCS	11/21/14 08:40		A_Spec	Alpha_012	170.02	3.48 E+02	0.00 E+00	19.4
02	TH-230	MBL	11/21/14 08:40		A_Spec	Alpha_014	170.02	1.05 E+01	9.00 E-03	18.4
03	TH-230	DUP	11/21/14 08:40		A_Spec	Alpha_015	170	4.78 E+01	1.00 E-03	14.4
04	TH-230	DO	11/21/14 08:40		A_Spec	Alpha_033	170	5.62 E+01	5.00 E-03	18

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Eberline Services
Oak Ridge Laboratory

Preliminary Data Report & Analytical Calculations

Work Order: 14-11095-ThISO-1

Client	Eberline Services Work Order	Analysis Code	Run
Feezor Engineering, Inc.	14-11095	ThISO	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	TH-232	LCS	LCS	pCi/l	5.00E+00	8.36E-01	7.85E-02	5.10E+00	98.09	OK		OK	
02	TH-232	MBL	BLANK	pCi/l	1.51E-02	3.78E-02	7.86E-02					OK	OK
03	TH-232	DUP	FEE-BRI-W-FADW29206L	pCi/l	6.07E-01	3.27E-01	2.27E-01				NA	OK	
04	TH-232	DO	FEE-BRI-W-FADW29206L	pCi/l	6.53E-01	2.93E-01	1.70E-01					OK	

Preliminary Data Report & Analytical Calculations
Work Order: 14-11095-ThISO-1

Client	Eberline Services Work Order	Analysis Code	Run
Feezor Engineering, Inc.	14-11095	ThISO	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	TH-232	LCS	11/18/14 00:00	1.00E+00	91.51	0.00	0.00			
02	TH-232	MBL	11/18/14 00:00	1.00E+00	109.68	0.00	0.00			
03	TH-232	DUP	11/13/14 00:00	5.00E-01	96.88	0.00	0.00			
04	TH-232	DO	11/13/14 00:00	5.00E-01	103.47	0.00	0.00			

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Preliminary Data Report & Analytical Calculations
Work Order: 14-11095-ThISO-1

Client: Feezor Engineering, Inc.
Eberline Services Work Order: 14-11095
Analysis Code: ThISO
Run: 1

Lab Fraction	Nuclide	Sample Desc	Counting Date/Time	Halflife (days)	Detect	Carrier	Count Time	Counts	Bkg CPM	Eff
01	TH-232	LCS	11/21/14 08:40		A_Spec	Alpha_012	170.02	3.34 E+02	3.00 E-03	19.4
02	TH-232	MBL	11/21/14 08:40		A_Spec	Alpha_014	170.02	1.15 E+00	5.00 E-03	18.4
03	TH-232	DUP	11/21/14 08:40		A_Spec	Alpha_015	170	1.60 E+01	0.00 E+00	14.4
04	TH-232	DO	11/21/14 08:40		A_Spec	Alpha_033	170	2.30 E+01	0.00 E+00	18

WLLFOIA4312 - 001 - 0030560

Count Room Report
Client: Feezor Engineering, Inc.

14-11095-ThISO-1 (pCi/l) in WA
Tracer ID: Th-18a

0840 12
15
77

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	11/18/14 00:00	1.0000	0.4455	10.0077		0.00		
02	MBL	BLANK	11/18/14 00:00	1.0000	0.2237	5.0252		0.00		
03	DUP	FEE-BRI-W-FADW29206L	11/13/14 00:00	0.5000	0.2239	5.0297		0.00		
04	DO	FEE-BRI-W-FADW29206L	11/13/14 00:00	0.5000	0.2239	5.0297		0.00		

WLLFOIA4312 - 001 - 0030561

Eberline Services
Oak Ridge Laboratory

Spike and Tracer Worksheet

Printed: 11/18/2014 3:59 PM

Internal Work Order	Run	Analysis Code	Date	Technician	Technician Initials	Witness Initials
14-11095	1	ThISO	11/18/2014 15:51	LWALKER		

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
Th-228	Th-8b	103.560	11/18/2014	0.100	0.1093				5.10	0.184	0.00	0.000	0.00	0.000	0.00	0.000
Th-230	Th-1b	23.525	11/18/2014	0.500	0.5063				5.37	0.145	0.00	0.000	0.00	0.000	0.00	0.000
Th-232	Th-8b	103.560	11/18/2014	0.100	0.1093				5.10	0.184	0.00	0.000	0.00	0.000	0.00	0.000
Tc-99 MS	Tc-2a	22043.688	10/16/2013	0.1												

Tracers

fraction	Isotope	Sol #	Activity dpm/g	Solution Date	Volume Used (g)	Approx Addition
01	Th-229	Th-18a	22.464	11/18/2014	0.4455	0.2200
02	Th-229	Th-18a	22.464	11/18/2014	0.2237	0.2200
03	Th-229	Th-18a	22.464	11/18/2014	0.2239	0.2200
04	Th-229	Th-18a	22.464	11/18/2014	0.2239	0.2200

Balance Printer Tapes

Tracer

0.4455 g
0.2237 g
0.2239 g
0.2239 g

LCS

0.1093 g
0.5063 g

Matrix Spike

Version 2.0 08/99

WLLFOIA4312 - 001 - 0030562

Eberline Analytical
Oak Ridge Laboratory

Aliquot Worksheet

Work Order	Run	Analysis Code	Rpt Units	Lab Deadline	Technician
14-11095	1	ThISO	liters	11/24/2014	LWALKER

Lab Fraction	Feezor Engineering, 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	FEE-BRI-W-FADW29206L	DUP					5.0000E-01	5.0000E-01				
04	FEE-BRI-W-FADW29206L	DO					5.0000E-01	5.0000E-01				

Comments	

146

Technician: LWalker Date: 11/18/14

WLLFOIA4312 - 001 - 0030563

KB 11/21/14

Apex-Alpha™

Sample Description: SPIKE
Spectrum File: \\OR-ALPHA1\Canberra\ApexAlpha\Root\Data\00001030
Batch Identification: 1411095A-TH
Sample Identification: 01
Sample Geometry: Shelf 2
Procedure Description: Th iso

Detector Name: Alpha_012
Chamber Serial Number:
Detector Serial Number: 12
Env. Background: System Bkgd 101689
Reagent Blank: <not performed>

Sample Size: 1.000E+000 +/- 0.000E+000 liter
Sample Date/Time: 11/21/2014 6:24:56 AM
Acquisition Date/Time: 11/21/2014 8:40:18 AM
Acquisition Live Time: 170.0 minutes
Acquisition Real Time: 170.0 minutes

Tracer Certificate: Th229_TH-18A
Tracer Quantity: 0.445 mL
Effective Efficiency: 0.1772 +/- 0.0116
Counting Efficiency: 0.1936 +/- 0.0034 on 10/25/2014 6:44:33 PM
Chem. Recovery Factor: 0.9151 +/- 0.0620

Control Certificate Name: NatTh_Th-8
Chem. Recov. of Control: TH-232 0.980857 +/- 0.088709
Peak Match Tolerance: 0.175 MeV

PEAK AREA REPORT

Nuclide		Energy (MeV)	Net Pk Area	Pk Area Error %	Ambient Backgnd	Reagent Backgnd	FWHM (keV)
TH-227		5.795	13.15	56.06	0.85	0.00E+000	3.0
TH-228		5.353	336.79	10.72	2.21	0.00E+000	8.1
TH-229	T	4.873	301.49	11.30	0.51	0.00E+000	9.8
TH-230		4.615	348.00	10.52	0.00	0.00E+000	26.7
TH-232		3.940	334.49	10.73	0.51	0.00E+000	12.4

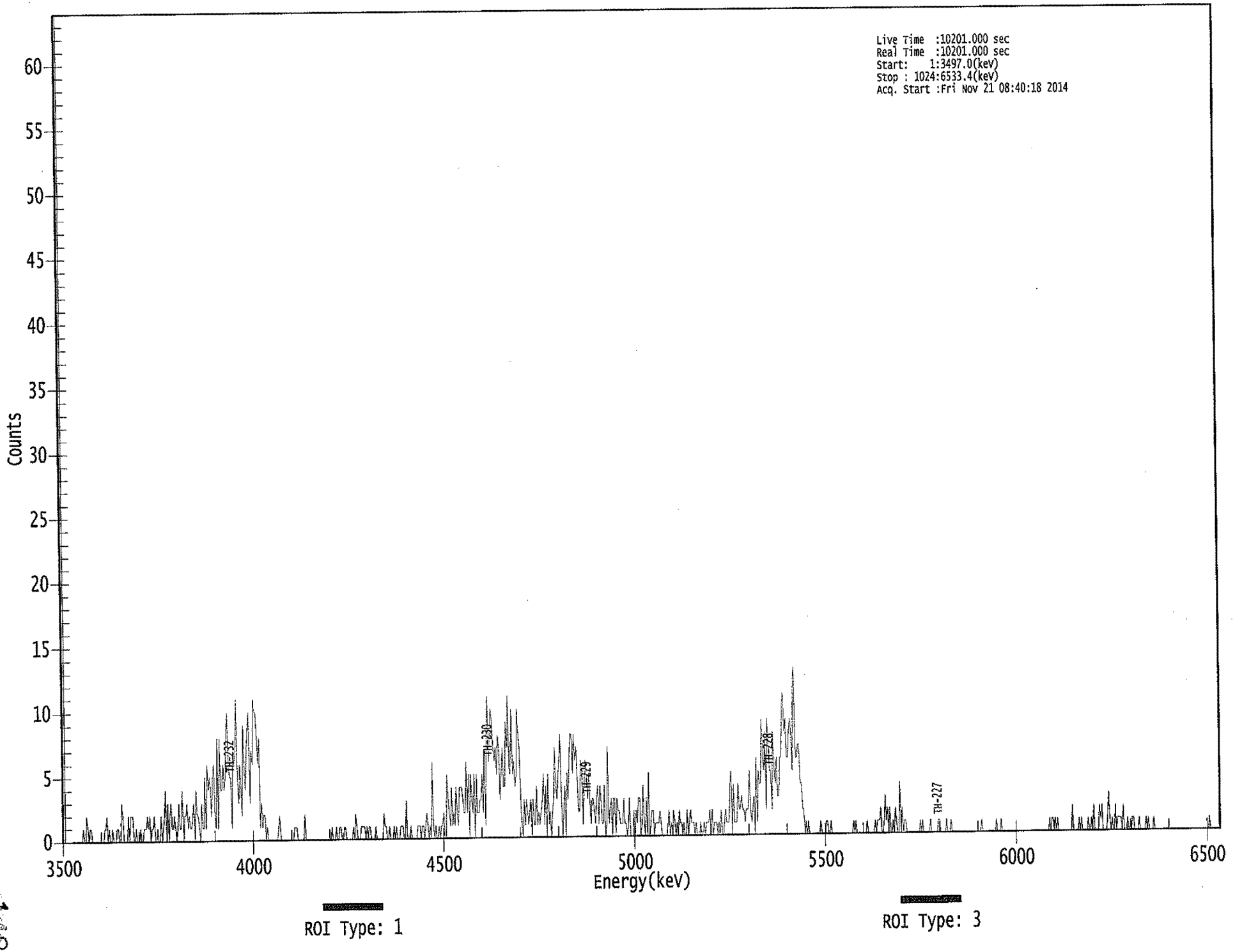
T = Tracer Peak used for Effective Efficiency

NUCLIDE ANALYSIS RESULTS

Nuclide	Id Conf.	Energy (keV)	Activity (pCi/liter)	MDA (pCi/liter)
TH-227	0.984	5850.00*	2.02E-001 +/- 1.16E-001	9.18E-002 +/- 1.18E-002
TH-228	0.988	5400.00*	5.04E+000 +/- 8.42E-001	1.20E-001 +/- 1.53E-002
TH-229	1.000	4872.00*	4.53E+000 +/- 5.81E-001	7.88E-002 +/- 1.01E-002
TH-230	0.983	4672.00*	5.21E+000 +/- 8.65E-001	8.98E-002 +/- 1.15E-002
TH-232	0.983	3997.00*	5.00E+000 +/- 8.36E-001	7.85E-002 +/- 1.01E-002

AG 11/21/14

0000103028.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: 10201
Elapsed Real Time: 10201

Channel								
1:	10201	10201	0	0	0	0	0	0
9:	0	0	0	0	0	0	0	0
17:	0	0	1	0	0	2	1	0
25:	1	1	0	0	0	0	0	0
33:	0	0	0	0	0	1	1	2
41:	0	1	0	0	1	0	0	0
49:	1	1	0	0	3	2	0	0
57:	0	0	2	0	2	2	2	0
65:	0	1	0	0	0	1	0	0
73:	1	1	1	2	1	2	0	1
81:	1	2	0	0	1	0	0	2
89:	0	1	2	4	0	3	0	2
97:	3	1	1	2	1	0	1	3
105:	1	1	4	0	2	2	3	1
113:	2	1	1	2	3	0	4	2
121:	2	1	0	3	1	1	5	1
129:	6	4	5	4	2	5	6	2
137:	1	8	1	8	4	4	6	4
145:	5	8	10	6	5	5	1	7
153:	6	7	11	5	3	6	4	2
161:	9	6	4	7	9	10	3	7
169:	6	11	10	10	8	6	8	1
177:	3	1	2	2	0	1	0	0
185:	0	0	0	0	0	0	0	1
193:	2	0	0	0	0	0	0	0
201:	0	0	0	0	0	1	1	1
209:	0	0	0	0	0	0	2	0
217:	0	0	0	0	0	0	0	0
225:	0	0	0	0	0	0	0	0
233:	0	0	0	0	0	0	1	0
241:	0	0	1	0	0	1	1	0
249:	0	1	1	0	0	0	0	0
257:	0	1	0	2	1	0	0	0
265:	1	1	1	1	0	1	0	1
273:	1	0	0	0	0	1	0	0
281:	0	0	0	0	2	1	1	0
289:	0	1	0	0	0	1	0	1
297:	0	0	0	1	1	1	0	0
305:	3	0	0	0	1	0	0	0
313:	0	0	1	1	1	0	1	1
321:	0	1	2	1	0	1	0	6
329:	1	0	1	0	0	1	0	1
337:	1	2	0	0	5	3	2	1
345:	4	1	2	1	4	2	1	4
353:	4	4	3	2	2	6	2	5
361:	0	5	3	2	5	0	5	2

369:	2	3	3	5	2	7	1	7

Sample Title: 01

Channel								
377:	11	6	8	10	9	7	6	7
385:	5	8	7	3	5	7	4	4
393:	9	7	11	5	5	10	5	6
401:	4	5	10	8	7	3	1	0
409:	3	1	3	2	1	2	3	0
417:	3	1	1	4	1	2	1	2
425:	3	5	1	4	0	5	1	2
433:	0	2	3	7	4	3	5	6
441:	8	3	0	2	4	0	5	3
449:	6	8	8	5	8	6	7	5
457:	2	2	6	5	1	4	6	5
465:	3	5	3	1	3	3	2	1
473:	3	4	1	4	3	1	1	4
481:	0	1	7	1	2	3	0	3
489:	3	0	3	2	2	1	1	1
497:	3	1	1	0	1	3	0	0
505:	0	2	0	2	1	3	3	0
513:	1	4	1	0	3	0	5	0
521:	1	2	2	0	1	1	1	1
529:	2	1	0	0	0	0	0	1
537:	2	0	1	0	2	1	0	1
545:	0	2	1	1	0	1	0	0
553:	2	0	1	2	1	1	1	0
561:	1	0	0	0	1	0	0	1
569:	0	1	1	1	2	0	2	0
577:	1	1	1	0	1	0	2	0
585:	0	1	2	1	1	1	4	5
593:	0	4	1	1	1	4	2	2
601:	3	2	2	1	2	2	2	5
609:	2	1	2	3	0	6	1	5
617:	4	4	9	6	5	8	2	9
625:	7	5	5	2	8	5	4	6
633:	3	3	6	6	10	11	8	9
641:	6	6	8	9	8	5	12	13
649:	6	6	7	7	4	4	2	2
657:	0	1	0	1	0	0	0	0
665:	0	0	0	0	0	0	1	0
673:	0	0	0	1	1	0	0	1
681:	0	0	0	0	0	0	0	0
689:	0	0	0	0	0	0	0	0
697:	0	0	0	1	0	1	0	0
705:	0	0	0	0	0	0	0	1
713:	0	0	0	0	0	0	1	0
721:	1	1	1	2	0	0	1	3
729:	1	2	0	2	0	0	1	0
737:	2	1	0	0	4	0	2	0
745:	1	1	0	0	0	0	0	0
753:	0	0	0	0	0	0	1	0
761:	1	0	0	0	0	0	0	1
769:	0	0	0	0	0	0	1	1
777:	0	0	0	0	0	1	0	0
785:	0	1	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: 01

Channel								
809:	0	0	0	0	1	0	0	0
817:	0	0	0	0	0	0	0	0
825:	0	1	0	0	0	1	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:	1	0	1	1	0	1	0	1
881:	0	0	0	0	0	0	0	0
889:	0	0	0	0	2	0	0	0
897:	0	0	1	0	1	0	0	0
905:	0	0	1	0	0	1	0	2
913:	0	0	0	0	2	1	2	0
921:	0	0	0	1	3	1	0	1
929:	0	0	2	0	1	1	1	1
937:	0	2	0	0	0	1	0	0
945:	0	1	1	0	0	0	0	1
953:	0	0	0	0	0	1	0	1
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	1	0	0
1017:	0	0	0	0	0	0	0	0

KP 11/21/14

Apex-Alpha™

Sample Description: BLANK
Spectrum File: \\OR-ALPHA1\Canberra\ApexAlpha\Root\Data\00001030
Batch Identification: 1411095A-TH
Sample Identification: 02
Sample Geometry: Shelf 2
Procedure Description: Th iso

Detector Name: Alpha_014
Chamber Serial Number:
Detector Serial Number: 14
Env. Background: System Bkgd 101690
Reagent Blank: <not performed>

Sample Size: 1.000E+000 +/- 0.000E+000 liter
Sample Date/Time: 11/21/2014 6:24:56 AM
Acquisition Date/Time: 11/21/2014 8:40:19 AM
Acquisition Live Time: 170.0 minutes
Acquisition Real Time: 170.0 minutes

Tracer Certificate: Th229_TH-18A
Tracer Quantity: 0.224 mL
Effective Efficiency: 0.2019 +/- 0.0167
Counting Efficiency: 0.1840 +/- 0.0032 on 10/25/2014 6:45:28 PM
Chem. Recovery Factor: 1.0968 +/- 0.0928

Peak Match Tolerance: 0.175 MeV

PEAK AREA REPORT

Nuclide		Energy (MeV)	Net Pk Area	Pk Area Error %	Ambient Backgnd	Reagent Backgnd	FWHM (keV)
TH-227		5.799	2.90	201.29	5.10	0.00E+000	5.9
TH-228		5.277	-1.61	270.88	5.61	0.00E+000	2.9
TH-229	T	4.876	172.45	15.05	2.55	0.00E+000	3.8
TH-230		4.660	10.47	65.55	1.53	0.00E+000	2.9
TH-232		4.069	1.15	249.60	0.85	0.00E+000	5.9

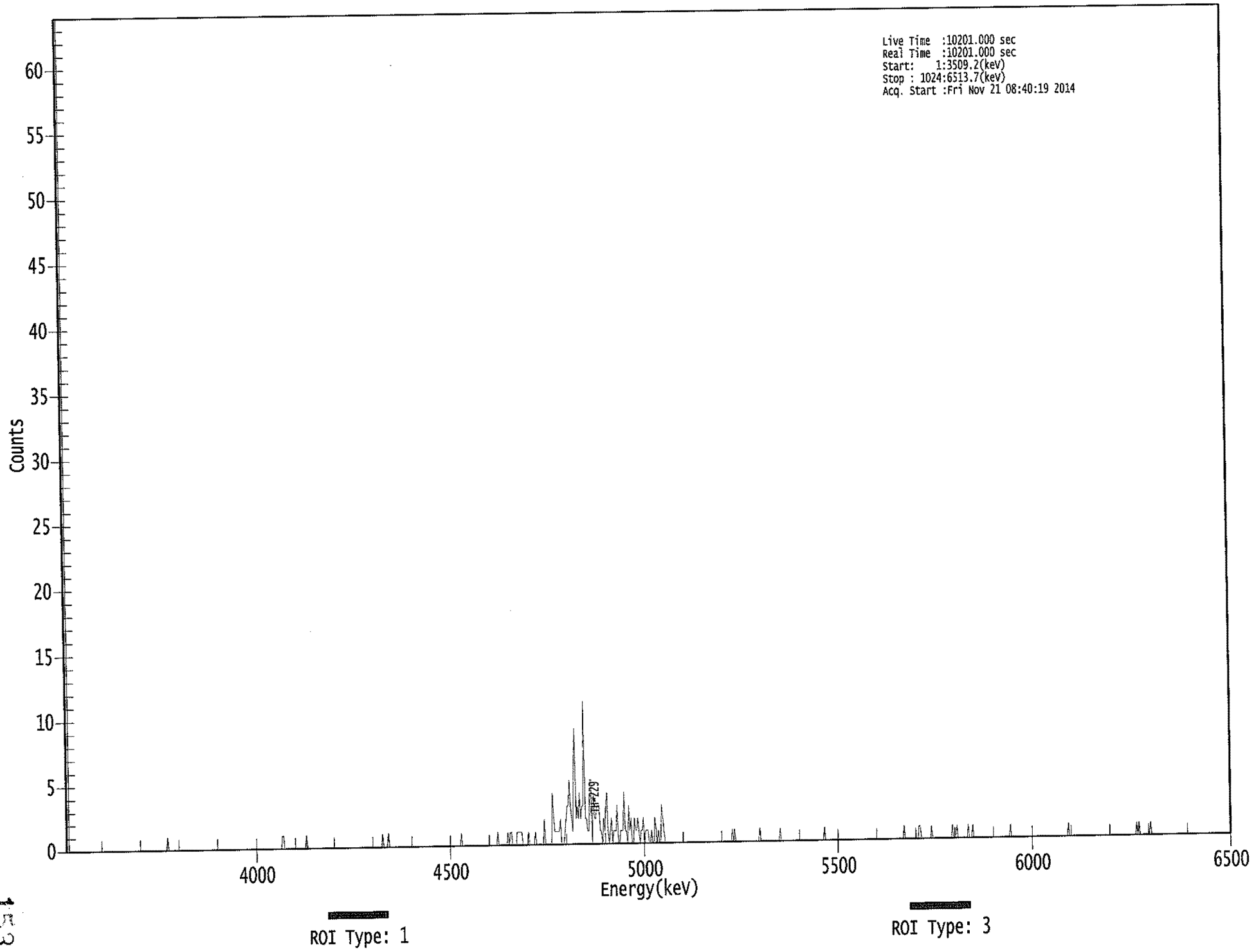
T = Tracer Peak used for Effective Efficiency

NUCLIDE ANALYSIS RESULTS

Nuclide	Id Conf.	Energy (keV)	Activity (pCi/liter)	MDA (pCi/liter)
TH-227	0.986	5850.00*	3.90E-002 +/- 7.88E-002	1.45E-001 +/- 2.35E-002
TH-228	0.924	5400.00*	-2.12E-002 +/- 5.74E-002	1.46E-001 +/- 2.37E-002
TH-229	1.000	4872.00*	2.27E+000 +/- 3.69E-001	1.11E-001 +/- 1.80E-002
TH-230	0.999	4672.00*	1.38E-001 +/- 9.30E-002	9.35E-002 +/- 1.52E-002
TH-232	0.973	3997.00*	1.51E-002 +/- 3.78E-002	7.86E-002 +/- 1.28E-002

AG 11/21/14

0000103027.CNF



WLLFOIA4312 - 001 - 0030570

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

Sample Title: 02

Elapsed Live time: 10201
Elapsed Real Time: 10201

Channel								
1:	10201	10201	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	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	1	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	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	0	0	0	0
185:	0	0	0	0	0	0	1	1
193:	0	0	0	0	0	0	0	0
201:	0	0	0	0	0	0	0	0
209:	0	0	0	1	0	0	0	0
217:	0	0	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	1	0
281:	0	0	0	1	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	1	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	0

Sample Title: 02

Channel								
377:	0	0	0	1	0	0	0	0
385:	0	0	0	0	1	0	1	1
393:	0	0	0	0	1	1	1	1
401:	1	0	0	0	0	0	1	0
409:	0	0	0	0	1	0	0	0
417:	0	0	0	0	2	0	0	0
425:	0	0	0	4	2	1	1	1
433:	1	1	2	0	0	0	1	2
441:	3	3	5	3	2	1	6	9
449:	2	3	2	4	2	3	3	11
457:	2	2	1	1	5	5	0	4
465:	2	2	3	3	3	1	1	0
473:	2	1	3	4	1	0	1	2
481:	0	1	1	1	3	0	0	1
489:	1	1	4	1	1	0	3	1
497:	2	0	0	2	1	1	2	1
505:	0	1	1	2	0	1	1	1
513:	0	0	1	0	0	2	1	0
521:	1	0	0	3	2	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:	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	1	0	1	0	0	0	0
593:	0	0	0	0	0	0	0	0
601:	0	0	0	0	0	0	0	0
609:	0	1	0	0	0	0	0	0
617:	0	0	0	0	0	0	0	0
625:	0	0	0	1	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	0	1	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:	1	0	0	0	0	0	0	0
745:	0	0	0	0	0	1	1	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	1	0	0	0	1	0
785:	0	0	0	0	0	0	0	0
793:	1	0	0	0	1	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	0	1	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:	1	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	1	0	1	0
945:	0	0	0	0	0	0	0	0
953:	1	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

KB 11/21/14

Apex-Alpha™

Sample Description: FEE-BRI-W-FADW29206L-DUP
Spectrum File: \\OR-ALPHA1\Canberra\ApexAlpha\Root\Data\00001030
Batch Identification: 1411095A-TH
Sample Identification: 03
Sample Geometry: Shelf 2
Procedure Description: Th iso

Detector Name: Alpha_015
Chamber Serial Number:
Detector Serial Number: 15
Env. Background: System Bkgd 101691
Reagent Blank: <not performed>

Sample Size: 5.000E-001 +/- 0.000E+000 liter
Sample Date/Time: 11/13/2014 6:24:56 AM
Acquisition Date/Time: 11/21/2014 8:40:20 AM
Acquisition Live Time: 170.0 minutes
Acquisition Real Time: 170.0 minutes

Tracer Certificate: Th229_TH-18A
Tracer Quantity: 0.224 mL
Effective Efficiency: 0.1398 +/- 0.0135
Counting Efficiency: 0.1443 +/- 0.0026 on 10/25/2014 6:45:48 PM
Chem. Recovery Factor: 0.9688 +/- 0.0954

Peak Match Tolerance: 0.175 MeV

PEAK AREA REPORT

Nuclide		Energy (MeV)	Net Pk Area	Pk Area Error %	Ambient Backgnd	Reagent Backgnd	FWHM (keV)
TH-227		5.818	3.15	126.67	0.85	0.00E+000	3.0
TH-228		5.354	26.47	39.36	1.53	0.00E+000	3.7
TH-229	T	4.871	119.49	17.98	0.51	0.00E+000	6.0
TH-230		4.648	47.83	28.40	0.17	0.00E+000	4.3
TH-232		3.959	16.00	50.51	0.00	0.00E+000	3.0

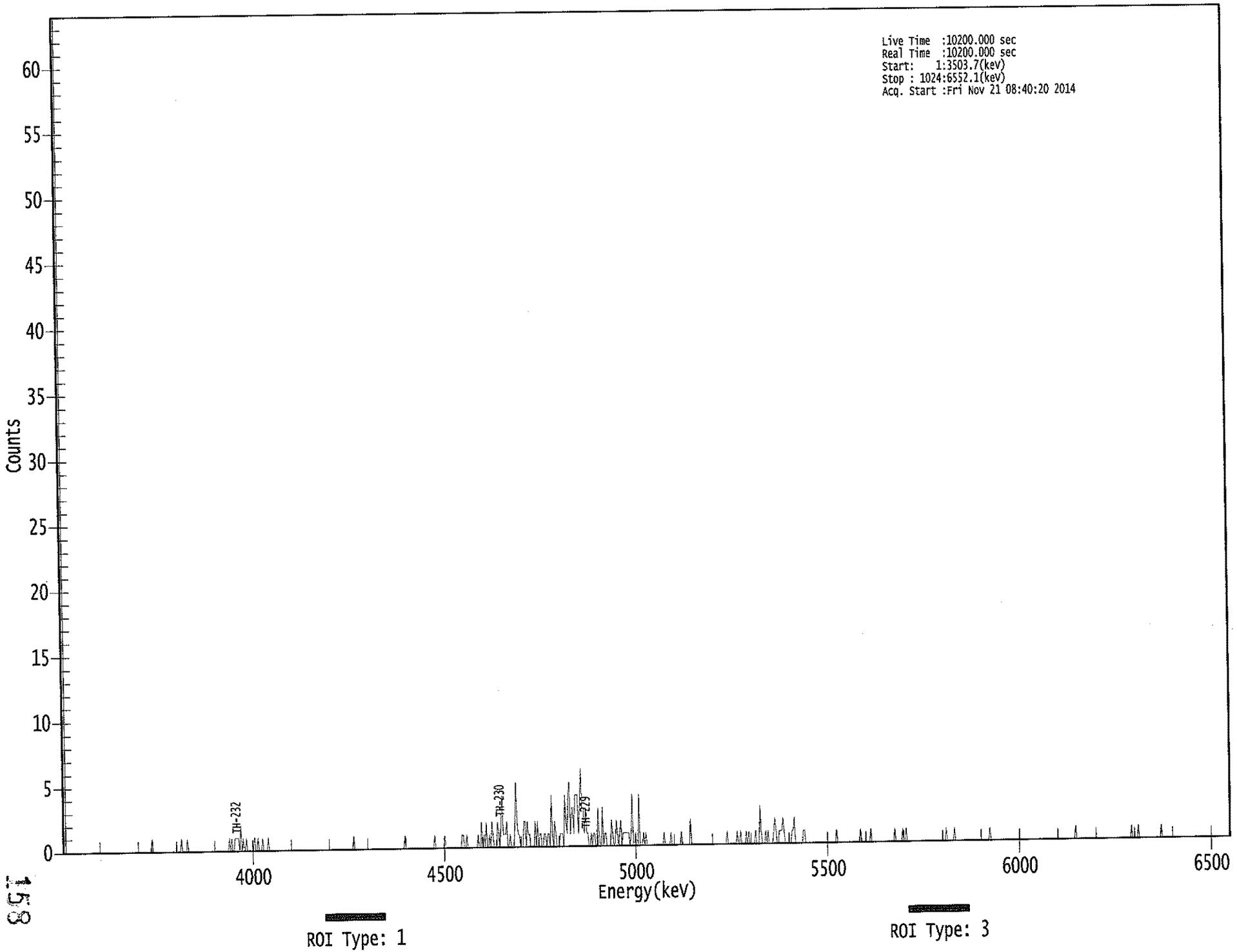
T = Tracer Peak used for Effective Efficiency

NUCLIDE ANALYSIS RESULTS

Nuclide	Id Conf.	Energy (keV)	Activity (pCi/liter)	MDA (pCi/liter)
TH-227	0.995	5850.00*	1.23E-001 +/- 1.57E-001	2.33E-001 +/- 4.42E-002
TH-228	0.989	5400.00*	1.01E+000 +/- 4.42E-001	2.72E-001 +/- 5.16E-002
TH-229	1.000	4872.00*	4.55E+000 +/- 8.64E-001	2.00E-001 +/- 3.79E-002
TH-230	0.997	4672.00*	1.82E+000 +/- 6.21E-001	1.59E-001 +/- 3.01E-002
TH-232	0.992	3997.00*	6.07E-001 +/- 3.27E-001	2.27E-001 +/- 4.31E-002

AG 11/21/14

0000103026.CNF



158

****
***** 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:	10200	10200	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	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	1	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:	1	0	0	0	0	1	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	1	0	1	0	0	1
153:	1	1	1	0	2	0	1	0
161:	0	1	0	0	0	0	0	0
169:	1	0	0	1	0	0	0	1
177:	0	0	0	0	1	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	0	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	1
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	1	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	1	0
329:	0	0	0	0	0	0	0	1
337:	0	0	0	0	0	0	0	0
345:	0	0	0	0	0	0	1	1
353:	0	0	1	0	0	0	0	0
361:	0	0	0	0	1	0	0	2

369:	0	1	0	2	0	0	1	0

Sample Title: 03

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

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801:	0	0	0	0	0	0	0	0

Sample Title: 03

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:	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	1
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:	1	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	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	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™

DCB 11/24/14

Sample Description: FEE-BRI-W-FADW29206L
Spectrum File: \\OR-ALPHA1\Canberra\ApexAlpha\Root\Data\00001030
Batch Identification: 1411095A-TH
Sample Identification: 04
Sample Geometry: Shelf 2
Procedure Description: Th iso

Detector Name: Alpha_033
Chamber Serial Number: 04026479A
Detector Serial Number: 91132
Env. Background: System Bkgd 101692
Reagent Blank: <not performed>

Sample Size: 5.000E-001 +/- 0.000E+000 liter
Sample Date/Time: 11/13/2014 6:24:56 AM
Acquisition Date/Time: 11/21/2014 8:40:33 AM
Acquisition Live Time: 170.0 minutes
Acquisition Real Time: 170.0 minutes

Tracer Certificate: Th229_TH-18A
Tracer Quantity: 0.224 mL
Effective Efficiency: 0.1867 +/- 0.0159
Counting Efficiency: 0.1805 +/- 0.0032 on 10/25/2014 2:26:39 PM
Chem. Recovery Factor: 1.0347 +/- 0.0899

Peak Match Tolerance: 0.175 MeV

PEAK AREA REPORT

Nuclide		Energy (MeV)	Net Pk Area	Pk Area Error %	Ambient Backgnd	Reagent Backgnd	FWHM (keV)
TH-227		5.813	4.66	94.59	0.34	0.00E+000	3.0
TH-228		5.354	32.81	34.94	1.19	0.00E+000	3.7
TH-229	T	4.887	159.66	15.53	0.34	0.00E+000	6.9
TH-230		4.641	56.15	26.39	0.85	0.00E+000	4.0
TH-232		3.984	23.00	41.75	0.00	0.00E+000	3.0

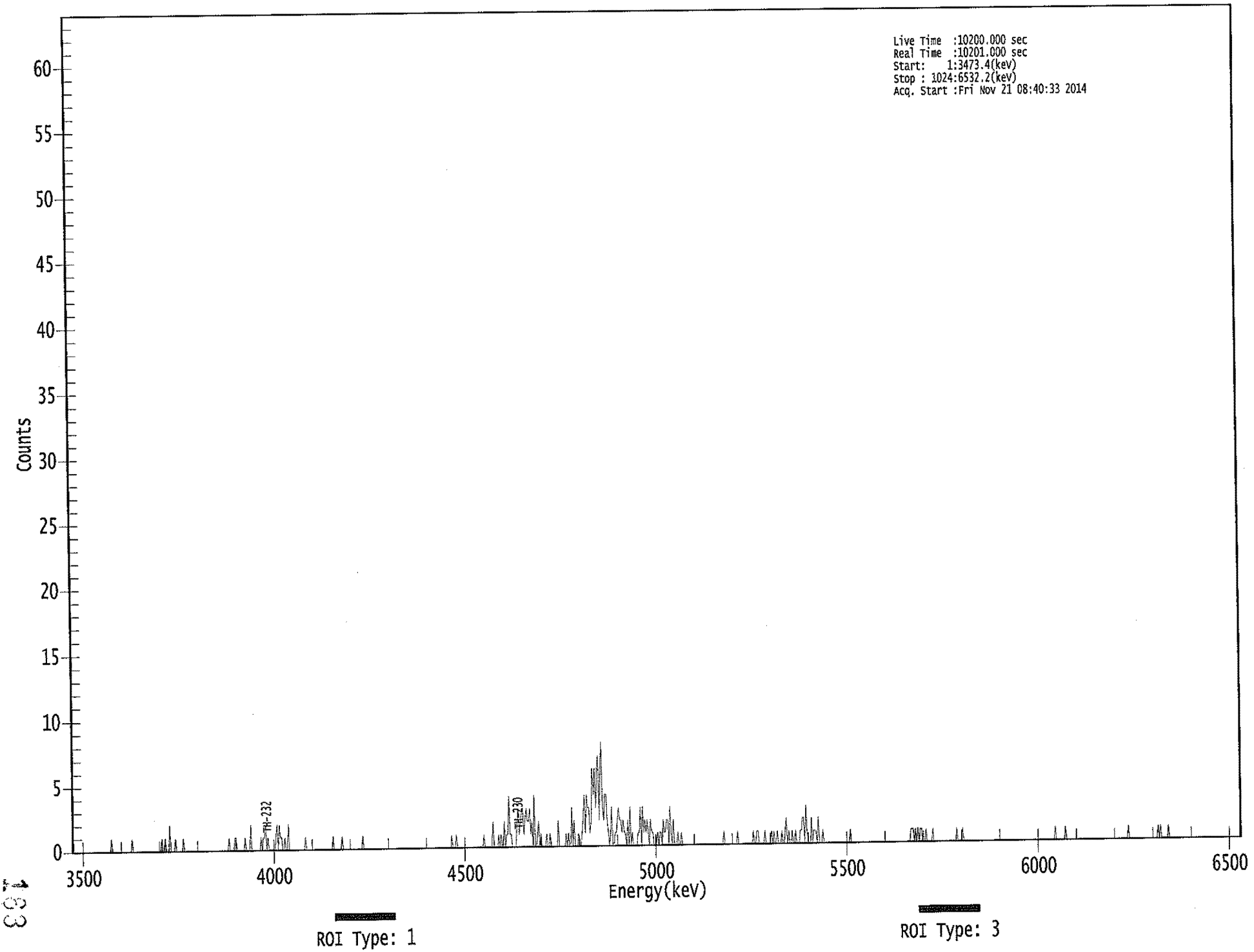
T = Tracer Peak used for Effective Efficiency

NUCLIDE ANALYSIS RESULTS

Nuclide	Id Conf.	Energy (keV)	Activity (pCi/liter)	MDA (pCi/liter)
TH-227	0.993	5850.00*	1.36E-001 +/- 1.30E-001	1.39E-001 +/- 2.32E-002
TH-228	0.989	5400.00*	9.39E-001 +/- 3.64E-001	1.89E-001 +/- 3.15E-002
TH-229	0.999	4872.00*	4.55E+000 +/- 7.59E-001	1.36E-001 +/- 2.27E-002
TH-230	0.995	4672.00*	1.60E+000 +/- 4.98E-001	1.70E-001 +/- 2.84E-002
TH-232	0.999	3997.00*	6.53E-001 +/- 2.93E-001	1.70E-001 +/- 2.84E-002

AG 11/24/14

0000103031.CNF



WLLFOIA4312 - 001 - 0030580

****
***** 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: 10201

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	0	0	0	0	0
33:	0	0	1	0	0	0	0	0
41:	0	0	0	0	0	0	0	0
49:	0	0	0	0	1	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	1	0
81:	0	1	0	0	0	2	0	0
89:	0	0	1	0	0	0	0	0
97:	0	1	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	1	0	0	0	0	1	1
145:	0	0	0	0	0	0	0	1
153:	0	0	0	0	2	0	0	0
161:	0	0	0	0	0	1	0	1
169:	1	2	0	1	0	0	0	0
177:	0	0	1	2	0	2	1	1
185:	0	0	1	0	0	2	0	0
193:	0	0	0	0	0	0	0	0
201:	0	0	0	0	1	0	0	0
209:	0	0	0	0	0	0	0	0
217:	0	0	0	0	0	0	0	0
225:	0	0	0	0	1	0	0	0
233:	0	0	0	0	1	0	0	0
241:	0	0	0	0	0	0	0	0
249:	0	0	0	0	0	0	1	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	1	0	0	0
337:	1	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:	1	0	0	0	0	0	0	0

369:	2	0	0	0	0	1	0	1

Sample Title: 04

Channel								
377:	0	0	2	0	1	1	4	1
385:	1	0	0	0	0	2	3	1
393:	2	3	3	1	2	3	2	2
401:	3	1	2	0	4	0	0	1
409:	2	0	1	0	0	0	0	1
417:	0	0	1	0	0	0	0	0
425:	0	2	0	0	0	0	0	0
433:	1	0	1	0	0	3	0	2
441:	0	0	0	1	0	0	1	2
449:	4	1	4	3	3	1	2	6
457:	4	6	3	6	7	2	6	8
465:	3	2	4	4	2	1	0	1
473:	3	0	0	1	1	2	3	2
481:	2	1	2	1	1	0	2	0
489:	3	0	1	0	0	0	0	1
497:	1	3	0	3	1	2	1	2
505:	1	0	2	1	1	0	0	0
513:	1	0	1	1	0	2	1	1
521:	2	2	0	3	1	0	2	0
529:	0	0	1	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	0	0	0	0	0	0
569:	0	0	1	0	0	0	0	0
577:	0	0	0	0	0	0	1	0
585:	0	0	0	0	0	0	0	0
593:	0	0	0	0	1	0	0	1
601:	1	0	0	0	0	0	1	0
609:	0	0	0	0	1	0	1	0
617:	0	1	0	0	0	1	0	0
625:	1	2	0	1	0	0	1	0
633:	0	1	0	0	0	1	1	2
641:	2	0	3	1	0	0	0	2
649:	0	1	1	1	0	2	0	0
657:	0	1	0	0	0	0	0	0
665:	0	0	0	0	0	0	0	0
673:	0	0	0	0	0	0	0	0
681:	0	1	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	1	1
737:	1	0	1	0	1	0	1	1
745:	0	0	0	1	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	1	0
777:	0	0	0	1	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	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	0	0	0	0	0	0
857:	0	0	0	0	1	0	0	0
865:	0	0	0	0	0	1	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	0	0
921:	0	0	0	0	1	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	0	1	0
953:	1	0	0	0	0	0	0	1
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

11/21/2014 5:20:12 AM

Apex-Alpha™

QA SUMMARY REPORT

Review Of QA Results - Pulser Check

Date : 11/21/2014
Time : 5:20:12 AM

CHAMBER	DEVICE	PARAMETER	FLAG	DATE
Alpha_001	21f	ALL	Not Done	
Alpha_002	21f	ALL	Not Done	
Alpha_003	21f	ALL	Passed	11/21/2014 5:00:18 AM
Alpha_004	21f	ALL	Passed	11/21/2014 5:00:19 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	11/21/2014 5:00:20 AM
Alpha_011	21f	ALL	Passed	11/21/2014 5:00:21 AM
Alpha_012	21f	ALL	Passed	11/21/2014 5:00:21 AM
Alpha_013	21f	ALL	Not Done	
Alpha_014	21f	ALL	Passed	11/21/2014 5:00:22 AM
Alpha_015	21f	Peak FWHM	Action	11/21/2014 5:00:23 AM
Alpha_016	21f	ALL	Not Done	
Alpha_033	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:00:24 AM
Alpha_034	Alpha Analyst100DC	Peak FWHM	Action	11/21/2014 5:00:26 AM
Alpha_035	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:00:27 AM
Alpha_036	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:00:29 AM
Alpha_037	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:00:30 AM
Alpha_038	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:00:32 AM
Alpha_039	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:00:33 AM
Alpha_040	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:00:35 AM
Alpha_041	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:00:37 AM
Alpha_042	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:00:39 AM
Alpha_043	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:00:40 AM
Alpha_044	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:00:42 AM
Alpha_045	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:00:43 AM
Alpha_046	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:00:45 AM
Alpha_047	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:00:47 AM
Alpha_048	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:00:49 AM
Alpha_049	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:00:50 AM
Alpha_050	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:00:52 AM
Alpha_051	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:00:53 AM
Alpha_052	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:00:56 AM
Alpha_053	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:00:58 AM
Alpha_054	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:01:00 AM
Alpha_055	Alpha Analyst100DC	Peak FWHM	Action	11/21/2014 5:01:03 AM
Alpha_056	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:01:06 AM
Alpha_057	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:01:08 AM
Alpha_058	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:01:11 AM

Review of QA Results - Pulser Check

11/21/2014 5:20:12 AM

CHAMBER	DEVICE	PARAMETER	FLAG	DATE
Alpha_059	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:01:14 AM
Alpha_060	Alpha Analyst100DC	ALL	Passed	11/21/2014 5:01:17 AM

APPROVED BY: _____

APPROVAL DATE: 11/21

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

Nuclide Library Title: Thorium

Nuclide Library Description: Th-227,-228,-229,-230,-232

Nuclide Name	Half-Life (Seconds)	Energy (keV)	Energy Uncert. (keV)	Yield (%)	Yield Uncert.(Abs.+-)
TH-227	6.873E+008	5850.000*	0.000	97.5000	0.0000
TH-228	6.034E+007	5400.000*	0.000	99.9400	0.0000
TH-229	2.487E+011	4872.000*	0.000	99.5200	0.0000
TH-230	2.379E+012	4672.000*	0.000	99.8200	0.0000
TH-232	4.434E+017	3997.000*	0.000	100.0000	0.0000

* = key line

TOTALS: 5 Nuclides 5 Energy Lines

SECTION X

ANALYTICAL DATA (RADIUM-226)

WLLFOIA4312 - 001 - 0030587

Eberline Services
Oak Ridge Laboratory
Analysis Sheet

14-11095
Ra226
Run 1

Work Order	14-11095
Analysis Code	Ra226
Run	1
Date Received	11/18/2014
Lab Deadline	11/24/2014
Client	Feezor Engineering, Inc.
Project	FEEBRI
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)	909.766
Carrier	
Carrier Conc (mg/ml)	

Internal Fraction	Sample Desc	Client ID	Login CPM	Sample Date	Sample Aliquot
01	LCS	LCS		11/18/14 00:00	1.0000E+00
02	MBL	BLANK		11/18/14 00:00	1.0000E+00
03	DUP	FEE-BRI-W-FADW29206L	39	11/13/14 00:00	5.0000E-01
04	DO	FEE-BRI-W-FADW29206L	39	11/13/14 00:00	5.0000E-01

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

WLLFOIA4312 - 001 - 0030588

Eberline Services
Oak Ridge Laboratory
Analysis Sheet

14-11095
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	0.9054	823.7	345.0	92.98		0.0221	0.0281	0.0060		92.98	2.16	1.00
02	MBL	0.9034	821.9	364.0	98.32		0.0215	0.0284	0.0069		98.32	2.47	1.00
03	DUP	0.9051	823.4	551.0	148.55		0.0216	0.0285	0.0069		110.00	2.47	1.00
04	DO	0.9047	823.1	536.0	144.57		0.0211	0.0289	0.0078		110.00	2.72	1.00

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

WLLFOIA4312 - 001 - 0030589

Eberline Services
Oak Ridge Laboratory
Analysis Sheet

14-11095
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			11/18/14 15:46	LWALKER	11/19/14 12:20	RMARTZ		
02	MBL			11/18/14 15:46	LWALKER	11/19/14 12:20	RMARTZ		
03	DUP			11/18/14 15:46	LWALKER	11/19/14 12:20	RMARTZ		
04	DO			11/18/14 15:46	LWALKER	11/19/14 12:20	RMARTZ		

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

WLLFOIA4312 - 001 - 0030590

Eberline Services
Oak Ridge Laboratory

Preliminary Data Report & Analytical Calculations

Work Order: 14-11095-Ra226-1

Client: Feezor Engineering, Inc.
Eberline Services Work Order: 14-11095
Analysis Code: Ra226
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-226	LCS	LCS	pCi/l	1.10E+01	1.26E+00	2.15E-01	9.98E+00	110.38	OK		OK	
02	RA-226	MBL	BLANK	pCi/l	2.46E-02	7.50E-02	1.78E-01					OK	OK
03	RA-226	DUP	FEE-BRI-W-FADW29206L	pCi/l	1.80E+00	7.50E-01	3.80E-01				NA	OK	
04	RA-226	DO	FEE-BRI-W-FADW29206L	pCi/l	1.70E+00	7.38E-01	4.50E-01					OK	

WLLFOIA4312 - 001 - 0030591

Preliminary Data Report & Analytical Calculations
Work Order: 14-11095-Ra226-1

Client: Feezor Engineering, Inc.
Eberline Services Work Order: 14-11095
Analysis Code: Ra226
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-226	LCS	11/18/14 00:00	1.00E+00	92.98	0.00	92.98		11/19/2014 12:20	
02	RA-226	MBL	11/18/14 00:00	1.00E+00	98.32	0.00	98.32		11/19/2014 12:20	
03	RA-226	DUP	11/13/14 00:00	5.00E-01	100.00	0.00	110.00		11/19/2014 12:20	
04	RA-226	DO	11/13/14 00:00	5.00E-01	100.00	0.00	110.00		11/19/2014 12:20	

Preliminary Data Report & Analytical Calculations
Work Order: 14-11095-Ra226-1

Client	Eberline Services Work Order	Analysis Code	Run
Feezor Engineering, Inc.	14-11095	Ra226	1

Lab Fraction	Nuclide	Sample Desc	Counting Date/Time	Halflife (days)	Detect	Carrier	Count Time	Counts	Bkg CPM	Eff
01	RA-226	LCS	11/20/14 11:29		A_Spec	Alpha_033	170	3.23 E+02	6.00 E-03	18
02	RA-226	MBL	11/20/14 11:29		A_Spec	Alpha_034	170	6.60 E-01	2.00 E-03	17.9
03	RA-226	DUP	11/20/14 11:28		A_Spec	Alpha_035	170	2.27 E+01	2.00 E-03	16.5
04	RA-226	DO	11/20/14 11:28		A_Spec	Alpha_036	170	2.13 E+01	4.00 E-03	18.1

Count Room Report
Client: Feezor Engineering, Inc.

14-11095-Ra226-1 (pCi/l) in WA
Tracer ID: Ba-6a

33-34

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	11/18/14 00:00	1.0000	0.9054	823.7021	345.0000	92.98	2.16	1.00
02	MBL	BLANK	11/18/14 00:00	1.0000	0.9034	821.8826	364.0000	98.32	2.47	1.00
03	DUP	FEE-BRI-W-FADW29206L	11/13/14 00:00	0.5000	0.9051	823.4292	551.0000	148.55	2.47	1.00
04	DO	FEE-BRI-W-FADW29206L	11/13/14 00:00	0.5000	0.9047	823.0653	536.0000	144.57	2.72	1.00

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WLLFOIA4312 - 001 - 0030594

Eberline Services
Oak Ridge Laboratory

Spike and Tracer Worksheet

Printed: 11/18/2014 3:46 PM

Internal Work Order	Run	Analysis Code	Date	Technician	Technician Initials	Witness Initials
14-11095	1	Ra226	11/18/2014 15:40	LWALKER		

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	44.041	11/18/2014	0.500	0.5031				9.98	0.459	0.00	0.000	0.00	0.000	0.00	0.000
Tc-99 MS	Tc-2a	22043.688	10/16/2013	0.1												

Tracers

fraction	Isotope	Sol #	Activity dpm/g	Solution Date	Volume Used (g)	Approx Addition
01	Ba-133	Ba-6a	909.766	11/18/2014	0.9054	1.1100
02	Ba-133	Ba-6a	909.766	11/18/2014	0.9034	1.1100
03	Ba-133	Ba-6a	909.766	11/18/2014	0.9051	1.1100
04	Ba-133	Ba-6a	909.766	11/18/2014	0.9047	1.1100

Balance Printer Tapes

Tracer

0.9054 g
0.9034 g
0.9051 g
0.9047 g

LCS

0.5031 g

Matrix Spike

Version 2.0 08/99

Eberline Analytical
Oak Ridge Laboratory

Aliquot Worksheet

Work Order	Run	Analysis Code	Rpt Units	Lab Deadline	Technician
14-11095	1	Ra226	liters	11/24/2014	RMARTZ

Lab Fraction	Feezor Engineering, 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	FEE-BRI-W-FADW29206L	DUP		1	2.00	5.00E-01	1.0000E+00	5.0000E-01				
04	FEE-BRI-W-FADW29206L	DO		1	2.00	5.00E-01	1.0000E+00	5.0000E-01				

Comments	

Technician: _____ Date: 11/20/14

WLLFOIA4312 - 001 - 0030596

EBERLINE SERVICES	Internal Work Order	14-11095
	Fraction	> 03 <
Dilution Worksheet	Analysis Code	Ra226
	Run Number	1
	Analyst	RMARTZ

Dilution Number	...	Amount Taken	Units	...	Diluted To	Units	Ratio
1	I took	**10**	ml	from the original sample and diluted it to	**20**	ml	0.5000
2	I took		ml	from the 1st dilution and diluted it to		ml	
3	I took		ml	from the 2nd dilution and diluted it to		ml	
4	I took		ml	from the 3rd dilution and diluted it to		ml	
5	I took		ml	from the 4th dilution and diluted it to		ml	

Dilutions Taken	1

Dilution Ratio	**0.5**
Dilution Factor	**2**

Diluted by: RM

Date: 11/20/14

EBERLINE SERVICES

Dilution Worksheet

Internal Work Order	14-11095
Fraction	**> 04 <**
Analysis Code	**Ra226**
Run Number	**1**
Analyst	**RMARTZ**

Dilution Number	...	Amount Taken	Units	...	Diluted To	Units	Ratio
1	I took	**10**	ml	from the original sample and diluted it to	**20**	ml	0.5000
2	I took		ml	from the 1st dilution and diluted it to		ml	
3	I took		ml	from the 2nd dilution and diluted it to		ml	
4	I took		ml	from the 3rd dilution and diluted it to		ml	
5	I took		ml	from the 4th dilution and diluted it to		ml	

Dilutions Taken	1

Dilution Ratio	**0.5**
Dilution Factor	**2**

Diluted by: _____ Date: 11/20/14

Eberline Analytical
Oak Ridge Laboratory

Aliquot Worksheet

Work Order	Run	Analysis Code	Rpt Units	Lab Deadline	Technician
14-11095	1	Ra226	liters	11/24/2014	LWALKER

Lab Fraction	Feezor Engineering, 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				1.0000E+00	1.0000E+00				
02	BLANK	MBL	1				1.0000E+00	1.0000E+00				
03	FEE-BRI-W-FADW29206L	DUP	[illegible]				1.0000E+00	1.0000E+00				
04	FEE-BRI-W-FADW29206L	DO	[illegible]				1.0000E+00	1.0000E+00				

Comments	

Technician: L Walker Date: 11/18/14

WLLFOIA4312 - 001 - 0030599

Eberline Services - Oak Ridge
Version 1.0 9/1999

Gravimetric Worksheet

Work Order	Run	Analysis Code	Gravimetric Carrier	Carrier Conc (mg/ml)	Technician
14-11095	1	Ra226			RMARTZ

TRetec Fraction	Feezor Engineering, Inc. Client ID	Sample Type	Carrier Data: Carrier Added (ml)	Filter Data: Filter Tare (g)	Filter Final (g)	Filter Net (g)	Gravimetric % Recovery
01	LCS	LCS		0.0221	0.0281	**0.0060**	
02	BLANK	MBL		0.0215	0.0284	**0.0069**	
03	DUP	DUP		0.0216	0.0285	**0.0069**	
04	FEE-BRI-W-FADW29206L	DO		0.0211	0.0289	**0.0078**	

Technician: _____ Date: 11/20/14

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WLLFOIA4312 - 001 - 0030600

KB 11/20/14

Apex-Alpha™

Sample Description: SPIKE
Spectrum File: \\OR-ALPHA1\Canberra\ApexAlpha\Root\Data\00001029
Batch Identification: 1411095A-RA
Sample Identification: 01
Sample Geometry: Shelf 2
Procedure Description: Ra

Detector Name: Alpha_033
Chamber Serial Number: 04026479A
Detector Serial Number: 91132
Env. Background: System Bkgd 101692
Reagent Blank: <not performed>

Sample Size: 1.000E+000 +/- 0.000E+000 liter
Generic Mult. Factor: 2.160E+000 Generic Div. Factor: 1.000E+000
Sample Date/Time: 11/20/2014 10:11:54 AM
Acquisition Date/Time: 11/20/2014 11:29:01 AM
Acquisition Live Time: 170.0 minutes
Acquisition Real Time: 170.0 minutes

Chem. Recovery Factor: 0.9298 +/- 0.0000
Counting Efficiency: 0.1805 +/- 0.0032 on 10/25/2014 2:26:39 PM
Effective Efficiency: 0.1678 +/- 0.0030

Control Certificate Name: Ra226_Ra-5b
Chem. Recov. of Control: RA-226 0.510970 +/- 0.033574
Peak Match Tolerance: 0.350 MeV

PEAK AREA REPORT

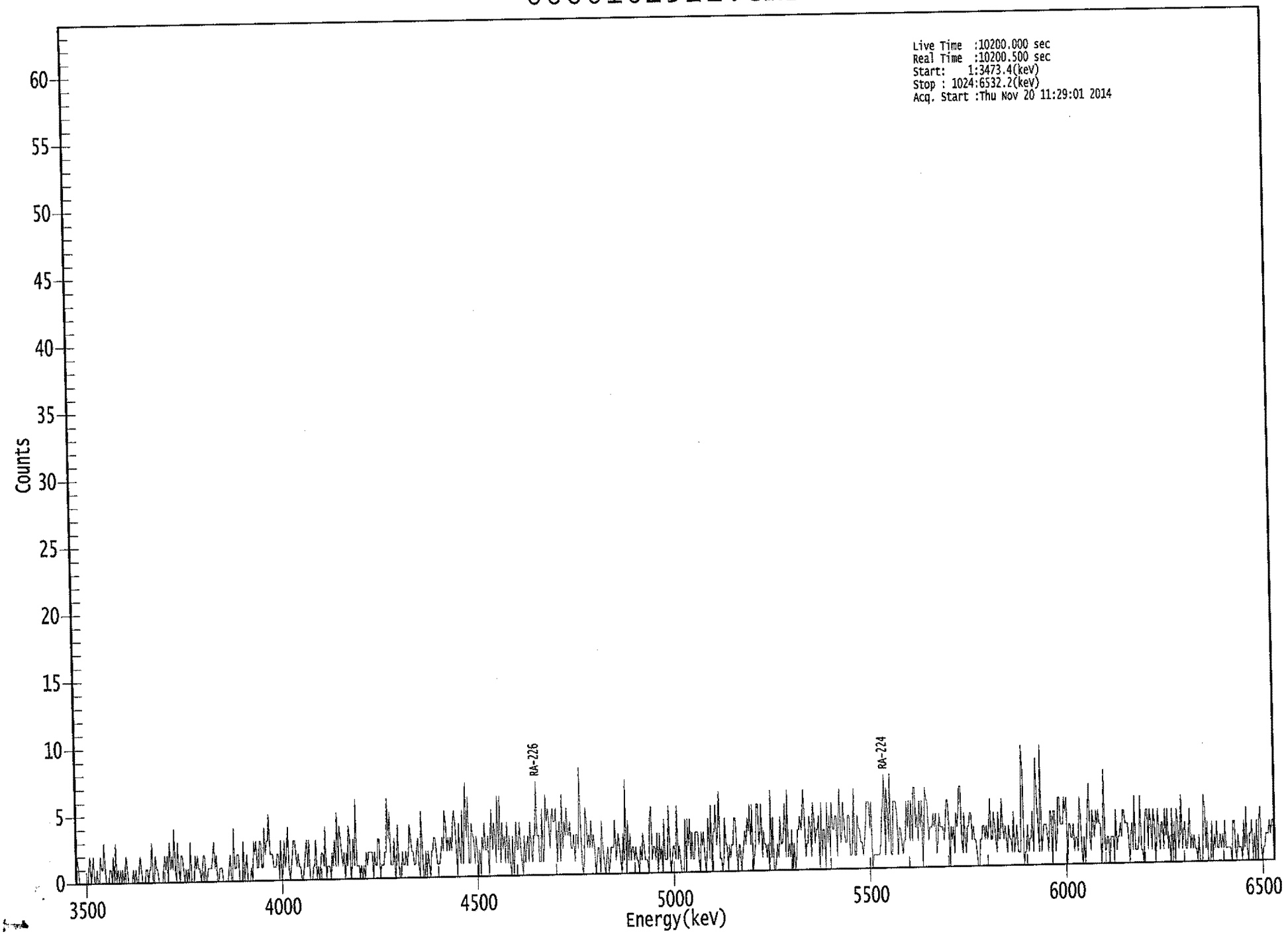
Nuclide	Energy (MeV)	Net Pk Area	Pk Area Error %	Ambient Backgnd	Reagent Backgnd	FWHM (keV)
RA-224	5.536	326.64	10.87	1.36	0.00E+000	8.5
RA-226	4.647	322.98	10.93	1.02	0.00E+000	5.0

NUCLIDE ANALYSIS RESULTS

Nuclide	Id Conf.	Energy (keV)	Activity (pCi/liter)	MDA (pCi/liter)
RA-224	0.971	5685.50*	1.17E+001 +/- 1.34E+000	2.46E-001 +/- 8.48E-003
RA-226	0.976	4785.00*	1.10E+001 +/- 1.26E+000	2.15E-001 +/- 7.41E-003

AG 11/20/14

0000102921.CNF



ROI Type: 1

WLLFOIA4312 - 001 - 0030602

****
***** 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: 10201

Channel								
1:	0	2	1	0	0	0	0	0
9:	0	0	0	1	2	0	1	2
17:	0	0	1	0	0	2	1	1
25:	3	1	0	0	0	1	1	0
33:	2	0	3	0	1	0	1	0
41:	1	0	1	2	1	0	0	0
49:	0	1	0	1	0	0	1	2
57:	1	0	0	0	1	1	0	1
65:	1	3	0	0	2	1	1	0
73:	0	0	0	1	2	1	2	0
81:	3	1	2	1	4	1	0	3
89:	1	0	2	2	1	0	1	0
97:	1	0	3	0	0	0	2	1
105:	2	1	1	0	1	2	2	0
113:	0	1	1	1	1	2	3	1
121:	2	0	0	1	1	1	0	0
129:	0	0	0	1	2	0	0	4
137:	1	1	2	2	0	0	0	3
145:	0	1	2	0	0	0	1	0
153:	3	2	3	1	1	3	3	1
161:	1	4	2	3	3	5	2	2
169:	2	1	1	1	2	2	0	3
177:	0	1	3	1	2	4	1	0
185:	1	2	3	3	2	1	2	1
193:	1	0	0	1	2	3	1	3
201:	0	0	0	1	1	3	0	1
209:	0	1	2	2	1	4	0	1
217:	1	1	0	2	1	3	1	5
225:	1	4	3	2	1	2	0	2
233:	1	4	3	0	1	3	1	6
241:	1	1	1	0	1	0	1	0
249:	2	1	2	2	2	2	0	2
257:	1	1	3	3	0	1	1	1
265:	2	2	6	3	5	1	1	1
273:	3	0	1	4	1	0	0	2
281:	1	1	2	1	2	4	3	2
289:	2	1	1	2	3	1	0	5
297:	2	0	0	2	0	2	1	0
305:	2	2	3	3	2	1	1	1
313:	2	3	2	5	4	2	3	2
321:	3	2	4	5	4	2	0	4
329:	2	1	5	1	4	7	3	6
337:	1	1	4	3	3	1	3	2
345:	0	2	0	3	2	4	2	2
353:	3	0	3	5	2	4	3	1
361:	6	2	6	1	4	2	3	1

369:	4	1	3	1	0	3	0	2

Sample Title: 01

Channel								
377:	4	2	2	4	2	1	0	3
385:	1	2	3	1	4	2	1	3
393:	3	7	3	3	1	1	5	1
401:	2	6	4	5	4	2	4	5
409:	4	4	5	1	3	4	1	6
417:	2	4	3	5	3	3	4	2
425:	2	3	1	3	3	2	8	4
433:	1	0	1	5	4	2	3	2
441:	4	2	3	2	0	1	2	2
449:	0	4	2	1	0	1	2	0
457:	1	2	2	2	4	1	2	3
465:	2	1	0	3	1	7	0	4
473:	1	3	1	2	2	1	2	1
481:	1	0	2	1	3	2	1	1
489:	1	0	4	5	1	2	2	1
497:	3	0	3	1	2	0	4	1
505:	1	1	5	2	0	1	2	2
513:	1	5	1	2	1	0	0	0
521:	4	0	4	2	4	1	3	1
529:	1	3	3	3	1	0	3	2
537:	3	1	0	2	4	1	5	0
545:	3	3	5	2	3	6	1	1
553:	0	1	4	2	2	0	2	1
561:	2	2	4	4	2	0	2	2
569:	0	1	2	3	2	4	3	5
577:	2	5	0	1	2	5	5	2
585:	3	5	1	3	2	2	1	2
593:	0	6	1	4	0	0	1	2
601:	1	4	2	2	3	5	1	6
609:	1	2	1	3	0	2	0	1
617:	3	3	4	3	4	6	4	1
625:	2	2	4	3	1	5	4	2
633:	3	3	4	0	5	1	3	3
641:	0	5	2	4	1	5	3	3
649:	4	4	1	4	6	2	3	5
657:	3	2	2	4	4	1	1	2
665:	6	1	1	4	3	3	2	2
673:	1	2	3	5	5	5	3	5
681:	0	1	1	1	1	1	1	2
689:	4	5	7	1	6	4	2	7
697:	1	1	5	5	5	4	1	3
705:	3	2	1	2	2	5	3	5
713:	2	5	2	6	6	3	4	2
721:	5	3	5	0	3	6	5	5
729:	2	3	3	3	4	3	4	1
737:	2	4	3	3	3	2	3	5
745:	5	3	0	3	2	3	1	4
753:	3	4	6	6	2	1	4	2
761:	1	3	3	4	4	2	3	2
769:	2	1	0	0	2	2	3	3
777:	2	3	2	3	5	2	2	4
785:	3	2	1	4	2	2	5	3
793:	2	3	2	1	3	2	2	1

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801:	4	1	2	3	1	1	1	9

Sample Title: 01

Channel								
809:	7	0	1	1	3	1	2	2
817:	4	1	4	8	5	3	1	9
825:	1	2	3	3	3	2	1	4
833:	4	0	4	4	1	2	5	5
841:	3	3	3	5	4	5	0	3
849:	3	2	2	3	1	2	2	1
857:	5	4	1	0	2	0	2	4
865:	6	2	1	4	3	2	4	3
873:	4	3	3	0	2	7	1	1
881:	2	2	0	2	2	2	0	4
889:	1	2	2	3	2	4	4	3
897:	3	3	2	0	2	3	1	5
905:	1	1	1	2	5	1	1	0
913:	3	4	4	1	4	3	1	4
921:	3	0	2	4	2	1	3	3
929:	1	4	2	4	1	2	0	4
937:	0	3	0	4	3	1	2	5
945:	1	2	3	1	1	2	4	1
953:	2	1	2	1	1	0	2	0
961:	0	0	5	4	1	3	0	0
969:	0	3	0	2	1	3	1	1
977:	2	1	2	1	3	1	1	1
985:	1	1	0	3	3	1	0	2
993:	1	1	1	0	3	1	4	1
1001:	0	2	2	3	0	2	0	3
1009:	0	3	4	1	0	1	1	2
1017:	2	2	3	2	3	3	1	0

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KB 11/20/14

Apex-Alpha™

Sample Description: BLANK
Spectrum File: \\OR-ALPHA1\Canberra\ApexAlpha\Root\Data\00001028
Batch Identification: 1411095A-RA
Sample Identification: 02
Sample Geometry: Shelf 2
Procedure Description: Ra

Detector Name: Alpha_034
Chamber Serial Number: 04026479B
Detector Serial Number: 91136
Env. Background: System Bkgd 101693
Reagent Blank: <not performed>

Sample Size: 1.000E+000 +/- 0.000E+000 liter
Generic Mult. Factor: 2.470E+000 Generic Div. Factor: 1.000E+000
Sample Date/Time: 11/20/2014 10:11:54 AM
Acquisition Date/Time: 11/20/2014 11:29:02 AM
Acquisition Live Time: 170.0 minutes
Acquisition Real Time: 170.0 minutes

Chem. Recovery Factor: 0.9832 +/- 0.0000
Counting Efficiency: 0.1789 +/- 0.0031 on 10/25/2014 2:30:05 PM
Effective Efficiency: 0.1759 +/- 0.0031

Peak Match Tolerance: 0.350 MeV

PEAK AREA REPORT

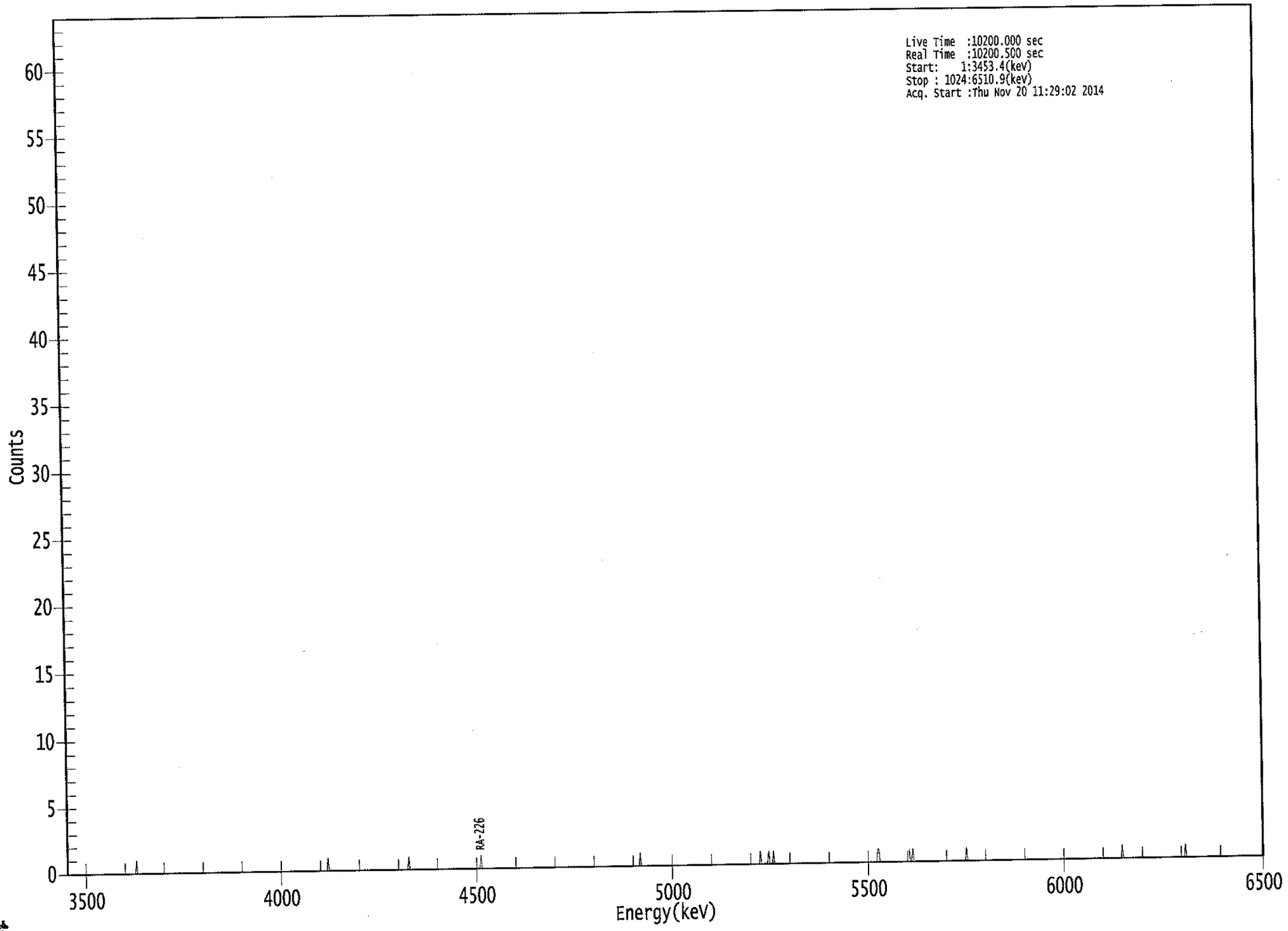
Nuclide	Energy (MeV)	Net Pk Area	Pk Area Error %	Ambient Backgnd	Reagent Backgnd	FWHM (keV)
RA-224	5.568	4.00	109.57	0.00	0.00E+000	6.0
RA-226	4.511	0.66	305.43	0.34	0.00E+000	3.0

NUCLIDE ANALYSIS RESULTS

Nuclide	Id Conf.	Energy (keV)	Activity (pCi/liter)	MDA (pCi/liter)
RA-224	0.982	5685.50*	1.57E-001 +/- 1.72E-001	2.35E-001 +/- 8.05E-003
RA-226	0.907	4785.00*	2.46E-002 +/- 7.50E-002	1.78E-001 +/- 6.10E-003

AG 11/20/14

0000102895.CNF



ROI Type: 1

190

****
***** 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: 10201

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	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	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	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	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	1
217:	0	0	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	1	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	1	0	0	0	0	0
361:	0	0	0	0	0	0	0	0

369:	0	0	0	0	0	0	0	0

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:	0	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	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	1	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	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	1	0	0	0	0	0	0
601:	1	0	0	0	1	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	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	1	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	0	0
721:	1	0	0	1	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	1	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	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	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	1	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	0	0	0
953:	0	0	0	0	1	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

KB 11/20/14

Apex-Alpha™

Sample Description: FEE-BRI-W-FADW29206L DUP
Spectrum File: \\OR-ALPHA1\Canberra\ApexAlpha\Root\Data\00001028
Batch Identification: 1411095A-RA
Sample Identification: 03
Sample Geometry: Shelf 2
Procedure Description: Ra

Detector Name: Alpha_035
Chamber Serial Number: 04026477A
Detector Serial Number: 58771
Env. Background: System Bkgd 101694
Reagent Blank: <not performed>

Sample Size: 5.000E-001 +/- 0.000E+000 liter
Generic Mult. Factor: 2.470E+000 Generic Div. Factor: 1.000E+000
Sample Date/Time: 11/13/2014 10:11:54 AM
Acquisition Date/Time: 11/20/2014 11:28:58 AM
Acquisition Live Time: 170.0 minutes
Acquisition Real Time: 170.0 minutes

Chem. Recovery Factor: 1.0000 +/- 0.0000
Counting Efficiency: 0.1647 +/- 0.0029 on 10/25/2014 2:34:10 PM
Effective Efficiency: 0.1647 +/- 0.0029

Peak Match Tolerance: 0.350 MeV

PEAK AREA REPORT

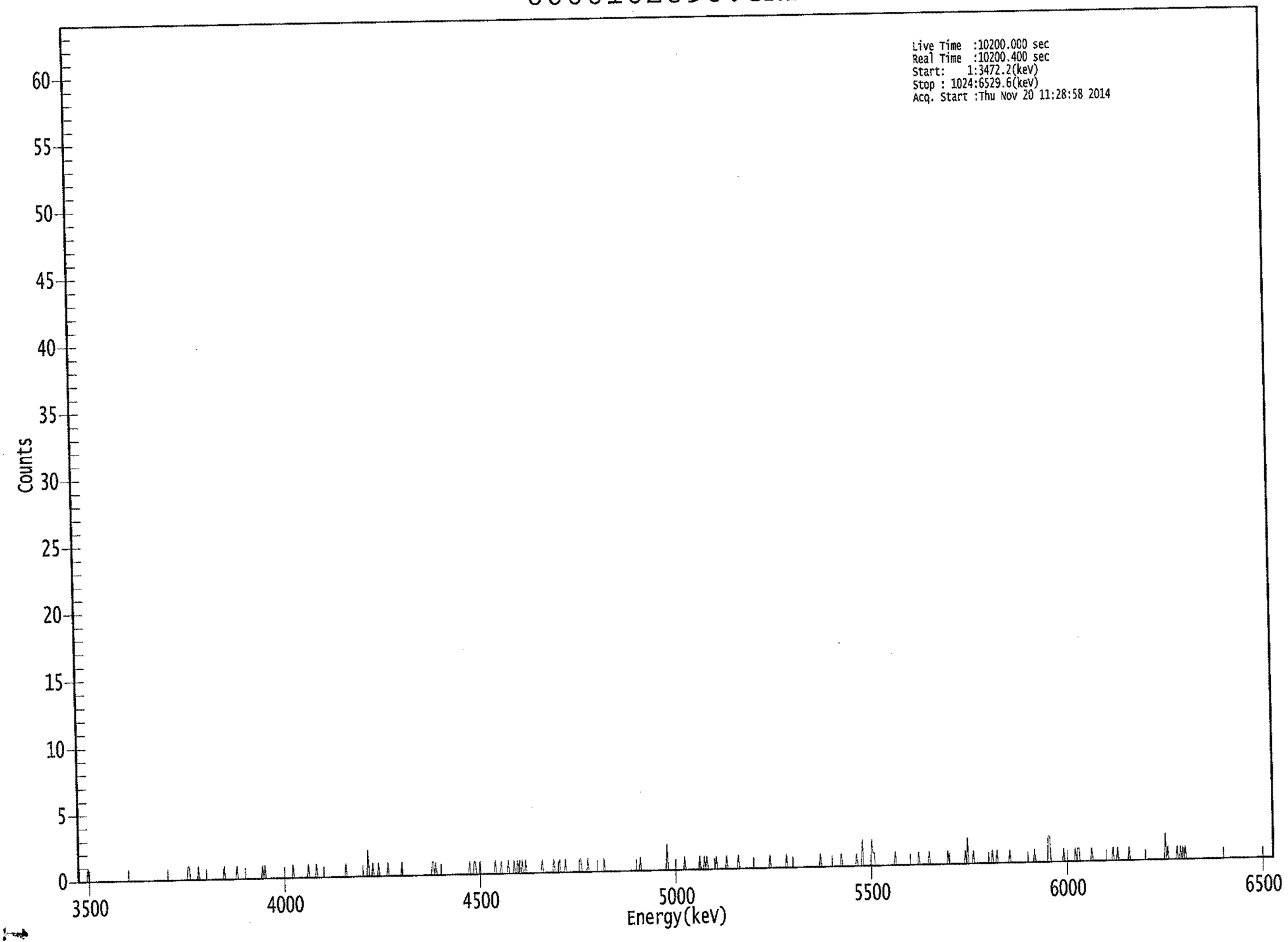
Nuclide	Energy (MeV)	Net Pk Area	Pk Area Error %	Ambient Backgnd	Reagent Backgnd	FWHM (keV)
RA-224	5.517	9.64	68.14	1.36	0.00E+000	3.0
RA-226	4.593	22.66	41.53	0.34	0.00E+000	6.0

NUCLIDE ANALYSIS RESULTS

Nuclide	Id Conf.	Energy (keV)	Activity (pCi/liter)	MDA (pCi/liter)
RA-224	0.964	5685.50*	8.07E-001 +/- 5.51E-001	5.74E-001 +/- 1.99E-002
RA-226	0.953	4785.00*	1.80E+000 +/- 7.50E-001	3.80E-001 +/- 1.32E-002

AG 11/20/14

0000102896.CNF



ROI Type: 1

193

WLLFOIA4312 - 001 - 0030612

****
***** 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:	1	0	0	0	0	0	0	0
17:	0	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	1	1
97:	0	0	0	0	0	0	0	1
105:	0	0	0	0	0	0	0	0
113:	0	0	0	0	0	0	0	0
121:	0	0	0	0	0	1	0	0
129:	0	0	0	0	0	0	0	0
137:	1	0	0	0	0	0	0	0
145:	0	0	0	0	0	0	0	0
153:	0	0	0	0	0	0	1	0
161:	1	0	0	0	0	0	0	0
169:	0	0	0	0	0	0	0	0
177:	0	0	0	0	0	0	0	0
185:	1	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	0	0	0	0	0	0
217:	0	0	0	0	0	0	0	0
225:	0	0	0	0	0	1	0	0
233:	0	0	0	0	0	0	0	0
241:	0	0	0	0	0	0	0	0
249:	2	0	0	0	1	0	0	0
257:	0	1	0	0	0	0	0	0
265:	0	1	0	0	0	0	0	0
273:	0	0	0	0	0	1	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	1
305:	1	0	1	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	1
337:	0	0	0	1	1	0	0	0
345:	1	0	0	0	0	0	0	0
353:	0	0	0	0	0	1	0	0
361:	0	0	1	0	0	0	0	0

369:	1	0	0	0	0	1	0	0

Sample Title: 03

Channel								
377:	1	0	1	0	1	0	0	1
385:	0	0	0	0	0	0	0	0
393:	0	0	0	0	0	1	0	0
401:	0	0	0	0	0	0	0	1
409:	0	0	0	0	1	0	0	0
417:	0	1	0	0	0	0	0	0
425:	0	0	0	0	0	1	1	0
433:	0	0	0	0	1	0	0	0
441:	0	0	0	0	0	0	0	0
449:	0	0	1	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	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:	2	0	0	0	0	0	0	0
513:	0	0	0	0	0	0	0	1
521:	0	0	0	0	0	0	0	0
529:	0	0	0	0	1	0	0	0
537:	1	0	1	0	0	0	0	0
545:	0	0	1	0	0	0	0	0
553:	0	0	0	1	0	0	0	0
561:	0	0	0	0	0	1	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:	1	0	0	0	0	0	0	0
601:	0	0	0	0	0	0	1	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	1	0	0	0	0
641:	0	0	0	0	0	0	0	0
649:	0	0	0	0	0	1	0	0
657:	0	0	0	0	0	0	0	0
665:	0	0	1	0	0	0	0	2
673:	0	0	0	0	0	0	0	2
681:	1	1	0	0	0	0	0	0
689:	0	0	0	0	0	0	0	0
697:	0	0	0	1	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:	1	0	0	0	0	0	0	0
737:	0	0	0	0	0	0	0	0
745:	1	0	0	0	0	0	0	0
753:	0	0	0	0	0	0	0	1
761:	0	2	0	0	0	0	1	0
769:	0	0	0	0	0	0	0	0
777:	0	0	0	0	0	0	1	0
785:	0	0	1	0	0	0	0	0
793:	0	0	0	0	0	1	0	0

801:	0	0	0	0	0	0	0	0

Sample Title: 03

Channel								
809:	0	0	0	0	0	0	0	0
817:	0	0	1	0	0	0	0	0
825:	0	0	0	0	0	0	2	2
833:	0	0	0	0	0	0	0	0
841:	0	0	0	1	0	0	0	0
849:	0	0	0	0	0	1	0	1
857:	1	0	0	0	0	0	0	0
865:	0	0	0	1	0	0	0	0
873:	0	0	0	0	0	0	0	0
881:	0	0	0	0	0	1	0	0
889:	0	1	0	0	0	0	0	0
897:	0	0	0	1	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	2	0	1	0	0	0
937:	0	0	0	0	1	0	0	1
945:	0	1	0	1	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	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

KB 11/20/14

Apex-Alpha™

Sample Description: FEE-BRI-W-FADW29206L
Spectrum File: \\OR-ALPHA1\Canberra\ApexAlpha\Root\Data\00001028
Batch Identification: 1411095A-RA
Sample Identification: 04
Sample Geometry: Shelf 2
Procedure Description: Ra

Detector Name: Alpha_036
Chamber Serial Number: 04026477B
Detector Serial Number: 84167
Env. Background: System Bkgd 101695
Reagent Blank: <not performed>

Sample Size: 5.000E-001 +/- 0.000E+000 liter
Generic Mult. Factor: 2.720E+000 Generic Div. Factor: 1.000E+000
Sample Date/Time: 11/13/2014 10:11:54 AM
Acquisition Date/Time: 11/20/2014 11:28:59 AM
Acquisition Live Time: 170.0 minutes
Acquisition Real Time: 170.0 minutes

Chem. Recovery Factor: 1.0000 +/- 0.0000
Counting Efficiency: 0.1806 +/- 0.0032 on 10/25/2014 2:38:17 PM
Effective Efficiency: 0.1806 +/- 0.0032

Peak Match Tolerance: 0.350 MeV

PEAK AREA REPORT

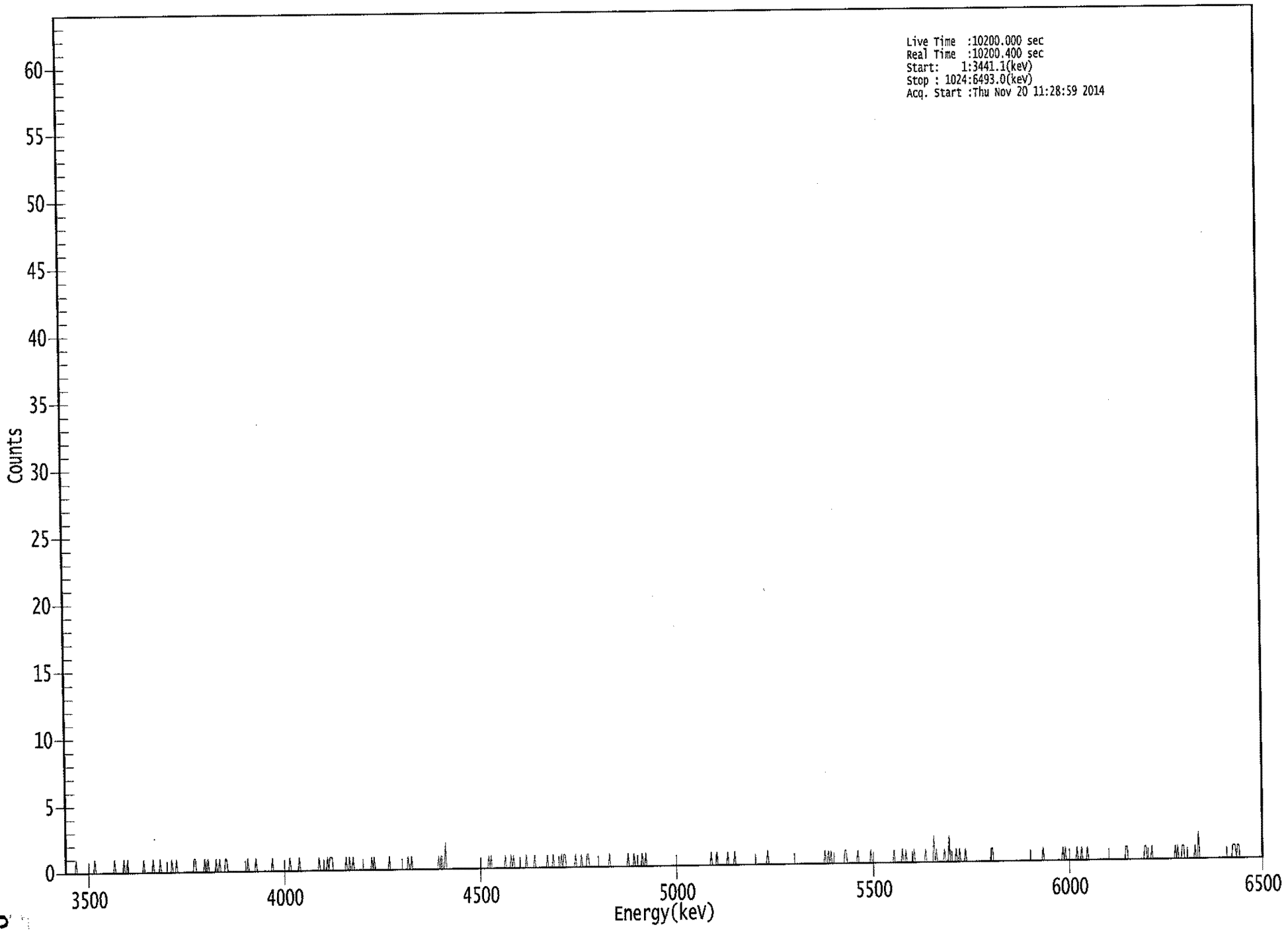
Nuclide	Energy (MeV)	Net Pk Area	Pk Area Error %	Ambient Backgnd	Reagent Backgnd	FWHM (keV)
RA-224	5.536	13.96	56.77	2.04	0.00E+000	3.0
RA-226	4.609	21.32	43.23	0.68	0.00E+000	3.0

NUCLIDE ANALYSIS RESULTS

Nuclide	Id Conf.	Energy (keV)	Activity (pCi/liter)	MDA (pCi/liter)
RA-224	0.971	5685.50*	1.17E+000 +/- 6.68E-001	6.55E-001 +/- 2.25E-002
RA-226	0.960	4785.00*	1.70E+000 +/- 7.38E-001	4.50E-001 +/- 1.55E-002

AG 11/20/14

0000102897.CNF



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

369:	0	0	0	0	0	0	0	0

Sample Title: 04

Channel								
377:	1	0	0	0	0	1	0	1
385:	0	0	0	0	0	0	0	0
393:	0	0	1	0	0	0	0	0
401:	0	1	0	0	0	0	0	0
409:	0	0	0	0	1	0	0	0
417:	0	1	0	0	0	0	0	0
425:	1	0	1	1	0	0	0	0
433:	0	0	0	0	1	0	0	0
441:	0	1	0	0	0	0	1	1
449:	0	0	0	0	0	0	0	0
457:	0	0	0	0	0	0	0	0
465:	0	1	0	0	0	0	0	0
473:	0	0	0	0	0	0	0	0
481:	0	1	0	0	0	0	1	0
489:	0	0	0	0	0	1	0	0
497:	1	0	0	0	0	0	0	0
505:	0	0	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:	1	0	0	0	0	1	0	0
561:	0	0	0	0	0	0	1	0
569:	0	0	0	0	1	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:	1	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	1	0	0	1	0	1	0
657:	0	0	0	0	0	0	0	0
665:	0	0	1	1	0	0	0	0
673:	0	0	0	0	0	1	0	0
681:	0	0	0	0	0	0	0	0
689:	1	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	0	0	1	0	0	1	0
721:	0	0	0	0	0	1	0	0
729:	0	0	0	0	0	0	0	1
737:	0	0	0	0	0	0	2	0
745:	1	0	0	0	0	0	0	1
753:	0	0	0	2	0	0	0	0
761:	0	1	0	0	1	0	0	0
769:	0	1	0	0	0	0	0	0
777:	0	0	0	0	0	0	0	0
785:	0	0	0	0	0	0	0	1
793:	1	0	0	0	0	0	0	0

202

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	0	0	0
825:	0	0	0	0	0	0	0	0
833:	0	0	0	1	0	0	0	0
841:	0	0	0	0	0	0	0	0
849:	0	0	0	0	1	0	1	0
857:	0	0	0	0	0	0	0	0
865:	1	0	0	0	1	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	1	1	0	0	0	0
913:	0	0	0	0	0	0	0	0
921:	0	0	1	1	0	0	0	0
929:	1	0	0	0	0	0	0	0
937:	0	0	0	0	0	0	0	0
945:	0	0	0	0	1	0	1	0
953:	0	0	1	1	0	0	0	0
961:	0	0	0	0	0	1	0	0
969:	2	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	1	1	1
1001:	0	1	1	0	0	0	0	0
1009:	0	0	0	0	0	0	0	0
1017:	0	0	0	0	0	0	0	0

11/20/2014 5:37:59 AM

Apex-Alpha™

QA SUMMARY REPORT

Review Of QA Results - Pulser Check

Date : 11/20/2014
Time : 5:37:59 AM

CHAMBER	DEVICE	PARAMETER	FLAG	DATE
Alpha_001	21f	ALL	Not Done	
Alpha_002	21f	ALL	Not Done	
Alpha_003	21f	ALL	Passed	11/20/2014 5:23:11 AM
Alpha_004	21f	ALL	Passed	11/20/2014 5:23:12 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	11/20/2014 5:23:13 AM
Alpha_011	21f	ALL	Passed	11/20/2014 5:23:14 AM
Alpha_012	21f	ALL	Passed	11/20/2014 5:23:15 AM
Alpha_013	21f	ALL	Not Done	
Alpha_014	21f	ALL	Passed	11/20/2014 5:23:15 AM
Alpha_015	21f	Peak FWHM	Action	11/20/2014 5:23:16 AM
Alpha_016	21f	ALL	Not Done	
Alpha_033	Alpha Analyst100DC	ALL	Passed	11/20/2014 5:23:17 AM
Alpha_034	Alpha Analyst100DC	ALL	Passed	11/20/2014 5:23:19 AM
Alpha_035	Alpha Analyst100DC	ALL	Passed	11/20/2014 5:23:21 AM
Alpha_036	Alpha Analyst100DC	ALL	Passed	11/20/2014 5:23:22 AM
Alpha_037	Alpha Analyst100DC	ALL	Passed	11/20/2014 5:23:25 AM
Alpha_038	Alpha Analyst100DC	Peak Energy	Action	11/20/2014 5:23:27 AM
Alpha_039	Alpha Analyst100DC	ALL	Passed	11/20/2014 5:23:29 AM
Alpha_040	Alpha Analyst100DC	ALL	Passed	11/20/2014 5:23:31 AM
Alpha_041	Alpha Analyst100DC	ALL	Passed	11/20/2014 5:23:35 AM
Alpha_042	Alpha Analyst100DC	ALL	Passed	11/20/2014 5:23:37 AM
Alpha_043	Alpha Analyst100DC	ALL	Passed	11/20/2014 5:23:40 AM
Alpha_044	Alpha Analyst100DC	ALL	Passed	11/20/2014 5:23:42 AM
Alpha_045	Alpha Analyst100DC	ALL	Passed	11/20/2014 5:23:45 AM
Alpha_046	Alpha Analyst100DC	ALL	Passed	11/20/2014 5:23:47 AM
Alpha_047	Alpha Analyst100DC	ALL	Passed	11/20/2014 5:23:50 AM
Alpha_048	Alpha Analyst100DC	ALL	Passed	11/20/2014 5:23:53 AM
Alpha_049	Alpha Analyst100DC	ALL	Passed	11/20/2014 5:23:55 AM
Alpha_050	Alpha Analyst100DC	ALL	Passed	11/20/2014 5:23:58 AM
Alpha_051	Alpha Analyst100DC	ALL	Passed	11/20/2014 5:24:00 AM
Alpha_052	Alpha Analyst100DC	ALL	Passed	11/20/2014 5:24:03 AM
Alpha_053	Alpha Analyst100DC	ALL	Passed	11/20/2014 5:24:06 AM
Alpha_054	Alpha Analyst100DC	ALL	Passed	11/20/2014 5:24:09 AM
Alpha_055	Alpha Analyst100DC	Peak FWHM	Action	11/20/2014 5:24:11 AM
Alpha_056	Alpha Analyst100DC	ALL	Passed	11/20/2014 5:24:14 AM
Alpha_057	Alpha Analyst100DC	ALL	Passed	11/20/2014 5:24:16 AM
Alpha_058	Alpha Analyst100DC	ALL	Passed	11/20/2014 5:24:19 AM

Review of QA Results - Pulser Check

11/20/2014 5:37:59 AM

CHAMBER	DEVICE	PARAMETER	FLAG	DATE
Alpha_059	Alpha Analyst100DC	ALL	Passed	11/20/2014 5:24:22 AM
Alpha_060	Alpha Analyst100DC	ALL	Passed	11/20/2014 5:24:25 AM

APPROVED BY: _____

APPROVAL DATE: _____

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

WLLFOIA4312 - 001 - 0030623

SECTION XI

ANALYTICAL DATA (RADIUM-228)

WLLFOIA4312 - 001 - 0030624

Eberline Services
Oak Ridge Laboratory
Analysis Sheet

14-11095
Ra228
Run 1

Work Order	14-11095
Analysis Code	Ra228
Run	1
Date Received	11/18/2014
Lab Deadline	11/24/2014
Client	Feezor Engineering, Inc.
Project	FEEBRI
Report Level	4
Activity Units	pCi
Aliquot Units	l
Matrix	WA
Method	EPA 904.0 Modified
Instrument Type	Alpha/Beta GPC
Radiometric Tracer	Ba-133
Radiometric Sol#	Ba-6a
Tracer Act (dpm/g)	909.766
Carrier	Yttirum
Carrier Conc (mg/ml)	40.56226

Internal Fraction	Sample Desc	Client ID	Login CPM	Sample Date	Sample Aliquot
01	LCS	LCS		11/18/14 00:00	1.0000E+00
02	MBL	BLANK		11/18/14 00:00	1.0000E+00
03	DUP	FEE-BRI-W-FADW29206L	39	11/13/14 00:00	1.0000E+00
04	DO	FEE-BRI-W-FADW29206L	39	11/13/14 00:00	1.0000E+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.

14-11095
Ra228
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	0.9054	823.7	345.0	92.98	2.000	0.0930	0.1553	0.0623	76.80	71.41	1.00	1.00
02	MBL	0.9034	821.9	364.0	98.32	2.000	0.0931	0.1532	0.0601	74.08	72.84	1.00	1.00
03	DUP	0.9051	823.4	551.0	148.55	2.000	0.0935	0.1554	0.0619	76.30	83.93	1.00	1.00
04	DO	0.9047	823.1	536.0	144.57	2.000	0.0931	0.1495	0.0564	69.52	76.48	1.00	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.

Eberline Services
Oak Ridge Laboratory
Analysis Sheet

14-11095
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			11/18/14 15:47	LWALKER	11/19/14 12:20	RMARTZ	11/24/14 06:15	RMARTZ
02	MBL			11/18/14 15:47	LWALKER	11/19/14 12:20	RMARTZ	11/24/14 06:15	RMARTZ
03	DUP			11/18/14 15:47	LWALKER	11/19/14 12:20	RMARTZ	11/24/14 06:15	RMARTZ
04	DO			11/18/14 15:47	LWALKER	11/19/14 12:20	RMARTZ	11/24/14 06:15	RMARTZ

* 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.

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Eberline Services
Oak Ridge Laboratory

Preliminary Data Report & Analytical Calculations

Work Order: 14-11095-Ra228-1

Run: 1
Analysis Code: Ra228
Eberline Services Work Order: 14-11095
Client: Feezor Engineering, Inc.

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	7.82E+00	9.59E-01	1.38E+00	7.38E+00	105.99	OK		OK	
02	RA-228	MBL	BLANK	pCi/l	6.86E-01	6.48E-01	1.31E+00					OK	OK
03	RA-228	DUP	FEE-BRI-W-FADW29206L	pCi/l	2.82E+00	5.89E-01	9.50E-01				NA	OK	
04	RA-228	DO	FEE-BRI-W-FADW29206L	pCi/l	2.10E+00	6.93E-01	1.27E+00					OK	

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Preliminary Data Report & Analytical Calculations
Work Order: 14-11095-Ra228-1

Client: Feezor Engineering, Inc.
Eberline Services Work Order: 14-11095
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	11/18/14 00:00	1.00E+00	92.98	76.80	71.41	1.00	11/19/2014 12:20	11/24/2014 6:15
02	RA-228	MBL	11/18/14 00:00	1.00E+00	98.32	74.08	72.84	1.00	11/19/2014 12:20	11/24/2014 6:15
03	RA-228	DUP	11/13/14 00:00	1.00E+00	148.55	76.30	83.93	1.00	11/19/2014 12:20	11/24/2014 6:15
04	RA-228	DO	11/13/14 00:00	1.00E+00	144.57	69.52	76.48	1.00	11/19/2014 12:20	11/24/2014 6:15

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Preliminary Data Report & Analytical Calculations
Work Order: 14-11095-Ra228-1

Client: Feezor Engineering, Inc.
Eberline Services Work Order: 14-11095
Analysis Code: Ra228
Run: 1

Lab Fraction	Nuclide	Sample Desc	Counting Date/Time	Halflife (days)	Detect	Carrier	Count Time	Counts	Bkg CPM	Eff
01	RA-228	LCS	11/24/14 08:37		LB4110A	B4	120	665	1.633333333	0.4619
02	RA-228	MBL	11/24/14 08:37		LB4110A	B1	120	226	1.533333333	0.4626
03	RA-228	DUP	11/24/14 08:37		LB4110A	B2	120	332	1.083333333	0.4691
04	RA-228	DO	11/24/14 08:37		LB4110A	B3	120	309	1.483333333	0.449

WLLFOIA4312 - 001 - 0030630

Count Room Report
Client: Feezor Engineering, Inc.

14-11095-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	11/18/14 00:00	1.0000	0.9054	823.7021	345.0000	92.98	1.00	1.00
02	MBL	BLANK	11/18/14 00:00	1.0000	0.9034	821.8826	364.0000	98.32	1.00	1.00
03	DUP	FEE-BRI-W-FADW29206L	11/13/14 00:00	1.0000	0.9051	823.4292	551.0000	148.55	1.00	1.00
04	DO	FEE-BRI-W-FADW29206L	11/13/14 00:00	1.0000	0.9047	823.0653	536.0000	144.57	1.00	1.00

Eberline Services
Oak Ridge Laboratory

Spike and Tracer Worksheet

Printed: 11/18/2014 3:47 PM

Internal Work Order	Run	Analysis Code	Date	Technician	Technician Initials	Witness Initials
14-11095	1	Ra228	11/18/2014 15:46	LWALKER		

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-11	32.242	11/18/2014	0.620	0.5082				7.38	0.376	0.00	0.000	0.00	0.000	0.00	0.000
Tc-99 MS	Tc-2a	22043.688	10/16/2013	0.1												

Tracers

fraction	Isotope	Sol #	Activity dpm/g	Solution Date	Volume Used (g)	Approx Addition
01	Ba-133	Ba-6a	909.766	11/18/2014	0.9054	1.1100
02	Ba-133	Ba-6a	909.766	11/18/2014	0.9034	1.1100
03	Ba-133	Ba-6a	909.766	11/18/2014	0.9051	1.1100
04	Ba-133	Ba-6a	909.766	11/18/2014	0.9047	1.1100

Balance Printer Tapes

Tracer	LCS
	0.5082 g

Matrix Spike

Version 2.0 08/99

WLLFOIA4312 - 001 - 0030632

Eberline Analytical
Oak Ridge Laboratory

Aliquot Worksheet

Work Order	Run	Analysis Code	Rpt Units	Lab Deadline	Technician
14-11095	1	Ra228	liters	11/24/2014	LWALKER

Lab Fraction	Feezor Engineering, 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	FEE-BRI-W-FADW29206L	DUP					1.0000E+00	1.0000E+00				
04	FEE-BRI-W-FADW29206L	DO					1.0000E+00	1.0000E+00				

Comments	

Technician: L Walker Date: 11/18/14

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WLLFOIA4312 - 001 - 0030633

Eberline Services - Oak Ridge
Version 1.0 9/1999

Gravimetric Worksheet

Work Order	Run	Analysis Code	Gravimetric Carrier	Carrier Conc (mg/ml)	Technician
14-11095	1	Ra228	Yttirum	40.5623	RMARTZ

TRetec Fraction	Feezor Engineering, Inc. Client ID	Sample Type	Carrier Data: Carrier Added (ml)	Filter Data: Filter Tare (g)	Filter Final (g)	Filter Net (g)	Gravimetric: % Recovery
01	LCS	LCS	2.0000	0.0930	0.1553	0.0623	76.80
02	BLANK	MBL	2.0000	0.0931	0.1532	0.0601	74.08
03	DUP	DUP	2.0000	0.0935	0.1554	0.0619	76.30
04	FEE-BRI-W-FADW29206L	DO	2.0000	0.0931	0.1495	0.0564	69.52

Technician: RT Date: 11/24/14

WLLFOIA4312 - 001 - 0030634

Detector ID	Sample ID	Alpha	Beta	Count Time	Voltage	TOD
B1	1411095-02	11	226	120	1400	11/24/14 10:37
B2	1411095-03	11	332	120	1400	11/24/14 10:37
B3	1411095-04	16	309	120	1400	11/24/14 10:37
B4	1411095-01	19	665	120	1400	11/24/14 10:37

WLLFOIA4312 - 001 - 0030635

GPC Detector Report
(ALL Backgrounds)

Detector	Alpha/Beta	Calibration Date	Count Date	Bkg CPM	PFW	LCL	Mean	UCL
LB4110A - A1	Alpha	11/18/2007	11/24/2014	0.00E+00	P	-1.94E+01	2.41E-01	1.98E+01
LB4110A - A2	Alpha	11/18/2007	11/24/2014	3.33E-02	P	-1.64E+01	2.18E-01	1.69E+01
LB4110A - A3	Alpha	11/18/2007	11/24/2014	5.00E-02	P	-1.60E+01	1.90E-01	1.64E+01
LB4110A - A4	Alpha	11/18/2007	11/24/2014	6.67E-02	P	-1.70E+01	2.03E-01	1.74E+01
LB4110A - B1	Alpha	11/18/2007	11/24/2014	3.33E-02	P	-9.16E-02	7.25E-02	2.37E-01
LB4110A - B2	Alpha	11/18/2007	11/24/2014	1.67E-02	P	-7.14E-02	7.32E-02	2.18E-01
LB4110A - B3	Alpha	11/18/2007	11/24/2014	5.00E-02	P	-6.24E-02	5.55E-02	1.73E-01
LB4110A - B4	Alpha	11/18/2007	11/24/2014	6.67E-02	P	-1.28E-01	7.72E-02	2.82E-01
LB4110A - C1	Alpha	11/18/2007	11/24/2014	1.00E-01	P	-1.37E-01	8.77E-02	3.12E-01
LB4110A - C2	Alpha	11/18/2007	11/24/2014	8.33E-02	P	-1.66E-01	7.99E-02	3.25E-01
LB4110A - C3	Alpha	11/18/2007	11/24/2014	8.33E-02	P	-1.61E-01	9.40E-02	3.49E-01
LB4110A - C4	Alpha	11/18/2007	11/24/2014	3.33E-02	P	-6.48E-02	6.90E-02	2.03E-01
LB4110A - D1	Alpha	11/18/2007	11/24/2014	1.67E-02	P	-5.43E-02	8.01E-02	2.15E-01
LB4110A - D2	Alpha	11/18/2007	11/24/2014	1.67E-02	P	-6.96E-02	6.01E-02	1.90E-01
LB4110A - D3	Alpha	11/18/2007	11/24/2014	3.33E-02	P	-5.06E-02	6.74E-02	1.85E-01
LB4110A - D4	Alpha	11/18/2007	11/24/2014	3.33E-02	P	-6.69E-02	6.99E-02	2.07E-01
LB4110R - A1	Alpha	11/24/2006	11/24/2014	3.33E-02	P	-9.21E-02	9.80E-02	2.88E-01
LB4110R - A2	Alpha	11/24/2006	11/24/2014	8.33E-02	P	-8.50E-02	7.23E-02	2.30E-01
LB4110R - A3	Alpha	11/24/2006	11/24/2014	0.00E+00	P	-7.07E-02	8.13E-02	2.33E-01
LB4110R - A4	Alpha	11/24/2006	11/24/2014	5.00E-02	P	-5.13E-02	6.90E-02	1.89E-01
LB4110R - B1	Alpha	11/24/2006	11/24/2014	1.00E-01	P	-8.91E-02	6.18E-02	2.13E-01
LB4110R - B2	Alpha	11/24/2006	11/24/2014	3.33E-02	P	-6.80E-02	6.02E-02	1.88E-01
LB4110R - B3	Alpha	11/24/2006	11/24/2014	5.00E-02	P	-6.48E-02	7.19E-02	2.09E-01
LB4110R - B4	Alpha	11/24/2006	11/24/2014	3.33E-02	P	-6.09E-02	6.82E-02	1.97E-01
LB4110R - C1	Alpha	11/24/2006	11/24/2014	1.00E-01	P	-7.48E-02	7.26E-02	2.20E-01
LB4110R - C2	Alpha	11/24/2006	11/24/2014	1.67E-02	P	-7.50E-02	6.77E-02	2.10E-01
LB4110R - C3	Alpha	11/24/2006	11/24/2014	0.00E+00	P	-8.19E-02	8.40E-02	2.50E-01
LB4110R - C4	Alpha	11/24/2006	11/24/2014	3.33E-02	P	-5.96E-02	7.83E-02	2.16E-01
LB4110R - D1	Alpha	11/24/2006	11/1/2014	0.00E+00	P	-1.06E-01	6.70E-02	2.40E-01
LB4110R - D2	Alpha	11/24/2006	11/1/2014	0.00E+00	P	-8.23E-02	6.65E-02	2.15E-01
LB4110R - D3	Alpha	11/24/2006	11/1/2014	0.00E+00	P	-8.71E-02	6.63E-02	2.20E-01
LB4110R - D4	Alpha	11/24/2006	11/1/2014	0.00E+00	P	-8.04E-02	7.08E-02	2.22E-01
LB5100 - 1	Alpha	7/10/2006	10/26/2007	5.00E-02	P	-1.56E-02	9.58E-02	2.07E-01

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GPC Detector Report
(ALL Backgrounds)

Detector	Alpha/Beta	Calibration Date	Count Date	Bkg CPM	PFW	LCL	Mean	UCL
LB4110A - A1	Beta	11/18/2007	11/24/2014	1.25E+00	P	-2.62E+02	7.05E+00	2.76E+02
LB4110A - A2	Beta	11/18/2007	11/24/2014	1.82E+00	P	-2.74E+01	2.70E+00	3.28E+01
LB4110A - A3	Beta	11/18/2007	11/24/2014	1.45E+00	P	-4.54E+01	2.56E+00	5.06E+01
LB4110A - A4	Beta	11/18/2007	11/24/2014	7.42E+00	F	-2.89E+01	3.88E+00	3.67E+01
LB4110A - B1	Beta	11/18/2007	11/24/2014	1.53E+00	P	-9.42E+00	3.01E+00	1.54E+01
LB4110A - B2	Beta	11/18/2007	11/24/2014	1.08E+00	P	-6.84E+00	1.91E+00	1.07E+01
LB4110A - B3	Beta	11/18/2007	11/24/2014	1.48E+00	P	-3.79E-01	1.41E+00	3.19E+00
LB4110A - B4	Beta	11/18/2007	11/24/2014	1.63E+00	P	-6.80E+00	1.91E+00	1.06E+01
LB4110A - C1	Beta	11/18/2007	11/24/2014	1.10E+00	P	-4.84E+00	2.00E+00	8.84E+00
LB4110A - C2	Beta	11/18/2007	11/24/2014	1.20E+00	P	3.75E-01	1.28E+00	2.18E+00
LB4110A - C3	Beta	11/18/2007	11/24/2014	2.23E+00	F	4.36E-01	1.52E+00	2.61E+00
LB4110A - C4	Beta	11/18/2007	11/24/2014	1.47E+00	P	-1.60E+00	1.98E+00	5.56E+00
LB4110A - D1	Beta	11/18/2007	11/24/2014	1.62E+00	P	-2.24E+00	2.49E+00	7.21E+00
LB4110A - D2	Beta	11/18/2007	11/24/2014	5.80E+00	F	-3.78E+00	1.98E+00	7.73E+00
LB4110A - D3	Beta	11/18/2007	11/24/2014	2.30E+00	F	6.85E-01	4.30E+00	7.92E+00
LB4110A - D4	Beta	11/18/2007	11/24/2014	1.26E+01	F	-7.52E+00	1.93E+00	1.14E+01
LB4110R - A1	Beta	11/24/2006	11/24/2014	1.50E+00	P	-5.60E+01	3.31E+00	6.26E+01
LB4110R - A2	Beta	11/24/2006	11/24/2014	1.60E+00	P	-4.43E+01	1.93E+00	4.82E+01
LB4110R - A3	Beta	11/24/2006	11/24/2014	1.75E+00	P	-4.11E+01	2.53E+00	4.61E+01
LB4110R - A4	Beta	11/24/2006	11/24/2014	2.45E+00	F	-4.08E+01	2.01E+00	4.48E+01
LB4110R - B1	Beta	11/24/2006	11/24/2014	1.42E+00	P	-4.30E+01	1.93E+00	4.69E+01
LB4110R - B2	Beta	11/24/2006	11/24/2014	6.37E+00	F	-4.82E+01	3.28E+00	5.47E+01
LB4110R - B3	Beta	11/24/2006	11/24/2014	1.55E+00	P	-4.29E+01	2.47E+00	4.78E+01
LB4110R - B4	Beta	11/24/2006	11/24/2014	1.10E+00	P	-4.31E+01	1.83E+00	4.68E+01
LB4110R - C1	Beta	11/24/2006	11/24/2014	1.32E+00	P	-4.30E+01	2.72E+00	4.85E+01
LB4110R - C2	Beta	11/24/2006	11/24/2014	1.52E+00	P	-4.29E+01	2.56E+00	4.80E+01
LB4110R - C3	Beta	11/24/2006	11/24/2014	1.50E+00	P	-4.34E+01	2.36E+00	4.81E+01
LB4110R - C4	Beta	11/24/2006	11/24/2014	1.52E+00	P	-4.90E+01	2.72E+00	5.44E+01
LB4110R - D1	Beta	11/24/2006	11/1/2014	0.00E+00	P	-4.36E+01	5.31E+00	5.43E+01
LB4110R - D2	Beta	11/24/2006	11/1/2014	0.00E+00	P	-4.67E+01	1.79E+00	5.03E+01
LB4110R - D3	Beta	11/24/2006	11/1/2014	0.00E+00	P	-5.02E+01	5.28E+00	6.07E+01
LB4110R - D4	Beta	11/24/2006	11/1/2014	0.00E+00	P	-4.64E+01	2.13E+00	5.07E+01
LB5100 - 1	Beta	7/10/2006	10/26/2007	4.52E+00	F	-3.19E-01	1.58E+00	3.48E+00

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GPC Detector Report
(ALL Efficiencies)

11/24

Detector	Alpha/Beta	Calibration Date	Count Date	Eff	PFW	LCL	Mean	UCL
LB4110A - A1	Alpha	11/18/2007	11/24/2014	0.2375	P	0.0106	0.2189	0.4271
LB4110A - A2	Alpha	11/18/2007	11/24/2014	0.2037	P	-0.0266	0.1787	0.3840
LB4110A - A3	Alpha	11/18/2007	11/24/2014	0.1996	P	-0.0483	0.1698	0.3878
LB4110A - A4	Alpha	11/18/2007	11/24/2014	0.2289	P	-0.0272	0.1903	0.4079
LB4110A - B1	Alpha	11/18/2007	11/24/2014	0.2229	P	0.1953	0.2235	0.2517
LB4110A - B2	Alpha	11/18/2007	11/24/2014	0.2100	P	0.1889	0.2189	0.2488
LB4110A - B3	Alpha	11/18/2007	11/24/2014	0.2333	P	0.1377	0.2326	0.3276
LB4110A - B4	Alpha	11/18/2007	11/24/2014	0.2304	P	0.2058	0.2343	0.2627
LB4110A - C1	Alpha	11/18/2007	11/24/2014	0.2165	P	0.1980	0.2200	0.2421
LB4110A - C2	Alpha	11/18/2007	11/24/2014	0.2265	P	0.1989	0.2250	0.2510
LB4110A - C3	Alpha	11/18/2007	11/24/2014	0.2445	P	0.2242	0.2489	0.2735
LB4110A - C4	Alpha	11/18/2007	11/24/2014	0.2184	P	0.1982	0.2249	0.2517
LB4110A - D1	Alpha	11/18/2007	11/24/2014	0.2193	P	0.1797	0.2303	0.2809
LB4110A - D2	Alpha	11/18/2007	11/24/2014	0.2469	P	0.2017	0.2557	0.3097
LB4110A - D3	Alpha	11/18/2007	11/24/2014	0.2554	P	0.2054	0.2611	0.3168
LB4110A - D4	Alpha	11/18/2007	11/24/2014	0.1930	P	0.1488	0.1973	0.2458
LB4110R - A1	Alpha	11/24/2006	11/24/2014	0.2320	P	0.2002	0.2376	0.2751
LB4110R - A2	Alpha	11/24/2006	11/24/2014	0.1972	P	0.1847	0.2185	0.2524
LB4110R - A3	Alpha	11/24/2006	11/24/2014	0.2134	P	0.1922	0.2230	0.2537
LB4110R - A4	Alpha	11/24/2006	11/24/2014	0.2378	P	0.2130	0.2445	0.2760
LB4110R - B1	Alpha	11/24/2006	11/24/2014	0.1977	P	0.1702	0.2224	0.2746
LB4110R - B2	Alpha	11/24/2006	11/24/2014	0.1787	P	0.1670	0.2142	0.2615
LB4110R - B3	Alpha	11/24/2006	11/24/2014	0.2103	P	0.1969	0.2431	0.2892
LB4110R - B4	Alpha	11/24/2006	11/24/2014	0.1866	W	0.1799	0.2283	0.2768
LB4110R - C1	Alpha	11/24/2006	11/24/2014	0.2059	P	0.1795	0.2138	0.2481
LB4110R - C2	Alpha	11/24/2006	11/24/2014	0.2157	P	0.1898	0.2228	0.2558
LB4110R - C3	Alpha	11/24/2006	11/24/2014	0.2275	P	0.2033	0.2380	0.2726
LB4110R - C4	Alpha	11/24/2006	11/24/2014	0.2068	P	0.1778	0.2194	0.2611
LB4110R - D1	Alpha	11/24/2006	11/1/2014	0.0000	W	-0.0281	0.1904	0.4089
LB4110R - D2	Alpha	11/24/2006	11/1/2014	0.0000	W	-0.0314	0.2165	0.4644
LB4110R - D3	Alpha	11/24/2006	11/1/2014	0.0000	W	-0.0308	0.2127	0.4562
LB4110R - D4	Alpha	11/24/2006	11/1/2014	0.0000	W	-0.0260	0.1714	0.3689
LB5100 - 1	Alpha	7/10/2006	10/26/2007	0.3368	P	0.3332	0.3455	0.3578

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GPC Detector Report
(ALL Efficiencies)

Detector	Alpha/Beta	Calibration Date	Count Date	Eff	PFW	LCL	Mean	UCL
LB4110A - A1	Beta	11/18/2007	11/24/2014	0.5692	P	0.2439	0.5629	0.8819
LB4110A - A2	Beta	11/18/2007	11/24/2014	0.4648	P	0.1921	0.4677	0.7433
LB4110A - A3	Beta	11/18/2007	11/24/2014	0.4926	P	0.1281	0.4632	0.7982
LB4110A - A4	Beta	11/18/2007	11/24/2014	0.5618	P	0.1784	0.5028	0.8272
LB4110A - B1	Beta	11/18/2007	11/24/2014	0.5485	P	0.4666	0.5333	0.5999
LB4110A - B2	Beta	11/18/2007	11/24/2014	0.5336	P	0.4678	0.5272	0.5866
LB4110A - B3	Beta	11/18/2007	11/24/2014	0.5970	P	0.3373	0.5417	0.7462
LB4110A - B4	Beta	11/18/2007	11/24/2014	0.5700	P	0.4951	0.5559	0.6166
LB4110A - C1	Beta	11/18/2007	11/24/2014	0.5457	P	0.4368	0.5115	0.5863
LB4110A - C2	Beta	11/18/2007	11/24/2014	0.5601	P	0.3994	0.5160	0.6325
LB4110A - C3	Beta	11/18/2007	11/24/2014	0.6207	P	0.5259	0.5978	0.6697
LB4110A - C4	Beta	11/18/2007	11/24/2014	0.5721	P	0.4528	0.5330	0.6131
LB4110A - D1	Beta	11/18/2007	11/24/2014	0.7162	W	0.3872	0.5646	0.7420
LB4110A - D2	Beta	11/18/2007	11/24/2014	0.6806	P	0.4358	0.5915	0.7471
LB4110A - D3	Beta	11/18/2007	11/24/2014	0.6681	P	0.4806	0.6156	0.7507
LB4110A - D4	Beta	11/18/2007	11/24/2014	0.4929	P	0.3516	0.4714	0.5912
LB4110R - A1	Beta	11/24/2006	11/24/2014	0.5733	P	0.4818	0.5701	0.6583
LB4110R - A2	Beta	11/24/2006	11/24/2014	0.5053	P	0.4236	0.5114	0.5993
LB4110R - A3	Beta	11/24/2006	11/24/2014	0.5401	P	0.4568	0.5386	0.6203
LB4110R - A4	Beta	11/24/2006	11/24/2014	0.6187	P	0.5100	0.5953	0.6806
LB4110R - B1	Beta	11/24/2006	11/24/2014	0.4721	P	0.4284	0.5393	0.6502
LB4110R - B2	Beta	11/24/2006	11/24/2014	0.4497	P	0.4117	0.5172	0.6227
LB4110R - B3	Beta	11/24/2006	11/24/2014	0.5364	P	0.4824	0.5958	0.7091
LB4110R - B4	Beta	11/24/2006	11/24/2014	0.4726	P	0.4429	0.5478	0.6527
LB4110R - C1	Beta	11/24/2006	11/24/2014	0.4874	P	0.4140	0.5016	0.5892
LB4110R - C2	Beta	11/24/2006	11/24/2014	0.5304	P	0.4337	0.5357	0.6376
LB4110R - C3	Beta	11/24/2006	11/24/2014	0.5786	P	0.4822	0.5742	0.6663
LB4110R - C4	Beta	11/24/2006	11/24/2014	0.5276	P	0.4316	0.5258	0.6201
LB4110R - D1	Beta	11/24/2006	11/1/2014	0.0000	W	-0.0678	0.4553	0.9785
LB4110R - D2	Beta	11/24/2006	11/1/2014	0.0000	W	-0.0756	0.5116	1.0989
LB4110R - D3	Beta	11/24/2006	11/1/2014	0.0000	W	-0.0736	0.4969	1.0674
LB4110R - D4	Beta	11/24/2006	11/1/2014	0.0000	W	-0.0630	0.4090	0.8811
LB5100 - 1	Beta	7/10/2006	10/26/2007	0.4428	F	0.4555	0.4731	0.4906

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SECTION XII

BARIUM-133 ANALYTICAL TRACER DATA

WLLFOIA4312 - 001 - 0030640

Apex-Gamma

Analysis Report for 1411095-01
SPIKE

GAMMA SPECTRUM ANALYSIS

Sample Identification	: 1411095-01
Sample Description	: SPIKE
Sample Type	: RA RECOVERY
Sample Size	: 1.000E+00 units
Facility	: Countroom
Sample Taken On	: 11/20/2014 7:46:47AM
Acquisition Started	: 11/20/2014 7:59:08AM
Procedure	: BAFIL
Operator	: Administrator
Detector Name	: GE2
Geometry	: BAFIL
Live Time	: 900.0 seconds
Real Time	: 900.2 seconds
Dead Time	: 0.03 %
Peak Locate Threshold	: 2.50
Peak Locate Range (in channels)	: 1 - 4096
Peak Area Range (in channels)	: 7 - 4096
Identification Energy Tolerance	: 1.000 keV
Energy Calibration Used Done On	: 11/2/2014
Efficiency Calibration Used Done On	: 11/9/2014
Efficiency Calibration Description	:
Sample Number	: 15272

PEAK ANALYSIS REPORT

Peak Analysis Performed on : 11/20/2014 8:14:11AM

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)

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Analysis Report for 1411095-01

SPIKE

	Peak No.	Energy (keV)	ROI start	ROI end	Peak Centroid	Net Peak Area	Net Area Uncertainty	Continuum Counts	FWHM (keV)
M	1	30.92	27 -	40	31.03	1.53E+03	84.05	2.55E+02	1.35
m	2	35.12	27 -	40	35.23	3.75E+02	49.83	1.18E+02	1.61
	3	52.66	49 -	57	52.76	5.74E+01	35.85	1.63E+02	3.89
	4	61.55	58 -	65	61.64	1.22E+02	51.11	3.58E+02	1.31
	5	66.35	65 -	69	66.45	6.57E+01	29.15	1.19E+02	1.79
	6	81.09	76 -	85	81.17	6.39E+02	64.83	2.35E+02	1.41
	7	102.85	99 -	106	102.92	3.18E+01	29.12	1.20E+02	1.26
M	8	111.69	107 -	119	111.76	1.57E+02	31.68	7.61E+01	1.71
m	9	116.16	107 -	119	116.22	2.83E+01	22.08	7.13E+01	1.73
	10	137.41	135 -	139	137.46	1.72E+01	19.04	6.56E+01	1.80
	11	239.53	235 -	245	239.53	3.58E+01	33.62	1.30E+02	2.09
	12	276.31	271 -	283	276.29	4.36E+01	30.72	8.89E+01	1.85
M	13	293.97	291 -	315	293.93	1.39E+01	11.40	1.58E+00	1.99
m	14	302.85	291 -	315	302.82	1.36E+02	24.53	1.27E+01	1.63
M	15	330.05	329 -	341	330.00	6.63E+00	5.66	6.10E+00	1.41
m	16	333.71	329 -	341	333.65	5.83E+01	19.95	1.91E+01	1.77
m	17	338.20	329 -	341	338.14	1.28E+01	12.25	2.39E+01	1.56
M	18	355.98	352 -	362	355.92	4.20E+02	42.17	2.18E+01	1.56
m	19	360.07	352 -	362	360.00	9.13E+00	10.58	8.36E+00	1.44
	20	385.66	381 -	389	385.58	2.10E+02	37.53	1.12E+02	3.99
	21	391.23	390 -	394	391.14	2.92E+01	16.55	3.16E+01	1.33
	22	436.73	432 -	440	436.63	7.74E+01	19.92	1.33E+01	1.51
	23	454.57	451 -	458	454.46	1.10E+01	9.59	8.00E+00	3.94
	24	469.04	465 -	473	468.92	1.73E+01	15.41	2.33E+01	1.58
	25	674.42	671 -	676	674.20	5.00E+00	4.47	0.00E+00	2.31

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 : 11/20/2014 8:14:11AM

Env. Background File : \\OR-GAMMA1\ApexRoot\Countroom\Data\0000015027.CNF

	Peak No.	Energy (keV)	Original Area	Orig. Area Uncertainty	Ambient Background	Backgr. Uncert.	Subtracted Area	Subtracted Uncert.
M	1	30.92	1.53E+03	84.05			1.53E+03	8.40E+01
m	2	35.12	3.75E+02	49.83			3.75E+02	4.98E+01
	3	52.66	5.74E+01	35.85			5.74E+01	3.58E+01
	4	61.55	1.22E+02	51.11			1.22E+02	5.11E+01

Analysis Report for 1411095-01

SPIKE

	Peak No.	Energy (keV)	Original Area	Orig. Area Uncertainty	Ambient Background	Backgr. Uncert.	Subtracted Area	Subtracted Uncert.
	5	66.35	6.57E+01	29.15			6.57E+01	2.92E+01
	6	81.09	6.39E+02	64.83			6.39E+02	6.48E+01
	7	102.85	3.18E+01	29.12			3.18E+01	2.91E+01
M	8	111.69	1.57E+02	31.68			1.57E+02	3.17E+01
m	9	116.16	2.83E+01	22.08			2.83E+01	2.21E+01
	10	137.41	1.72E+01	19.04			1.72E+01	1.90E+01
	11	239.53	3.58E+01	33.62	3.89E+00	1.82E+00	3.19E+01	3.37E+01
	12	276.31	4.36E+01	30.72			4.36E+01	3.07E+01
M	13	293.97	1.39E+01	11.40			1.39E+01	1.14E+01
m	14	302.85	1.36E+02	24.53			1.36E+02	2.45E+01
M	15	330.05	6.63E+00	5.66			6.63E+00	5.66E+00
m	16	333.71	5.83E+01	19.95			5.83E+01	1.99E+01
m	17	338.20	1.28E+01	12.25			1.28E+01	1.22E+01
M	18	355.98	4.20E+02	42.17			4.20E+02	4.22E+01
m	19	360.07	9.13E+00	10.58			9.13E+00	1.06E+01
	20	385.66	2.10E+02	37.53			2.10E+02	3.75E+01
	21	391.23	2.92E+01	16.55			2.92E+01	1.65E+01
	22	436.73	7.74E+01	19.92			7.74E+01	1.99E+01
	23	454.57	1.10E+01	9.59			1.10E+01	9.59E+00
	24	469.04	1.73E+01	15.41			1.73E+01	1.54E+01
	25	674.42	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
SN-113	0.92	255.12		1.93		
		391.69	*	61.90	2.02E+01	1.16E+01
I-125	0.97	35.49	*	6.49	3.98E+01	5.29E+00
BA-133	0.98	30.80	*	97.60	5.54E+00	4.57E-01
		81.00	*	33.00	3.44E+02	6.36E+01
		302.84	*	17.80	4.50E+02	1.44E+02
		356.01	*	60.00	3.45E+02	5.94E+01
		383.85		8.70		

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Analysis Report for 1411095-01

SPIKE

* = Energy line found in the spectrum.
\- = Manually added nuclide.
? = Manually edited nuclide.
@ = Energy line not used for Weighted Mean Activity
Energy Tolerance : 1.000 keV
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	0.928	2.02E+01	1.16E+01	
I-125	0.978	3.98E+01	5.29E+00	
BA-133	0.987	5.58E+00	4.57E-01	

? = 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 1411095-01

SPIKE

UNIDENTIFIED PEAKS

Peak Locate Performed on : 11/20/2014 8:14:11AM
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	52.66	6.37770E-02	31.23		
	4	61.55	1.35382E-01	20.97	Sum	
	5	66.35	7.29911E-02	22.19	Sum	
	7	102.85	3.52899E-02	45.84		
M	8	111.69	1.74575E-01	10.08	Sum	
m	9	116.16	3.14813E-02	38.96	Sum	
	10	137.41	1.91111E-02	55.35		
	11	239.53	3.54511E-02	52.76		
	12	276.31	4.83965E-02	35.26		
M	13	293.97	1.54358E-02	41.04		
M	15	330.05	7.36567E-03	42.67		
m	16	333.71	6.47319E-02	17.12	Sum	
m	17	338.20	1.41894E-02	47.95	Sum	
m	19	360.07	1.01431E-02	57.96		
	20	385.66	2.33354E-01	8.93		
	22	436.73	8.59722E-02	12.87	Sum	
	23	454.57	1.22222E-02	43.60		
	24	469.04	1.92529E-02	44.47		
	25	674.42	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

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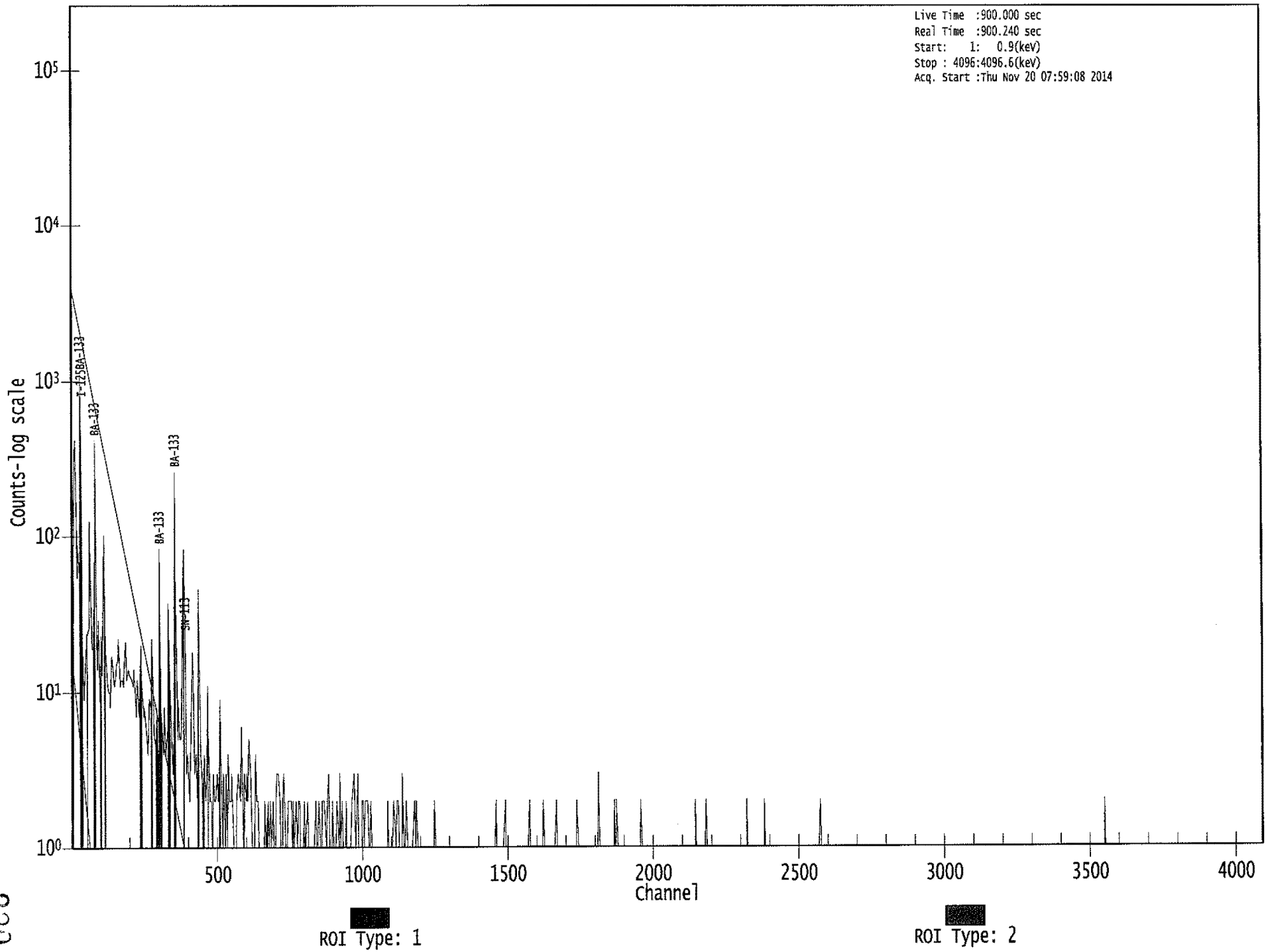
Analysis Report for 1411095-01

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	1.17E-06	1.17E-06	-5.53E-06	5.28E-07
	CO-57	122.06		85.51	1.69E+01	1.69E+01	4.53E+00	7.77E+00
		136.48		10.60	1.70E+02		4.49E+01	7.85E+01
	NI-59	6.92		29.80	1.12E-05	1.12E-05	-2.37E-05	5.38E-06
	MO-93	16.59		52.90	7.40E-03	7.40E-03	2.90E-03	3.52E-03
		18.60		10.00	8.87E-02		-1.48E-01	4.22E-02
	NB-93M	16.57		9.43	4.12E-02	4.12E-02	1.61E-02	1.96E-02
	CD-109	88.03		3.72	2.36E+02	2.36E+02	7.73E+01	1.10E+02
+	SN-113	255.12		1.93	8.08E+02	1.61E+01	-2.20E+02	3.57E+02
		391.69	*	61.90	1.61E+01		2.02E+01	7.13E+00
	SN-119M	23.87		16.10	2.82E-01	2.78E-01	-1.13E-01	1.34E-01
		25.10		22.70	2.78E-01		-7.13E-03	1.32E-01
+	I-125	35.49	*	6.49	1.37E+01	1.37E+01	3.98E+01	6.69E+00
	I-129	29.78		57.00	8.92E-01	8.92E-01	4.90E+00	4.39E-01
		33.60		13.20	3.47E+00		-1.25E+01	1.68E+00
		39.58		7.52	4.10E+00		-1.85E+00	1.83E+00
+	BA-133	30.80	*	97.60	4.78E-01	4.78E-01	5.54E+00	2.34E-01
		81.00	*	33.00	3.73E+01		3.44E+02	1.79E+01
		302.84	*	17.80	1.78E+02		4.50E+02	8.48E+01
		356.01	*	60.00	2.73E+01		3.45E+02	1.26E+01
		383.85		8.70	3.12E+02		-2.49E+02	1.49E+02
	CE-139	165.85		80.35	2.47E+01	2.47E+01	7.38E+00	1.13E+01
	CE-144	133.54		10.80	1.41E+02	1.41E+02	2.95E+01	6.44E+01
	HG-203	279.19		77.30	2.53E+01	2.53E+01	-2.40E+00	1.15E+01
	PB-210	10.80		9.57	3.55E-03	3.55E-03	-1.21E-02	1.74E-03
		46.50		4.25	1.81E+01		3.24E+00	8.22E+00
	PA-231	9.28		42.00	2.34E-04	2.34E-04	6.26E-04	1.15E-04
		10.11		20.20	1.06E-03		3.49E-03	5.21E-04
		283.67		1.60	8.31E+02		-1.42E+01	3.63E+02
		302.67		2.30	1.49E+03		3.12E+03	7.10E+02
	TH-231	25.64		14.70	5.03E-01	5.03E-01	3.22E-02	2.40E-01
		84.21		6.40	9.40E+01		-3.64E+02	4.28E+01
	PA-234	9.89		89.00	2.00E-04	2.00E-04	6.57E-04	9.81E-05
		21.72		64.90	4.57E-02		3.85E-02	2.19E-02
		37.93		23.75	1.45E+00		-2.57E+00	6.69E-01
		131.42		20.40	7.75E+01		1.68E+00	3.55E+01
	TH-234	63.29		3.80	1.43E+02	1.43E+02	2.39E+02	6.87E+01
	NP-237	29.37		14.00	1.67E+00	1.67E+00	-2.78E+01	8.09E-01
		86.50		12.60	6.52E+01		1.46E+01	3.04E+01
	U-237	97.08		16.30	5.60E+01	4.36E+01	7.91E+00	2.57E+01
		101.07		26.30	4.36E+01		2.25E+00	2.03E+01
		114.00		12.30	2.02E+02		1.92E+02	9.66E+01
		208.01		22.00	9.16E+01		1.57E+01	4.16E+01
	AM-241	59.54		35.90	8.60E+00	8.60E+00	-2.19E+01	4.05E+00
	AM-243	74.67		66.00	6.76E+00	6.76E+00	1.28E+00	3.09E+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

0000015272.CNF



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Apex-Gamma

Analysis Report for 1411095-02
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GAMMA SPECTRUM ANALYSIS

Sample Identification	: 1411095-02
Sample Description	: BLANK
Sample Type	: RA RECOVERY
Sample Size	: 1.000E+00 units
Facility	: Countroom
Sample Taken On	: 11/20/2014 7:46:58AM
Acquisition Started	: 11/20/2014 8:18:49AM
Procedure	: BAFIL
Operator	: Administrator
Detector Name	: GE2
Geometry	: BAFIL
Live Time	: 900.0 seconds
Real Time	: 900.3 seconds
Dead Time	: 0.03 %
Peak Locate Threshold	: 2.50
Peak Locate Range (in channels)	: 1 - 4096
Peak Area Range (in channels)	: 7 - 4096
Identification Energy Tolerance	: 1.000 keV
Energy Calibration Used Done On	: 11/2/2014
Efficiency Calibration Used Done On	: 11/9/2014
Efficiency Calibration Description	:
Sample Number	: 15276

PEAK ANALYSIS REPORT

Peak Analysis Performed on : 11/20/2014 8:33:52AM

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 1411095-02

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	Peak No.	Energy (keV)	ROI start	ROI end	Peak Centroid	Net Peak Area	Net Area Uncertainty	Continuum Counts	FWHM (keV)
	1	20.73	18 -	23	20.85	6.96E+01	53.68	5.19E+02	1.58
M	2	27.98	27 -	40	28.10	3.91E+01	14.67	8.48E+01	1.10
m	3	30.95	27 -	40	31.07	1.70E+03	89.49	2.36E+02	1.33
m	4	35.16	27 -	40	35.27	3.51E+02	47.37	1.21E+02	1.33
M	5	61.90	58 -	72	62.00	1.92E+02	35.10	1.05E+02	1.57
m	6	66.10	58 -	72	66.20	1.19E+02	30.20	9.89E+01	1.77
	7	81.12	78 -	85	81.21	7.62E+02	63.78	1.67E+02	1.49
M	8	111.73	108 -	120	111.79	1.76E+02	34.34	9.75E+01	1.71
m	9	116.04	108 -	120	116.11	3.22E+01	24.07	8.01E+01	1.73
	10	172.51	169 -	176	172.54	2.55E+01	27.78	1.11E+02	3.75
	11	276.01	272 -	279	275.98	3.23E+01	24.74	8.15E+01	1.29
	12	285.79	283 -	290	285.76	1.46E+01	15.10	2.88E+01	2.48
M	13	302.83	299 -	316	302.79	1.37E+02	25.38	2.34E+01	1.59
m	14	307.02	299 -	316	306.98	3.59E+01	18.03	2.54E+01	1.97
M	15	333.76	329 -	342	333.70	5.99E+01	20.27	2.86E+01	1.71
m	16	337.89	329 -	342	337.83	1.85E+01	15.46	3.30E+01	1.71
	17	355.95	352 -	359	355.89	4.44E+02	46.95	7.07E+01	1.52
	18	365.98	361 -	371	365.91	1.93E+01	22.06	5.34E+01	5.72
	19	385.61	381 -	389	385.53	2.23E+02	40.28	1.12E+02	3.72
	20	391.01	390 -	395	390.92	2.31E+01	20.20	4.98E+01	1.49
	21	416.44	410 -	424	416.35	7.02E+01	25.32	3.96E+01	4.08
M	22	434.11	431 -	441	434.00	6.65E+00	11.68	8.66E+00	1.53
m	23	437.12	431 -	441	437.02	7.52E+01	18.34	5.09E+00	1.68
	24	467.73	465 -	470	467.60	1.86E+01	11.49	1.08E+01	1.97
	25	596.96	592 -	601	596.77	2.20E+01	9.38	0.00E+00	5.00
	26	766.69	764 -	769	766.43	7.00E+00	5.29	0.00E+00	2.22
	27	1011.77	1008 -	1013	1011.40	5.00E+00	4.47	0.00E+00	1.70

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 : 11/20/2014 8:33:52AM

Env. Background File : \\OR-GAMMA1\ApexRoot\Countroom\Data\0000015027.CNF

	Peak No.	Energy (keV)	Original Area	Orig. Area Uncertainty	Ambient Background	Backgr. Uncert.	Subtracted Area	Subtracted Uncert.
	1	20.73	6.96E+01	53.68			6.96E+01	5.37E+01
M	2	27.98	3.91E+01	14.67			3.91E+01	1.47E+01

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Analysis Report for 1411095-02

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	Peak No.	Energy (keV)	Original Area	Orig. Area Uncertainty	Ambient Background	Backgr. Uncert.	Subtracted Area	Subtracted Uncert.
m	3	30.95	1.70E+03	89.49			1.70E+03	8.95E+01
m	4	35.16	3.51E+02	47.37			3.51E+02	4.74E+01
M	5	61.90	1.92E+02	35.10			1.92E+02	3.51E+01
m	6	66.10	1.19E+02	30.20			1.19E+02	3.02E+01
	7	81.12	7.62E+02	63.78			7.62E+02	6.38E+01
M	8	111.73	1.76E+02	34.34			1.76E+02	3.43E+01
m	9	116.04	3.22E+01	24.07			3.22E+01	2.41E+01
	10	172.51	2.55E+01	27.78			2.55E+01	2.78E+01
	11	276.01	3.23E+01	24.74			3.23E+01	2.47E+01
	12	285.79	1.46E+01	15.10			1.46E+01	1.51E+01
M	13	302.83	1.37E+02	25.38			1.37E+02	2.54E+01
m	14	307.02	3.59E+01	18.03			3.59E+01	1.80E+01
M	15	333.76	5.99E+01	20.27			5.99E+01	2.03E+01
m	16	337.89	1.85E+01	15.46			1.85E+01	1.55E+01
	17	355.95	4.44E+02	46.95			4.44E+02	4.69E+01
	18	365.98	1.93E+01	22.06			1.93E+01	2.21E+01
	19	385.61	2.23E+02	40.28			2.23E+02	4.03E+01
	20	391.01	2.31E+01	20.20			2.31E+01	2.02E+01
	21	416.44	7.02E+01	25.32			7.02E+01	2.53E+01
M	22	434.11	6.65E+00	11.68			6.65E+00	1.17E+01
m	23	437.12	7.52E+01	18.34			7.52E+01	1.83E+01
	24	467.73	1.86E+01	11.49			1.86E+01	1.15E+01
	25	596.96	2.20E+01	9.38			2.20E+01	9.38E+00
	26	766.69	7.00E+00	5.29			7.00E+00	5.29E+00
	27	1011.77	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
SN-113	0.89	255.12		1.93		
		391.69	*	61.90	1.60E+01	1.41E+01
I-125	0.98	35.49	*	6.49	3.74E+01	5.06E+00
BA-133	0.98	30.80	*	97.60	6.19E+00	5.02E-01

Analysis Report for 1411095-02

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Nuclide Name	Id Confidence	Energy (keV)		Yield(%)	Activity (pCi/units)	Activity Uncertainty
BA-133	0.98	81.00	*	33.00	4.10E+02	7.22E+01
		302.84	*	17.80	4.55E+02	1.47E+02
		356.01	*	60.00	3.64E+02	6.39E+01
		383.85		8.70		

* = Energy line found in the spectrum.
~ = Manually added nuclide.
? = Manually edited nuclide.
@ = Energy line not used for Weighted Mean Activity
Energy Tolerance : 1.000 keV
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	0.891	1.60E+01	1.41E+01	
I-125	0.983	3.74E+01	5.06E+00	
BA-133	0.986	6.24E+00	5.02E-01	

? = 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 1411095-02
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UNIDENTIFIED PEAKS

Peak Locate Performed on : 11/20/2014 8:33:52AM
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	20.73	7.72881E-02	38.59	Tol.	PA-234
M	2	27.98	4.34523E-02	18.76		
M	5	61.90	2.13684E-01	9.13	Sum	
m	6	66.10	1.32565E-01	12.66	Sum	
M	8	111.73	1.95199E-01	9.77	Sum	
m	9	116.04	3.57936E-02	37.36	Sum	
	10	172.51	2.83813E-02	54.39		
	11	276.01	3.58447E-02	38.34		
	12	285.79	1.62452E-02	51.64		
m	14	307.02	3.99223E-02	25.09		
M	15	333.76	6.65293E-02	16.93	Sum	
m	16	337.89	2.05795E-02	41.73	Sum	
	18	365.98	2.14493E-02	57.13		
	19	385.61	2.47708E-01	9.03		
	21	416.44	7.79938E-02	18.04		
M	22	434.11	7.39074E-03	87.82		
m	23	437.12	8.35953E-02	12.19	Sum	
	24	467.73	2.06481E-02	30.91		
	25	596.96	2.44444E-02	21.32		
	26	766.69	7.77778E-03	37.80		
	27	1011.77	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

Analysis Report for 1411095-02

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	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	1.01E-06	1.01E-06	-6.34E-06	4.46E-07
	CO-57	122.06		85.51	1.54E+01	1.54E+01	-5.74E+00	7.03E+00
		136.48		10.60	1.78E+02		1.53E+01	8.24E+01
	NI-59	6.92		29.80	1.13E-05	1.13E-05	-2.05E-05	5.42E-06
	MO-93	16.59		52.90	7.46E-03	7.46E-03	-1.49E-03	3.55E-03
		18.60		10.00	9.60E-02		-9.40E-02	4.58E-02
	NB-93M	16.57		9.43	4.15E-02	4.15E-02	-8.26E-03	1.97E-02
	CD-109	88.03		3.72	2.05E+02	2.05E+02	-6.42E+00	9.44E+01
+	SN-113	255.12		1.93	9.54E+02	2.21E+01	4.03E+01	4.30E+02
		391.69	*	61.90	2.21E+01		1.60E+01	1.01E+01
	SN-119M	23.87		16.10	2.85E-01	2.81E-01	1.57E-01	1.36E-01
		25.10		22.70	2.81E-01		8.43E-02	1.34E-01
+	I-125	35.49	*	6.49	1.34E+01	1.34E+01	3.74E+01	6.56E+00
	I-129	29.78		57.00	9.47E-01	9.47E-01	5.29E+00	4.67E-01
		33.60		13.20	3.51E+00		-1.81E+01	1.70E+00
		39.58		7.52	4.82E+00		2.14E+00	2.19E+00
+	BA-133	30.80	*	97.60	4.68E-01	4.68E-01	6.19E+00	2.29E-01
		81.00	*	33.00	2.98E+01		4.10E+02	1.42E+01
		302.84	*	17.80	1.61E+02		4.55E+02	7.61E+01
		356.01	*	60.00	3.02E+01		3.64E+02	1.40E+01
		383.85		8.70	3.19E+02		-3.32E+02	1.53E+02
	CE-139	165.85		80.35	2.56E+01	2.56E+01	4.60E+00	1.17E+01
	CE-144	133.54		10.80	1.74E+02	1.74E+02	4.58E+01	8.07E+01
	HG-203	279.19		77.30	2.30E+01	2.30E+01	4.90E+00	1.04E+01
	PB-210	10.80		9.57	3.46E-03	3.46E-03	-9.98E-03	1.69E-03
		46.50		4.25	2.17E+01		7.77E+00	1.00E+01
	PA-231	9.28		42.00	2.31E-04	2.31E-04	6.46E-04	1.13E-04
		10.11		20.20	1.03E-03		2.96E-03	5.07E-04
		283.67		1.60	9.36E+02		7.31E+02	4.15E+02
		302.67		2.30	1.52E+03		2.65E+03	7.25E+02
	TH-231	25.64		14.70	4.83E-01	4.83E-01	-2.59E-02	2.30E-01
		84.21		6.40	9.52E+01		-5.78E+02	4.34E+01
	PA-234	9.89		89.00	1.95E-04	1.95E-04	5.57E-04	9.54E-05
		21.72		64.90	4.44E-02		1.51E-02	2.13E-02
		37.93		23.75	1.35E+00		-3.57E+00	6.16E-01
		131.42		20.40	8.55E+01		-7.07E+00	3.96E+01
	TH-234	63.29		3.80	1.44E+02	1.44E+02	2.29E+02	6.90E+01
	NP-237	29.37		14.00	1.76E+00	1.76E+00	-3.17E+01	8.55E-01
		86.50		12.60	5.84E+01		9.21E+00	2.69E+01
	U-237	97.08		16.30	6.02E+01	4.48E+01	-4.54E+01	2.78E+01
		101.07		26.30	4.48E+01		2.54E+00	2.08E+01
		114.00		12.30	2.19E+02		2.81E+02	1.05E+02
		208.01		22.00	1.07E+02		-2.80E+01	4.92E+01
	AM-241	59.54		35.90	8.17E+00	8.17E+00	-2.69E+01	3.83E+00
	AM-243	74.67		66.00	7.50E+00	7.50E+00	2.80E+00	3.46E+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

Analysis Report for 1411095-02

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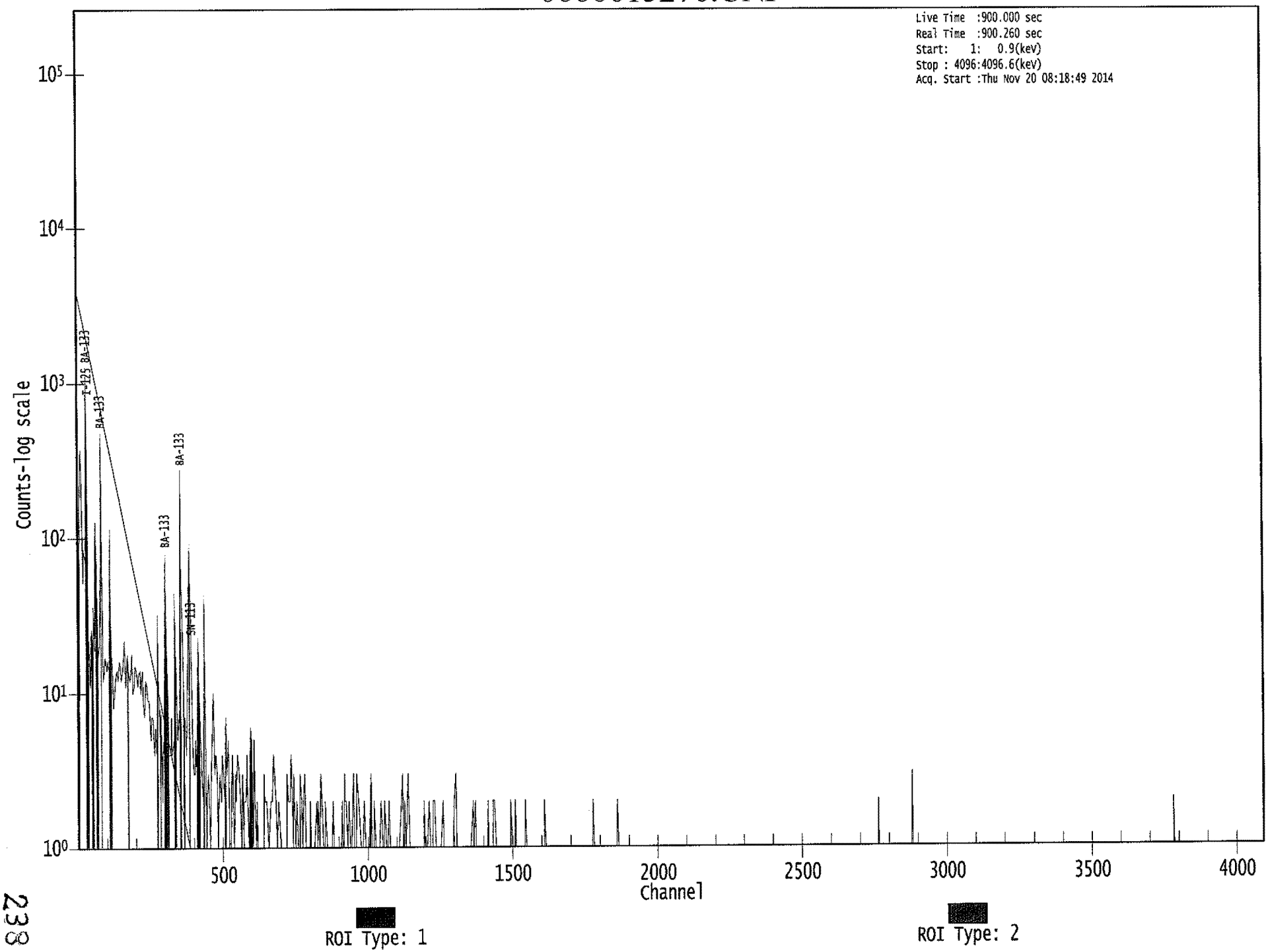

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Apex-Gamma

Analysis Report for 1411095-03

FEE-DRI-W-FADW29206L

1112

GAMMA SPECTRUM ANALYSIS

Sample Identification	: 1411095-03
Sample Description	: FEE-DRI-W-FADW29206L
Sample Type	: RA RECOVERY
Sample Size	: 1.000E+00 units
Facility	: Countroom
Sample Taken On	: 11/20/2014 7:47:25AM
Acquisition Started	: 11/20/2014 8:42:08AM
Procedure	: BAFIL
Operator	: Administrator
Detector Name	: GE2
Geometry	: BAFIL
Live Time	: 900.0 seconds
Real Time	: 900.3 seconds
Dead Time	: 0.03 %
Peak Locate Threshold	: 2.50
Peak Locate Range (in channels)	: 1 - 4096
Peak Area Range (in channels)	: 7 - 4096
Identification Energy Tolerance	: 1.000 keV
Energy Calibration Used Done On	: 11/2/2014
Efficiency Calibration Used Done On	: 11/9/2014
Efficiency Calibration Description	:
Sample Number	: 15281

PEAK ANALYSIS REPORT

Peak Analysis Performed on : 11/20/2014 8:57:11AM

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)

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Analysis Report for 1411095-03

FEE-DRI-W-FADW29206L

	Peak No.	Energy (keV)	ROI start	ROI end	Peak Centroid	Net Peak Area	Net Area Uncertainty	Continuum Counts	FWHM (keV)
	1	20.98	19 -	23	21.10	1.55E+02	48.90	3.91E+02	1.30
M	2	30.94	27 -	39	31.06	2.37E+03	106.09	2.78E+02	1.33
m	3	35.15	27 -	39	35.26	4.90E+02	54.99	1.21E+02	1.33
	4	53.17	50 -	58	53.27	6.41E+01	43.01	2.50E+02	2.26
M	5	61.87	58 -	74	61.97	2.67E+02	39.60	1.27E+02	1.48
m	6	66.10	58 -	74	66.19	1.14E+02	34.55	1.57E+02	1.61
m	7	70.30	58 -	74	70.39	2.06E+01	29.42	1.56E+02	1.61
	8	81.03	77 -	84	81.11	9.72E+02	73.81	2.60E+02	1.32
M	9	112.02	108 -	119	112.08	2.32E+02	39.27	1.19E+02	1.56
m	10	115.84	108 -	119	115.90	5.43E+01	28.32	9.30E+01	1.57
	11	276.92	273 -	282	276.90	6.80E+01	31.11	9.81E+01	1.82
	12	303.25	298 -	311	303.21	1.79E+02	45.98	1.60E+02	1.41
M	13	333.65	329 -	342	333.60	8.42E+01	23.81	3.25E+01	2.07
m	14	338.21	329 -	342	338.15	2.66E+01	18.52	3.50E+01	2.07
	15	356.01	351 -	360	355.94	6.71E+02	55.38	5.44E+01	1.47
M	16	377.01	373 -	395	376.93	1.31E+01	11.30	2.45E+01	1.61
m	17	384.11	373 -	395	384.02	1.26E+02	30.79	2.07E+01	1.62
m	18	386.93	373 -	395	386.85	2.45E+02	32.92	1.23E+01	1.43
m	19	391.04	373 -	395	390.96	5.26E+01	17.08	1.09E+01	1.63
M	20	414.29	409 -	428	414.20	3.99E+01	15.87	1.50E+01	2.00
m	21	418.60	409 -	428	418.50	2.80E+01	16.73	1.04E+01	2.01
	22	436.96	433 -	439	436.85	1.22E+02	23.34	1.02E+01	1.85
	23	448.16	443 -	453	448.05	2.45E+01	11.76	4.93E+00	8.23
	24	468.80	463 -	475	468.68	2.60E+01	18.03	2.60E+01	1.83
	25	575.15	572 -	577	574.97	7.50E+00	6.71	3.00E+00	2.46
	26	641.76	638 -	644	641.56	9.00E+00	6.00	0.00E+00	2.92
	27	709.24	706 -	711	709.00	5.00E+00	4.47	0.00E+00	2.98
	28	1119.81	1117 -	1121	1119.40	5.00E+00	4.47	0.00E+00	1.24

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 : 11/20/2014 8:57:11AM

Env. Background File : \\OR-GAMMA1\ApexRoot\Countroom\Data\0000015027.CNF

Peak No.	Energy (keV)	Original Area	Orig. Area Uncertainty	Ambient Background	Backgr. Uncert.	Subtracted Area	Subtracted Uncert.
1	20.98	1.55E+02	48.90	7.47E-01	3.74E+00	1.55E+02	4.90E+01

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Analysis Report for 1411095-03

FEE-DRI-W-FADW29206L

	Peak No.	Energy (keV)	Original Area	Orig. Area Uncertainty	Ambient Background	Backgr. Uncert.	Subtracted Area	Subtracted Uncert.
M	2	30.94	2.37E+03	106.09			2.37E+03	1.06E+02
m	3	35.15	4.90E+02	54.99			4.90E+02	5.50E+01
	4	53.17	6.41E+01	43.01	2.51E+00	1.44E+00	6.16E+01	4.30E+01
M	5	61.87	2.67E+02	39.60			2.67E+02	3.96E+01
m	6	66.10	1.14E+02	34.55			1.14E+02	3.46E+01
m	7	70.30	2.06E+01	29.42			2.06E+01	2.94E+01
	8	81.03	9.72E+02	73.81			9.72E+02	7.38E+01
M	9	112.02	2.32E+02	39.27			2.32E+02	3.93E+01
m	10	115.84	5.43E+01	28.32			5.43E+01	2.83E+01
	11	276.92	6.80E+01	31.11			6.80E+01	3.11E+01
	12	303.25	1.79E+02	45.98			1.79E+02	4.60E+01
M	13	333.65	8.42E+01	23.81			8.42E+01	2.38E+01
m	14	338.21	2.66E+01	18.52			2.66E+01	1.85E+01
	15	356.01	6.71E+02	55.38			6.71E+02	5.54E+01
M	16	377.01	1.31E+01	11.30			1.31E+01	1.13E+01
m	17	384.11	1.26E+02	30.79			1.26E+02	3.08E+01
m	18	386.93	2.45E+02	32.92			2.45E+02	3.29E+01
m	19	391.04	5.26E+01	17.08			5.26E+01	1.71E+01
M	20	414.29	3.99E+01	15.87			3.99E+01	1.59E+01
m	21	418.60	2.80E+01	16.73			2.80E+01	1.67E+01
	22	436.96	1.22E+02	23.34			1.22E+02	2.33E+01
	23	448.16	2.45E+01	11.76			2.45E+01	1.18E+01
	24	468.80	2.60E+01	18.03			2.60E+01	1.80E+01
	25	575.15	7.50E+00	6.71			7.50E+00	6.71E+00
	26	641.76	9.00E+00	6.00			9.00E+00	6.00E+00
	27	709.24	5.00E+00	4.47			5.00E+00	4.47E+00
	28	1119.81	5.00E+00	4.47	6.93E-01	6.94E-01	4.31E+00	4.53E+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	0.89	255.12		1.93		
		391.69	*	61.90	3.65E+01	1.22E+01

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Analysis Report for 1411095-03

FEE-DRI-W-FADW29206L

Nuclide Name	Id Confidence	Energy (keV)		Yield(%)	Activity (pCi/units)	Activity Uncertainty
I-125	0.98	35.49	*	6.49	5.21E+01	5.86E+00
BA-133	0.99	30.80	*	97.60	8.64E+00	6.57E-01
		81.00	*	33.00	5.22E+02	8.99E+01
		302.84	*	17.80	5.94E+02	2.19E+02
		356.01	*	60.00	5.51E+02	8.94E+01
		383.85	*	8.70	6.41E+02	4.72E+02

* = Energy line found in the spectrum.
\- = Manually added nuclide.
? = Manually edited nuclide.
@ = Energy line not used for Weighted Mean Activity
Energy Tolerance : 1.000 keV
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	0.898	3.65E+01	1.22E+01	
I-125	0.981	5.21E+01	5.86E+00	
BA-133	0.996	8.70E+00	6.57E-01	

? = 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

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Analysis Report for 1411095-03

FEE-DRI-W-FADW29206L

UNIDENTIFIED PEAKS

Peak Locate Performed on : 11/20/2014 8:57:11AM
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	20.98	1.71771E-01	15.86	Tol.	PA-234
	4	53.17	6.84558E-02	34.92		
M	5	61.87	2.96131E-01	7.43	Sum	
m	6	66.10	1.26297E-01	15.20	Sum	
m	7	70.30	2.29290E-02	71.29	Sum	
M	9	112.02	2.57282E-01	8.48	Sum	
m	10	115.84	6.03576E-02	26.06	Sum	
	11	276.92	7.55081E-02	22.89		
M	13	333.65	9.35814E-02	14.14	Sum	
m	14	338.21	2.96006E-02	34.76	Sum	
M	16	377.01	1.45966E-02	43.02		
m	18	386.93	2.71684E-01	6.73	Sum	
M	20	414.29	4.43805E-02	19.87	Sum	
m	21	418.60	3.10889E-02	29.90	Sum	
	22	436.96	1.35464E-01	9.57	Sum	
	23	448.16	2.72634E-02	23.96		
	24	468.80	2.88889E-02	34.67		
	25	575.15	8.33333E-03	44.72		
	26	641.76	1.00000E-02	33.33		
	27	709.24	5.55556E-03	44.72		
	28	1119.81	4.78522E-03	52.54		

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 1411095-03

FEE-DRI-W-FADW29206L

	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	1.23E-06	1.23E-06	-4.84E-06	5.55E-07
	CO-57	122.06		85.51	1.89E+01	1.89E+01	1.22E+01	8.77E+00
		136.48		10.60	1.95E+02		-8.38E+01	9.09E+01
	NI-59	6.92		29.80	1.09E-05	1.09E-05	-2.63E-05	5.23E-06
	MO-93	16.59		52.90	7.49E-03	7.49E-03	2.96E-03	3.56E-03
		18.60		10.00	9.26E-02		-3.11E-01	4.41E-02
	NB-93M	16.57		9.43	4.17E-02	4.17E-02	1.65E-02	1.98E-02
	CD-109	88.03		3.72	2.41E+02	2.41E+02	7.60E+01	1.13E+02
+	SN-113	255.12		1.93	1.09E+03	3.70E+01	-2.99E+01	4.99E+02
		391.69	*	61.90	3.70E+01		3.65E+01	1.75E+01
	SN-119M	23.87		16.10	2.77E-01	2.77E-01	1.04E-02	1.32E-01
		25.10		22.70	2.78E-01		-2.64E-02	1.32E-01
+	I-125	35.49	*	6.49	1.34E+01	1.34E+01	5.21E+01	6.53E+00
	I-129	29.78		57.00	1.12E+00	1.12E+00	7.55E+00	5.54E-01
		33.60		13.20	4.17E+00		-2.68E+01	2.03E+00
		39.58		7.52	4.89E+00		-1.50E+00	2.22E+00
+	BA-133	30.80	*	97.60	4.69E-01	4.69E-01	8.64E+00	2.30E-01
		81.00	*	33.00	3.63E+01		5.22E+02	1.74E+01
		302.84	*	17.80	2.13E+02		5.94E+02	1.02E+02
		356.01	*	60.00	2.87E+01		5.51E+02	1.32E+01
		383.85	*	8.70	2.73E+02		6.41E+02	1.30E+02
	CE-139	165.85		80.35	2.76E+01	2.76E+01	-1.69E+00	1.28E+01
	CE-144	133.54		10.80	1.68E+02	1.68E+02	-4.55E+00	7.78E+01
	HG-203	279.19		77.30	3.19E+01	3.19E+01	2.69E+00	1.48E+01
	PB-210	10.80		9.57	3.52E-03	3.52E-03	-8.28E-03	1.72E-03
		46.50		4.25	2.05E+01		4.70E+00	9.43E+00
	PA-231	9.28		42.00	2.29E-04	2.29E-04	5.41E-04	1.12E-04
		10.11		20.20	1.05E-03		3.32E-03	5.15E-04
		283.67		1.60	1.03E+03		-1.56E+02	4.62E+02
		302.67		2.30	1.76E+03		4.46E+03	8.46E+02
	TH-231	25.64		14.70	5.15E-01	5.15E-01	4.02E-03	2.46E-01
		84.21		6.40	1.12E+02		-5.58E+02	5.20E+01
	PA-234	9.89		89.00	1.98E-04	1.98E-04	6.24E-04	9.69E-05
		21.72		64.90	5.30E-02		9.07E-02	2.56E-02
		37.93		23.75	1.49E+00		-5.59E+00	6.90E-01
		131.42		20.40	8.24E+01		-2.68E+01	3.80E+01
	TH-234	63.29		3.80	1.70E+02	1.70E+02	3.34E+02	8.18E+01
	NP-237	29.37		14.00	2.02E+00	2.02E+00	-4.28E+01	9.84E-01
		86.50		12.60	6.82E+01		-3.20E+01	3.18E+01
	U-237	97.08		16.30	7.21E+01	4.78E+01	-1.71E+01	3.38E+01
		101.07		26.30	4.78E+01		1.77E+01	2.24E+01
		114.00		12.30	2.63E+02		4.24E+02	1.27E+02
		208.01		22.00	1.22E+02		-7.16E+00	5.67E+01
	AM-241	59.54		35.90	9.31E+00	9.31E+00	-3.91E+01	4.40E+00
	AM-243	74.67		66.00	7.22E+00	7.22E+00	2.60E+00	3.32E+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

Analysis Report for 1411095-03

FEE-DRI-W-FADW29206L

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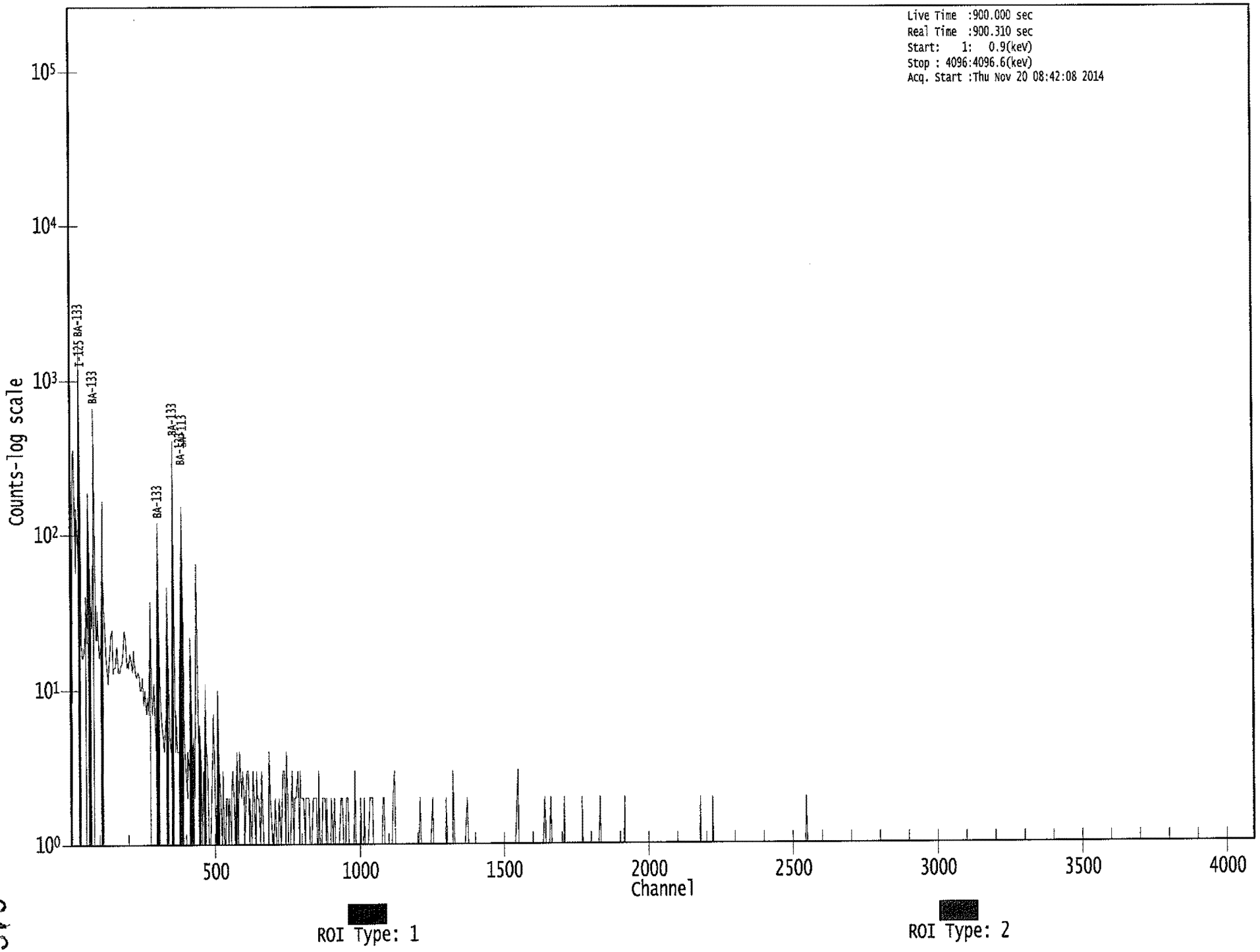

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Apex-Gamma

Analysis Report for 1411095-04
FEE-BRI-W-FADW29206L

GAMMA SPECTRUM ANALYSIS

Sample Identification	: 1411095-04
Sample Description	: FEE-BRI-W-FADW29206L
Sample Type	: RA RECOVERY
Sample Size	: 1.000E+00 units
Facility	: Countroom
Sample Taken On	: 11/20/2014 7:47:48AM
Acquisition Started	: 11/20/2014 9:00:05AM
Procedure	: BAFIL
Operator	: Administrator
Detector Name	: GE2
Geometry	: BAFIL
Live Time	: 900.0 seconds
Real Time	: 900.3 seconds
Dead Time	: 0.03 %
Peak Locate Threshold	: 2.50
Peak Locate Range (in channels)	: 1 - 4096
Peak Area Range (in channels)	: 7 - 4096
Identification Energy Tolerance	: 1.000 keV
Energy Calibration Used Done On	: 11/2/2014
Efficiency Calibration Used Done On	: 11/9/2014
Efficiency Calibration Description	:
Sample Number	: 15285

PEAK ANALYSIS REPORT

Peak Analysis Performed on : 11/20/2014 9:15:09AM

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)

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Analysis Report for 1411095-04

FEE-BRI-W-FADW29206L

	Peak No.	Energy (keV)	ROI start	ROI end	Peak Centroid	Net Peak Area	Net Area Uncertainty	Continuum Counts	FWHM (keV)
	1	20.92	18 -	24	21.04	9.80E+01	61.22	6.12E+02	1.17
M	2	30.94	27 -	40	31.05	2.34E+03	102.98	3.14E+02	1.35
m	3	35.18	27 -	40	35.29	5.67E+02	56.92	1.33E+02	1.46
	4	52.89	50 -	57	52.99	8.38E+01	37.26	1.74E+02	2.86
M	5	61.95	58 -	72	62.04	2.70E+02	40.26	1.18E+02	1.77
m	6	65.98	58 -	72	66.08	1.21E+02	36.73	1.39E+02	1.77
M	7	81.10	77 -	86	81.18	8.97E+02	65.51	1.12E+02	1.33
m	8	83.92	77 -	86	84.00	1.54E+01	19.03	8.68E+01	1.00
	9	92.48	89 -	96	92.56	4.47E+01	35.04	1.73E+02	2.95
	10	111.68	109 -	115	111.75	2.00E+02	46.05	2.50E+02	1.29
	11	142.64	138 -	147	142.69	5.52E+01	41.51	2.14E+02	3.25
	12	161.16	158 -	164	161.20	3.54E+01	31.93	1.57E+02	1.44
	13	238.42	236 -	240	238.42	2.34E+01	18.65	5.53E+01	1.86
	14	276.59	273 -	282	276.56	8.10E+01	28.53	7.00E+01	1.90
M	15	302.93	299 -	314	302.90	1.59E+02	27.26	3.57E+01	1.60
m	16	307.50	299 -	314	307.46	3.39E+01	17.97	2.10E+01	1.83
m	17	311.33	299 -	314	311.29	1.06E+01	13.82	1.64E+01	1.67
	18	333.28	328 -	336	333.23	1.08E+02	28.97	6.20E+01	1.99
	19	337.96	337 -	341	337.91	1.35E+01	16.14	4.70E+01	1.09
	20	356.00	352 -	360	355.93	6.53E+02	56.72	9.03E+01	1.42
M	21	384.23	380 -	396	384.15	1.44E+02	31.26	1.49E+01	1.62
m	22	391.17	380 -	396	391.09	5.46E+01	17.46	1.60E+00	1.63
	23	399.83	397 -	404	399.75	1.04E+01	11.83	1.73E+01	3.38
	24	415.34	411 -	420	415.24	4.37E+01	27.20	8.26E+01	1.86
	25	436.92	433 -	441	436.81	1.01E+02	24.61	3.09E+01	1.40
	26	468.66	464 -	473	468.54	2.60E+01	15.62	2.00E+01	1.99
	27	608.73	605 -	611	608.54	1.35E+01	9.62	7.00E+00	1.21
	28	803.12	799 -	805	802.84	6.60E+00	8.03	6.80E+00	2.77

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 : 11/20/2014 9:15:09AM

Env. Background File : \\OR-GAMMA1\ApexRoot\Countroom\Data\0000015027.CNF

Peak No.	Energy (keV)	Original Area	Orig. Area Uncertainty	Ambient Background	Backgr. Uncert.	Subtracted Area	Subtracted Uncert.
1	20.92	9.80E+01	61.22	7.47E-01	3.74E+00	9.73E+01	6.13E+01

Analysis Report for 1411095-04

FEE-BRI-W-FADW29206L

	Peak No.	Energy (keV)	Original Area	Orig. Area Uncertainty	Ambient Background	Backgr. Uncert.	Subtracted Area	Subtracted Uncert.
M	2	30.94	2.34E+03	102.98			2.34E+03	1.03E+02
m	3	35.18	5.67E+02	56.92			5.67E+02	5.69E+01
	4	52.89	8.38E+01	37.26			8.38E+01	3.73E+01
M	5	61.95	2.70E+02	40.26			2.70E+02	4.03E+01
m	6	65.98	1.21E+02	36.73			1.21E+02	3.67E+01
M	7	81.10	8.97E+02	65.51			8.97E+02	6.55E+01
m	8	83.92	1.54E+01	19.03			1.54E+01	1.90E+01
	9	92.48	4.47E+01	35.04	1.49E+01	2.18E+00	2.98E+01	3.51E+01
	10	111.68	2.00E+02	46.05			2.00E+02	4.61E+01
	11	142.64	5.52E+01	41.51			5.52E+01	4.15E+01
	12	161.16	3.54E+01	31.93			3.54E+01	3.19E+01
	13	238.42	2.34E+01	18.65	3.89E+00	1.82E+00	1.95E+01	1.87E+01
	14	276.59	8.10E+01	28.53			8.10E+01	2.85E+01
M	15	302.93	1.59E+02	27.26			1.59E+02	2.73E+01
m	16	307.50	3.39E+01	17.97			3.39E+01	1.80E+01
m	17	311.33	1.06E+01	13.82			1.06E+01	1.38E+01
	18	333.28	1.08E+02	28.97			1.08E+02	2.90E+01
	19	337.96	1.35E+01	16.14			1.35E+01	1.61E+01
	20	356.00	6.53E+02	56.72			6.53E+02	5.67E+01
M	21	384.23	1.44E+02	31.26			1.44E+02	3.13E+01
m	22	391.17	5.46E+01	17.46			5.46E+01	1.75E+01
	23	399.83	1.04E+01	11.83			1.04E+01	1.18E+01
	24	415.34	4.37E+01	27.20			4.37E+01	2.72E+01
	25	436.92	1.01E+02	24.61			1.01E+02	2.46E+01
	26	468.66	2.60E+01	15.62			2.60E+01	1.56E+01
	27	608.73	1.35E+01	9.62	3.02E+00	1.07E+00	1.05E+01	9.68E+00
	28	803.12	6.60E+00	8.03			6.60E+00	8.03E+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	0.92	255.12		1.93		
		391.69	*	61.90	3.78E+01	1.25E+01

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Analysis Report for 1411095-04

FEE-BRI-W-FADW29206L

Nuclide Name	Id Confidence	Energy (keV)		Yield(%)	Activity (pCi/units)	Activity Uncertainty
I-125	0.98	35.49	*	6.49	6.07E+01	6.10E+00
BA-133	0.99	30.80	*	97.60	8.52E+00	6.45E-01
		81.00	*	33.00	4.83E+02	8.26E+01
		302.84	*	17.80	5.29E+02	1.67E+02
		356.01	*	60.00	5.36E+02	8.82E+01
		383.85	*	8.70	7.30E+02	5.32E+02

* = Energy line found in the spectrum.
\- = Manually added nuclide.
? = Manually edited nuclide.
@ = Energy line not used for Weighted Mean Activity
Energy Tolerance : 1.000 keV
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	0.920	3.78E+01	1.25E+01	
I-125	0.985	6.07E+01	6.10E+00	
BA-133	0.997	8.59E+00	6.44E-01	

? = 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

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Analysis Report for 1411095-04

FEE-BRI-W-FADW29206L

UNIDENTIFIED PEAKS

Peak Locate Performed on : 11/20/2014 9:15:09AM
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	20.92	1.08092E-01	31.52	Tol.	PA-234
	4	52.89	9.31514E-02	22.22		
M	5	61.95	3.00424E-01	7.45	Sum	
m	6	65.98	1.34361E-01	15.19	Sum	
m	8	83.92	1.71032E-02	61.80	Tol.	TH-231
	9	92.48	3.31259E-02	58.88		
	10	111.68	2.22400E-01	11.50	Sum	
	11	142.64	6.13169E-02	37.61		
	12	161.16	3.92982E-02	45.14		
	13	238.42	2.16243E-02	48.14		
	14	276.59	9.00000E-02	17.61		
m	16	307.50	3.76300E-02	26.53		
m	17	311.33	1.17351E-02	65.43		
	18	333.28	1.19976E-01	13.42	Sum	
	19	337.96	1.49850E-02	59.84	Sum	
	23	399.83	1.15205E-02	57.06		
	24	415.34	4.85621E-02	31.12	Sum	
	25	436.92	1.11743E-01	12.24	Sum	
	26	468.66	2.88889E-02	30.04		
	27	608.73	1.16483E-02	46.16		
	28	803.12	7.33333E-03	60.84		

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

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Analysis Report for 1411095-04

FEE-BRI-W-FADW29206L

	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	1.33E-06	1.33E-06	-5.36E-06	6.06E-07
	CO-57	122.06		85.51	1.94E+01	1.94E+01	7.95E+00	9.00E+00
		136.48		10.60	1.79E+02		-3.71E+00	8.31E+01
	NI-59	6.92		29.80	1.16E-05	1.16E-05	-2.16E-05	5.58E-06
	MO-93	16.59		52.90	7.35E-03	7.35E-03	3.76E-04	3.49E-03
		18.60		10.00	9.00E-02		-2.76E-01	4.28E-02
	NB-93M	16.57		9.43	4.09E-02	4.09E-02	2.09E-03	1.94E-02
	CD-109	88.03		3.72	2.46E+02	2.46E+02	7.59E+01	1.15E+02
+	SN-113	255.12		1.93	9.54E+02	2.13E+01	-4.75E+02	4.30E+02
		391.69	*	61.90	2.13E+01		3.78E+01	9.74E+00
	SN-119M	23.87		16.10	2.74E-01	2.74E-01	-2.35E-01	1.30E-01
		25.10		22.70	2.82E-01		-2.52E-02	1.35E-01
+	I-125	35.49	*	6.49	1.52E+01	1.52E+01	6.07E+01	7.43E+00
	I-129	29.78		57.00	1.09E+00	1.09E+00	7.22E+00	5.37E-01
		33.60		13.20	4.25E+00		-2.36E+01	2.07E+00
		39.58		7.52	4.69E+00		7.88E-01	2.12E+00
+	BA-133	30.80	*	97.60	5.28E-01	5.28E-01	8.52E+00	2.59E-01
		81.00	*	33.00	3.71E+01		4.83E+02	1.78E+01
		302.84	*	17.80	1.67E+02		5.29E+02	7.91E+01
		356.01	*	60.00	3.55E+01		5.36E+02	1.66E+01
		383.85	*	8.70	1.63E+02		7.30E+02	7.44E+01
	CE-139	165.85		80.35	3.03E+01	3.03E+01	1.35E+01	1.41E+01
	CE-144	133.54		10.80	1.78E+02	1.78E+02	4.01E+01	8.27E+01
	HG-203	279.19		77.30	3.04E+01	3.04E+01	8.90E+00	1.41E+01
	PB-210	10.80		9.57	3.54E-03	3.54E-03	-9.57E-03	1.73E-03
		46.50		4.25	2.28E+01		1.04E+01	1.06E+01
	PA-231	9.28		42.00	2.31E-04	2.31E-04	4.97E-04	1.13E-04
		10.11		20.20	1.06E-03		3.39E-03	5.18E-04
		283.67		1.60	9.36E+02		3.43E+02	4.15E+02
		302.67		2.30	1.63E+03		3.91E+03	7.80E+02
	TH-231	25.64		14.70	5.29E-01	5.29E-01	-4.42E-02	2.53E-01
		84.21		6.40	1.18E+02		-6.60E+02	5.48E+01
	PA-234	9.89		89.00	1.99E-04	1.99E-04	6.38E-04	9.75E-05
		21.72		64.90	5.04E-02		7.12E-02	2.43E-02
		37.93		23.75	1.58E+00		-3.45E+00	7.31E-01
		131.42		20.40	8.08E+01		-2.90E+01	3.72E+01
	TH-234	63.29		3.80	1.71E+02	1.71E+02	3.38E+02	8.23E+01
	NP-237	29.37		14.00	2.00E+00	2.00E+00	-3.83E+01	9.75E-01
		86.50		12.60	6.91E+01		2.14E+01	3.23E+01
	U-237	97.08		16.30	6.53E+01	4.82E+01	1.37E+01	3.03E+01
		101.07		26.30	4.82E+01		-7.50E+00	2.25E+01
		114.00		12.30	2.48E+02		3.89E+02	1.20E+02
		208.01		22.00	1.02E+02		-3.90E+01	4.65E+01
	AM-241	59.54		35.90	8.65E+00	8.65E+00	-3.65E+01	4.07E+00
	AM-243	74.67		66.00	7.50E+00	7.50E+00	2.77E+00	3.46E+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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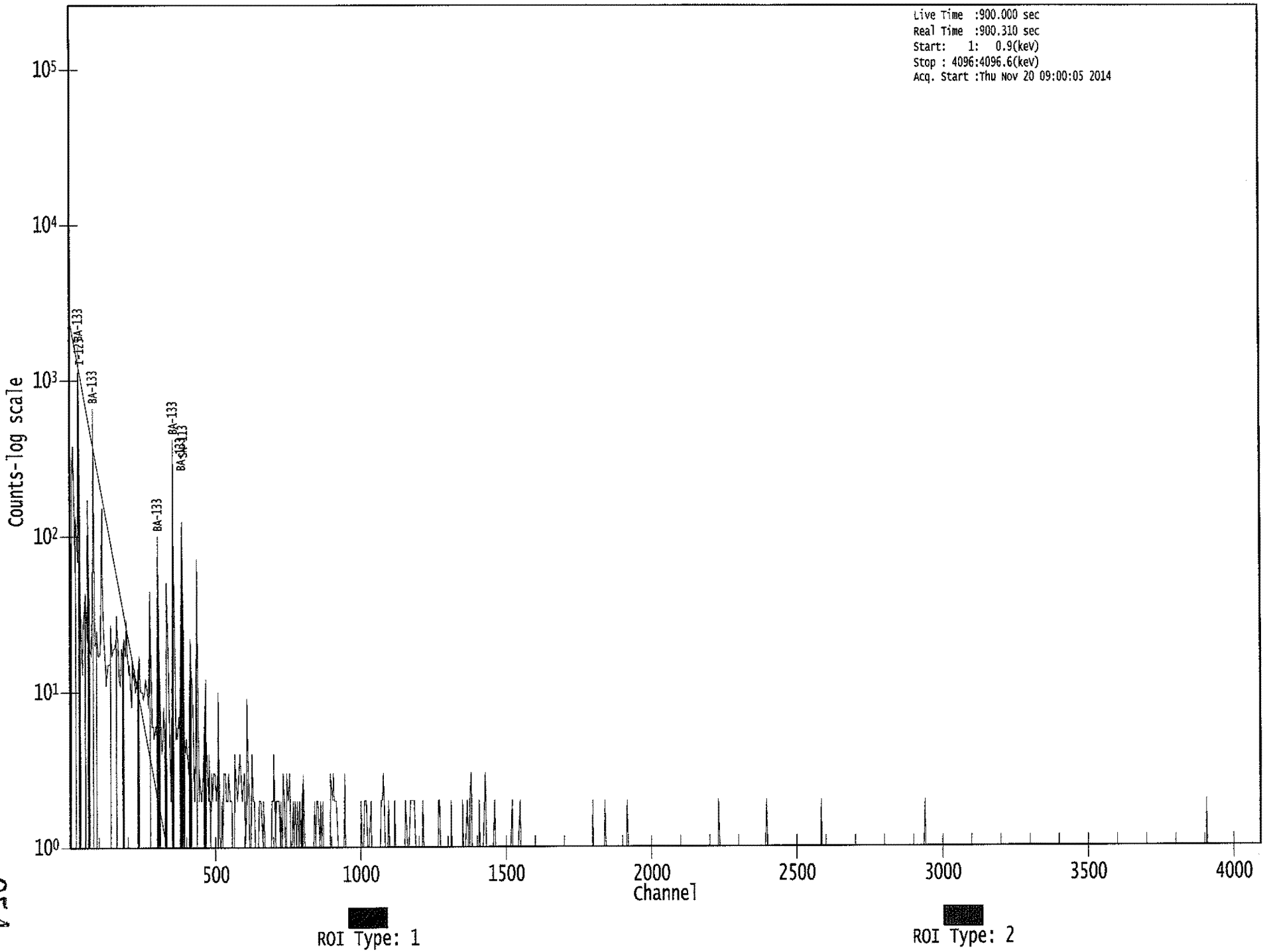
Analysis Report for 1411095-04

FEE-BRI-W-FADW29206L

0000015285.CNF



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SECTION XII

ANALYTICAL DATA (GROSS ALPHA/BETA)

WLLFOIA4312 - 001 - 0030672

Eberline Services
Oak Ridge Laboratory
Analysis Sheet

14-11095
GaGbT_ThSr
Run 1

Work Order	14-11095
Analysis Code	GaGbT_ThSr
Run	1
Date Received	11/18/2014
Lab Deadline	11/24/2014
Client	Feezor Engineering, Inc.
Project	FEEBRI
Report Level	4
Activity Units	pCi
Aliquot Units	l
Matrix	WA
Method	EPA 900.0 Modified
Instrument Type	Alpha/Beta GPC
Radiometric Tracer	
Radiometric Sol#	
Tracer Act (dpm/g)	
Carrier	
Carrier Conc (mg/ml)	

Internal Fraction	Sample Desc	Client ID	Login CPM	Sample Date	Sample Aliquot
01	LCS	LCS		11/18/14 00:00	1.0000E+00
02	MBL	BLANK		11/18/14 00:00	1.0000E+00
03	DUP	FEE-BRI-W-FADW29206L	39	11/13/14 00:00	6.0000E-02
04	DO	FEE-BRI-W-FADW29206L	39	11/13/14 00:00	6.0000E-02

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

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WLLFOIA4312 - 001 - 0030673

Eberline Services
Oak Ridge Laboratory
Analysis Sheet

14-11095
GaGbT_ThSr
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				0.00		7.5961	7.5963	0.0002			1.00	1.00
02	MBL				0.00		7.4932	7.4940	0.0008			1.00	1.00
03	DUP				0.00		7.4654	7.5278	0.0624			1.00	1.00
04	DO				0.00		7.4628	7.5283	0.0655			1.00	1.00

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

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Eberline Services
Oak Ridge Laboratory
Analysis Sheet

14-11095
GaGbT_ThSr
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			11/20/14 05:56	MHIGHTOWER				
02	MBL			11/20/14 05:56	MHIGHTOWER				
03	DUP			11/20/14 05:56	MHIGHTOWER				
04	DO			11/20/14 05:56	MHIGHTOWER				

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

WLLFOIA4312 - 001 - 0030675

Eberline Services
Oak Ridge Laboratory

Preliminary Data Report & Analytical Calculations
Work Order: 14-11095-GaGbT-1

Client: Feezor Engineering, Inc.
Eberline Services Work Order: 14-11095
Analysis Code: GaGbT
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	GROSS ALPHA	LCS	LCS	pCi/l	2.64E+02	3.66E+00	2.52E-01	2.69E+02	98.08	OK		OK	
02	GROSS ALPHA	MBL	BLANK	pCi/l	3.94E-02	6.81E-02	1.45E-01					OK	OK
03	GROSS ALPHA	DUP	FEE-BRI-W-FADW29206L	pCi/l	3.05E+01	7.77E+00	5.36E+00				NA	INV	
04	GROSS ALPHA	DO	FEE-BRI-W-FADW29206L	pCi/l	3.37E+01	8.91E+00	7.82E+00					INV	

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WLLFOIA4312 - 001 - 0030676

Preliminary Data Report & Analytical Calculations
Work Order: 14-11095-GaGbT-1

Client	Eberline Services Work Order	Analysis Code	Run
Feezor Engineering, Inc.	14-11095	GaGbT	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	GROSS ALPHA	LCS	11/18/14 00:00	1.00E+00	0.00	0.00	0.00	1.00		
02	GROSS ALPHA	MBL	11/18/14 00:00	1.00E+00	0.00	0.00	0.00	1.00		
03	GROSS ALPHA	DUP	11/13/14 00:00	6.00E-02	0.00	0.00	0.00	2.23		
04	GROSS ALPHA	DO	11/13/14 00:00	6.00E-02	0.00	0.00	0.00	2.31		

WLLFOIA4312 - 001 - 0030677

Preliminary Data Report & Analytical Calculations
Work Order: 14-11095-GaGbT-1

Client	Eberline Services Work Order	Analysis Code	Run
Feezor Engineering, Inc.	14-11095	GaGbT	1

Lab Fraction	Nuclide	Sample Desc	Counting Date/Time	Halflife (days)	Detect	Carrier	Count Time	Counts	Bkg CPM	Eff
01	GROSS ALPHA	LCS	11/20/14 09:54		LB4110A	C1	120	20029	0.066666667	0.2845
02	GROSS ALPHA	MBL	11/20/14 09:54		LB4110A	C2	120	5	0.016666667	0.2857
03	GROSS ALPHA	DUP	11/20/14 09:54		LB4110A	C3	120	65	0.016666667	0.2878
04	GROSS ALPHA	DO	11/20/14 09:54		LB4110A	C4	120	66	0.033333333	0.2657

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Eberline Services
Oak Ridge Laboratory

Preliminary Data Report & Analytical Calculations

Work Order: 14-11095-GaGbT-1

Client: Feezor Engineering, Inc.
Eberline Services Work Order: 14-11095
Analysis Code: GaGbT
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	GROSS BETA	LCS	LCS	pCi/l	2.83E+02	3.14E+00	5.57E-01	3.00E+02	94.58	OK		OK	
02	GROSS BETA	MBL	BLANK	pCi/l	1.65E-02	2.51E-01	5.39E-01					OK	OK
03	GROSS BETA	DUP	FEE-BRI-W-FADW29206L	pCi/l	6.29E+01	8.23E+00	1.18E+01				OK	INV	
04	GROSS BETA	DO	FEE-BRI-W-FADW29206L	pCi/l	6.02E+01	7.88E+00	1.08E+01					INV	

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Preliminary Data Report & Analytical Calculations

Work Order: 14-11095-GaGbT-1

Client: Feezor Engineering, Inc.
Eberline Services Work Order: 14-11095
Analysis Code: GaGbT
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	GROSS BETA	LCS	11/18/14 00:00	1.00E+00	0.00	0.00	0.00	1.00		
02	GROSS BETA	MBL	11/18/14 00:00	1.00E+00	0.00	0.00	0.00	1.00		
03	GROSS BETA	DUP	11/13/14 00:00	6.00E-02	0.00	0.00	0.00	1.14		
04	GROSS BETA	DO	11/13/14 00:00	6.00E-02	0.00	0.00	0.00	1.14		

WLLFOIA4312 - 001 - 0030680

Preliminary Data Report & Analytical Calculations
Work Order: 14-11095-GaGbT-1

Client: Feezor Engineering, Inc.
Eberline Services Work Order: 14-11095
Analysis Code: GaGbT
Run: 1

Lab Fraction	Nuclide	Sample Desc	Counting Date/Time	Halflife (days)	Detect	Carrier	Count Time	Counts	Bkg CPM	Eff	A to B, Cor
01	GROSS BETA	LCS	11/20/14 09:54		LB4110A	C1	120	41348	1.183333333	0.4775	301.5543892
02	GROSS BETA	MBL	11/20/14 09:54		LB4110A	C2	120	122	1	0.4555	1.016666667
03	GROSS BETA	DUP	11/20/14 09:54		LB4110A	C3	120	624	1.516666667	0.4808	5.062741667
04	GROSS BETA	DO	11/20/14 09:54		LB4110A	C4	120	557	1.2	0.4713	4.502296667

WLLFOIA4312 - 001 - 0030681

Count Room Report
Client: Feezor Engineering, Inc.

14-11095-GaGbT_ThSr-1 (pCi/l) in WA
Tracer ID:

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	11/18/14 00:00	1.0000				0.00	1.00	1.00
02	MBL	BLANK	11/18/14 00:00	1.0000				0.00	1.00	1.00
03	DUP	FEE-BRI-W-FADW29206L	11/13/14 00:00	0.0600				0.00	1.00	1.00
04	DO	FEE-BRI-W-FADW29206L	11/13/14 00:00	0.0600				0.00	1.00	1.00

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Eberline Services
Oak Ridge Laboratory

Spike and Tracer Worksheet

Printed: 11/20/2014 5:56 AM

Internal Work Order	Run	Analysis Code	Date	Technician	Technician Initials	Witness Initials
14-11095	1	GaGbT_ThSr	11/20/2014 5:54	MHIGHTOWER	MH	

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
Am-241	A/B-07	596.872	11/20/2014	0.791	1.0018				269.35	11.582	0.00	0.000	0.00	0.000	0.00	0.000
SrY-90	A/B-07	663.937	11/20/2014	0.828	1.0018				299.61	8.988	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

Balance Printer Tapes

Tracer	LCS

Matrix Spike

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Version 2.0 08/99

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Eberline Analytical
Oak Ridge Laboratory

Aliquot Worksheet

Work Order	Run	Analysis Code	Rpt Units	Lab Deadline	Technician
14-11095	1	GaGbT_ThSr	liters	11/24/2014	MHIGHTOWER

Lab Fraction	Feezor Engineering, 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	FEE-BRI-W-FADW29206L	DUP					6.0000E-02	6.0000E-02				
04	FEE-BRI-W-FADW29206L	DO					6.0000E-02	6.0000E-02				

Comments	

Technician: Mh Date: 11 / 20 / 14

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Eberline Services - Oak Ridge
Version 1.0 9/1999

Gravimetric Worksheet

Work Order	Run	Analysis Code	Gravimetric Carrier	Carrier Conc (mg/ml)	Technician
14-11095	1	GaGbT_ThSr			MHIGHTOWER

TRetec	Feezor Engineering, 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			7.5961	7.5963	0.0002	
02	BLANK			7.4932	7.4940	0.0008	
03	DUP			7.4654	7.5278	0.0624	
04	FEE-BRI-W-FADW29206L			7.4628	7.5283	0.0655	

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Technician: MH Date: 11 / 20 / 14

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Eberline Services - Oak Ridge
Version 1.0 9/1999

TDS / TSS Worksheet

Work Order	Run	Analysis Code	Technician
14-11095	1	GaGbT_ThSr	MHIGHTOWER

TRetec Fraction	Feezor Engineering, Inc. Client ID	Aliquot ml	Filter Data: Filter Tare (g)	Filter Final (g)	Filter Net (g)	TDS/TSS (mg/L)	Maximum Aliq (mL)
04	FEE-BRI-W-FADW29206L	5.0000	7.6139	7.6218	0.0079	1580.0000	63.29

Technician: Mn Date: 11 / 20 / 14

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11/20/14 KB

Detector ID	Sample ID	Alpha	Beta	Count Time	Voltage	TOD
C1	1411095-01	20029	41348	120	1400	11/20/14 11:54
C2	1411095-02	5	122	120	1400	11/20/14 11:54
C3	1411095-03	65	624	120	1400	11/20/14 11:54
C4	1411095-04	66	557	120	1400	11/20/14 11:54

WLLFOIA4312 - 001 - 0030687

Eberline Analytical
Oak Ridge Laboratory

GPC Detector Report
(ALL Backgrounds)

Detector	Alpha/Beta	Calibration Date	Count Date	Bkg CPM	PFW	LCL	Mean	UCL
LB4110A - A1	Alpha	11/18/2007	11/20/2014	5.00E-02	P	-1.94E+01	2.42E-01	1.99E+01
LB4110A - A2	Alpha	11/18/2007	11/20/2014	1.00E-01	P	-1.64E+01	2.18E-01	1.69E+01
LB4110A - A3	Alpha	11/18/2007	11/20/2014	8.33E-02	P	-1.60E+01	1.90E-01	1.64E+01
LB4110A - A4	Alpha	11/18/2007	11/20/2014	5.00E-02	P	-1.70E+01	2.03E-01	1.74E+01
LB4110A - B1	Alpha	11/18/2007	11/20/2014	1.67E-02	P	-9.16E-02	7.25E-02	2.37E-01
LB4110A - B2	Alpha	11/18/2007	11/20/2014	6.67E-02	P	-7.14E-02	7.32E-02	2.18E-01
LB4110A - B3	Alpha	11/18/2007	11/20/2014	1.67E-02	P	-6.25E-02	5.55E-02	1.73E-01
LB4110A - B4	Alpha	11/18/2007	11/20/2014	5.00E-02	P	-1.28E-01	7.73E-02	2.83E-01
LB4110A - C1	Alpha	11/18/2007	11/20/2014	6.67E-02	P	-1.37E-01	8.78E-02	3.12E-01
LB4110A - C2	Alpha	11/18/2007	11/20/2014	1.67E-02	P	-1.66E-01	8.00E-02	3.26E-01
LB4110A - C3	Alpha	11/18/2007	11/20/2014	1.67E-02	P	-1.61E-01	9.41E-02	3.49E-01
LB4110A - C4	Alpha	11/18/2007	11/20/2014	3.33E-02	P	-6.48E-02	6.90E-02	2.03E-01
LB4110A - D1	Alpha	11/18/2007	11/20/2014	3.33E-02	P	-5.43E-02	8.01E-02	2.15E-01
LB4110A - D2	Alpha	11/18/2007	11/20/2014	8.33E-02	P	-6.96E-02	6.02E-02	1.90E-01
LB4110A - D3	Alpha	11/18/2007	11/20/2014	6.67E-02	P	-5.06E-02	6.74E-02	1.85E-01
LB4110A - D4	Alpha	11/18/2007	11/20/2014	8.33E-02	P	-6.69E-02	6.99E-02	2.07E-01
LB4110R - A1	Alpha	11/24/2006	11/20/2014	5.00E-02	P	-9.21E-02	9.81E-02	2.88E-01
LB4110R - A2	Alpha	11/24/2006	11/20/2014	6.67E-02	P	-8.51E-02	7.23E-02	2.30E-01
LB4110R - A3	Alpha	11/24/2006	11/20/2014	5.00E-02	P	-7.07E-02	8.13E-02	2.33E-01
LB4110R - A4	Alpha	11/24/2006	11/20/2014	1.67E-02	P	-5.13E-02	6.90E-02	1.89E-01
LB4110R - B1	Alpha	11/24/2006	11/20/2014	1.67E-02	P	-8.92E-02	6.18E-02	2.13E-01
LB4110R - B2	Alpha	11/24/2006	11/20/2014	5.00E-02	P	-6.80E-02	6.03E-02	1.89E-01
LB4110R - B3	Alpha	11/24/2006	11/20/2014	5.00E-02	P	-6.48E-02	7.19E-02	2.09E-01
LB4110R - B4	Alpha	11/24/2006	11/20/2014	8.33E-02	P	-6.09E-02	6.83E-02	1.97E-01
LB4110R - C1	Alpha	11/24/2006	11/20/2014	0.00E+00	P	-7.49E-02	7.26E-02	2.20E-01
LB4110R - C2	Alpha	11/24/2006	11/20/2014	6.67E-02	P	-7.50E-02	6.77E-02	2.10E-01
LB4110R - C3	Alpha	11/24/2006	11/20/2014	5.00E-02	P	-8.18E-02	8.40E-02	2.50E-01
LB4110R - C4	Alpha	11/24/2006	11/20/2014	8.33E-02	P	-5.96E-02	7.83E-02	2.16E-01
LB4110R - D1	Alpha	11/24/2006	11/1/2014	0.00E+00	P	-1.06E-01	6.70E-02	2.40E-01
LB4110R - D2	Alpha	11/24/2006	11/1/2014	0.00E+00	P	-8.23E-02	6.65E-02	2.15E-01
LB4110R - D3	Alpha	11/24/2006	11/1/2014	0.00E+00	P	-8.71E-02	6.63E-02	2.20E-01
LB4110R - D4	Alpha	11/24/2006	11/1/2014	0.00E+00	P	-8.04E-02	7.08E-02	2.22E-01
LB5100 - 1	Alpha	7/10/2006	10/26/2007	5.00E-02	P	-1.56E-02	9.58E-02	2.07E-01

WLLFOIA4312 - 001 - 0030688

GPC Detector Report
(ALL Backgrounds)

Detector	Alpha/Beta	Calibration Date	Count Date	Bkg CPM	PFW	LCL	Mean	UCL
LB4110A - A1	Beta	11/18/2007	11/20/2014	1.40E+00	P	-2.62E+02	7.05E+00	2.76E+02
LB4110A - A2	Beta	11/18/2007	11/20/2014	1.67E+00	P	-2.74E+01	2.70E+00	3.28E+01
LB4110A - A3	Beta	11/18/2007	11/20/2014	1.50E+00	P	-4.55E+01	2.57E+00	5.06E+01
LB4110A - A4	Beta	11/18/2007	11/20/2014	7.07E+00	P	-2.90E+01	3.87E+00	3.67E+01
LB4110A - B1	Beta	11/18/2007	11/20/2014	1.50E+00	P	-9.42E+00	3.01E+00	1.54E+01
LB4110A - B2	Beta	11/18/2007	11/20/2014	1.52E+00	P	-6.84E+00	1.91E+00	1.07E+01
LB4110A - B3	Beta	11/18/2007	11/20/2014	1.35E+00	P	-3.80E-01	1.41E+00	3.19E+00
LB4110A - B4	Beta	11/18/2007	11/20/2014	1.48E+00	P	-6.81E+00	1.91E+00	1.06E+01
LB4110A - C1	Beta	11/18/2007	11/20/2014	1.18E+00	P	-4.84E+00	2.00E+00	8.85E+00
LB4110A - C2	Beta	11/18/2007	11/20/2014	1.00E+00	P	3.75E-01	1.28E+00	2.18E+00
LB4110A - C3	Beta	11/18/2007	11/20/2014	1.52E+00	P	4.36E-01	1.52E+00	2.61E+00
LB4110A - C4	Beta	11/18/2007	11/20/2014	1.20E+00	P	-1.60E+00	1.98E+00	5.56E+00
LB4110A - D1	Beta	11/18/2007	11/20/2014	1.35E+00	P	-2.24E+00	2.49E+00	7.22E+00
LB4110A - D2	Beta	11/18/2007	11/20/2014	5.35E+00	P	-3.78E+00	1.97E+00	7.72E+00
LB4110A - D3	Beta	11/18/2007	11/20/2014	2.05E+00	P	6.90E-01	4.30E+00	7.92E+00
LB4110A - D4	Beta	11/18/2007	11/20/2014	7.03E+00	P	-7.51E+00	1.93E+00	1.14E+01
LB4110R - A1	Beta	11/24/2006	11/20/2014	9.00E-01	P	-5.60E+01	3.31E+00	6.26E+01
LB4110R - A2	Beta	11/24/2006	11/20/2014	1.17E+00	P	-4.43E+01	1.93E+00	4.82E+01
LB4110R - A3	Beta	11/24/2006	11/20/2014	1.23E+00	P	-4.11E+01	2.53E+00	4.62E+01
LB4110R - A4	Beta	11/24/2006	11/20/2014	1.18E+00	P	-4.08E+01	2.01E+00	4.48E+01
LB4110R - B1	Beta	11/24/2006	11/20/2014	1.45E+00	P	-4.30E+01	1.93E+00	4.69E+01
LB4110R - B2	Beta	11/24/2006	11/20/2014	2.12E+00	P	-4.82E+01	3.28E+00	5.48E+01
LB4110R - B3	Beta	11/24/2006	11/20/2014	1.40E+00	P	-4.29E+01	2.47E+00	4.78E+01
LB4110R - B4	Beta	11/24/2006	11/20/2014	1.28E+00	P	-4.32E+01	1.83E+00	4.68E+01
LB4110R - C1	Beta	11/24/2006	11/20/2014	1.43E+00	P	-4.31E+01	2.72E+00	4.85E+01
LB4110R - C2	Beta	11/24/2006	11/20/2014	1.80E+00	P	-4.29E+01	2.56E+00	4.81E+01
LB4110R - C3	Beta	11/24/2006	11/20/2014	1.17E+00	P	-4.34E+01	2.36E+00	4.81E+01
LB4110R - C4	Beta	11/24/2006	11/20/2014	1.35E+00	P	-4.90E+01	2.72E+00	5.44E+01
LB4110R - D1	Beta	11/24/2006	11/1/2014	0.00E+00	P	-4.36E+01	5.31E+00	5.43E+01
LB4110R - D2	Beta	11/24/2006	11/1/2014	0.00E+00	P	-4.67E+01	1.79E+00	5.03E+01
LB4110R - D3	Beta	11/24/2006	11/1/2014	0.00E+00	P	-5.02E+01	5.28E+00	6.07E+01
LB4110R - D4	Beta	11/24/2006	11/1/2014	0.00E+00	P	-4.64E+01	2.13E+00	5.07E+01
LB5100 - 1	Beta	7/10/2006	10/26/2007	4.52E+00	F	-3.19E-01	1.58E+00	3.48E+00

WLLFOIA4312 - 001 - 0030689

GPC Detector Report
(ALL Efficiencies)

Detector	Alpha/Beta	Calibration Date	Count Date	Eff	PFW	LCL	Mean	UCL
LB4110A - A1	Alpha	11/18/2007	11/20/2014	0.2297	P	0.0105	0.2188	0.4272
LB4110A - A2	Alpha	11/18/2007	11/20/2014	0.1995	P	-0.0268	0.1787	0.3841
LB4110A - A3	Alpha	11/18/2007	11/20/2014	0.1970	P	-0.0484	0.1697	0.3879
LB4110A - A4	Alpha	11/18/2007	11/20/2014	0.2300	P	-0.0273	0.1903	0.4079
LB4110A - B1	Alpha	11/18/2007	11/20/2014	0.2175	P	0.1953	0.2235	0.2518
LB4110A - B2	Alpha	11/18/2007	11/20/2014	0.2011	P	0.1889	0.2189	0.2489
LB4110A - B3	Alpha	11/18/2007	11/20/2014	0.2369	P	0.1376	0.2326	0.3276
LB4110A - B4	Alpha	11/18/2007	11/20/2014	0.2107	W	0.2058	0.2343	0.2627
LB4110A - C1	Alpha	11/18/2007	11/20/2014	0.2133	P	0.1980	0.2200	0.2421
LB4110A - C2	Alpha	11/18/2007	11/20/2014	0.2279	P	0.1989	0.2250	0.2510
LB4110A - C3	Alpha	11/18/2007	11/20/2014	0.2452	P	0.2242	0.2489	0.2735
LB4110A - C4	Alpha	11/18/2007	11/20/2014	0.2181	P	0.1982	0.2249	0.2517
LB4110A - D1	Alpha	11/18/2007	11/20/2014	0.2208	P	0.1797	0.2303	0.2809
LB4110A - D2	Alpha	11/18/2007	11/20/2014	0.2438	P	0.2017	0.2557	0.3097
LB4110A - D3	Alpha	11/18/2007	11/20/2014	0.2535	P	0.2054	0.2611	0.3168
LB4110A - D4	Alpha	11/18/2007	11/20/2014	0.1883	P	0.1488	0.1973	0.2458
LB4110R - A1	Alpha	11/24/2006	11/20/2014	0.2293	P	0.2002	0.2376	0.2751
LB4110R - A2	Alpha	11/24/2006	11/20/2014	0.2059	P	0.1847	0.2186	0.2524
LB4110R - A3	Alpha	11/24/2006	11/20/2014	0.2108	P	0.1922	0.2230	0.2537
LB4110R - A4	Alpha	11/24/2006	11/20/2014	0.2412	P	0.2130	0.2445	0.2760
LB4110R - B1	Alpha	11/24/2006	11/20/2014	0.1939	P	0.1703	0.2225	0.2746
LB4110R - B2	Alpha	11/24/2006	11/20/2014	0.1750	W	0.1671	0.2143	0.2615
LB4110R - B3	Alpha	11/24/2006	11/20/2014	0.2104	P	0.1970	0.2431	0.2892
LB4110R - B4	Alpha	11/24/2006	11/20/2014	0.1898	W	0.1800	0.2284	0.2768
LB4110R - C1	Alpha	11/24/2006	11/20/2014	0.2102	P	0.1795	0.2138	0.2481
LB4110R - C2	Alpha	11/24/2006	11/20/2014	0.2086	P	0.1898	0.2228	0.2558
LB4110R - C3	Alpha	11/24/2006	11/20/2014	0.2261	P	0.2033	0.2380	0.2727
LB4110R - C4	Alpha	11/24/2006	11/20/2014	0.2029	P	0.1778	0.2195	0.2611
LB4110R - D1	Alpha	11/24/2006	11/1/2014	0.0000	W	-0.0281	0.1904	0.4089
LB4110R - D2	Alpha	11/24/2006	11/1/2014	0.0000	W	-0.0314	0.2165	0.4644
LB4110R - D3	Alpha	11/24/2006	11/1/2014	0.0000	W	-0.0308	0.2127	0.4562
LB4110R - D4	Alpha	11/24/2006	11/1/2014	0.0000	W	-0.0260	0.1714	0.3689
LB5100 - 1	Alpha	7/10/2006	10/26/2007	0.3368	P	0.3332	0.3455	0.3578

WLLFOIA4312 - 001 - 0030690

GPC Detector Report
(ALL Efficiencies)

Detector	Alpha/Beta	Calibration Date	Count Date	Eff	PFW	LCL	Mean	UCL
LB4110A - A1	Beta	11/18/2007	11/20/2014	0.5638	P	0.2437	0.5629	0.8821
LB4110A - A2	Beta	11/18/2007	11/20/2014	0.4609	P	0.1919	0.4677	0.7435
LB4110A - A3	Beta	11/18/2007	11/20/2014	0.4851	P	0.1279	0.4631	0.7984
LB4110A - A4	Beta	11/18/2007	11/20/2014	0.5729	P	0.1783	0.5028	0.8273
LB4110A - B1	Beta	11/18/2007	11/20/2014	0.5347	P	0.4666	0.5332	0.5999
LB4110A - B2	Beta	11/18/2007	11/20/2014	0.4993	P	0.4677	0.5272	0.5867
LB4110A - B3	Beta	11/18/2007	11/20/2014	0.5907	P	0.3372	0.5417	0.7462
LB4110A - B4	Beta	11/18/2007	11/20/2014	0.5402	P	0.4951	0.5558	0.6166
LB4110A - C1	Beta	11/18/2007	11/20/2014	0.5386	P	0.4367	0.5115	0.5863
LB4110A - C2	Beta	11/18/2007	11/20/2014	0.5585	P	0.3994	0.5159	0.6325
LB4110A - C3	Beta	11/18/2007	11/20/2014	0.6203	P	0.5258	0.5977	0.6697
LB4110A - C4	Beta	11/18/2007	11/20/2014	0.5711	P	0.4528	0.5329	0.6130
LB4110A - D1	Beta	11/18/2007	11/20/2014	0.7199	W	0.3874	0.5644	0.7414
LB4110A - D2	Beta	11/18/2007	11/20/2014	0.6741	P	0.4358	0.5914	0.7469
LB4110A - D3	Beta	11/18/2007	11/20/2014	0.6537	P	0.4806	0.6156	0.7506
LB4110A - D4	Beta	11/18/2007	11/20/2014	0.4874	P	0.3515	0.4714	0.5912
LB4110R - A1	Beta	11/24/2006	11/20/2014	0.5674	P	0.4818	0.5701	0.6584
LB4110R - A2	Beta	11/24/2006	11/20/2014	0.5119	P	0.4235	0.5114	0.5993
LB4110R - A3	Beta	11/24/2006	11/20/2014	0.5285	P	0.4568	0.5386	0.6204
LB4110R - A4	Beta	11/24/2006	11/20/2014	0.6097	P	0.5099	0.5952	0.6806
LB4110R - B1	Beta	11/24/2006	11/20/2014	0.4657	P	0.4285	0.5394	0.6502
LB4110R - B2	Beta	11/24/2006	11/20/2014	0.4356	W	0.4119	0.5173	0.6227
LB4110R - B3	Beta	11/24/2006	11/20/2014	0.5298	P	0.4826	0.5958	0.7091
LB4110R - B4	Beta	11/24/2006	11/20/2014	0.4641	W	0.4431	0.5479	0.6527
LB4110R - C1	Beta	11/24/2006	11/20/2014	0.4935	P	0.4140	0.5016	0.5893
LB4110R - C2	Beta	11/24/2006	11/20/2014	0.5315	P	0.4337	0.5357	0.6376
LB4110R - C3	Beta	11/24/2006	11/20/2014	0.5815	P	0.4821	0.5742	0.6663
LB4110R - C4	Beta	11/24/2006	11/20/2014	0.5229	P	0.4316	0.5258	0.6201
LB4110R - D1	Beta	11/24/2006	11/1/2014	0.0000	W	-0.0678	0.4553	0.9785
LB4110R - D2	Beta	11/24/2006	11/1/2014	0.0000	W	-0.0756	0.5116	1.0989
LB4110R - D3	Beta	11/24/2006	11/1/2014	0.0000	W	-0.0736	0.4969	1.0674
LB4110R - D4	Beta	11/24/2006	11/1/2014	0.0000	W	-0.0630	0.4090	0.8811
LB5100 - 1	Beta	7/10/2006	10/26/2007	0.4428	F	0.4555	0.4731	0.4906

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