FEEZOR ENGINEERING, INC.

FEE/BRI

Air

STANDARD LEVEL IV
REPORT OF ANALYSIS

WORK ORDER #14-07110-OR

August 20, 2014

EBERLINE ANALYTICAL/OAK RIDGE LABORATORY
OAK RIDGE, TN

0001

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WLLFOIA4312 - 001 - 0004095

Eberline Services – Oak Ridge Laboratory

LABORATORY DATA SUPPORT CHECKLIST

MP-001-3

Eberline Services Work Order # 14-07110

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

Date for Partial	Initials	Date	Initials	Checklist Items
		7/21/14	KC	Sample Log-In
		8/7/14	JG	Data Compilation
		8-15-14	MLT	First Technical Data Review
		8/18/14	MSf	Second Technical Data Review
		08/18/14	EJT	Data Entry/Electronic Deliverable
		08/18/14	EJT	Case Narrative
		8/18/14	KBS	Electronic Deliverable Proof
		8/18/14	MSf	Samples Analyzed within Holding Time Yes? [X] No? [ ]
		8/18/14	MSf	QA/QC Review
				Client in Possession of Data Electronic or Hard Copy
				Invoiced by Laboratory

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

Date package approved by: [signature] 8/20/14

Laboratory Manager Date

Copy No. _____

SECTION I

CHAIN OF CUSTODY

14-07110

REC'D JUL 21 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	START COLLECTION	STOP COLLECTION	CFM Start	CFM Stop	TOTAL HOURS	SAMPLE DESCRIPTION
4 OUTSIDE TRAILER	7/4/14 1140	7/18/14 0840	3	2.5	333.0	AIR FILTER
5 TRANSFER STATION	7/4/14 1200	7/18/14 0900	3	<2	333.0	AIR FILTER
	ANALYZE FOR GROSS ALPHA, GROSS BETA, + ISOTOPIC THORIUM					
		STANDARD T.A.T.				

Relinquished By/Date: [signature] 7/18/14 1000	Received In Good Condition By: Kristen Carlsten	Time: 1600	Date: 7/21/14
Method Of Shipment/Tracking #: FEDEX / 770625494250			
Relinquished By:	Received In Good Condition By:	Time:	Date:
Method Of Shipment:			

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

WLLFOIA4312 - 001 - 0004098

EBERLINE SERVICES Oak Ridge Laboratory	Internal Chain of Custody	Work Order #	14-07110
		Lab Deadline	8/11/2014
		Analysis	ThISO - Level 4
		Sample Matrix	Air Filter

Comments	Sample Fraction	HP 210 / 270 Detector Activity	Storage Location
	04	26	S1.2
	05	31	S1.2

	Location (circle one)					Initials	Date
Received by	Sample Storage	Rough Prep	Prep	Separations	Count Room	JWOIB	8/4/14 0600
Relinquished by	Sample Storage	Rough Prep	Prep	Separations	Count Room	JWOIB	8/5/14 1015
Received by	Sample Storage	Rough Prep	Prep	Separations	Count Room	[illegible]	8-6-14 0400
Relinquished by	Sample Storage	Rough Prep	Prep	Separations	Count Room	[illegible]	8-7-14 0908
Received by	Sample Storage	Rough Prep	Prep	Separations	Count Room	[illegible]	0808
Relinquished by	Sample Storage	Rough Prep	Prep	Separations	Count Room	KB	8/7/14 1440
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		

0006

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EBERLINE SERVICES Oak Ridge Laboratory	Internal Chain of Custody	Work Order #	14-07110
		Lab Deadline	8/11/2014
		Analysis	GaGbT_ThSr - Level 4
		Sample Matrix	Air Filter

Comments	Sample Fraction	HP 210 / 270 Detector Activity	Storage Location
	04	26	S1.2
	05	31	S1.2

	Location (circle one)					Initials	Date
Received by	(Sample Storage)	Rough Prep	Prep	Separations	Count Room	[illegible]	8/4/14 0600
Relinquished by	Sample Storage	Rough Prep	(Prep)	Separations	Count Room	[illegible]	8/4/14 0700
Received by	Sample Storage	Rough Prep	Prep	Separations	(Count Room)	[illegible]	8/4 0720
Relinquished by	Sample Storage	Rough Prep	Prep	Separations	(Count Room)	[illegible]	8/4 1170
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		

0007

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SECTION II

SAMPLE ACKNOWLEDGEMENT

Client Name	Contract/PO	Project Type	Date Received	Required Turnaround Days	Eberline Services Work Order
Feezor Engineering, Inc.	BT-026-PO1	Environmental	07/21/2014	28	14-07110
Project Name	**Client WO**	**Sample Disp**	**Lab Deadline**	**Internal Deadline**	**Client Deadline**
FEEBRI	FEE/BRI Bridgeton, MO	H	08/11/2014	08/15/2014	08/18/2014

Internal ID	Client ID	Sample Date	Matrix	Storage	GaGbT	ThISO																							Ttl
01	LCS	07/21/14	AF	S1.2	X	X																							2
02	BLANK	07/21/14	AF	S1.2	X	X																							2
03	DUP	07/21/14	AF	S1.2	X	X																							2
04	OUTSIDE TRAILER	07/18/14 08:40	AF	S1.2	X	X																							2
05	TRANSFER STATION	07/18/14 09:00	AF	S1.2	X	X																							2
																													0
																													0
																													0
																													0
																													0
																													0
																													0
																													0
																													0
																													0
																													0
																													0
																													0
																													0
																													0
				Totals Per Analysis (non QA samples)	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

EBERLINE SERVICES

Sample Log In Report

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

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

Invoice	Accounts Payable 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	

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Eberline Services – Oak Ridge Laboratory

SAMPLE RECEIPT CHECKLIST
MP-001-2

WORK ORDER # 14-07110

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 Carlston DATE: 7/21/14

SECTION III

CASE NARRATIVE

EBERLINE SERVICES

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

EBS-OR-37724

August 20, 2014

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

CASE NARRATIVE
Work Order # 14-07110-OR

SAMPLE RECEIPT

This work order contains two air filter samples received 07/21/2014. These samples were analyzed for Isotopic Thorium and Gross Alpha/Beta.

CLIENT ID	LAB ID
OUTSIDE TRAILER	14-07110-04
TRANSFER STATION	14-07110-05

ANALYTICAL METHODS

Isotopic Thorium was analyzed using Method EML Th-01 Modified. Gross Alpha/Beta was analyzed using Method LANL MLR-100 Modified.

ANALYTICAL RESULTS

Combined Standard Uncertainty is reported at 2-sigma value.

ISOTOPIC THORIUM

Samples were prepared by digestion of filter media using mixed acids followed by subsequent dilutions as appropriate. Aliquots from were taken and 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.

Samples 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 and Thorium-232 duplicate demonstrated a high relative percent difference; however, normalized difference is within acceptable limits for the analytical technique. Results for the Thorium-230 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.

ANALYTICAL RESULTS CONTINUED

GROSS ALPHA & BETA

Air filters analyzed for Gross Alpha and Beta activity were attached directly to stainless steel planchets and transferred to the counting room for activity determinations by gas-flow proportional counting.

Samples 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 replicate 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: 8/20/2014

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

Eberline Analytical
Final Report of Analysis

Report To:

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

Work Order Details:

SDG:	**14-07110**
Purchase Order:	BT-026-PO1
Analysis Category:	ENVIRONMENTAL
Sample Matrix:	AF

Lab ID	Sample Type	Client ID	Sample Date	Receipt Date	Analysis Date	Batch ID	Analyte	Method	Result	CU	CSU	MDA	CV	Report Units
14-07110-01	LCS	KNOWN	07/21/14 00:00	7/21/2014	8/4/2014	14-07110	Gross Alpha	LANL MLR-100 Modified	2.48E-04	1.07E-05				uCi/ml
14-07110-01	LCS	SPIKE	07/21/14 00:00	7/21/2014	8/4/2014	14-07110	Gross Alpha	LANL MLR-100 Modified	2.81E-04	3.79E-06	3.09E-05	3.99E-08	1.41E-07	uCi/ml
14-07110-02	MBL	BLANK	07/21/14 00:00	7/21/2014	8/4/2014	14-07110	Gross Alpha	LANL MLR-100 Modified	4.28E-16	3.43E-16	3.46E-16	6.05E-16	5.93E-16	uCi/ml
14-07110-03	DUP	OUTSIDE TRAILER	07/18/14 08:40	7/21/2014	8/4/2014	14-07110	Gross Alpha	LANL MLR-100 Modified	4.15E-15	7.76E-16	8.99E-16	5.82E-16	5.70E-16	uCi/ml
14-07110-04	DO	OUTSIDE TRAILER	07/18/14 08:40	7/21/2014	8/4/2014	14-07110	Gross Alpha	LANL MLR-100 Modified	4.67E-15	7.83E-16	9.34E-16	1.02E-16	3.62E-16	uCi/ml
14-07110-05	TRG	TRANSFER STATION	07/18/14 09:00	7/21/2014	8/4/2014	14-07110	Gross Alpha	LANL MLR-100 Modified	2.99E-15	7.33E-16	8.03E-16	7.86E-16	7.71E-16	uCi/ml
14-07110-01	LCS	KNOWN	07/21/14 00:00	7/21/2014	8/4/2014	14-07110	Gross Beta	LANL MLR-100 Modified	2.78E-04	8.33E-06				uCi/ml
14-07110-01	LCS	SPIKE	07/21/14 00:00	7/21/2014	8/4/2014	14-07110	Gross Beta	LANL MLR-100 Modified	2.78E-04	3.11E-06	3.85E-05	6.51E-07	2.32E-06	uCi/ml
14-07110-02	MBL	BLANK	07/21/14 00:00	7/21/2014	8/4/2014	14-07110	Gross Beta	LANL MLR-100 Modified	-8.25E-17	7.84E-16	7.84E-16	1.68E-15	5.93E-15	uCi/ml
14-07110-03	DUP	OUTSIDE TRAILER	07/18/14 08:40	7/21/2014	8/4/2014	14-07110	Gross Beta	LANL MLR-100 Modified	2.10E-14	1.50E-15	3.27E-15	1.60E-15	5.55E-15	uCi/ml
14-07110-04	DO	OUTSIDE TRAILER	07/18/14 08:40	7/21/2014	8/4/2014	14-07110	Gross Beta	LANL MLR-100 Modified	2.29E-14	1.56E-15	3.53E-15	1.67E-15	5.94E-15	uCi/ml
14-07110-05	TRG	TRANSFER STATION	07/18/14 09:00	7/21/2014	8/4/2014	14-07110	Gross Beta	LANL MLR-100 Modified	1.87E-14	1.56E-15	3.02E-15	1.94E-15	7.06E-15	uCi/ml
14-07110-01	LCS	KNOWN	07/21/14 00:00	7/21/2014	8/7/2014	14-07110	Thorium-228	EML Th-01 Modified	5.01E-06	1.81E-07				uCi/ml
14-07110-01	LCS	SPIKE	07/21/14 00:00	7/21/2014	8/7/2014	14-07110	Thorium-228	EML Th-01 Modified	5.00E-06	1.32E-06	1.40E-06	4.45E-07	2.26E-07	uCi/ml
14-07110-02	MBL	BLANK	07/21/14 00:00	7/21/2014	8/7/2014	14-07110	Thorium-228	EML Th-01 Modified	3.25E-17	6.33E-17	6.34E-17	1.18E-16	2.39E-17	uCi/ml
14-07110-03	DUP	OUTSIDE TRAILER	07/18/14 08:40	7/21/2014	8/7/2014	14-07110	Thorium-228	EML Th-01 Modified	1.08E-16	1.22E-16	1.22E-16	1.87E-16	7.21E-17	uCi/ml
14-07110-04	DO	OUTSIDE TRAILER	07/18/14 08:40	7/21/2014	8/7/2014	14-07110	Thorium-228	EML Th-01 Modified	2.40E-16	1.42E-16	1.44E-16	1.17E-16	2.10E-17	uCi/ml
14-07110-05	TRG	TRANSFER STATION	07/18/14 09:00	7/21/2014	8/7/2014	14-07110	Thorium-228	EML Th-01 Modified	4.95E-16	1.95E-16	2.00E-16	1.06E-16	2.61E-17	uCi/ml
14-07110-01	LCS	KNOWN	07/21/14 00:00	7/21/2014	8/7/2014	14-07110	Thorium-230	EML Th-01 Modified	5.48E-06	1.48E-07				uCi/ml
14-07110-01	LCS	SPIKE	07/21/14 00:00	7/21/2014	8/7/2014	14-07110	Thorium-230	EML Th-01 Modified	5.73E-06	1.46E-06	1.62E-06	3.75E-07	1.46E-07	uCi/ml
14-07110-02	MBL	BLANK	07/21/14 00:00	7/21/2014	8/7/2014	14-07110	Thorium-230	EML Th-01 Modified	1.71E-16	1.16E-16	1.18E-16	9.44E-17	1.27E-17	uCi/ml
14-07110-03	DUP	OUTSIDE TRAILER	07/18/14 08:40	7/21/2014	8/7/2014	14-07110	Thorium-230	EML Th-01 Modified	3.40E-16	1.77E-16	1.82E-16	1.38E-16	3.36E-17	uCi/ml
14-07110-04	DO	OUTSIDE TRAILER	07/18/14 08:40	7/21/2014	8/7/2014	14-07110	Thorium-230	EML Th-01 Modified	3.60E-16	1.70E-16	1.75E-16	7.58E-17	6.73E-18	uCi/ml
14-07110-05	TRG	TRANSFER STATION	07/18/14 09:00	7/21/2014	8/7/2014	14-07110	Thorium-230	EML Th-01 Modified	6.49E-16	2.25E-16	2.39E-16	5.91E-17	5.26E-18	uCi/ml
14-07110-01	LCS	KNOWN	07/21/14 00:00	7/21/2014	8/7/2014	14-07110	Thorium-232	EML Th-01 Modified	5.01E-06	1.81E-07				uCi/ml
14-07110-01	LCS	SPIKE	07/21/14 00:00	7/21/2014	8/7/2014	14-07110	Thorium-232	EML Th-01 Modified	5.41E-06	1.39E-06	1.47E-06	2.66E-07	2.62E-07	uCi/ml
14-07110-02	MBL	BLANK	07/21/14 00:00	7/21/2014	8/7/2014	14-07110	Thorium-232	EML Th-01 Modified	5.08E-17	6.19E-17	6.21E-17	7.49E-17	9.77E-17	uCi/ml
14-07110-03	DUP	OUTSIDE TRAILER	07/18/14 08:40	7/21/2014	8/7/2014	14-07110	Thorium-232	EML Th-01 Modified	2.46E-16	1.44E-16	1.45E-16	9.28E-17	1.09E-16	uCi/ml
14-07110-04	DO	OUTSIDE TRAILER	07/18/14 08:40	7/21/2014	8/7/2014	14-07110	Thorium-232	EML Th-01 Modified	3.50E-16	1.69E-16	1.72E-16	1.02E-16	1.08E-16	uCi/ml
14-07110-05	TRG	TRANSFER STATION	07/18/14 09:00	7/21/2014	8/7/2014	14-07110	Thorium-232	EML Th-01 Modified	4.76E-16	1.86E-16	1.90E-16	6.76E-17	7.96E-17	uCi/ml

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 - 0004108

SECTION V

ANALYTICAL STANDARDS

WLLFOIA4312 - 001 - 0004109

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

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

ISOTOPE PRODUCTS LABORATORIES
1800 No. Keystone Street.,
Burbank, California 91504
(818) 843 - 7000

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

0018

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}Thorium
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

0019

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. Khan
QUALITY CONTROL

Nov. 8, 1993
Date Signed

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

0020

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: 9/23/2013 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 H2O

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: September 23, 2014

Verified & Approved By _____ Date: 9/23/2013 0:00

QC Approval _____ Date: 9/27/13

0021

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 9/23/2013 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: September 23, 2014

Verified & Approved By _____ Date: 9/23/2013 0:00

QC Approval _____ Date: 9/27/13

0022

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.

Ann U Khan
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: 9/23/2013 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

Radionuclide: ^{229}Th
Reference Date: 1/15/2002 0:00
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: September 23, 2014

Verified & Approved By _____ Date: 9/23/2013 0:00

QC Approval _____ Date: 9/27/13

0024

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 9/23/2013 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

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: September 23, 2014

Verified & Approved By _____ Date: 9/23/2013 0:00

QC Approval _____ Date: 9/27/13

0025

Am-4

ANALYTICS

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

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

0026

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 (RE-CERTIFICATION)

Date: 9/25/2013 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
Parent Solution Conc.: 1.19E+04 dpm/ml
Reference Date: 3/19/1996 0:00

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: September 5, 2014

Verified & Approved By: _____ Date: 9/25/13

QC Approval: _____ Date: 9/27/13

0027

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.

0028

WLLFOIA4312 - 001 - 0004121

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

Date: 9/25/2013 0:00

Solution Reference #: NIST 4234A

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

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: September 5, 2014

Verified & Approved By _____ Date: 09/25/13

QC Approval _____ Date: 9/27/13

0029

SECTION VI

QUALITY CONTROL SAMPLE RESULTS SUMMARY

WLLFOIA4312 - 001 - 0004123

WO	Analysis	Run	Activity Units	Aliquot Units	Client Name
14-07110	ThISO	1	uCi	ml	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	0.03	99.64%	27.98%	100.00%	3.60%	5.01E-06	1.81E-07	5.00E-06	1.40E-06	Th-8b	1.04E+02	3.60E+00	1.08E-01
TH-230	0.31	104.62%	28.26%	100.00%	2.70%	5.48E-06	1.48E-07	5.73E-06	1.62E-06	Th-1b	2.35E+01	2.70E+00	5.17E-01
TH-232	0.52	107.82%	27.11%	100.00%	3.60%	5.01E-06	1.81E-07	5.41E-06	1.47E-06	Th-8b	1.04E+02	3.60E+00	1.08E-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

Analyte	Normalized Difference	RPD	Original Result	Original CSU	Replicate Result	Replicate CSU
TH-228	1.38	76.22	2.40E-16	1.44E-16	1.08E-16	1.22E-16
TH-230	0.16	5.79	3.60E-16	1.75E-16	3.40E-16	1.82E-16
TH-232	0.91	35.02	3.50E-16	1.72E-16	2.46E-16	1.45E-16

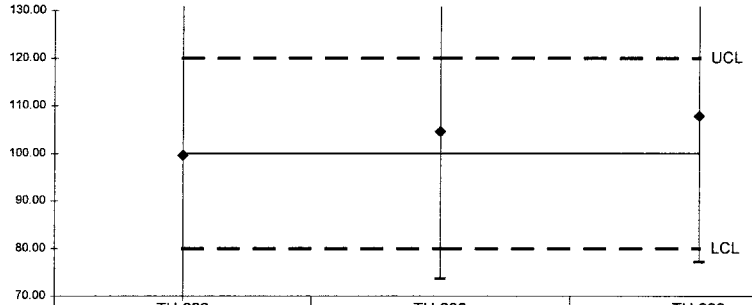
QC Summary

Analyte	LCS Relative Bias	LCS % R	LCS ND	MS % R	MS ND	Rep RPD	Rep ND
TH-228	1.00	OK	OK			NA	OK
TH-230	1.05	OK	OK			OK	OK
TH-232	1.08	OK	OK			INV	OK

WLLFOIA4312 - 001 - 0004124

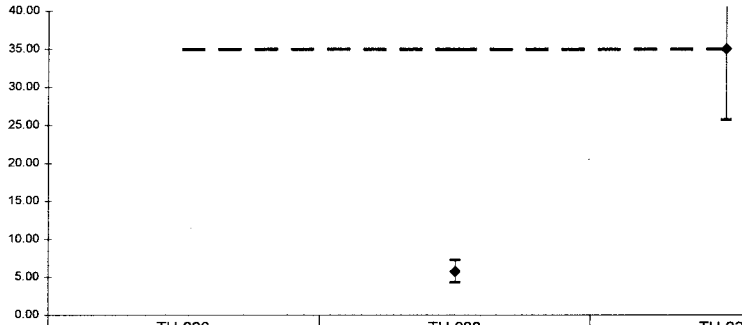
WO	Analysis	Run	Activity Units	Aliquot Units	Client Name
14-07110	ThISO	1	uCi	ml	Feezor Engineering, Inc.

LCS % Recovery



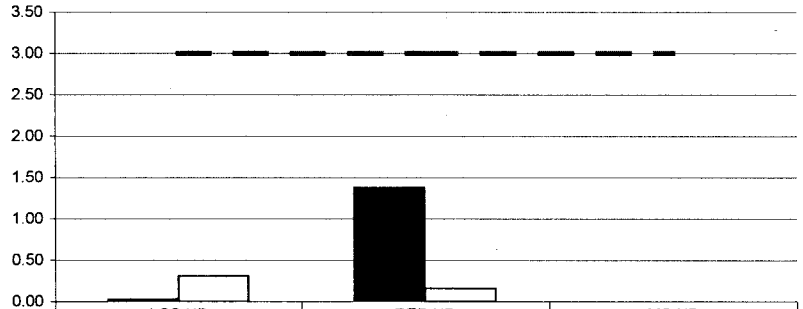
	TH-228	TH-230	TH-232
Lower Error	68.06	73.66	77.11
Upper Error	131.22	135.59	138.52
%R	99.64	104.62	107.82
LCL	80	80	80
Mean	100	100	100
UCL	120	120	120

Replicate Sample RPD



	TH-228	TH-230	TH-232
Lower Error	105.37	7.26	44.35
Upper Error	47.07	4.31	25.70
RPD	76.22	5.79	35.02
CL	35	35	35

Normalized Difference



	LCS ND	REP ND	MS ND
TH-228	0.03	1.38	0.00
TH-230	0.31	0.16	0.00
UCL	3	3	3

No Matrix Spike

Version
0.3.2

WLLFOIA4312 - 001 - 0004125

WO	Analysis	Run	Activity Units	Aliquot Units	Client Name
14-07110	GaGbT_ThSr	1	uCi	ml	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	2.06	113.44%	11.00%	100.00%	4.30%	2.48E-04	1.07E-05	2.81E-04	3.09E-05	A/B-07	5.97E+02	4.30E+00	9.22E-01
GROSS BETA_SR	0.00	100.01%	13.86%	100.00%	3.00%	2.78E-04	8.33E-06	2.78E-04	3.85E-05	A/B-07	6.69E+02	3.00E+00	9.22E-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

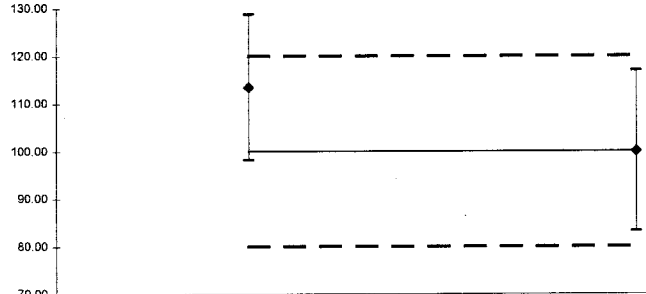
Analyte	Normalized Difference	RPD	Original Result	Original CSU	Replicate Result	Replicate CSU
GROSS ALPHA_TH	0.79	11.80	4.67E-15	9.34E-16	4.15E-15	8.99E-16
GROSS BETA_SR	0.78	8.69	2.29E-14	3.53E-15	2.10E-14	3.27E-15

QC Summary

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

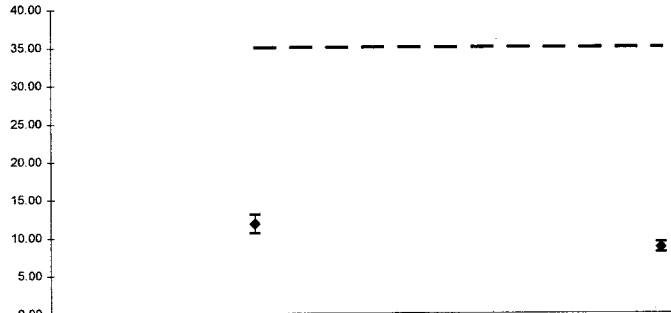
WO	Analysis	Run	Activity Units	Aliquot Units	Client Name
14-07110	GaGbT_ThSr	1	uCi	ml	Feezor Engineering, Inc.

LCS % Recovery



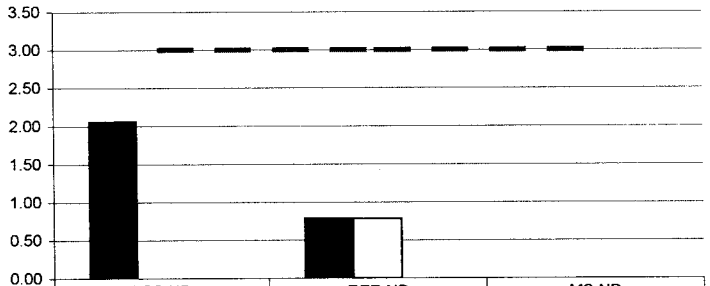
	GROSS ALPHA_TH	GROSS BETA_SR
Lower Error	98.14	83.14
Upper Error	128.75	116.87
%R	113.44	100.01
LCL	80	80
Mean	100	100
UCL	120	120

Replicate Sample RPD



	GROSS ALPHA_TH	GROSS BETA_SR
Lower Error	13.03	9.37
Upper Error	10.58	8.02
RPD	11.80	8.69
CL	35	35

Normalized Difference



	LCS ND	REP ND	MS ND
GROSS ALPHA_TH	2.06	0.79	0.00
GROSS BETA_SR	0.00	0.78	0.00
	0.00	0.00	0.00
UCL	3	3	3

No Matrix Spike

WLLFOIA4312 - 001 - 0004127

SECTION VII

LABORATORY TECHNICIAN'S NOTES & RUNLOGS

WLLFOIA4312 - 001 - 0004128

ISO-TH NOTES

WLLFOIA4312 - 001 - 0004129

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	14-07110
Analysis Code	ThISO
Run Number	1

#	Date	Dept	User	Notes
1	08/04/14 06:48	PREP	JWOLFE	DISSOLVED BOTH OF THE ENTIRE SAMPLES WITH HF AND DRIED SAMPLES DOWN- DIGESTED WITH MIXED ACIDS AND TOOK SAMPLES TO DRYNESS- ADDED HNO3 AND WATER AND CENTRIFUGED- DILUTED- SPLIT FRACTION 4 FOR QC- ADDED SPIKES AND TRACERS- DRIED SAMPLES DOWN AND SUBMITTED TO SEPARATIONS

JWolfe
8/4/14

0037

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	14-07110
Analysis Code	ThISO
Run Number	1

#	Date	Dept	User	Notes
1	08/04/14 06:48	PREP	JWOLFE	DISSOLVED BOTH OF THE ENTIRE SAMPLES WITH HF AND DRIED SAMPLES DOWN- DIGESTED WITH MIXED ACIDS AND TOOK SAMPLES TO DRYNESS- ADDED HNO3 AND WATER AND CENTRIFUGED- DILUTED- SPLIT FRACTION 4 FOR QC- ADDED SPIKES AND TRACERS- DRIED SAMPLES DOWN AND SUBMITTED TO SEPARATIONS
2	08/06/14 16:46	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.

8/6/14

0038

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	14-07110
Analysis Code	ThISO
Run Number	1

#	Date	Dept	User	Notes
1	08/04/14 06:48	PREP	JWOLFE	DISSOLVED BOTH OF THE ENTIRE SAMPLES WITH HF AND DRIED SAMPLES DOWN- DIGESTED WITH MIXED ACIDS AND TOOK SAMPLES TO DRYNESS- ADDED HNO3 AND WATER AND CENTRIFUGED- DILUTED- SPLIT FRACTION 4 FOR QC- ADDED SPIKES AND TRACERS- DRIED SAMPLES DOWN AND SUBMITTED TO SEPARATIONS
2	08/06/14 16:46	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.
3	08/07/14 05:17	CHEM	TSMITH	Followed steps 12.2.4 to 12.4.5 in AP-005 . (Precipitated and filtered samples for Thorium)

8-7-14
JW

EBERLINE SERVICES

Reagents Used in an Analysis

Internal Work Order	
14-07110	
Analysis Code	Run
ThISO	1

Reagent ID	Reagent Name	Reagent Concentration	Analyst ID	Date Recorded
014973P	Hydrofluoric Acid	Reagent Grade	JWOLFE	8/4/2014
014954P	Nitric Acid	Reagent Grade	JWOLFE	8/4/2014
014832P	Perchloric Acid	Reagent Grade	JWOLFE	8/4/2014
009098P	Sulfuric Acid	Reagent Grade	JWOLFE	8/4/2014
015294P	Anion Exchange Resin	Reagent Grade	JDEMELAS	8/6/2014
014955P	Hydrochloric Acid	Reagent Grade	JDEMELAS	8/6/2014
014954P	Nitric Acid	Reagent Grade	JDEMELAS	8/6/2014
015387S	Hydrochloric Acid	8N	JDEMELAS	8/6/2014
015381S	Nitric Acid	8N	JDEMELAS	8/6/2014
015250S	Cerrium Carrier	0.1mg/ml	TSMITH	8/7/2014
014973P	Hydrofluoric Acid	Reagent Grade	TSMITH	8/7/2014
015015P	Reagent Alcohol	Reagent Grade	TSMITH	8/7/2014
015375S	Carbon substrate	Solution	TSMITH	8/7/2014

Alpha #1

Date	Sample	Clinic	Freezer	Centrifuge	Analyst	Proc
8/4/14	1407164A(1-4,7)	UCOR	1442	2hr50min	PU	RB
8/4/14	1407164A (4)	UCOR	1442	2hr50min	PUNT	RB
8/5	Daily Pulse	LAB	0521	1	VM	
8/6	Daily Pulse	LAB	0524	1	VM	
8/6/14	1407183A(1-4)	UCOR	0936	2hr50min	AM	AC
8/6/14	1407183A (1-3)	UCOR	0936	2hr50min	AM-243	AC
8/6/14	1407165A(1-7)	Seaway	1252	2hr50min	UU	RB
8/7	Daily Pulse	LAB	0718	1	VM	
8/7	1407120B(1-4,7)	UCOR	0871	2hr	PU250	
8/7	1407120BNT(4)	UCOR	0871	2hr	PUNT	
8/7	1407187A(1)	UCOR	0872	2hr	PU250	
8/7/14	1407181A(4-7,12)	UCOR	1131	2hr50min	UU	RB
8/7/14	1407110A(1-2)	FEEZOR	1132	2hr50min	YH	RB

0041

Alphatrac

Date	Sample	Client	Time	CT Time	Analysis	Tech
8/6/14	1407183A (1-3)	UCOR	0939	2hr 50min	ISO-U	AG
8/6/14	1407165A (8-9)	Searay	1252	2hr 50min	UU	RB
8/6/14	1407165A (1-2)	Searay	1253	2hr 50min	Th	RB
8/7	Daily Pulse	LAB	0818	1	U	—
8/7	1407187A (2-4A)	UCOR	0872	2hr	PLZ50	—
8/7/14	1407110A (3-5)	Feezor	1142	2hr 50	Th	RB
8/7/14	1407065A (1)	PCC	1140	2hr 50	Th	RB

0042

GROSS A/B NOTES

EBERLINE SERVICES

Work Order Analysis Notes

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

Internal Work Order	14-07110
Analysis Code	GaGbT_ThSr
Run Number	1

#	Date	Dept	User	Notes
1	08/04/14 06:41	PREP	JWOLFE	Cut out a piece of each sample and glued to planchets- Prepared a spike and blank- Completed paperwork and submitted to the count room

JWolfe
8/4/14

0044

CB4110 Agu

Date	Sample #	Client	Time	CT Time	Analysis	Tech
7/31	1407142Pb(1-4)	UCON	0710	2L	Pb210	—
7/31	1407140Pb(1-7)	Geosyntec	0711	2L	Pb210	—
7/31	1407062S4(2-8)	UCON	0917	2L	SR90/Y	C
7/31	1407068S4(2-5)	UCON	0919	2L	SR90/Y	C
7/31	1407062S4(1)	UCON	0920	2L	SR90/Y	C
7/31	1407068S4(1)	UCON	0957	2L	SR90/Y	C
7/31	1407170Pb(6-8)	Geosyntec	1022	2L	Pb210	—
7/31	1407168AD(2-9)	Hudson	1124	2L	LIB	—
7/31/14	1407130Pb1(14-16)	GeoSyntec	1239	2hrs	Pb210	KCB
7/31	1407062C11(5)	UCON	1328	20L	CL76	—
7/31	1407170Pb2(17-19)	Geosyntec	1328	2L	Pb210	—
7/31/14	1407056AB(1-4)	North Troy	1402	2hrs	αβ	KCB
8/1	Bkgrnd	LAB	0522	6L	LIB	—
8/1	C-77-R	LAB	0628	2L	LIB	—
8/1	1407147RA(1-4)	USA	0802	2L	RAB	—
8/1	1407115AD(6-10)	Washington	0841	2L	LIB	—
8/2/14	Weekly Bkgd	Lab	1145	12 hr	αβ	KC
8/4/14	Bkgrnd	LAB	0504	6L	LIB	—
8/4	C-77-R	LAB	0609	2L	LIB	—
8/4	1407110AD(1-3,5)	Feezor	0725	2L	LIB	—
	1407110	Feezor		2L	LIB	—
8/4	1407091S4(2-4,6)	UCON	0751	2L	SR90/Y	C
8/4	1407091S4(1)	UCON	0751	2L	SR90/Y	—
8/4	1407075RA(1)	ORA	0825	2L	RAB	C
8/4	1407110AD(4)	Feezor	0929	2L	LIB	—
8/4	1407065AD(2-4)	UCON	0900	2L	LIB	—

0045

CB4110 Agh

Date	Sample #	Client	Sampling Time	Counting Time	Analysis	Technic
7/31	1407142Pb(1-4)	UCON	0710	2L	Pb210	—
7/31	1407140Pb(1-7)	Sevacy	0711	2L	Pb210	—
7/31	1407062SY(2-5)	UCON	0917	2L	SR90/Y	C
7/31	1407068SY(2-5)	UCON	0919	2L	SR90/Y	C
7/31	1407062SY(1)	UCON	0920	2L	SR90/Y	C
7/31	1407068SY(1)	UCON	0917	2L	SR90/Y	C
7/31	1407130Pb(6-8)	Geosyntec	1022	2L	Pb210	—
7/31	1407168AB(2-9)	Hudson	1124	2L	LIB	—
7/31/14	1407130Pb1(14-16)	GeoSyntec	1239	2hrs	Pb210	KCB
7/31	1407062C(1-5)	UCON	1328	20	C-14	—
7/31	1407130Pb2(17-19)	Geosyntec	1328	2L	Pb210	—
7/31/14	1407056AB(1-4)	NorthStar	1402	2hrs	αβ	KCB
8/1	Blanks	LAB	0522	6	LIB	—
8/1	C-7-7-14	LAB	0628	2L	LIB	—
8/1	1407147RA(1-4)	LAB	0807	2L	RA8	—
8/1	1407115AB(1-10)	Washington	0841	2L	LIB	—
8/2/14	Weekly Bkgd	Lab	1145	12 hr	αβ	AG
8/4/14	Blanks	LAB	0504	6	LIB	—
8/4/14	7-7-14	LAB	0608	2L	LIB	—
8/4/14	1407110AB(1-3.5)	Feezor	0725	2L	LIB	—
	1407110	Feezor		2L	LIB	—

WLLFOIA4312 - 001 - 0004139

SECTION VIII

ANALYTICAL DATA (ISOTOPIC THORIUM)

Eberline Services
Oak Ridge Laboratory
Analysis Sheet

14-07110
ThISO
Run 1

Work Order	14-07110
Analysis Code	ThISO
Run	1
Date Received	7/21/2014
Lab Deadline	8/11/2014
Client	Feezor Engineering, Inc.
Project	FEEBRI
Report Level	4
Activity Units	uCi
Aliquot Units	ml
Matrix	AF
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		07/21/14 00:00	1.0000E+00
02	MBL	BLANK		07/21/14 00:00	9.9000E+08
03	DUP	OUTSIDE TRAILER	26	07/18/14 08:40	7.8000E+08
04	DO	OUTSIDE TRAILER	26	07/18/14 08:40	7.8000E+08
05	TRG	TRANSFER STATION	31	07/18/14 09:00	1.4100E+09

* 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.

WLLFOIA4312 - 001 - 0004141

14-07110
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	0.4724	10.6		0.00								
02	MBL	0.2356	5.3		0.00								
03	DUP	0.2354	5.3		0.00								
04	DO	0.2349	5.3		0.00								
05	TRG	0.2355	5.3		0.00								

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.

WLLFOIA4312 - 001 - 0004142

14-07110
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			08/04/14 06:44	JWOLFE				
02	MBL			08/04/14 06:44	JWOLFE				
03	DUP			08/04/14 06:44	JWOLFE				
04	DO			08/04/14 06:44	JWOLFE				
05	TRG			08/04/14 06:44	JWOLFE				

* 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

Preliminary Data Report & Analytical Calculations

Work Order: 14-07110-ThISO-1

Client	Eberline Services Work Order	Analysis Code	Run
Feezor Engineering, Inc.	14-07110	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-228	LCS	LCS	uCi/ml	5.00E-06	1.32E-06	4.45E-07	5.01E-06	99.64	OK		INV	
02	TH-228	MBL	BLANK	uCi/ml	3.25E-17	6.33E-17	1.18E-16					OK	OK
03	TH-228	DUP	OUTSIDE TRAILER	uCi/ml	1.08E-16	1.22E-16	1.87E-16				NA	OK	
04	TH-228	DO	OUTSIDE TRAILER	uCi/ml	2.40E-16	1.42E-16	1.17E-16					OK	
05	TH-228	TRG	TRANSFER STATION	uCi/ml	4.95E-16	1.95E-16	1.06E-16					OK	

Preliminary Data Report & Analytical Calculations
Work Order: 14-07110-ThISO-1

Client	Eberline Services Work Order	Analysis Code	Run
Feezor Engineering, Inc.	14-07110	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	07/21/14 00:00	1.00E+00	35.82	0.00	0.00			
02	TH-228	MBL	07/21/14 00:00	9.90E+08	104.56	0.00	0.00			
03	TH-228	DUP	07/18/14 08:40	7.80E+08	104.17	0.00	0.00			
04	TH-228	DO	07/18/14 08:40	7.80E+08	106.09	0.00	0.00			
05	TH-228	TRG	07/18/14 09:00	1.41E+09	70.67	0.00	0.00			

Preliminary Data Report & Analytical Calculations
Work Order: 14-07110-ThISO-1

Client	Eberline Services Work Order	Analysis Code	Run
Feezor Engineering, Inc.	14-07110	ThISO	1

Lab Fraction	Nuclide	Sample Desc	Counting Date/Time	Halflife (days)	Detect	Carrier	Count Time	Counts	Bkg CPM	Eff
01	TH-228	LCS	08/07/14 11:32		A_Spec	Alpha_014	170	1.24 E+02	3.20 E-02	18.3
02	TH-228	MBL	08/07/14 11:32		A_Spec	Alpha_015	170	1.81 E+00	7.00 E-03	14.3
03	TH-228	DUP	08/07/14 11:42		A_Spec	Alpha_024	170	5.43 E+00	2.10 E-02	16.8
04	TH-228	DO	08/07/14 11:42		A_Spec	Alpha_025	170	1.30 E+01	6.00 E-03	17.7
05	TH-228	TRG	08/07/14 11:42		A_Spec	Alpha_029	170	3.43 E+01	1.00 E-02	18.8

Eberline Services
Oak Ridge Laboratory

Preliminary Data Report & Analytical Calculations
Work Order: 14-07110-ThISO-1

Run: 1
Analysis Code: ThISO
Eberline Services Work Order: 14-07110
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	uCi/ml	5.73E-06	1.46E-06	3.75E-07	5.48E-06	104.62	OK		INV	
02	TH-230	MBL	BLANK	uCi/ml	1.71E-16	1.16E-16	9.44E-17					OK	OK
03	TH-230	DUP	OUTSIDE TRAILER	uCi/ml	3.40E-16	1.77E-16	1.38E-16				OK	OK	
04	TH-230	DO	OUTSIDE TRAILER	uCi/ml	3.60E-16	1.70E-16	7.58E-17					OK	
05	TH-230	TRG	TRANSFER STATION	uCi/ml	6.49E-16	2.25E-16	5.91E-17					OK	

WLLFOIA4312 - 001 - 0004147
0054

Preliminary Data Report & Analytical Calculations
Work Order: 14-07110-ThISO-1

Client	Eberline Services Work Order	Analysis Code	Run
Feezor Engineering, Inc.	14-07110	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	07/21/14 00:00	1.00E+00	35.82	0.00	0.00			
02	TH-230	MBL	07/21/14 00:00	9.90E+08	104.56	0.00	0.00			
03	TH-230	DUP	07/18/14 08:40	7.80E+08	104.17	0.00	0.00			
04	TH-230	DO	07/18/14 08:40	7.80E+08	106.09	0.00	0.00			
05	TH-230	TRG	07/18/14 09:00	1.41E+09	70.67	0.00	0.00			

Preliminary Data Report & Analytical Calculations
Work Order: 14-07110-ThISO-1

Client	Eberline Services Work Order	Analysis Code	Run
Feezor Engineering, Inc.	14-07110	ThISO	1

Lab Fraction	Nuclide	Sample Desc	Counting Date/Time	Halflife (days)	Detect	Carrier	Count Time	Counts	Bkg CPM	Eff
01	TH-230	LCS	08/07/14 11:32		A_Spec	Alpha_014	170	1.42 E+02	2.00 E-02	18.3
02	TH-230	MBL	08/07/14 11:32		A_Spec	Alpha_015	170	9.49 E+00	3.00 E-03	14.3
03	TH-230	DUP	08/07/14 11:42		A_Spec	Alpha_024	170	1.75 E+01	9.00 E-03	16.8
04	TH-230	DO	08/07/14 11:42		A_Spec	Alpha_025	170	1.98 E+01	1.00 E-03	17.7
05	TH-230	TRG	08/07/14 11:42		A_Spec	Alpha_029	170	4.58 E+01	1.00 E-03	18.8

Eberline Services
Oak Ridge Laboratory

Preliminary Data Report & Analytical Calculations

Work Order: 14-07110-ThISO-1

Client: Feezor Engineering, Inc.
Eberline Services Work Order: 14-07110
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-232	LCS	LCS	uCi/ml	5.41E-06	1.39E-06	2.66E-07	5.01E-06	107.82	OK		INV	
02	TH-232	MBL	BLANK	uCi/ml	5.08E-17	6.19E-17	7.49E-17					OK	OK
03	TH-232	DUP	OUTSIDE TRAILER	uCi/ml	2.46E-16	1.44E-16	9.28E-17				INV	OK	
04	TH-232	DO	OUTSIDE TRAILER	uCi/ml	3.50E-16	1.69E-16	1.02E-16					OK	
05	TH-232	TRG	TRANSFER STATION	uCi/ml	4.76E-16	1.86E-16	6.76E-17					OK	

Preliminary Data Report & Analytical Calculations
Work Order: 14-07110-ThISO-1

Client: Feezor Engineering, Inc.
Eberline Services Work Order: 14-07110
Analysis Code: ThISO
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	TH-232	LCS	07/21/14 00:00	1.00E+00	35.82	0.00	0.00			
02	TH-232	MBL	07/21/14 00:00	9.90E+08	104.56	0.00	0.00			
03	TH-232	DUP	07/18/14 08:40	7.80E+08	104.17	0.00	0.00			
04	TH-232	DO	07/18/14 08:40	7.80E+08	106.09	0.00	0.00			
05	TH-232	TRG	07/18/14 09:00	1.41E+09	70.67	0.00	0.00			

Preliminary Data Report & Analytical Calculations

Work Order: 14-07110-ThISO-1

Client	Eberline Services Work Order	Analysis Code	Run
Feezor Engineering, Inc.	14-07110	ThISO	1

Lab Fraction	Nuclide	Sample Desc	Counting Date/Time	Halflife (days)	Detect	Carrier	Count Time	Counts	Bkg CPM	Eff
01	TH-232	LCS	08/07/14 11:32		A_Spec	Alpha_014	170	1.34 E+02	7.00 E-03	18.3
02	TH-232	MBL	08/07/14 11:32		A_Spec	Alpha_015	170	2.83 E+00	1.00 E-03	14.3
03	TH-232	DUP	08/07/14 11:42		A_Spec	Alpha_024	170	1.27 E+01	2.00 E-03	16.8
04	TH-232	DO	08/07/14 11:42		A_Spec	Alpha_025	170	1.93 E+01	4.00 E-03	17.7
05	TH-232	TRG	08/07/14 11:42		A_Spec	Alpha_029	170	3.37 E+01	2.00 E-03	18.8

Count Room Report
Client: Feezor Engineering, Inc.

14-07110-ThISO-1 (uCi/ml) in AF
Tracer ID: Th-18a

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	07/21/14 00:00	1.0000	0.4724	10.6120		0.00		
02	MBL	BLANK	07/21/14 00:00	990000000.0000	0.2356	5.2925		0.00		
03	DUP	OUTSIDE TRAILER	07/18/14 08:40	780000000.0000	0.2354	5.2880		0.00		
04	DO	OUTSIDE TRAILER	07/18/14 08:40	780000000.0000	0.2349	5.2768		0.00		
05	TRG	TRANSFER STATION	07/18/14 09:00	1410000000.0000	0.2355	5.2903		0.00		

Eberline Services
Oak Ridge Laboratory

Spike and Tracer Worksheet

Printed: 8/4/2014 6:44 AM

Internal Work Order	Run	Analysis Code	Date	Technician	Technician Initials	Witness Initials
14-07110	1	ThISO	8/4/2014 6:43	JWOLFE	JW	

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	8/4/2014	0.100	0.1075				5.01	0.181	0.00	0.000	0.00	0.000	0.00	0.000
Th-230	Th-1b	23.525	8/4/2014	0.500	0.5170				5.48	0.148	0.00	0.000	0.00	0.000	0.00	0.000
Th-232	Th-8b	103.560	8/4/2014	0.100	0.1075				5.01	0.181	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	8/4/2014	0.4724	0.2200
02	Th-229	Th-18a	22.464	8/4/2014	0.2356	0.2200
03	Th-229	Th-18a	22.464	8/4/2014	0.2354	0.2200
04	Th-229	Th-18a	22.464	8/4/2014	0.2349	0.2200
05	Th-229	Th-18a	22.464	8/4/2014	0.2355	0.2200

Balance Printer Tapes

Tracer	LCS
0.4724 g 0.2356 g 0.2354 g 0.2349 g 0.2355 g	0.5170 g 0.1075 g

Matrix Spike

Version 2.0 08/99

WLLFOIA4312 - 001 - 0004154

Eberline Analytical
Oak Ridge Laboratory

Aliquot Worksheet

Work Order	Run	Analysis Code	Rpt Units	Lab Deadline	Technician
14-07110	1	ThISO	ml	8/11/2014	JWOLFE

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					9.9000E+08	9.9000E+08				
03	OUTSIDE TRAILER	DUP					7.8000E+08	7.8000E+08				
04	OUTSIDE TRAILER	DO					7.8000E+08	7.8000E+08				
05	TRANSFER STATION	TRG					1.4100E+09	1.4100E+09				

Comments	

Technician: JWolfe Date: 8/4/14

WLLFOIA4312 - 001 - 0004155

Apex-Alpha™

ICB 8/7/14

Sample Description: SPIKE
Spectrum File: \\OR-ALPHA1\Canberra\ApexAlpha\Root\Data\00000943
Batch Identification: 1407110A-TH
Sample Identification: 01
Sample Geometry: Shelf 2
Procedure Description: Th iso

Detector Name: Alpha_014
Chamber Serial Number:
Detector Serial Number: 14
Env. Background: System Bkgd 92962
Reagent Blank: <not performed>

Sample Size: 1.000E+000 +/- 0.000E+000 mL
Sample Date/Time: 8/7/2014 6:03:15 AM
Acquisition Date/Time: 8/7/2014 11:32:01 AM
Acquisition Live Time: 170.0 minutes
Acquisition Real Time: 170.0 minutes

Tracer Certificate: Th229_TH-18A
Tracer Quantity: 0.472 mL
Effective Efficiency: 0.0656 +/- 0.0064
Counting Efficiency: 0.1831 +/- 0.0032 on 1/11/2014 12:12:59 PM
Chem. Recovery Factor: 0.3582 +/- 0.0356

Control Certificate Name: NatTh_Th-8
Chem. Recov. of Control: TH-232 1.078162 +/- 0.144680
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		5.745	2.47	163.78	1.53	0.00E+000	2.9
TH-228		5.368	123.56	18.08	5.44	0.00E+000	7.7
TH-229	T	4.877	118.30	18.17	1.70	0.00E+000	5.9
TH-230		4.640	141.60	16.70	3.40	0.00E+000	7.2
TH-232		3.969	133.81	17.03	1.19	0.00E+000	14.7

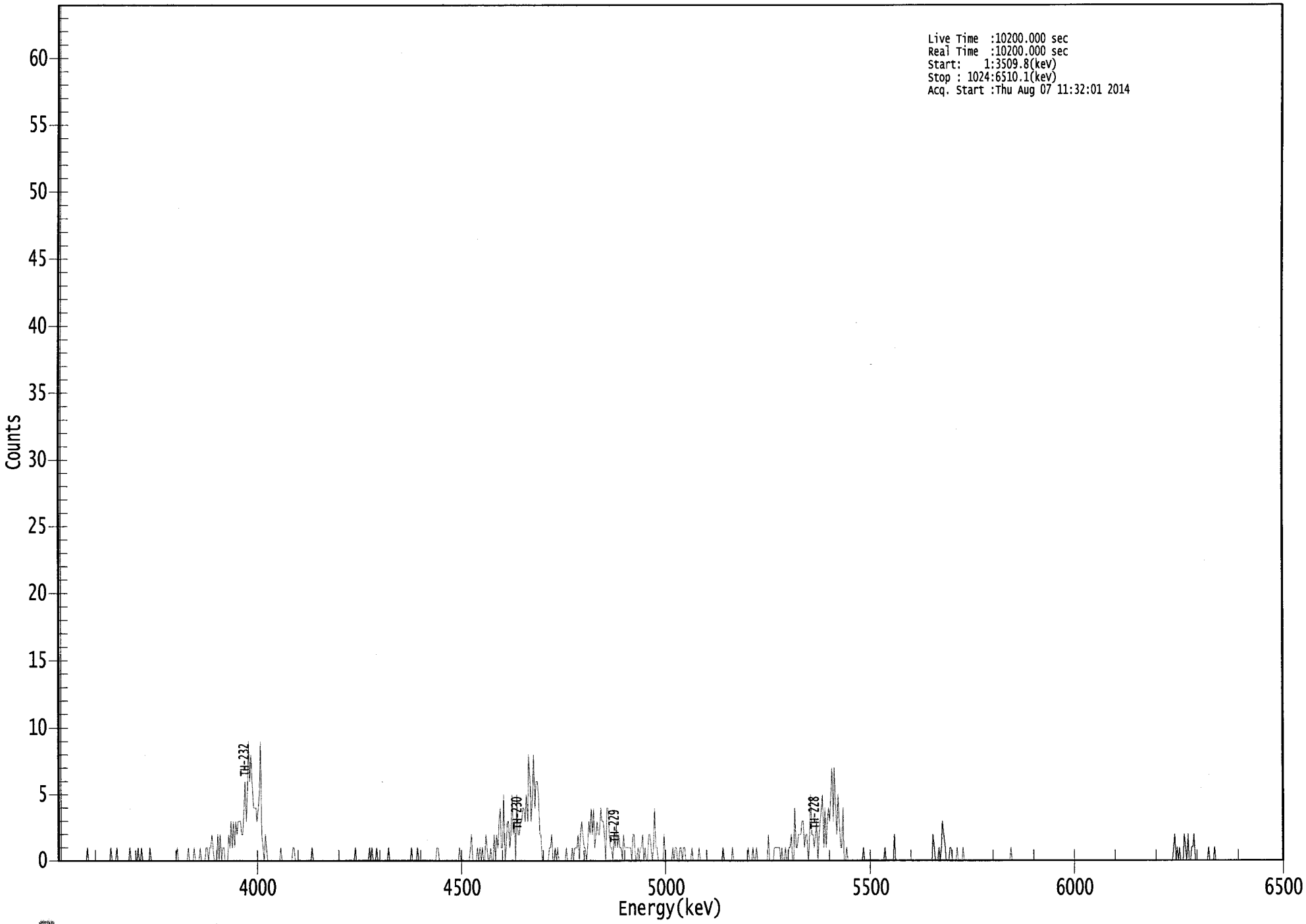
T = Tracer Peak used for Effective Efficiency

NUCLIDE ANALYSIS RESULTS

Nuclide	Id Conf.	Energy (keV)	Activity (uCi/mL)	MDA (uCi/mL)
TH-227	0.944	5850.00*	1.02E-007 +/- 1.69E-007	2.95E-007 +/- 5.64E-008
TH-228	0.995	5400.00*	5.00E-006 +/- 1.32E-006	4.45E-007 +/- 8.53E-008
TH-229	1.000	4872.00*	4.80E-006 +/- 9.20E-007	2.98E-007 +/- 5.71E-008
TH-230	0.995	4672.00*	5.73E-006 +/- 1.46E-006	3.75E-007 +/- 7.19E-008
TH-232	0.996	3997.00*	5.41E-006 +/- 1.39E-006	2.66E-007 +/- 5.10E-008

AG 8/7/14

0000094368.CNF



WLLFOIA4312 - 001 - 0004157

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

Sample Title: 01

Elapsed Live time: 10200
Elapsed Real Time: 10200

Channel								
1:	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:	1	0	0	0	0	0	0	0
33:	0	0	0	0	0	0	0	0
41:	0	0	0	0	1	0	0	0
49:	0	1	0	0	0	0	0	0
57:	0	0	0	0	1	0	0	0
65:	0	0	0	1	0	0	1	0
73:	0	0	0	0	0	1	0	0
81:	0	0	0	0	0	0	0	0
89:	0	0	0	0	0	0	0	0
97:	0	0	0	0	1	0	0	0
105:	0	0	0	0	0	1	0	0
113:	0	0	1	0	0	0	0	1
121:	0	0	0	0	1	1	0	1
129:	1	2	1	0	0	0	2	0
137:	2	0	1	1	0	0	0	2
145:	1	3	1	3	1	3	2	3
153:	3	3	2	2	4	6	3	5
161:	9	6	8	6	4	4	4	3
169:	4	5	9	2	1	0	2	1
177:	0	0	0	0	0	0	0	0
185:	0	0	0	1	0	0	0	0
193:	0	0	0	0	0	1	1	0
201:	0	0	0	0	0	0	0	0
209:	0	0	0	0	0	1	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	1	0	0	0	0	0	0
257:	0	0	0	0	0	1	0	1
265:	0	0	0	1	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:	1	0	0	0	0	1	0	0
305:	0	0	0	0	0	0	0	0
313:	0	0	0	0	0	1	1	0
321:	0	0	0	0	0	0	0	0
329:	0	0	0	0	0	0	0	0
337:	1	0	0	0	0	0	0	0
345:	0	1	2	0	0	0	0	1
353:	0	1	0	1	0	0	2	1
361:	0	0	1	0	0	2	0	2

0065

369:	1	3	4	1	1	5	0	1

Sample Title: 01

Channel								
377:	3	3	1	2	5	2	3	0
385:	5	2	2	3	3	4	4	3
393:	5	3	8	6	3	5	8	4
401:	6	6	5	2	2	0	0	0
409:	0	0	0	1	1	2	0	0
417:	1	0	1	0	0	0	0	0
425:	0	1	0	0	0	0	1	0
433:	1	1	1	2	0	2	3	2
441:	1	1	0	1	3	2	4	2
449:	4	1	2	3	2	2	4	3
457:	3	2	0	4	4	2	1	1
465:	0	2	1	3	1	2	1	1
473:	0	2	1	1	1	1	1	1
481:	0	2	2	0	0	1	0	1
489:	1	2	0	1	0	0	2	2
497:	1	0	1	4	1	1	0	0
505:	0	0	0	2	0	0	0	0
513:	0	0	1	0	1	1	0	0
521:	1	1	0	1	1	0	0	0
529:	0	0	1	0	0	0	0	0
537:	1	0	0	0	0	0	0	0
545:	0	0	0	0	0	0	0	0
553:	0	0	0	0	1	0	0	0
561:	0	0	0	0	1	0	0	0
569:	0	0	0	0	0	0	0	0
577:	0	1	0	0	0	1	0	0
585:	1	0	0	0	0	0	0	0
593:	0	0	2	0	0	0	0	1
601:	1	1	1	1	0	1	0	0
609:	1	0	0	1	1	2	0	0
617:	4	1	1	2	2	2	3	3
625:	1	2	2	0	1	5	2	2
633:	1	2	3	0	2	3	4	5
641:	1	4	1	3	4	3	5	7
649:	3	7	4	2	5	3	1	1
657:	4	0	0	1	0	0	0	0
665:	0	0	0	0	0	0	0	0
673:	0	1	0	0	0	0	0	0
681:	0	0	0	0	0	0	0	0
689:	0	0	0	1	0	0	0	0
697:	0	0	0	2	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	2	1	0	0	0
737:	1	0	1	3	2	1	0	0
745:	0	1	1	0	0	0	0	1
753:	0	0	0	0	1	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	1	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	1	2	0	1
937:	0	1	0	0	0	2	1	0
945:	2	0	0	1	1	2	0	0
953:	0	0	0	0	0	0	0	0
961:	0	1	0	0	0	0	1	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 8/7/14

Apex-Alpha™

Sample Description: BLANK
Spectrum File: \\OR-ALPHA1\Canberra\ApexAlpha\Root\Data\00000943
Batch Identification: 1407110A-TH
Sample Identification: 02
Sample Geometry: Shelf 2
Procedure Description: Th iso

Detector Name: Alpha_015
Chamber Serial Number:
Detector Serial Number: 15
Env. Background: System Bkgd 92963
Reagent Blank: <not performed>

Sample Size: 9.900E+008 +/- 0.000E+000 mL
Sample Date/Time: 8/7/2014 6:03:15 AM
Acquisition Date/Time: 8/7/2014 11:32:02 AM
Acquisition Live Time: 170.0 minutes
Acquisition Real Time: 170.0 minutes

Tracer Certificate: Th229_TH-18A
Tracer Quantity: 0.236 mL
Effective Efficiency: 0.1491 +/- 0.0137
Counting Efficiency: 0.1426 +/- 0.0026 on 1/11/2014 12:12:56 PM
Chem. Recovery Factor: 1.0456 +/- 0.0981

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		5.860	5.15	94.34	0.85	0.00E+000	3.0
TH-228		5.377	1.81	193.78	1.19	0.00E+000	3.0
TH-229	T	4.858	134.15	16.98	0.85	0.00E+000	4.5
TH-230		4.617	9.49	65.59	0.51	0.00E+000	3.0
TH-232		3.983	2.83	120.53	0.17	0.00E+000	3.0

T = Tracer Peak used for Effective Efficiency

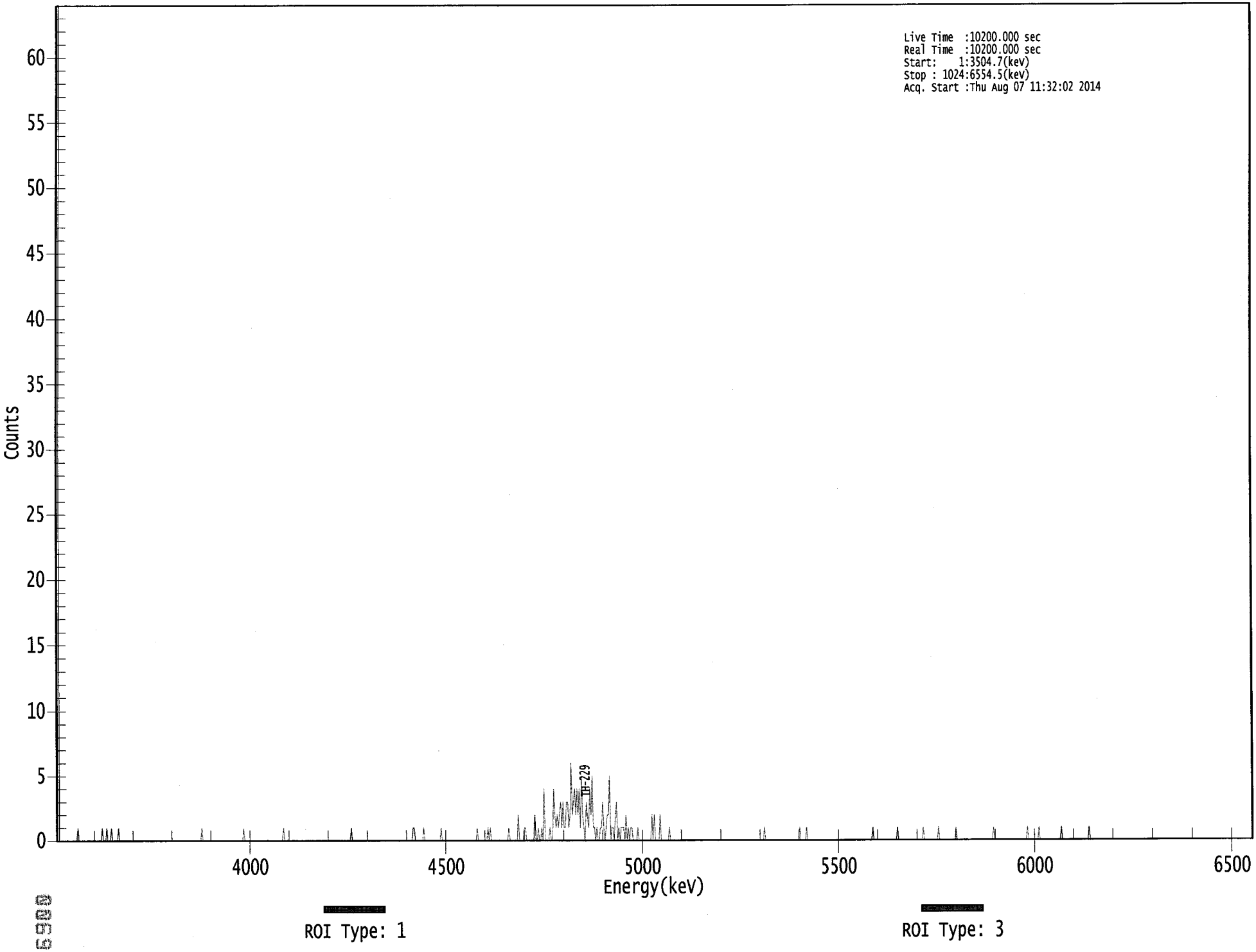
NUCLIDE ANALYSIS RESULTS

Nuclide	Id Conf.	Energy (keV)	Activity (uCi/mL)	MDA (uCi/mL)
TH-227	0.999	5850.00*	9.48E-017 +/- 9.11E-017	1.10E-016 +/- 1.99E-017
TH-228	0.997	5400.00*	3.25E-017 +/- 6.33E-017	1.18E-016 +/- 2.14E-017
TH-229	0.999	4872.00*	2.42E-015 +/- 4.36E-016	1.08E-016 +/- 1.95E-017
TH-230	0.984	4672.00*	1.71E-016 +/- 1.16E-016	9.44E-017 +/- 1.70E-017
TH-232	0.999	3997.00*	5.08E-017 +/- 6.19E-017	7.49E-017 +/- 1.35E-017

AG 8/7/14

0068

0000094369.CNF



WLLFOIA4312 - 001 - 0004162

****
***** 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	1	0	0	0	0	0
25:	0	0	0	0	0	0	0	0
33:	0	0	0	0	0	0	0	1
41:	0	0	0	1	0	0	0	1
49:	0	0	0	0	0	1	0	0
57:	0	0	0	0	0	0	0	0
65:	0	0	0	0	0	0	0	0
73:	0	0	0	0	0	0	0	0
81:	0	0	0	0	0	0	0	0
89:	0	0	0	0	0	0	0	0
97:	0	0	0	0	0	0	0	0
105:	0	0	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:	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	1	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	1	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	1	0	0
257:	0	0	0	0	0	0	0	0
265:	0	0	0	0	0	0	0	0
273:	0	0	0	0	0	0	0	0
281:	0	0	0	0	0	0	0	0
289:	0	0	0	0	0	0	0	0
297:	0	0	0	0	0	0	0	0
305:	0	0	1	1	0	0	0	0
313:	0	0	0	1	0	0	0	0
321:	0	0	0	0	0	0	0	0
329:	0	0	1	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	1	0	0	0	0	0	0

0070

369:	0	0	1	0	1	0	0	0

Sample Title: 02

Channel								
377:	0	0	0	0	0	0	0	0
385:	0	0	0	0	1	0	0	0
393:	0	0	0	0	2	0	0	0
401:	0	1	1	0	0	0	0	0
409:	0	0	2	0	0	1	0	0
417:	1	0	4	0	0	0	0	1
425:	0	0	4	2	1	2	1	2
433:	3	1	3	1	1	3	3	1
441:	2	6	2	3	4	2	4	2
449:	4	1	5	2	1	0	3	2
457:	1	4	2	5	1	1	0	1
465:	0	0	1	1	3	1	0	1
473:	2	2	5	0	1	1	0	2
481:	3	0	1	0	1	1	1	0
489:	2	0	1	0	1	1	0	0
497:	0	0	1	0	0	0	0	0
505:	0	0	0	0	0	0	2	0
513:	2	0	0	0	0	2	0	0
521:	0	0	0	0	0	1	0	0
529:	0	0	0	0	0	0	0	0
537:	0	0	0	0	0	0	0	0
545:	0	0	0	0	0	0	0	0
553:	0	0	0	0	0	0	0	0
561:	0	0	0	0	0	0	0	0
569:	0	0	0	0	0	0	0	0
577:	0	0	0	0	0	0	0	0
585:	0	0	0	0	0	0	0	0
593:	0	0	0	0	0	0	0	0
601:	0	0	0	0	0	0	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	0	1	0	0	0
641:	0	0	1	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	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	0
721:	1	0	0	0	0	0	0	0
729:	0	0	0	0	0	0	0	0
737:	0	0	0	0	0	0	1	0
745:	0	0	0	0	0	0	0	0
753:	0	0	0	1	0	0	0	0
761:	0	0	0	0	0	0	0	0
769:	0	0	1	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	1	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	1
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	1	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	1	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™

KB 8/7/14

Sample Description: OUTSIDE TRAILER-DUP
Spectrum File: \\OR-ALPHA1\Canberra\ApexAlpha\Root\Data\00000943
Batch Identification: 1407110A-TH
Sample Identification: 03
Sample Geometry: Shelf 2
Procedure Description: Th iso

Detector Name: Alpha_024
Chamber Serial Number:
Detector Serial Number: 24
Env. Background: System Bkgd 92964
Reagent Blank: <not performed>

Sample Size: 7.800E+008 +/- 0.000E+000 mL
Sample Date/Time: 7/18/2014 6:03:15 AM
Acquisition Date/Time: 8/7/2014 11:42:19 AM
Acquisition Live Time: 170.0 minutes
Acquisition Real Time: 170.0 minutes

Tracer Certificate: Th229_TH-18A
Tracer Quantity: 0.235 mL
Effective Efficiency: 0.1750 +/- 0.0151
Counting Efficiency: 0.1680 +/- 0.0030 on 1/11/2014 3:23:39 PM
Chem. Recovery Factor: 1.0417 +/- 0.0915

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		5.829	3.13	144.40	1.87	0.00E+000	3.1
TH-228		5.351	5.43	111.88	3.57	0.00E+000	3.1
TH-229	T	4.875	157.30	15.73	1.70	0.00E+000	5.5
TH-230		4.643	17.47	49.24	1.53	0.00E+000	3.9
TH-232		3.951	12.66	55.94	0.34	0.00E+000	3.1

T = Tracer Peak used for Effective Efficiency

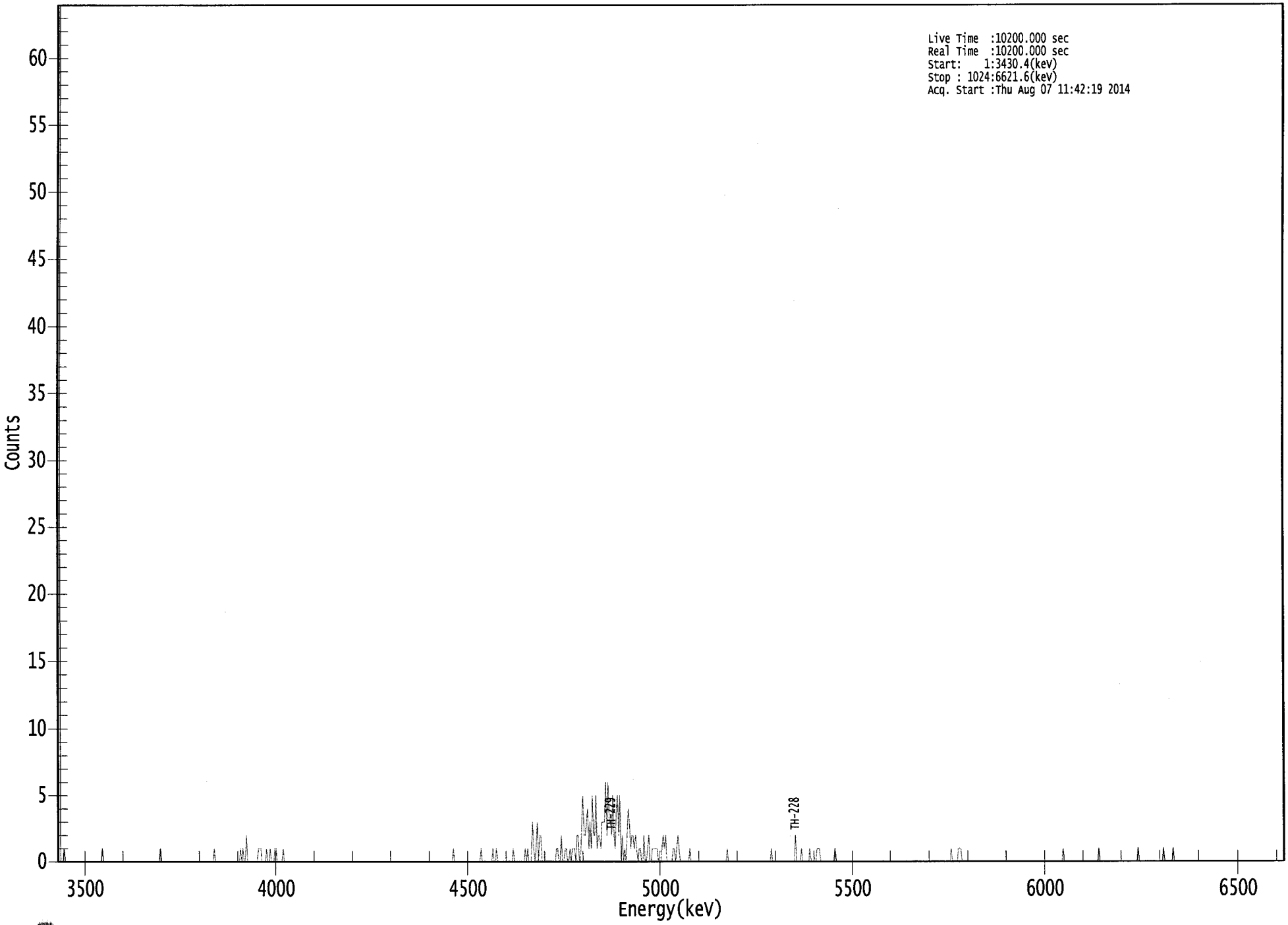
NUCLIDE ANALYSIS RESULTS

Nuclide	Id Conf.	Energy (keV)	Activity (uCi/mL)	MDA (uCi/mL)
TH-227	0.998	5850.00*	6.24E-017 +/- 9.08E-017	1.51E-016 +/- 2.55E-017
TH-228	0.988	5400.00*	1.08E-016 +/- 1.22E-016	1.87E-016 +/- 3.15E-017
TH-229	1.000	4872.00*	3.07E-015 +/- 5.17E-016	1.43E-016 +/- 2.42E-017
TH-230	0.996	4672.00*	3.40E-016 +/- 1.77E-016	1.38E-016 +/- 2.33E-017
TH-232	0.989	3997.00*	2.46E-016 +/- 1.44E-016	9.28E-017 +/- 1.56E-017

AG 8/7/14

0073

0000094385.CNF



WLLFOIA4312 - 001 - 0004167

****
***** 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	1	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	1	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	1	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	1	0	0	0	0
137:	0	0	0	0	0	0	0	0
145:	0	0	0	0	0	0	0	0
153:	0	1	0	1	0	0	2	0
161:	0	0	0	0	0	0	0	0
169:	1	1	1	0	0	0	0	1
177:	0	0	1	0	0	0	1	1
185:	0	0	0	0	0	1	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	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	1	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	1	0	0	1

0075

369:	0	0	0	0	0	0	0	0

Sample Title: 03

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

0076

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	0	0	0	0	0	0
825:	0	0	0	0	0	0	0	0
833:	0	0	0	0	0	0	0	1
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	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	1	0
905:	0	0	0	0	0	0	0	0
913:	0	0	0	0	0	0	0	0
921:	0	0	0	1	0	0	0	0
929:	0	0	0	1	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

KB 8/7/14

Apex-Alpha™

Sample Description: OUTSIDE TRAILER
Spectrum File: \\OR-ALPHA1\Canberra\ApexAlpha\Root\Data\00000943
Batch Identification: 1407110A-TH
Sample Identification: 04
Sample Geometry: Shelf 2
Procedure Description: Th iso

Detector Name: Alpha_025
Chamber Serial Number:
Detector Serial Number: 25
Env. Background: System Bkgd 92965
Reagent Blank: <not performed>

Sample Size: 7.800E+008 +/- 0.000E+000 mL
Sample Date/Time: 7/18/2014 6:03:15 AM
Acquisition Date/Time: 8/7/2014 11:42:20 AM
Acquisition Live Time: 170.0 minutes
Acquisition Real Time: 170.0 minutes

Tracer Certificate: Th229_TH-18A
Tracer Quantity: 0.235 mL
Effective Efficiency: 0.1875 +/- 0.0156
Counting Efficiency: 0.1767 +/- 0.0031 on 1/11/2014 3:20:19 PM
Chem. Recovery Factor: 1.0609 +/- 0.0903

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		5.847	2.47	163.78	1.53	0.00E+000	6.3
TH-228		5.358	12.98	56.85	1.02	0.00E+000	3.1
TH-229	T	4.862	168.15	15.16	0.85	0.00E+000	4.3
TH-230		4.630	19.83	44.23	0.17	0.00E+000	3.9
TH-232		3.961	19.32	45.50	0.68	0.00E+000	3.1

T = Tracer Peak used for Effective Efficiency

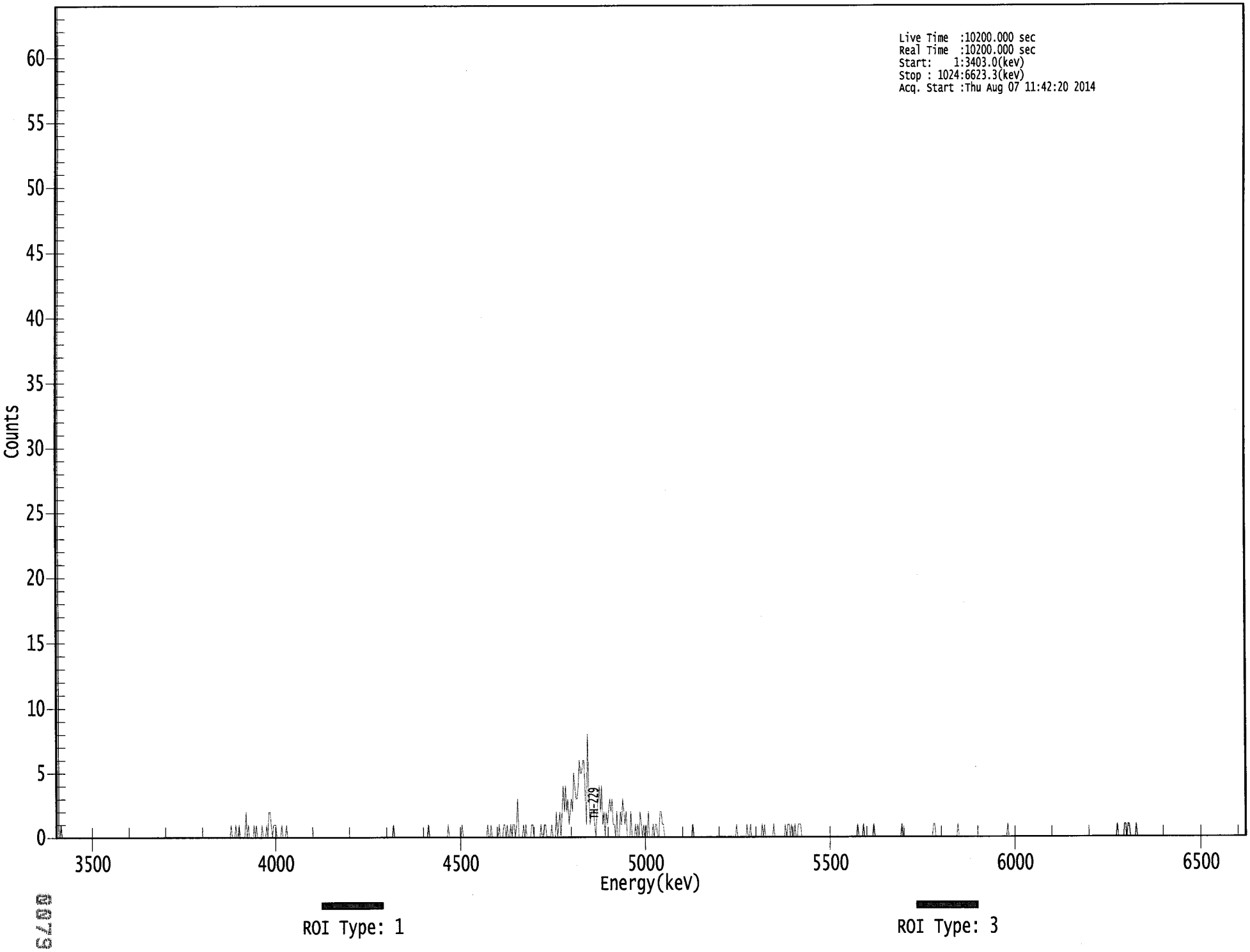
NUCLIDE ANALYSIS RESULTS

Nuclide	Id Conf.	Energy (keV)	Activity (uCi/mL)	MDA (uCi/mL)
TH-227	1.000	5850.00*	4.60E-017 +/- 7.57E-017	1.32E-016 +/- 2.16E-017
TH-228	0.991	5400.00*	2.40E-016 +/- 1.42E-016	1.17E-016 +/- 1.90E-017
TH-229	0.999	4872.00*	3.06E-015 +/- 5.00E-016	1.09E-016 +/- 1.78E-017
TH-230	0.991	4672.00*	3.60E-016 +/- 1.70E-016	7.58E-017 +/- 1.24E-017
TH-232	0.993	3997.00*	3.50E-016 +/- 1.69E-016	1.02E-016 +/- 1.67E-017

AG 8/7/14

0078

0000094386.CNF



WLLFOIA4312 - 001 - 0004172

****
***** 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:	10200	10200	0	0	1	0	0	0
9:	0	0	0	0	0	0	0	0
17:	0	0	0	0	0	0	0	0
25:	0	0	0	0	0	0	0	0
33:	0	0	0	0	0	0	0	0
41:	0	0	0	0	0	0	0	0
49:	0	0	0	0	0	0	0	0
57:	0	0	0	0	0	0	0	0
65:	0	0	0	0	0	0	0	0
73:	0	0	0	0	0	0	0	0
81:	0	0	0	0	0	0	0	0
89:	0	0	0	0	0	0	0	0
97:	0	0	0	0	0	0	0	0
105:	0	0	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	1
153:	0	0	0	1	0	0	1	0
161:	0	0	0	0	2	0	1	0
169:	0	0	0	1	0	1	0	0
177:	0	0	1	0	0	0	1	0
185:	2	2	1	0	1	1	1	0
193:	0	0	0	1	0	0	0	1
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	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	1	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	1	0	0	0	0	0	0
329:	0	0	0	0	0	0	0	0
337:	0	0	1	0	0	0	0	0
345:	0	0	0	0	0	0	1	0
353:	0	0	0	0	0	0	0	0
361:	0	0	0	0	0	0	0	0

0080

369:	0	0	0	0	1	0	0	1

Sample Title: 04

Channel								
377:	0	0	0	0	0	0	1	0
385:	0	0	1	1	0	1	0	0
393:	1	0	1	1	0	1	3	0
401:	0	0	0	1	0	1	0	0
409:	0	0	1	1	0	0	0	0
417:	0	0	1	0	0	1	1	0
425:	0	0	0	1	0	0	0	2
433:	0	1	2	0	2	4	2	4
441:	2	3	1	2	3	2	5	4
449:	3	3	4	6	5	5	6	6
457:	3	1	8	3	1	2	2	2
465:	1	0	2	3	4	2	4	1
473:	2	0	2	1	2	3	2	3
481:	1	1	0	2	0	0	2	1
489:	3	2	1	2	0	0	0	2
497:	0	0	0	1	0	1	0	2
505:	1	0	1	0	1	0	2	0
513:	0	0	1	0	1	1	0	0
521:	2	2	1	1	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	1	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	1	0	0	0	0	0
593:	0	0	0	1	0	0	1	0
601:	0	0	0	0	0	0	0	0
609:	1	0	1	0	0	0	0	0
617:	0	0	1	0	0	0	0	0
625:	0	0	0	0	1	0	1	1
633:	0	1	0	0	1	0	0	1
641:	1	1	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	1	0	0	0	0	1
697:	0	0	0	0	0	0	0	0
705:	1	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:	1	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	1	1	0	0	0
761:	0	0	0	0	0	0	0	0
769:	0	0	0	0	0	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	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	1	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	1	0	0	0	0	0	1
921:	1	0	1	1	0	0	0	0
929:	0	1	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™

RB 8/12/14

Sample Description: TRANSFER STATION
Spectrum File: \\OR-ALPHA1\Canberra\ApexAlpha\Root\Data\00000943
Batch Identification: 1407110A-TH
Sample Identification: 05
Sample Geometry: Shelf 2
Procedure Description: Th iso

Detector Name: Alpha_029
Chamber Serial Number:
Detector Serial Number: 29
Env. Background: System Bkgd 92966
Reagent Blank: <not performed>

Sample Size: 1.410E+009 +/- 0.000E+000 mL
Sample Date/Time: 7/18/2014 6:03:15 AM
Acquisition Date/Time: 8/7/2014 11:42:21 AM
Acquisition Live Time: 170.0 minutes
Acquisition Real Time: 170.0 minutes

Tracer Certificate: Th229_TH-18A
Tracer Quantity: 0.235 mL
Effective Efficiency: 0.1328 +/- 0.0129
Counting Efficiency: 0.1880 +/- 0.0033 on 1/11/2014 3:20:19 PM
Chem. Recovery Factor: 0.7067 +/- 0.0698

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		5.898	1.15	249.59	0.85	0.00E+000	3.1
TH-228		5.370	34.30	34.42	1.70	0.00E+000	3.9
TH-229	T	4.847	119.47	18.07	1.53	0.00E+000	3.8
TH-230		4.631	45.83	29.01	0.17	0.00E+000	4.6
TH-232		3.948	33.66	33.98	0.34	0.00E+000	3.9

T = Tracer Peak used for Effective Efficiency

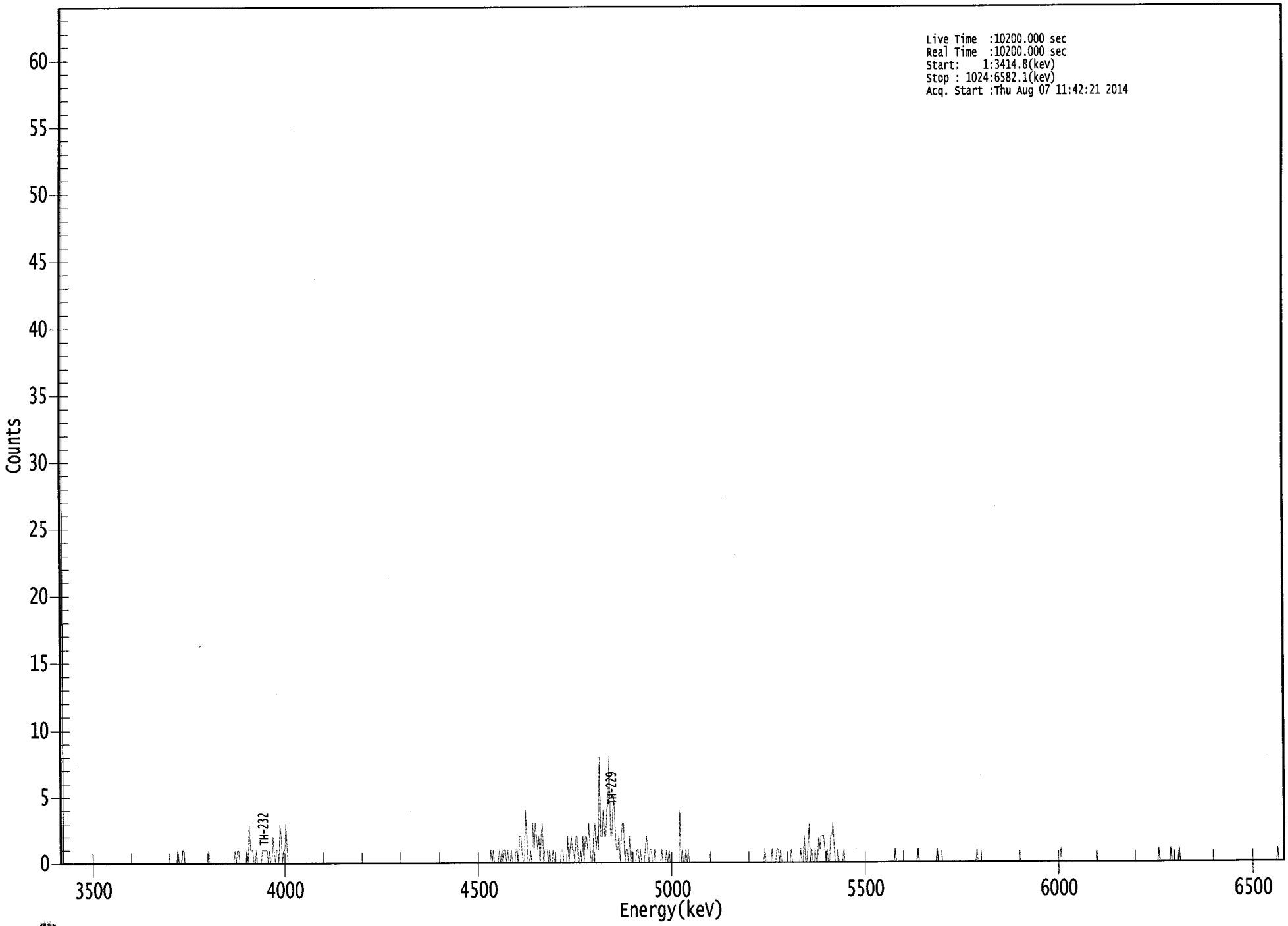
NUCLIDE ANALYSIS RESULTS

Nuclide	Id Conf.	Energy (keV)	Activity (uCi/mL)	MDA (uCi/mL)
TH-227	0.988	5850.00*	1.67E-017 +/- 4.18E-017	8.70E-017 +/- 1.66E-017
TH-228	0.995	5400.00*	4.95E-016 +/- 1.95E-016	1.06E-016 +/- 2.02E-017
TH-229	0.997	4872.00*	1.70E-015 +/- 3.24E-016	1.01E-016 +/- 1.93E-017
TH-230	0.991	4672.00*	6.49E-016 +/- 2.25E-016	5.91E-017 +/- 1.13E-017
TH-232	0.988	3997.00*	4.76E-016 +/- 1.86E-016	6.76E-017 +/- 1.29E-017

AG 8/7/14

0083

0000094387.CNF



WLLFOIA4312 - 001 - 0004177

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

Sample Title: 05

Elapsed Live time: 10200
Elapsed Real Time: 10200

Channel								
1:	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	0	0
81:	0	0	0	0	0	0	0	0
89:	0	0	0	0	0	0	0	0
97:	0	0	0	1	0	0	0	1
105:	1	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:	0	0	0	0	0	0	0	0
145:	0	0	0	1	0	1	1	0
153:	0	0	0	0	0	1	0	3
161:	1	1	1	0	0	1	0	0
169:	0	0	1	1	1	1	1	0
177:	1	0	0	2	1	0	1	1
185:	0	3	2	0	1	1	3	1
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	0
257:	0	0	0	0	0	0	0	0
265:	0	0	0	0	0	0	0	0
273:	0	0	0	0	0	0	0	0
281:	0	0	0	0	0	0	0	0
289:	0	0	0	0	0	0	0	0
297:	0	0	0	0	0	0	0	0
305:	0	0	0	0	0	0	0	0
313:	0	0	0	0	0	0	0	0
321:	0	0	0	0	0	0	0	0
329:	0	0	0	0	0	0	0	0
337:	0	0	0	0	0	0	0	0
345:	0	0	0	0	0	0	0	0
353:	0	0	0	0	0	0	0	0
361:	0	1	0	1	0	0	0	0

0085

369:	1	0	1	0	1	1	0	1

Sample Title: 05

Channel								
377:	0	0	1	0	0	0	1	1
385:	0	2	2	1	0	0	4	2
393:	0	0	1	0	3	1	3	2
401:	1	2	0	2	3	0	1	1
409:	1	0	1	0	0	1	0	0
417:	0	0	0	0	1	1	0	0
425:	0	2	0	1	2	1	1	0
433:	2	2	0	0	1	0	2	0
441:	2	2	1	3	1	0	0	2
449:	3	1	2	1	8	2	2	4
457:	2	2	4	5	8	2	2	4
465:	5	2	1	1	2	0	2	3
473:	3	0	1	1	0	2	0	1
481:	0	0	0	1	1	0	1	0
489:	0	0	1	2	1	0	1	1
497:	0	0	1	0	0	0	0	0
505:	1	0	0	0	1	0	1	0
513:	0	0	0	0	0	0	0	4
521:	0	1	0	0	1	0	1	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	1	0
593:	0	0	0	0	1	0	0	0
601:	1	1	0	1	0	0	0	0
609:	0	0	0	0	1	0	0	0
617:	0	0	0	0	1	0	0	2
625:	0	0	1	3	0	1	0	0
633:	1	0	0	2	1	2	2	2
641:	1	0	1	0	0	2	2	3
649:	1	0	0	1	0	0	0	0
657:	1	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	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	1	0
721:	0	0	0	0	0	0	0	0
729:	0	0	0	0	0	0	1	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	1
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: 05

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	1	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	1
921:	0	0	0	0	0	0	0	0
929:	0	1	0	0	0	0	0	0
937:	1	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	1	0	0	0	0	0	0

8/7/2014 5:33:51 AM

Apex-Alpha™

QA SUMMARY REPORT

Review Of QA Results - Pulser Check

Date : 8/7/2014
Time : 5:33:51 AM

CHAMBER	DEVICE	PARAMETER	FLAG	DATE
Alpha_001	21f	ALL	Not Done	
Alpha_002	21f	ALL	Not Done	
Alpha_003	21f	ALL	Passed	8/7/2014 5:18:35 AM
Alpha_004	21f	ALL	Passed	8/7/2014 5:18:36 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	8/7/2014 5:18:37 AM
Alpha_011	21f	ALL	Passed	8/7/2014 5:18:38 AM
Alpha_012	21f	ALL	Passed	8/7/2014 5:18:38 AM
Alpha_013	21f	ALL	Not Done	
Alpha_014	21f	ALL	Passed	8/7/2014 5:18:39 AM
Alpha_015	21f	Peak FWHM	Action	8/7/2014 5:18:40 AM
Alpha_016	21f	ALL	Not Done	
Alpha_017	AIM730	ALL	Not Done	
Alpha_018	AIM730	ALL	Not Done	
Alpha_019	AIM730	ALL	Not Done	
Alpha_020	AIM730	ALL	Not Done	
Alpha_021	AIM730	ALL	Not Done	
Alpha_022	AIM730	ALL	Not Done	
Alpha_023	AIM730	ALL	Not Done	
Alpha_024	AIM730	ALL	Passed	8/7/2014 5:18:41 AM
Alpha_025	AIM730	ALL	Passed	8/7/2014 5:18:42 AM
Alpha_026	AIM730	ALL	Not Done	
Alpha_027	AIM730	ALL	Not Done	
Alpha_028	AIM730	ALL	Not Done	
Alpha_029	AIM730	ALL	Passed	8/7/2014 5:18:43 AM
Alpha_030	AIM730	ALL	Not Done	
Alpha_031	AIM730	ALL	Passed	8/7/2014 5:18:43 AM
Alpha_032	AIM730	ALL	Not Done	
Alpha_033	Alpha Analyst100DC	Peak CPS	Action	8/6/2014 5:25:03 AM
Alpha_034	Alpha Analyst100DC	ALL	Passed	8/7/2014 5:18:46 AM
Alpha_035	Alpha Analyst100DC	ALL	Not Done	
Alpha_036	Alpha Analyst100DC	ALL	Not Done	
Alpha_037	Alpha Analyst100DC	ALL	Passed	8/7/2014 5:18:48 AM
Alpha_038	Alpha Analyst100DC	ALL	Passed	8/7/2014 5:18:49 AM
Alpha_039	Alpha Analyst100DC	ALL	Passed	8/7/2014 5:18:51 AM
Alpha_040	Alpha Analyst100DC	ALL	Passed	8/7/2014 5:18:54 AM
Alpha_041	Alpha Analyst100DC	ALL	Passed	8/7/2014 5:18:55 AM
Alpha_042	Alpha Analyst100DC	ALL	Passed	8/7/2014 5:18:58 AM

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Review of QA Results - Pulser Check

8/7/2014 5:33:51 AM

CHAMBER	DEVICE	PARAMETER	FLAG	DATE
Alpha_043	Alpha Analyst100DC	ALL	Passed	8/7/2014 5:19:00 AM
Alpha_044	Alpha Analyst100DC	ALL	Passed	8/7/2014 5:19:02 AM
Alpha_045	Alpha Analyst100DC	ALL	Passed	8/7/2014 5:19:05 AM
Alpha_046	Alpha Analyst100DC	ALL	Passed	8/7/2014 5:19:07 AM
Alpha_047	Alpha Analyst100DC	ALL	Passed	8/7/2014 5:19:10 AM
Alpha_048	Alpha Analyst100DC	ALL	Passed	8/7/2014 5:19:13 AM

APPROVED BY: _____

APPROVAL DATE: 8/7/14

****
***** 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 IX

ANALYTICAL DATA (GROSS ALPHA/BETA)

WLLFOIA4312 - 001 - 0004184

14-07110
GaGbT_ThSr
Run 1

Work Order	14-07110
Analysis Code	GaGbT_ThSr
Run	1
Date Received	7/21/2014
Lab Deadline	8/11/2014
Client	Feezor Engineering, Inc.
Project	FEEBRI
Report Level	4
Activity Units	uCi
Aliquot Units	ml
Matrix	AF
Method	LANL MLR-100 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		07/21/14 00:00	1.0000E+00
02	MBL	BLANK		07/21/14 00:00	3.7100E+08
03	DUP	OUTSIDE TRAILER	26	07/18/14 08:40	3.9000E+08
04	DO	OUTSIDE TRAILER	26	07/18/14 08:40	3.9000E+08
05	TRG	TRANSFER STATION	31	07/18/14 09:00	3.5300E+08

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.

14-07110
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		7.6333	7.6336	0.0003			1.00	1.00
02	MBL				0.00		7.5930	7.5933	0.0003			1.00	1.00
03	DUP				0.00		1.0000	1.0001	0.0001			1.00	1.00
04	DO				0.00		1.0000	1.0001	0.0001			1.00	1.00
05	TRG				0.00		1.0000	1.0001	0.0001			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.

14-07110
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			08/04/14 06:38	JWOLFE				
02	MBL			08/04/14 06:38	JWOLFE				
03	DUP			08/04/14 06:38	JWOLFE				
04	DO			08/04/14 06:38	JWOLFE				
05	TRG			08/04/14 06:38	JWOLFE				

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 - 0004187

Eberline Services
Oak Ridge Laboratory

Preliminary Data Report & Analytical Calculations

Work Order: 14-07110-GaGbT-1

Client: Feezor Engineering, Inc.
Eberline Services Work Order: 14-07110
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	uCi/ml	2.81E-04	3.79E-06	3.99E-08	2.48E-04	113.44	OK		INV	
02	GROSS ALPHA	MBL	BLANK	uCi/ml	4.28E-16	3.43E-16	6.05E-16					OK	OK
03	GROSS ALPHA	DUP	OUTSIDE TRAILER	uCi/ml	4.15E-15	7.76E-16	5.82E-16				NA	OK	
04	GROSS ALPHA	DO	OUTSIDE TRAILER	uCi/ml	4.67E-15	7.83E-16	1.02E-16					OK	
05	GROSS ALPHA	TRG	TRANSFER STATION	uCi/ml	2.99E-15	7.33E-16	7.86E-16					OK	

Preliminary Data Report & Analytical Calculations

Work Order: 14-07110-GaGbT-1

Client	Eberline Services Work Order	Analysis Code	Run
Feezor Engineering, Inc.	14-07110	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	07/21/14 00:00	1.00E+00	0.00	0.00	0.00	1.00		
02	GROSS ALPHA	MBL	07/21/14 00:00	3.71E+08	0.00	0.00	0.00	1.00		
03	GROSS ALPHA	DUP	07/18/14 08:40	3.90E+08	0.00	0.00	0.00	1.00		
04	GROSS ALPHA	DO	07/18/14 08:40	3.90E+08	0.00	0.00	0.00	1.00		
05	GROSS ALPHA	TRG	07/18/14 09:00	3.53E+08	0.00	0.00	0.00	1.00		

0090

Preliminary Data Report & Analytical Calculations

Work Order: 14-07110-GaGbT-1

Client	Eberline Services Work Order	Analysis Code	Run
Feezor Engineering, Inc.	14-07110	GaGbT	1

Lab Fraction	Nuclide	Sample Desc	Counting Date/Time	Halflife (days)	Detect	Carrier	Count Time	Counts	Bkg CPM	Eff
01	GROSS ALPHA	LCS	08/04/14 07:27		LB4110A	B1	120	21132	0	0.2821
02	GROSS ALPHA	MBL	08/04/14 07:27		LB4110A	B2	120	18	0.05	0.2835
03	GROSS ALPHA	DUP	08/04/14 07:27		LB4110A	B3	120	127	0.05	0.2804
04	GROSS ALPHA	DO	08/04/14 09:31		LB4110A	B1	120	137	0	0.2821
05	GROSS ALPHA	TRG	08/04/14 07:27		LB4110A	B4	120	90	0.083333333	0.2843

Preliminary Data Report & Analytical Calculations

Work Order: 14-07110-GaGbT-1

Run: 1
Analysis Code: GaGbT
Eberline Services Work Order: 14-07110
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	GROSS BETA	LCS	LCS	uCi/ml	2.78E-04	3.11E-06	6.51E-07	2.78E-04	100.01	OK		INV	
02	GROSS BETA	MBL	BLANK	uCi/ml	-8.25E-17	7.84E-16	1.68E-15					OK	OK
03	GROSS BETA	DUP	OUTSIDE TRAILER	uCi/ml	2.10E-14	1.50E-15	1.60E-15				OK	OK	
04	GROSS BETA	DO	OUTSIDE TRAILER	uCi/ml	2.29E-14	1.56E-15	1.67E-15					OK	
05	GROSS BETA	TRG	TRANSFER STATION	uCi/ml	1.87E-14	1.56E-15	1.94E-15					OK	

Preliminary Data Report & Analytical Calculations

Work Order: 14-07110-GaGbT-1

Client	Eberline Services Work Order	Analysis Code	Run
Feezor Engineering, Inc.	14-07110	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 BETA	LCS	07/21/14 00:00	1.00E+00	0.00	0.00	0.00	1.00		
02	GROSS BETA	MBL	07/21/14 00:00	3.71E+08	0.00	0.00	0.00	1.00		
03	GROSS BETA	DUP	07/18/14 08:40	3.90E+08	0.00	0.00	0.00	1.00		
04	GROSS BETA	DO	07/18/14 08:40	3.90E+08	0.00	0.00	0.00	1.00		
05	GROSS BETA	TRG	07/18/14 09:00	3.53E+08	0.00	0.00	0.00	1.00		

Preliminary Data Report & Analytical Calculations

Work Order: 14-07110-GaGbT-1

Client	Eberline Services Work Order	Analysis Code	Run
Feezor Engineering, Inc.	14-07110	GaGbT	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	08/04/14 07:27		LB4110A	B1	120	41268	1.666666667	0.4817	298.51903
02	GROSS BETA	MBL	08/04/14 07:27		LB4110A	B2	120	186	1.583333333	0.4903	1.55
03	GROSS BETA	DUP	08/04/14 07:27		LB4110A	B3	120	1233	1.45	0.4703	10.00681833
04	GROSS BETA	DO	08/04/14 09:31		LB4110A	B1	120	1382	1.666666667	0.4817	11.22736833
05	GROSS BETA	TRG	08/04/14 07:27		LB4110A	B4	120	1096	1.866666667	0.484	8.943283333

Count Room Report
Client: Feezor Engineering, Inc.

14-07110-GaGbT_ThSr-1 (uCi/ml) in AF
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	07/21/14 00:00	1.0000				0.00	1.00	1.00
02	MBL	BLANK	07/21/14 00:00	371000000.0000				0.00	1.00	1.00
03	DUP	OUTSIDE TRAILER	07/18/14 08:40	390000000.0000				0.00	1.00	1.00
04	DO	OUTSIDE TRAILER	07/18/14 08:40	390000000.0000				0.00	1.00	1.00
05	TRG	TRANSFER STATION	07/18/14 09:00	353000000.0000				0.00	1.00	1.00

WLLFOIA4312 - 001 - 0004194

Eberline Services
Oak Ridge Laboratory

Spike and Tracer Worksheet

Printed: 8/4/2014 6:38 AM

Internal Work Order	Run	Analysis Code	Date	Technician	Technician Initials	Witness Initials
14-07110	1	GaGbT_ThSr	8/4/2014 6:38	JWOLFE	JW	

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	597.155	8/4/2014	**0.790**	**0.9215**				247.87	10.659	0.00	0.000	0.00	0.000	0.00	0.000
SrY-90	A/B-07	668.712	8/4/2014	**0.820**	**0.9215**				277.58	8.327	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*

Balance Printer Tapes

Tracer	LCS

Matrix Spike

Version 2.0 08/99

WLLFOIA4312 - 001 - 0004195

Eberline Analytical
Oak Ridge Laboratory

Aliquot Worksheet

Work Order	Run	Analysis Code	Rpt Units	Lab Deadline	Technician
14-07110	1	GaGbT_ThSr	ml	8/11/2014	JWOLFE

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					3.7100E+08	3.7100E+08				
03	OUTSIDE TRAILER	DUP					3.9000E+08	3.9000E+08				
04	OUTSIDE TRAILER	DO					3.9000E+08	3.9000E+08				
05	TRANSFER STATION	TRG					3.5300E+08	3.5300E+08				

Comments	

Technician: JWolfe Date: 8/4/14

WLLFOIA4312 - 001 - 0004196

Eberline Services - Oak Ridge
Version 1.0 9/1999

Gravimetric Worksheet

Work Order	Run	Analysis Code	Gravimetric Carrier	Carrier Conc (mg/ml)	Technician
14-07110	1	GaGbT_ThSr			JWOLFE

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		7.6333	7.6336	**0.0003**	
02	BLANK	MBL		7.5930	7.5933	**0.0003**	
03	DUP	DUP		1.0000	1.0001	**0.0001**	
04	OUTSIDE TRAILER	DO		1.0000	1.0001	**0.0001**	
05	TRANSFER STATION	TRG		1.0000	1.0001	**0.0001**	

Technician: JWolfe Date: 8/4/14

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A

Detector ID	Sample ID	Alpha	Beta	Count Time	Voltage	TOD
B1	1407110-01	21132	41268	120	1400	8/4/14 9:27
B2	1407110-02	18	186	120	1400	8/4/14 9:27
B3	1407110-03	127	1233	120	1400	8/4/14 9:27
B4	1407110-05	90	1096	120	1400	8/4/14 9:27

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A

Detector ID	Sample ID	Alpha	Beta	Count Time	Voltage	TOD
B1	1407110-04	137	1382	120	1400	8/4/14 11:31

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GPC Detector Report
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Detector	Alpha/Beta	Calibration Date	Count Date	Bkg CPM	PFW	LCL	Mean	UCL
LB4110A - A1	Alpha	11/18/2007	8/4/2014	5.00E-02	P	-1.98E+01	2.49E-01	2.03E+01
LB4110A - A2	Alpha	11/18/2007	8/4/2014	3.33E-02	P	-1.68E+01	2.25E-01	1.72E+01
LB4110A - A3	Alpha	11/18/2007	8/4/2014	5.00E-02	P	-1.63E+01	1.95E-01	1.67E+01
LB4110A - A4	Alpha	11/18/2007	8/4/2014	6.67E-02	P	-1.74E+01	2.09E-01	1.78E+01
LB4110A - B1	Alpha	11/18/2007	8/4/2014	0.00E+00	P	-9.29E-02	7.26E-02	2.38E-01
LB4110A - B2	Alpha	11/18/2007	8/4/2014	5.00E-02	P	-7.33E-02	7.27E-02	2.19E-01
LB4110A - B3	Alpha	11/18/2007	8/4/2014	5.00E-02	P	-6.16E-02	5.43E-02	1.70E-01
LB4110A - B4	Alpha	11/18/2007	8/4/2014	8.33E-02	P	-1.31E-01	7.75E-02	2.86E-01
LB4110A - C1	Alpha	11/18/2007	8/4/2014	6.67E-02	P	-1.39E-01	8.71E-02	3.13E-01
LB4110A - C2	Alpha	11/18/2007	8/4/2014	6.67E-02	P	-1.68E-01	8.13E-02	3.31E-01
LB4110A - C3	Alpha	11/18/2007	8/4/2014	1.67E-02	P	-1.64E-01	9.51E-02	3.54E-01
LB4110A - C4	Alpha	11/18/2007	8/4/2014	1.67E-02	P	-6.39E-02	6.87E-02	2.01E-01
LB4110A - D1	Alpha	11/18/2007	8/4/2014	1.67E-02	P	-5.46E-02	8.12E-02	2.17E-01
LB4110A - D2	Alpha	11/18/2007	8/4/2014	1.67E-02	P	-7.07E-02	6.08E-02	1.92E-01
LB4110A - D3	Alpha	11/18/2007	8/4/2014	3.33E-02	P	-4.98E-02	6.87E-02	1.87E-01
LB4110A - D4	Alpha	11/18/2007	8/4/2014	1.67E-02	P	-6.80E-02	7.08E-02	2.10E-01
LB4110R - A1	Alpha	11/24/2006	8/4/2014	5.00E-02	P	-9.36E-02	9.85E-02	2.91E-01
LB4110R - A2	Alpha	11/24/2006	8/4/2014	1.67E-01	P	-8.65E-02	7.27E-02	2.32E-01
LB4110R - A3	Alpha	11/24/2006	8/4/2014	6.67E-02	P	-7.15E-02	8.07E-02	2.33E-01
LB4110R - A4	Alpha	11/24/2006	8/4/2014	3.33E-02	P	-5.21E-02	6.91E-02	1.90E-01
LB4110R - B1	Alpha	11/24/2006	8/4/2014	8.33E-02	P	-9.06E-02	6.14E-02	2.14E-01
LB4110R - B2	Alpha	11/24/2006	8/4/2014	5.00E-02	P	-6.91E-02	6.03E-02	1.90E-01
LB4110R - B3	Alpha	11/24/2006	8/4/2014	5.00E-02	P	-6.51E-02	7.17E-02	2.09E-01
LB4110R - B4	Alpha	11/24/2006	8/4/2014	1.17E-01	P	-6.20E-02	6.82E-02	1.98E-01
LB4110R - C1	Alpha	11/24/2006	8/4/2014	3.33E-02	P	-7.57E-02	7.29E-02	2.22E-01
LB4110R - C2	Alpha	11/24/2006	8/4/2014	5.00E-02	P	-7.57E-02	6.84E-02	2.13E-01
LB4110R - C3	Alpha	11/24/2006	8/4/2014	6.67E-02	P	-8.33E-02	8.40E-02	2.51E-01
LB4110R - C4	Alpha	11/24/2006	8/4/2014	6.67E-02	P	-6.01E-02	7.86E-02	2.17E-01
LB4110R - D1	Alpha	11/24/2006	12/12/2013	0.00E+00	P	-1.06E-01	6.71E-02	2.40E-01
LB4110R - D2	Alpha	11/24/2006	12/12/2013	0.00E+00	P	-8.22E-02	6.66E-02	2.15E-01
LB4110R - D3	Alpha	11/24/2006	12/12/2013	0.00E+00	P	-8.70E-02	6.63E-02	2.20E-01
LB4110R - D4	Alpha	11/24/2006	12/12/2013	0.00E+00	P	-8.03E-02	7.09E-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)

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Detector	Alpha/Beta	Calibration Date	Count Date	Bkg CPM	PFW	LCL	Mean	UCL
LB4110A - A1	Beta	11/18/2007	8/4/2014	1.25E+00	P	-2.68E+02	7.47E+00	2.83E+02
LB4110A - A2	Beta	11/18/2007	8/4/2014	1.65E+00	P	-2.80E+01	2.78E+00	3.35E+01
LB4110A - A3	Beta	11/18/2007	8/4/2014	1.87E+00	P	-4.65E+01	2.60E+00	5.17E+01
LB4110A - A4	Beta	11/18/2007	8/4/2014	6.68E+00	P	-2.96E+01	3.89E+00	3.74E+01
LB4110A - B1	Beta	11/18/2007	8/4/2014	1.67E+00	P	-9.59E+00	3.12E+00	1.58E+01
LB4110A - B2	Beta	11/18/2007	8/4/2014	1.58E+00	P	-7.02E+00	1.93E+00	1.09E+01
LB4110A - B3	Beta	11/18/2007	8/4/2014	1.45E+00	P	-4.21E-01	1.40E+00	3.22E+00
LB4110A - B4	Beta	11/18/2007	8/4/2014	1.87E+00	P	-7.61E+00	1.97E+00	1.16E+01
LB4110A - C1	Beta	11/18/2007	8/4/2014	1.27E+00	P	-4.96E+00	2.03E+00	9.01E+00
LB4110A - C2	Beta	11/18/2007	8/4/2014	1.18E+00	P	3.00E-01	1.28E+00	2.26E+00
LB4110A - C3	Beta	11/18/2007	8/4/2014	1.92E+00	P	2.79E-01	1.52E+00	2.75E+00
LB4110A - C4	Beta	11/18/2007	8/4/2014	1.22E+00	P	-1.63E+00	2.01E+00	5.64E+00
LB4110A - D1	Beta	11/18/2007	8/4/2014	1.92E+00	P	-2.30E+00	2.52E+00	7.34E+00
LB4110A - D2	Beta	11/18/2007	8/4/2014	6.35E+00	W	-3.65E+00	1.79E+00	7.23E+00
LB4110A - D3	Beta	11/18/2007	8/4/2014	2.57E+00	P	9.06E-01	4.40E+00	7.90E+00
LB4110A - D4	Beta	11/18/2007	8/4/2014	6.85E+00	P	-7.52E+00	1.71E+00	1.09E+01
LB4110R - A1	Beta	11/24/2006	8/4/2014	1.78E+00	P	-5.71E+01	3.37E+00	6.38E+01
LB4110R - A2	Beta	11/24/2006	8/4/2014	2.63E+00	P	-4.52E+01	1.91E+00	4.90E+01
LB4110R - A3	Beta	11/24/2006	8/4/2014	1.53E+00	P	-4.19E+01	2.56E+00	4.70E+01
LB4110R - A4	Beta	11/24/2006	8/4/2014	3.23E+00	P	-4.17E+01	1.95E+00	4.56E+01
LB4110R - B1	Beta	11/24/2006	8/4/2014	1.97E+00	P	-4.39E+01	1.94E+00	4.78E+01
LB4110R - B2	Beta	11/24/2006	8/4/2014	9.20E+01	F	-4.67E+01	2.32E+00	5.14E+01
LB4110R - B3	Beta	11/24/2006	8/4/2014	1.22E+00	P	-4.37E+01	2.51E+00	4.87E+01
LB4110R - B4	Beta	11/24/2006	8/4/2014	1.40E+00	P	-4.40E+01	1.85E+00	4.77E+01
LB4110R - C1	Beta	11/24/2006	8/4/2014	1.05E+00	P	-4.39E+01	2.76E+00	4.94E+01
LB4110R - C2	Beta	11/24/2006	8/4/2014	1.83E+00	P	-4.38E+01	2.58E+00	4.89E+01
LB4110R - C3	Beta	11/24/2006	8/4/2014	1.63E+00	P	-4.42E+01	2.39E+00	4.90E+01
LB4110R - C4	Beta	11/24/2006	8/4/2014	1.38E+00	P	-4.99E+01	2.76E+00	5.55E+01
LB4110R - D1	Beta	11/24/2006	12/12/2013	0.00E+00	P	-4.37E+01	5.31E+00	5.43E+01
LB4110R - D2	Beta	11/24/2006	12/12/2013	0.00E+00	P	-4.67E+01	1.79E+00	5.03E+01
LB4110R - D3	Beta	11/24/2006	12/12/2013	0.00E+00	P	-5.02E+01	5.29E+00	6.08E+01
LB4110R - D4	Beta	11/24/2006	12/12/2013	0.00E+00	P	-4.65E+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

GPC Detector Report
(ALL Efficiencies)

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Detector	Alpha/Beta	Calibration Date	Count Date	Eff	PFW	LCL	Mean	UCL
LB4110A - A1	Alpha	11/18/2007	8/4/2014	0.2308	P	0.0055	0.2183	0.4310
LB4110A - A2	Alpha	11/18/2007	8/4/2014	0.1975	P	-0.0318	0.1777	0.3871
LB4110A - A3	Alpha	11/18/2007	8/4/2014	0.1962	P	-0.0538	0.1685	0.3908
LB4110A - A4	Alpha	11/18/2007	8/4/2014	0.2293	P	-0.0327	0.1886	0.4098
LB4110A - B1	Alpha	11/18/2007	8/4/2014	0.2228	P	0.1951	0.2237	0.2523
LB4110A - B2	Alpha	11/18/2007	8/4/2014	0.2104	P	0.1898	0.2194	0.2491
LB4110A - B3	Alpha	11/18/2007	8/4/2014	0.2419	P	0.1356	0.2326	0.3296
LB4110A - B4	Alpha	11/18/2007	8/4/2014	0.2276	P	0.2064	0.2347	0.2630
LB4110A - C1	Alpha	11/18/2007	8/4/2014	0.2059	P	0.1980	0.2203	0.2426
LB4110A - C2	Alpha	11/18/2007	8/4/2014	0.2186	P	0.1985	0.2251	0.2516
LB4110A - C3	Alpha	11/18/2007	8/4/2014	0.2356	P	0.2241	0.2491	0.2741
LB4110A - C4	Alpha	11/18/2007	8/4/2014	0.2145	P	0.1980	0.2251	0.2523
LB4110A - D1	Alpha	11/18/2007	8/4/2014	0.2152	P	0.1796	0.2309	0.2822
LB4110A - D2	Alpha	11/18/2007	8/4/2014	0.2430	P	0.2013	0.2562	0.3111
LB4110A - D3	Alpha	11/18/2007	8/4/2014	0.2506	P	0.2047	0.2615	0.3183
LB4110A - D4	Alpha	11/18/2007	8/4/2014	0.1879	P	0.1481	0.1976	0.2471
LB4110R - A1	Alpha	11/24/2006	8/4/2014	0.2317	P	0.1998	0.2378	0.2759
LB4110R - A2	Alpha	11/24/2006	8/4/2014	0.2119	P	0.1847	0.2188	0.2530
LB4110R - A3	Alpha	11/24/2006	8/4/2014	0.2206	P	0.1922	0.2233	0.2543
LB4110R - A4	Alpha	11/24/2006	8/4/2014	0.2400	P	0.2127	0.2447	0.2767
LB4110R - B1	Alpha	11/24/2006	8/4/2014	0.1909	P	0.1707	0.2231	0.2754
LB4110R - B2	Alpha	11/24/2006	8/4/2014	0.1801	W	0.1692	0.2153	0.2613
LB4110R - B3	Alpha	11/24/2006	8/4/2014	0.2339	P	0.1968	0.2434	0.2900
LB4110R - B4	Alpha	11/24/2006	8/4/2014	0.2035	P	0.1812	0.2292	0.2771
LB4110R - C1	Alpha	11/24/2006	8/4/2014	0.2070	P	0.1794	0.2141	0.2488
LB4110R - C2	Alpha	11/24/2006	8/4/2014	0.2077	P	0.1901	0.2232	0.2564
LB4110R - C3	Alpha	11/24/2006	8/4/2014	0.2359	P	0.2034	0.2384	0.2733
LB4110R - C4	Alpha	11/24/2006	8/4/2014	0.2024	P	0.1784	0.2201	0.2617
LB4110R - D1	Alpha	11/24/2006	12/12/2013	0.0000	W	-0.0274	0.1906	0.4086
LB4110R - D2	Alpha	11/24/2006	12/12/2013	0.0000	W	-0.0306	0.2168	0.4641
LB4110R - D3	Alpha	11/24/2006	12/12/2013	0.0000	W	-0.0300	0.2129	0.4559
LB4110R - D4	Alpha	11/24/2006	12/12/2013	0.0000	W	-0.0254	0.1716	0.3686
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)

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Detector	Alpha/Beta	Calibration Date	Count Date	Eff	PFW	LCL	Mean	UCL
LB4110A - A1	Beta	11/18/2007	8/4/2014	0.5637	P	0.2368	0.5629	0.8890
LB4110A - A2	Beta	11/18/2007	8/4/2014	0.4688	P	0.1862	0.4679	0.7496
LB4110A - A3	Beta	11/18/2007	8/4/2014	0.4852	P	0.1199	0.4621	0.8044
LB4110A - A4	Beta	11/18/2007	8/4/2014	0.5647	P	0.1702	0.5002	0.8302
LB4110A - B1	Beta	11/18/2007	8/4/2014	0.5531	P	0.4654	0.5326	0.5998
LB4110A - B2	Beta	11/18/2007	8/4/2014	0.5286	P	0.4669	0.5273	0.5877
LB4110A - B3	Beta	11/18/2007	8/4/2014	0.6014	P	0.3326	0.5395	0.7463
LB4110A - B4	Beta	11/18/2007	8/4/2014	0.5789	P	0.4944	0.5555	0.6166
LB4110A - C1	Beta	11/18/2007	8/4/2014	0.5410	P	0.4362	0.5100	0.5838
LB4110A - C2	Beta	11/18/2007	8/4/2014	0.5533	P	0.3974	0.5140	0.6306
LB4110A - C3	Beta	11/18/2007	8/4/2014	0.6011	P	0.5246	0.5966	0.6687
LB4110A - C4	Beta	11/18/2007	8/4/2014	0.5603	P	0.4522	0.5313	0.6104
LB4110A - D1	Beta	11/18/2007	8/4/2014	0.7459	F	0.4007	0.5568	0.7129
LB4110A - D2	Beta	11/18/2007	8/4/2014	0.6878	P	0.4364	0.5871	0.7379
LB4110A - D3	Beta	11/18/2007	8/4/2014	0.6476	P	0.4776	0.6135	0.7494
LB4110A - D4	Beta	11/18/2007	8/4/2014	0.4991	P	0.3484	0.4702	0.5921
LB4110R - A1	Beta	11/24/2006	8/4/2014	0.5778	P	0.4799	0.5697	0.6594
LB4110R - A2	Beta	11/24/2006	8/4/2014	0.5360	P	0.4217	0.5108	0.5998
LB4110R - A3	Beta	11/24/2006	8/4/2014	0.5380	P	0.4553	0.5386	0.6219
LB4110R - A4	Beta	11/24/2006	8/4/2014	0.6247	P	0.5083	0.5944	0.6804
LB4110R - B1	Beta	11/24/2006	8/4/2014	0.4764	P	0.4290	0.5404	0.6518
LB4110R - B2	Beta	11/24/2006	8/4/2014	0.4368	W	0.4140	0.5188	0.6236
LB4110R - B3	Beta	11/24/2006	8/4/2014	0.6030	P	0.4808	0.5954	0.7099
LB4110R - B4	Beta	11/24/2006	8/4/2014	0.5136	P	0.4427	0.5486	0.6544
LB4110R - C1	Beta	11/24/2006	8/4/2014	0.5057	P	0.4126	0.5018	0.5910
LB4110R - C2	Beta	11/24/2006	8/4/2014	0.5515	P	0.4317	0.5355	0.6392
LB4110R - C3	Beta	11/24/2006	8/4/2014	0.5856	P	0.4801	0.5737	0.6673
LB4110R - C4	Beta	11/24/2006	8/4/2014	0.5278	P	0.4298	0.5258	0.6218
LB4110R - D1	Beta	11/24/2006	12/12/2013	0.0000	W	-0.0662	0.4558	0.9778
LB4110R - D2	Beta	11/24/2006	12/12/2013	0.0000	W	-0.0738	0.5122	1.0982
LB4110R - D3	Beta	11/24/2006	12/12/2013	0.0000	W	-0.0718	0.4974	1.0667
LB4110R - D4	Beta	11/24/2006	12/12/2013	0.0000	W	-0.0615	0.4095	0.8805
LB5100 - 1	Beta	7/10/2006	10/26/2007	0.4428	F	0.4555	0.4731	0.4906

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