# FEEZOR ENGINEERING, INC.

## FEE/BRI

## STANDARD LEVEL IV
## REPORT OF ANALYSIS

## WORK ORDER #14-09075-OR

## October 2, 2014

**EBERLINE ANALYTICAL/OAK RIDGE LABORATORY**
**OAK RIDGE, TN**

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**Eberline Services – Oak Ridge Laboratory**

**LABORATORY DATA SUPPORT CHECKLIST**

MP-001-3

Eberline Services Work Order # 14-09075

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

| Date for Partial | Initials | Date | Initials | Checklist Items |
|---|---|---|---|---|
| | | 9/16/14 | KC | Sample Log-In |
| | | 09/26/14 | EJT | Data Compilation |
| | | 9-29-14 | MT | First Technical Data Review |
| | | 9/29/14 | MSf | Second Technical Data Review |
| | | 9/30/14 | [illegible] | Data Entry/Electronic Deliverable |
| | | 9/30/14 | [illegible] | Case Narrative |
| | | 10/2/14 | KBJ | Electronic Deliverable Proof |
| | | 10/2/14 | MSf | Samples Analyzed within Holding Time Yes? [X] No? [ ] |
| | | 10/2/14 | 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] 10/2/14

Laboratory Manager — Date

# SECTION I

# CHAIN OF CUSTODY

14-09075
REC'D SEP 16 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 | 8/29/14 1420 | 9/15/14 1450 | 3.0 | - OFF - | 408.5 | AIR FILTER |
| 5 TRANSFER STATION | 8/29/14 1445 | 9/15/14 1515 | 3.0 | < 2 | 408.5 | AIR FILTER |
| | | | | | | |
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| | | | |
|---|---|---|---|
| Relinquished By/Date: [signature] 9/15/14 1600 | Received In Good Condition By: [signature] | Time: 1500 | Date: 9/16/14 |
| Method Of Shipment/Tracking #: FEDEX 7711 5422 9904 | | | |
| Relinquished By: | Received In Good Condition By: | Time: | Date: |
| Method Of Shipment: | | | |

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

0095

| EBERLINE SERVICES Oak Ridge Laboratory | Internal Chain of Custody | Work Order # | 14-09075 |
|---|---|---|---|
| | | Lab Deadline | 10/7/2014 |
| | | Analysis | ThISO - Level 4 |
| | | Sample Matrix | Air Filter |

| Comments | Sample Fraction | HP 210 / 270 Detector Activity | Storage Location |
|---|---|---|---|
| | 04 | 47 | S1.3 |
| | 05 | 53 | S1.3 |

| | Location (circle one) | | | | | Initials | Date |
|---|---|---|---|---|---|---|---|
| Received by | Sample Storage | Rough Prep | Prep | Separations | Count Room | [illegible] | 9/24/14 0900 |
| **Relinquished by** | Sample Storage | Rough Prep | Prep | Separations | Count Room | [illegible] | 9/24/14 1305 |
| Received by | Sample Storage | Rough Prep | Prep | Separations | Count Room | [illegible] | 9/24/14 1305 |
| **Relinquished by** | Sample Storage | Rough Prep | Prep | Separations | Count Room | [illegible] | 9/26/14 0953 |
| Received by | Sample Storage | Rough Prep | Prep | Separations | Count Room | [illegible] | 9/26 0953 |
| **Relinquished by** | Sample Storage | Rough Prep | Prep | Separations | Count Room | KB | 9/26/14 1429 |
| Received by | Sample Storage | Rough Prep | Prep | Separations | Count Room | | |
| **Relinquished by** | Sample Storage | Rough Prep | Prep | Separations | Count Room | | |
| Received by | Sample Storage | Rough Prep | Prep | Separations | Count Room | | |
| **Relinquished by** | Sample Storage | Rough Prep | Prep | Separations | Count Room | | |
| Received by | Sample Storage | Rough Prep | Prep | Separations | Count Room | | |
| **Relinquished by** | Sample Storage | Rough Prep | Prep | Separations | Count Room | | |
| Received by | Sample Storage | Rough Prep | Prep | Separations | Count Room | | |
| **Relinquished by** | Sample Storage | Rough Prep | Prep | Separations | Count Room | | |

| EBERLINE SERVICES Oak Ridge Laboratory | Internal Chain of Custody | Work Order # | 14-09075 |
|---|---|---|---|
| | | Lab Deadline | 10/7/2014 |
| | | Analysis | GaGbT_ThSr - Level 4 |
| | | Sample Matrix | Air Filter |

| Comments | Sample Fraction | HP 210 / 270 Detector Activity | Storage Location |
|---|---|---|---|
| | 04 | 47 | S1.3 |
| | 05 | 53 | S1.3 |

| | Location (circle one) | | | | | Initials | Date |
|---|---|---|---|---|---|---|---|
| Received by | Sample Storage | Rough Prep | Prep | Separations | Count Room | MM | 22SEP14 |
| **Relinquished by** | Sample Storage | Rough Prep | Prep | Separations | Count Room | MM | 23SEP14 0550 |
| Received by | Sample Storage | Rough Prep | Prep | Separations | Count Room | [illegible] | 9/23/2014 |
| **Relinquished by** | Sample Storage | Rough Prep | Prep | Separations | Count Room | KB | 9/23/14 1113 |
| 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 | | |

## 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** | **09/16/2014** | **28** | **14-09075** |
| **Project Name** | **Client WO** | **Sample Disp** | **Lab Deadline** | **Internal Deadline** | **Client Deadline** |
| **FEEBRI** | **FEE/BRI Bridgeton, MO** | **H** | **10/07/2014** | **10/13/2014** | **10/14/2014** |

| Internal ID | Client ID | Sample Date | Matrix | Storage | [illegible] | [illegible] | | | | | | | | | | | | | | | | | | | | | | | Ttl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **01** | LCS | 09/16/14 | AF | S1.3 | X | X | | | | | | | | | | | | | | | | | | | | | | | 2 |
| **02** | BLANK | 09/16/14 | AF | S1.3 | X | X | | | | | | | | | | | | | | | | | | | | | | | 2 |
| **03** | DUP | 09/16/14 | AF | S1.3 | X | X | | | | | | | | | | | | | | | | | | | | | | | 2 |
| **04** | OUTSIDE TRAILER | 09/15/14 14:50 | AF | S1.3 | X | X | | | | | | | | | | | | | | | | | | | | | | | 2 |
| **05** | TRANSFER STATION | 09/15/14 15:15 | AF | S1.3 | X | X | | | | | | | | | | | | | | | | | | | | | | | 2 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
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| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 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 | 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

**Report Data**
Dan Feezor
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

0009

Printed: 9/16/2014 4:48 PM

**Eberline Services – Oak Ridge Laboratory**

SAMPLE RECEIPT CHECKLIST
MP-001-2

WORK ORDER # 14-09075

SAMPLE MATRIX/MATRICES: (CIRCLE ONE OR BOTH)

AQUEOUS NON-AQUEOUS

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

WERE SAMPLES:

| | | | |
|---|---|---|---|
| Received in good condition? | Y | N | |
| If aqueous, properly preserved | Y | N | N/A |

WERE CHAIN OF CUSTODY SEALS:

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

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

REMARKS: _____

SIGNATURE: Kristen Coulston DATE: 9/16/14

# 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-37958

October 2, 2014

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

CASE NARRATIVE
Work Order # 14-09075-OR

SAMPLE RECEIPT

This work order contains two air filter samples received 09/16/2014. Both samples were analyzed for Isotopic Thorium and Gross Alpha/Beta.

| CLIENT ID | LAB ID |
|---|---|
| OUTSIDE TRAILER | 14-09075-04 |
| TRANSFER STATION | 14-09075-05 |

ANALYTICAL METHODS

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

ANALYTICAL RESULTS

Combined Standard Uncertainty is reported at 2-sigma value.

ISOTOPIC THORIUM

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

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 duplicate demonstrated a high relative percent difference; however, normalized difference is within acceptable limits for the analytical technique. Results for the Thorium-230 and Thorium-232 duplicate demonstrated an acceptable relative percent difference and normalized difference. Results for the Thorium-228, Thorium-230 and Thorium-232 laboratory control sample demonstrated an acceptable percent recovery.

ANALYTICAL RESULTS CONTINUED

GROSS ALPHA & BETA

An aliquot was taken from each filter for Gross Alpha and Beta analysis and attached directly to a stainless steel planchet. Samples were 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: 10/2/2014

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:* **14-09075**
*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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 14-09075-01 | LCS | KNOWN | 09/16/14 00:00 | 9/16/2014 | 9/23/2014 | 14-09075 | Gross Alpha | LANL MLR-100 Modified | 2.70E-04 | 1.16E-05 | | | | uCi/ml |
| 14-09075-01 | LCS | LCS | 09/16/14 00:00 | 9/16/2014 | 9/23/2014 | 14-09075 | Gross Alpha | LANL MLR-100 Modified | 2.87E-04 | 3.84E-06 | 3.16E-05 | 2.27E-07 | 4.88E-06 | uCi/ml |
| 14-09075-02 | MBL | BLANK | 09/16/14 00:00 | 9/16/2014 | 9/23/2014 | 14-09075 | Gross Alpha | LANL MLR-100 Modified | 7.48E-17 | 1.79E-16 | 1.80E-16 | 4.13E-16 | 1.35E-14 | uCi/ml |
| 14-09075-03 | DUP | OUTSIDE TRAILER | 09/15/14 14:50 | 9/16/2014 | 9/23/2014 | 14-09075 | Gross Alpha | LANL MLR-100 Modified | 3.06E-15 | 9.59E-16 | 1.02E-15 | 1.28E-15 | 1.97E-14 | uCi/ml |
| 14-09075-04 | DO | OUTSIDE TRAILER | 09/15/14 14:50 | 9/16/2014 | 9/23/2014 | 14-09075 | Gross Alpha | LANL MLR-100 Modified | 3.60E-15 | 8.99E-16 | 9.81E-16 | 8.49E-16 | 1.83E-14 | uCi/ml |
| 14-09075-05 | TRG | TRANSFER STATION | 09/15/14 15:15 | 9/16/2014 | 9/23/2014 | 14-09075 | Gross Alpha | LANL MLR-100 Modified | 2.06E-15 | 5.73E-16 | 6.15E-16 | 6.66E-16 | 1.17E-14 | uCi/ml |
| | | | | | | | | | | | | | | |
| 14-09075-01 | LCS | KNOWN | 09/16/14 00:00 | 9/16/2014 | 9/23/2014 | 14-09075 | Gross Beta | LANL MLR-100 Modified | 3.01E-04 | 9.04E-06 | | | | uCi/ml |
| 14-09075-01 | LCS | LCS | 09/16/14 00:00 | 9/16/2014 | 9/23/2014 | 14-09075 | Gross Beta | LANL MLR-100 Modified | 2.67E-04 | 3.07E-06 | 3.71E-05 | 5.28E-07 | 1.76E-06 | uCi/ml |
| 14-09075-02 | MBL | BLANK | 09/16/14 00:00 | 9/16/2014 | 9/23/2014 | 14-09075 | Gross Beta | LANL MLR-100 Modified | 4.31E-16 | 8.74E-16 | 8.76E-16 | 1.82E-15 | 6.37E-15 | uCi/ml |
| 14-09075-03 | DUP | OUTSIDE TRAILER | 09/15/14 14:50 | 9/16/2014 | 9/23/2014 | 14-09075 | Gross Beta | LANL MLR-100 Modified | 2.00E-14 | 1.94E-15 | 3.37E-15 | 2.46E-15 | 8.63E-15 | uCi/ml |
| 14-09075-04 | DO | OUTSIDE TRAILER | 09/15/14 14:50 | 9/16/2014 | 9/23/2014 | 14-09075 | Gross Beta | LANL MLR-100 Modified | 2.03E-14 | 2.02E-15 | 3.45E-15 | 2.74E-15 | 1.01E-14 | uCi/ml |
| 14-09075-05 | TRG | TRANSFER STATION | 09/15/14 15:15 | 9/16/2014 | 9/23/2014 | 14-09075 | Gross Beta | LANL MLR-100 Modified | 1.72E-14 | 1.28E-15 | 2.70E-15 | 1.38E-15 | 4.75E-15 | uCi/ml |
| | | | | | | | | | | | | | | |
| 14-09075-01 | LCS | KNOWN | 09/16/14 00:00 | 9/16/2014 | 9/26/2014 | 14-09075 | Thorium-228 | EML Th-01 Modified | 4.87E-06 | 1.75E-07 | | | | uCi/ml |
| 14-09075-01 | LCS | LCS | 09/16/14 00:00 | 9/16/2014 | 9/26/2014 | 14-09075 | Thorium-228 | EML Th-01 Modified | 5.00E-06 | 7.54E-07 | 8.89E-07 | 9.62E-08 | 2.82E-08 | uCi/ml |
| 14-09075-02 | MBL | BLANK | 09/16/14 00:00 | 9/16/2014 | 9/26/2014 | 14-09075 | Thorium-228 | EML Th-01 Modified | 2.86E-17 | 8.21E-17 | 8.22E-17 | 1.59E-16 | 8.49E-17 | uCi/ml |
| 14-09075-03 | DUP | OUTSIDE TRAILER | 09/15/14 14:50 | 9/16/2014 | 9/26/2014 | 14-09075 | Thorium-228 | EML Th-01 Modified | 5.42E-16 | 2.77E-16 | 2.82E-16 | 2.00E-16 | 3.99E-17 | uCi/ml |
| 14-09075-04 | DO | OUTSIDE TRAILER | 09/15/14 14:50 | 9/16/2014 | 9/26/2014 | 14-09075 | Thorium-228 | EML Th-01 Modified | 8.83E-16 | 3.84E-16 | 3.93E-16 | 1.97E-16 | 2.83E-17 | uCi/ml |
| 14-09075-05 | TRG | TRANSFER STATION | 09/15/14 15:15 | 9/16/2014 | 9/26/2014 | 14-09075 | Thorium-228 | EML Th-01 Modified | 3.80E-16 | 1.59E-16 | 1.63E-16 | 7.31E-17 | 1.05E-17 | uCi/ml |
| | | | | | | | | | | | | | | |
| 14-09075-01 | LCS | KNOWN | 09/16/14 00:00 | 9/16/2014 | 9/26/2014 | 14-09075 | Thorium-230 | EML Th-01 Modified | 5.43E-06 | 1.47E-07 | | | | uCi/ml |
| 14-09075-01 | LCS | LCS | 09/16/14 00:00 | 9/16/2014 | 9/26/2014 | 14-09075 | Thorium-230 | EML Th-01 Modified | 5.01E-06 | 7.56E-07 | 9.77E-07 | 6.32E-08 | 8.54E-09 | uCi/ml |
| 14-09075-02 | MBL | BLANK | 09/16/14 00:00 | 9/16/2014 | 9/26/2014 | 14-09075 | Thorium-230 | EML Th-01 Modified | 6.44E-17 | 7.51E-17 | 7.55E-17 | 1.14E-16 | 3.60E-17 | uCi/ml |
| 14-09075-03 | DUP | OUTSIDE TRAILER | 09/15/14 14:50 | 9/16/2014 | 9/26/2014 | 14-09075 | Thorium-230 | EML Th-01 Modified | 1.32E-15 | 4.52E-16 | 4.80E-16 | 1.26E-16 | 1.11E-17 | uCi/ml |
| 14-09075-04 | DO | OUTSIDE TRAILER | 09/15/14 14:50 | 9/16/2014 | 9/26/2014 | 14-09075 | Thorium-230 | EML Th-01 Modified | 1.13E-15 | 4.40E-16 | 4.62E-16 | 1.44E-16 | 1.28E-17 | uCi/ml |
| 14-09075-05 | TRG | TRANSFER STATION | 09/15/14 15:15 | 9/16/2014 | 9/26/2014 | 14-09075 | Thorium-230 | EML Th-01 Modified | 5.60E-16 | 2.01E-16 | 2.13E-16 | 6.13E-17 | 6.95E-18 | uCi/ml |
| | | | | | | | | | | | | | | |
| 14-09075-01 | LCS | KNOWN | 09/16/14 00:00 | 9/16/2014 | 9/26/2014 | 14-09075 | Thorium-232 | EML Th-01 Modified | 4.87E-06 | 1.75E-07 | | | | uCi/ml |
| 14-09075-01 | LCS | LCS | 09/16/14 00:00 | 9/16/2014 | 9/26/2014 | 14-09075 | Thorium-232 | EML Th-01 Modified | 4.80E-06 | 7.29E-07 | 8.43E-07 | 6.78E-08 | 7.16E-08 | uCi/ml |
| 14-09075-02 | MBL | BLANK | 09/16/14 00:00 | 9/16/2014 | 9/26/2014 | 14-09075 | Thorium-232 | EML Th-01 Modified | -2.65E-18 | 2.99E-17 | 2.99E-17 | 9.17E-17 | 9.02E-17 | uCi/ml |
| 14-09075-03 | DUP | OUTSIDE TRAILER | 09/15/14 14:50 | 9/16/2014 | 9/26/2014 | 14-09075 | Thorium-232 | EML Th-01 Modified | 7.46E-16 | 3.21E-16 | 3.28E-16 | 1.25E-16 | 1.64E-16 | uCi/ml |
| 14-09075-04 | DO | OUTSIDE TRAILER | 09/15/14 14:50 | 9/16/2014 | 9/26/2014 | 14-09075 | Thorium-232 | EML Th-01 Modified | 8.16E-16 | 3.63E-16 | 3.70E-16 | 1.65E-16 | 1.94E-16 | uCi/ml |
| 14-09075-05 | TRG | TRANSFER STATION | 09/15/14 15:15 | 9/16/2014 | 9/26/2014 | 14-09075 | Thorium-232 | EML Th-01 Modified | 6.28E-16 | 2.17E-16 | 2.24E-16 | 7.68E-17 | 6.78E-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

0015

# SECTION V

# ANALYTICAL STANDARD

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

EBERLINE SERVICES

# QUALITY CONTROL PROGRAM

MP-009

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

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

CURRENT DATE: 9/2/2014 0:00

SOLUTION REFERENCE #: IPL 435-104-2

SOLUTION #: Th-8

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

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

Reference Date: 11/1/1993 0:00

Certified Activity: 9.330E-02 µCi

Certified Concentration: µCi per gram

Ampoule /Solution Gross: 18.8415 Weight, Grams

Empty Ampoule: 6.9296 Weight, Grams

Solution Net: 11.9119 Weight, Grams

Total Activity in Ampoule: 0.0933 µCi

Chemical Composition of Standard Solution

$Th(NO_3)_4$ in 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: August 28, 2015

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

QC Approval _____ Date: 9/3/14

0018

EBERLINE SERVICES

# QUALITY CONTROL PROGRAM

MP-009

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

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

MP-009

Solution Reference # IPL 435-104-2

Date 9/2/2014 0:00

Solution # Th-8b

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

Radionuclide of Interest $^{228\ \&\ 232}Th$

Parent Solution Conc. 2.07E+02 dpm/ml

Reference Date 11/1/1993 0:00

Chemical Composition of Standard Solution

$Th(NO_3)_4$ in 1% $HNO_3$

Dilution Instructions:

Dilution Solvent Used 1% Nitric Acid

*SECONDARY VOLUMETRIC DILUTION*

Vol. Parent Solution: 500.0000 ml

Total Activity: 1.0355E+05 dpm

Final Volume: 1000.00 ml

Final Activity Concentration: 1.0355E+02 dpm/ml

NOTES:

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

Expiration Date: August 28, 2015

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

QC Approval _____ Date: 9/3/14

QA/QC REVIEWED
Date 10/14/91 Initials 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

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

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: 9/2/2014 0:00

SOLUTION REFERENCE #: IPL 867-54

SOLUTION #: Th-18

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

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: August 28, 2015

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

QC Approval _____ Date: 9/3/14

EBERLINE SERVICES

# QUALITY CONTROL PROGRAM

MP-009

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

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

MP-009
Solution Reference # IPL 867-54

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

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

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

Reference Date 1/15/2002 0:00

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

Dilution Instructions:

Dilution Solvent Used 0.1M $HNO_3$

*SECONDARY VOLUMETRIC DILUTION*

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

Final Activity Concentration: 2.2490E+01 dpm/ml

NOTES:

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

Expiration Date: August 28, 2015

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

QC Approval _____ Date: 9/3/14

# SECTION VI

# QUALITY CONTROL SAMPLE RESULTS SUMMARY

Eberline Services
Analysis Control Chart



| WO | Analysis | Run | Activity Units | Aliquot Units | Client Name |
|---|---|---|---|---|---|
| 14-09075 | 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 | 0.29 | 102.77% | 17.79% | 100.00% | 3.60% | 4.87E-06 | 1.75E-07 | 5.00E-06 | 8.89E-07 | Th-8b | 1.04E+02 | 3.60E+00 | 1.04E-01 |
| TH-230 | 0.83 | 92.36% | 19.49% | 100.00% | 2.70% | 5.43E-06 | 1.47E-07 | 5.01E-06 | 9.77E-07 | Th-1b | 2.35E+01 | 2.70E+00 | 5.12E-01 |
| TH-232 | 0.15 | 98.62% | 17.57% | 100.00% | 3.60% | 4.87E-06 | 1.75E-07 | 4.80E-06 | 8.43E-07 | Th-8b | 1.04E+02 | 3.60E+00 | 1.04E-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 | 47.98 | 8.83E-16 | 3.93E-16 | 5.42E-16 | 2.82E-16 |
| TH-230 | 0.55 | 15.12 | 1.13E-15 | 4.62E-16 | 1.32E-15 | 4.80E-16 |
| TH-232 | 0.28 | 8.91 | 8.16E-16 | 3.70E-16 | 7.46E-16 | 3.28E-16 |

## QC Summary

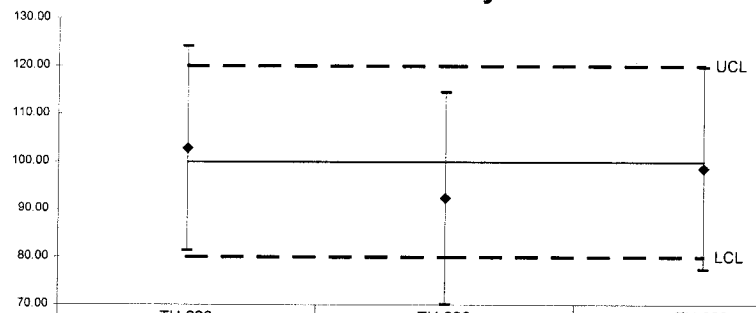
| LCS Relative Bias | LCS % R | LCS ND | MS % R | MS ND | Rep RPD | Rep ND |
|---|---|---|---|---|---|---|
| 1.03 | OK | OK | | | INV | OK |
| 0.92 | OK | OK | | | OK | OK |
| 0.99 | OK | OK | | | OK | OK |

Version

0027

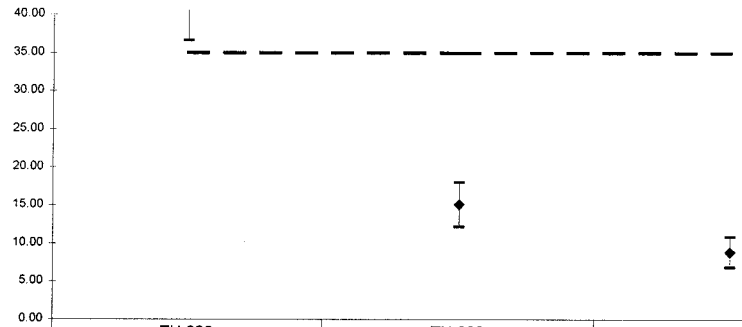
| WO | Analysis | Run | Activity Units | Aliquot Units | Client Name |
|---|---|---|---|---|---|
| 14-09075 | ThISO | 1 | uCi | ml | Feezor Engineering, Inc. |

## LCS % Recovery



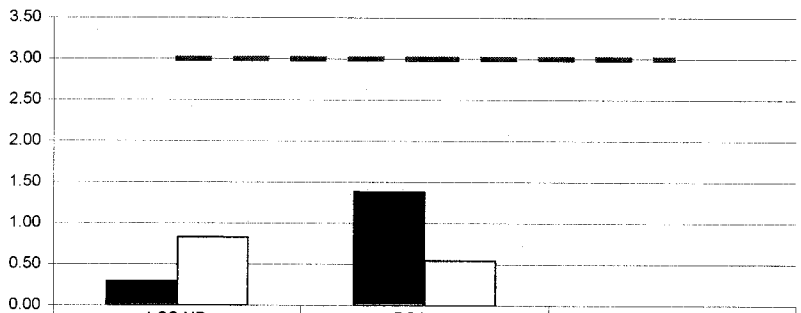

| | TH-228 | TH-230 | TH-232 |
|---|---|---|---|
| Lower Error | 81.38 | 70.16 | 77.45 |
| Upper Error | 124.15 | 114.55 | 119.79 |
| %R | 102.77 | 92.36 | 98.62 |
| LCL | 80 | 80 | 80 |
| Mean | 100 | 100 | 100 |
| UCL | 120 | 120 | 120 |

## Replicate Sample RPD




| | TH-228 | TH-230 | TH-232 |
|---|---|---|---|
| Lower Error | 59.34 | 18.03 | 10.90 |
| Upper Error | 36.61 | 12.22 | 6.92 |
| RPD | 47.98 | 15.12 | 8.91 |
| CL | 35 | 35 | 35 |

## Normalized Difference




| | LCS ND | REP ND | MS ND |
|---|---|---|---|
| TH-228 | 0.29 | 1.38 | 0.00 |
| TH-230 | 0.83 | 0.55 | 0.00 |
| UCL | 3 | 3 | 3 |

## No Matrix Spike

Version

00228

| WO | Analysis | Run | Activity Units | Aliquot Units | Client Name |
|---|---|---|---|---|---|
| 14-09075 | 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 | 1.04 | 106.37% | 11.00% | 100.00% | 4.30% | 2.70E-04 | 1.16E-05 | 2.87E-04 | 3.16E-05 | A/B-07 | 5.97E+02 | 4.30E+00 | 1.00E+00 |
| GROSS BETA_SR | 1.78 | 88.68% | 13.87% | 100.00% | 3.00% | 3.01E-04 | 9.04E-06 | 2.67E-04 | 3.71E-05 | A/B-07 | 6.66E+02 | 3.00E+00 | 1.00E+00 |
| | | | | | | | | | | | | | |

## Matrix Spike

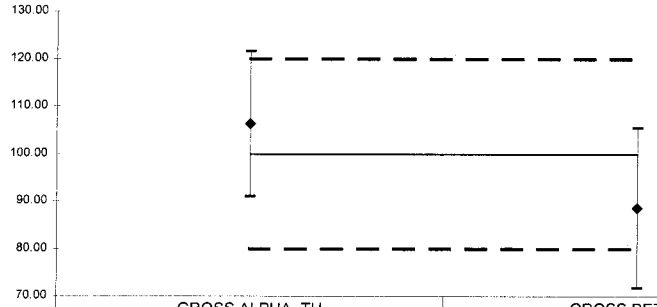
| Analyte | Normalized Difference | MS Actual % Rec | Expected MS Result | Expected MS Uncert | Actual MS Result | Actual MS CSU | Sample Result | Sample CSU | Sample Aliquot | Standard ID | Standard ACT (dpm) | Standard Error % | Standard Added (g) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|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

## Replicate Sample / QC Summary

| Analyte | Normalized Difference | RPD | Original Result | Original CSU | Replicate Result | Replicate CSU | LCS Relative Bias | LCS % R | LCS ND | MS % R | MS ND | Rep RPD | Rep ND |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GROSS ALPHA_TH | 0.75 | 16.28 | 3.60E-15 | 9.81E-16 | 3.06E-15 | 1.02E-15 | 1.06 | OK | OK | | | NA | OK |
| GROSS BETA_SR | 0.12 | 1.43 | 2.03E-14 | 3.45E-15 | 2.00E-14 | 3.37E-15 | 0.89 | OK | OK | | | OK | OK |
| | | | | | | | | | | | | | |

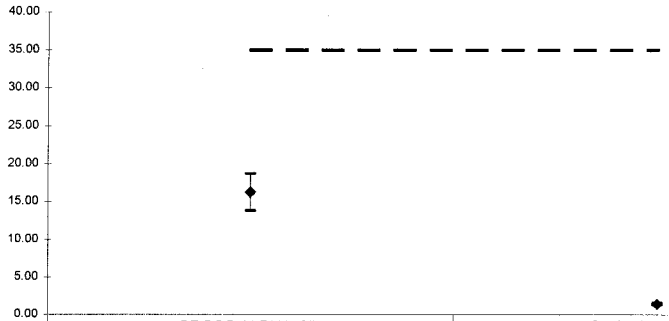
| WO | Analysis | Run | Activity Units | Aliquot Units | Client Name |
|---|---|---|---|---|---|
| 14-09075 | GaGbT_ThSr | 1 | uCi | ml | Feezor Engineering, Inc. |

## LCS % Recovery



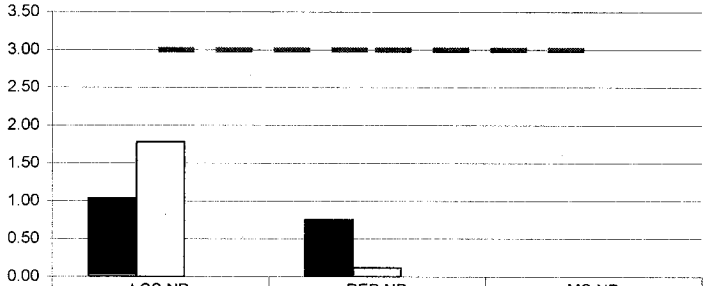

| | GROSS ALPHA_TH | GROSS BETA_SR |
|---|---|---|
| Lower Error | 91.07 | 71.82 |
| Upper Error | 121.67 | 105.55 |
| %R | 106.37 | 88.68 |
| LCL | 80 | 80 |
| Mean | 100 | 100 |
| UCL | 120 | 120 |

## Replicate Sample RPD




| | GROSS ALPHA_TH | GROSS BETA_SR |
|---|---|---|
| Lower Error | 18.72 | 1.55 |
| Upper Error | 13.84 | 1.31 |
| RPD | 16.28 | 1.43 |
| CL | 35 | 35 |

## Normalized Difference




| | LCS ND | REP ND | MS ND |
|---|---|---|---|
| GROSS ALPHA_TH | 1.04 | 0.75 | 0.00 |
| GROSS BETA_SR | 1.78 | 0.12 | 0.00 |
| | 0.00 | 0.00 | 0.00 |
| UCL | 3 | 3 | 3 |

## No Matrix Spike

Version

# SECTION VII

# LABORATORY TECHNICIAN'S NOTES

**ISO-TH NOTES**

| EBERLINE SERVICES<br>**Work Order Analysis Notes** | **Oak Ridge Laboratory**<br>**601 Scarboro Rd.**<br>**Oak Ridge, TN 37830**<br>**Voice: 865.481.0683**<br>**www.eberlineservices.com** | Internal Work Order | 14-09075 |
|---|---|---|---|
| | | Analysis Code | ThISO |
| | | Run Number | 1 |

| # | Date | Dept | User | Notes |
|---|---|---|---|---|
| 1 | 09/24/14 06:31 | PREP | JWOLFE | DISSOLVED SAMPLES WITH HF AND DRIED SAMPLES DOWN- ADDED MIXED ACIDS AND TOOK SAMPLES TO DRYNESS- ADDED HNO3 AND WATER AND CENTRIFUGED- SPLIT FRACTION 4 FOR QC ADDED SPIKES AND TRACERS- DRIED SAMPLES DOWN AND SUBMITTED TO SEPARATIONS |

JWDlDe
9/24/14

| EBERLINE SERVICES<br>**Work Order Analysis Notes** | **Oak Ridge Laboratory**<br>**601 Scarboro Rd.**<br>**Oak Ridge, TN 37830**<br>**Voice: 865.481.0683**<br>**www.eberlineservices.com** | Internal Work Order | 14-09075 |
|---|---|---|---|
| | | Analysis Code | ThISO |
| | | Run Number | 1 |

| # | Date | Dept | User | Notes |
|---|---|---|---|---|
| 1 | 09/24/14 06:31 | PREP | JWOLFE | DISSOLVED SAMPLES WITH HF AND DRIED SAMPLES DOWN- ADDED MIXED ACIDS AND TOOK SAMPLES TO DRYNESS- ADDED HNO3 AND WATER AND CENTRIFUGED- SPLIT FRACTION 4 FOR QC- ADDED SPIKES AND TRACERS- DRIED SAMPLES DOWN AND SUBMITTED TO SEPARATIONS |
| 2 | 09/25/14 18:13 | 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. |

John DeMelas
9/25/14

| EBERLINE SERVICES<br>**Work Order Analysis Notes** | **Oak Ridge Laboratory**<br>**601 Scarboro Rd.**<br>**Oak Ridge, TN 37830**<br>**Voice: 865.481.0683**<br>**www.eberlineservices.com** | Internal Work Order | 14-09075 |
|---|---|---|---|
| | | Analysis Code | ThISO |
| | | Run Number | 1 |

| # | Date | Dept | User | Notes |
|---|---|---|---|---|
| 1 | 09/24/14 06:31 | PREP | JWOLFE | DISSOLVED SAMPLES WITH HF AND DRIED SAMPLES DOWN- ADDED MIXED ACIDS AND TOOK SAMPLES TO DRYNESS- ADDED HNO3 AND WATER AND CENTRIFUGED- SPLIT FRACTION 4 FOR QC- ADDED SPIKES AND TRACERS- DRIED SAMPLES DOWN AND SUBMITTED TO SEPARATIONS |
| 2 | 09/25/14 18:13 | 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 | 09/26/14 05:17 | CHEM | TSMITH | Followed steps 12.2.4 to 12.4.5 in AP-005 . ( Precipitated and filtered samples for Thorium ) |

9-26-14
JMZ

EBERLINE SERVICES

# Reagents Used in an Analysis

| Internal Work Order | |
|---|---|
| 14-09075 | |
| Analysis Code | Run |
| ThISO | 1 |

| Reagent ID | Reagent Name | Reagent Concentration | Analyst ID | Date Recorded |
|---|---|---|---|---|
| 015414P | Hydrofluoric Acid | Reagent Grade | JWOLFE | 9/24/2014 |
| 015066P | Nitric Acid | Reagent Grade | JWOLFE | 9/24/2014 |
| 009098P | Sulfuric Acid | Reagent Grade | JWOLFE | 9/24/2014 |
| 015466P | Perchloric Acid | Reagent Grade | JWOLFE | 9/24/2014 |
| 014954P | Nitric Acid | Reagent Grade | JDEMELAS | 9/25/2014 |
| 015377P | Hydrochloric Acid | Reagent Grade | JDEMELAS | 9/25/2014 |
| 015469P | Anion Exchange Resin | Reagent Grade | JDEMELAS | 9/25/2014 |
| 015531S | Hydrochloric Acid | 8N | JDEMELAS | 9/25/2014 |
| 015527S | Nitric Acid | 8N | JDEMELAS | 9/25/2014 |
| 015414P | Hydrofluoric Acid | Reagent Grade | TSMITH | 9/26/2014 |
| 015015P | Reagent Alcohol | Reagent Grade | TSMITH | 9/26/2014 |
| 015517S | Cerrium Carrier | 0.1mg/ml | TSMITH | 9/26/2014 |
| 015540S | Carbon substrate | Solution | TSMITH | 9/26/2014 |

Alphett #1



| Date | Sample | Client | Time | Time Received | Analyzed | Tech |
|---|---|---|---|---|---|---|
| 9/24/14 | 1409073A(1-6) | TN Dept of Health | 1134 | 16:40 hrs | UU | KB |
| 9/25 | Daily Pulse | LAB | 2122 | 1 | NM | |
| 9/25 | 1409043A(1-4) | UCON | 0877 | 24 | AM241 | |
| 9/25 | 1409043A(1-7) | UCON | 0877 | 24 | AM247 | |
| 9/25/14 | 1409102A(1-7) | ECC | 1131 | 2hr50 | UU | RB |
| 9/25/14 | 1409048A(1-5) | Accutest | 1427 | 2hr50 | Rah | RB |
| 9/25/14 | 1409063A(1-2) | UCON | 1428 | 2hr50 | TH | RB |
| 9/26 | Daily Pulse | LAB | 0510 | 1 | NM | |
| 9/26 | SECCAL | LAB | 0800 | 24 | NM | |
| 9/26 | 1409054A(1-4) | UCON | 1076 | 24 | TH 250 | |
| 9/26 | 1409075A(1-7) | Freezer | 1076 | 24 | TH 250 | |

# Alpha #7



| Date | Sample # | Client | Total Time | CT Time | Analyst | Seal |
|---|---|---|---|---|---|---|
| 9/25 | 1409062A(1-4) | UCOR | 0924 | 24hr | Rak | C |
| 9/25/14 | 1409102A(4-8) | ECC | 1132 | 2hr50 | Th | KB |
| 9/25/14 | 1409102A(1-4) | ECC | 1133 | 2hr50 | Rak | KB |
| 9/25/14 | 1409102A(5-8) | ECC | 1220 | 2hr50 | Rak | KB |
| 9/25/14 | 1409043A(3) | UCOR | 1247 | 2hr50 | Am243 | KB |
| 9/25/14 | 1409057A(3) | UCOR | 1249 | 2hr50 | Am241 | KB |
| 9/25/14 | 1409058A(1-4) | ND | 1429 | 2hr50 | Rak | KB |
| 9/25/14 | 1409088A(1-10) | SolutionTech | 1620 | 2hr50 | UU | KB |
| 9/25/14 | 1409057A(3) | UCOR | 1723 | 2hr50 | Am241 | KB |
| 9/26 | Dry Run | LAB | 0510 | 1c | NN | — |
| 9/26 | SECCAL | LAB | 0525 | ~~24hr~~ | NN | — |
| 9/26 | 1409062A(1-4) | UCOR | 0870 | ~~Am241~~ 24hr | Am241 | C |
| 9/26 | 1409062A(1-4) | UCOR | 0870 | 24hr | Am243 | C |
| 9/26 | 1409062A(1-4) | UCOR | 0928 | 24hr | NP237 | C |
| 9/26/14 | 1409075A(4-8) | Feezor | 1122 | 2hr50 | Th | KB |
| 9/26/14 | 1409102B(1-3,8) | ECC | 1123 | 2hr50 | UU | KB |
| 9/26/14 | 1409112A(1-4) | NAVARRO | 1124 | 2hr50 | UU | KB |

# ALPHA/BETA NOTES

| EBERLINE SERVICES<br>**Work Order Analysis Notes** | **Oak Ridge Laboratory**<br>**601 Scarboro Rd.**<br>**Oak Ridge, TN 37830**<br>**Voice: 865.481.0683**<br>**www.eberlineservices.com** | Internal Work Order | 14-09075 |
|---|---|---|---|
| | | Analysis Code | GaGbT_ThSr |
| | | Run Number | 1 |

| # | Date | Dept | User | Notes |
|---|---|---|---|---|
| 1 | 09/22/14 12:37 | PREP | MHIGHTOWER | Prepared spike and blank, affixed samples to planchets, and submitted to count room |

Mu 22SEP14

EBERLINE SERVICES

## Reagents Used in an Analysis

| Internal Work Order | |
|---|---|
| 14-09075 | |
| Analysis Code | Run |
| GaGbT_ThSr | 1 |

| Reagent ID | Reagent Name | Reagent Concentration | Analyst ID | Date Recorded |
|---|---|---|---|---|
| 014954D02 | Nitric Acid | 3N | MHIGHTOWER | 9/22/2014 |

LB4110 RCN



| Date | Sample # | Client | Time | CT Time | Analyst | Reac |
|---|---|---|---|---|---|---|
| 9/18 | E7Zac | LAB | 0515 | 7h | LAB | C |
| 9/18 | BuOsac | LAB | 0548 | 6h | LAB | C |
| 9/18 | 1409027AB(1-9) | Miss. Dept. | 0705 | 2h | LAB | C |
| 9/18 | 1409054Pb(1-4) | CB | 1108 | 2h | Pb210 | C |
| 9/18/14 | 1409062CL(1-3,6) | UCOR | 1254 | 30mins | CL36 | KB |
| 9/18 | E7Zac | LAB | 0502 | 7h | LAB | C |
| 9/18 | BuOsac | LAB | 0535 | 6h | LAB | C |
| 9/18 | 1409067CL(1-3,5) | UCOR | 0612 | 7h | CL36 | C |
| 9/18 | 1409068NP(1-4) | Navarro | 0743 | 1h | NP237 | C |
| 9/18 | 1409026Rn(1-5) | MPA | 1120 | 2h | Rn | C |
| 9/18 | 1409047Rn(1-4) | UST | 1120 | 2h | Rn | C |
| 9/19/14 | Weekly Blksel | Lab | 0607 | 12hrs | alp | KB |
| 9/22 | E7Zac | LAB | 0516 | 7h | LAB | C |
| 9/22 | BuOsac | LAB | 0546 | 6h | LAB | C |
| 9/22 | 1408162S4(2-5,8,9) | DOE | 1006 | 2h | SrSolv | C |
| 9/22 | 1408162S4(1,1) | DOE | 1006 | 7h | SrSolv | C |
| 9/27 | E7Zac | LAB | 0518 | 7h | LAB | C |
| 9/27 | BuOsac | LAB | 0554 | 6h | LAB | C |
| 9/27 | 1409075AD(1-3,5) | Feezor | 0708 | 2h | LAB | C |
| 9/27 | 1409075AD(4) | Feezor | 0911 | 2h | LAB | C |

# SECTION VIII

# ANALYTICAL DATA (ISOTOPIC THORIUM)

# 14-09075
## ThISO
### Run 1



| | |
|---|---|
| Work Order | 14-09075 |
| Analysis Code | ThISO |
| Run | 1 |
| Date Received | 9/16/2014 |
| Lab Deadline | 10/7/2014 |
| 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 | | 09/16/14 00:00 | 1.0000E+00 |
| 02 | MBL | BLANK | | 09/16/14 00:00 | 9.2700E+08 |
| 03 | DUP | OUTSIDE TRAILER | 47 | 09/15/14 14:50 | 5.2000E+08 |
| 04 | DO | OUTSIDE TRAILER | 47 | 09/15/14 14:50 | 5.2000E+08 |
| 05 | TRG | TRANSFER STATION | 53 | 09/15/14 15:15 | 1.7400E+09 |

* 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.

# 14-09075
## 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 | 0.4673 | 10.5 | | 0.00 | | | | | | | | |
| 02 | MBL | 0.2334 | 5.2 | | 0.00 | | | | | | | | |
| 03 | DUP | 0.2337 | 5.2 | | 0.00 | | | | | | | | |
| 04 | DO | 0.2336 | 5.2 | | 0.00 | | | | | | | | |
| 05 | TRG | 0.2331 | 5.2 | | 0.00 | | | | | | | | |

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

# 14-09075
## 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 | | | 09/24/14 06:28 | JWOLFE | | | | |
| 02 | MBL | | | 09/24/14 06:28 | JWOLFE | | | | |
| 03 | DUP | | | 09/24/14 06:28 | JWOLFE | | | | |
| 04 | DO | | | 09/24/14 06:28 | JWOLFE | | | | |
| 05 | TRG | | | 09/24/14 06:28 | 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.

**Preliminary Data Report & Analytical Calculations**

# Work Order: 14-09075-ThISO-1



| Client | Eberline Services Work Order | Analysis Code | Run |
|---|---|---|---|
| Feezor Engineering, Inc. | 14-09075 | 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 | 7.54E-07 | 9.62E-08 | 4.87E-06 | 102.77 | OK | | INV | |
| 02 | TH-228 | MBL | BLANK | uCi/ml | 2.86E-17 | 8.21E-17 | 1.59E-16 | | | | | OK | OK |
| 03 | TH-228 | DUP | OUTSIDE TRAILER | uCi/ml | 5.42E-16 | 2.77E-16 | 2.00E-16 | | | | INV | OK | |
| 04 | TH-228 | DO | OUTSIDE TRAILER | uCi/ml | 8.83E-16 | 3.84E-16 | 1.97E-16 | | | | | OK | |
| 05 | TH-228 | TRG | TRANSFER STATION | uCi/ml | 3.80E-16 | 1.59E-16 | 7.31E-17 | | | | | OK | |

0047

# Preliminary Data Report & Analytical Calculations
# Work Order: 14-09075-ThISO-1



Client: Feezor Engineering, Inc.
Eberline Services Work Order: 14-09075
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-228 | LCS | 09/16/14 00:00 | 1.00E+00 | 114.46 | 0.00 | 0.00 | | | |
| 02 | TH-228 | MBL | 09/16/14 00:00 | 9.27E+08 | 112.12 | 0.00 | 0.00 | | | |
| 03 | TH-228 | DUP | 09/15/14 14:50 | 5.20E+08 | 118.89 | 0.00 | 0.00 | | | |
| 04 | TH-228 | DO | 09/15/14 14:50 | 5.20E+08 | 80.05 | 0.00 | 0.00 | | | |
| 05 | TH-228 | TRG | 09/15/14 15:15 | 1.74E+09 | 65.26 | 0.00 | 0.00 | | | |

**Preliminary Data Report & Analytical Calculations**

# Work Order: 14-09075-ThISO-1



| Client | Eberline Services Work Order | Analysis Code | Run |
|---|---|---|---|
| Feezor Engineering, Inc. | 14-09075 | ThISO | 1 |

| Lab Fraction | Nuclide | Sample Desc | Counting Date/Time | Halflife (days) | Detect | Carrier | Count Time | Counts | Bkg CPM | Eff |
|---|---|---|---|---|---|---|---|---|---|---|
| 01 | TH-228 | LCS | 09/26/14 10:36 | | A_Spec | Alpha_012 | 170.02 | 4.16 E+02 | 1.30 E-02 | 19.3 |
| 02 | TH-228 | MBL | 09/26/14 10:36 | | A_Spec | Alpha_014 | 170 | 2.05 E+00 | 3.50 E-02 | 18.3 |
| 03 | TH-228 | DUP | 09/26/14 10:36 | | A_Spec | Alpha_015 | 170.02 | 1.78 E+01 | 7.00 E-03 | 14.3 |
| 04 | TH-228 | DO | 09/26/14 11:22 | | A_Spec | Alpha_039 | 170 | 2.53 E+01 | 4.00 E-03 | 18.5 |
| 05 | TH-228 | TRG | 09/26/14 11:22 | | A_Spec | Alpha_040 | 170 | 2.93 E+01 | 4.00 E-03 | 18.2 |

**Preliminary Data Report & Analytical Calculations**

# Work Order: 14-09075-ThISO-1



Client: Feezor Engineering, Inc.
Eberline Services Work Order: 14-09075
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-230 | LCS | LCS | uCi/ml | 5.01E-06 | 7.56E-07 | 6.32E-08 | 5.43E-06 | 92.36 | OK | | INV | |
| 02 | TH-230 | MBL | BLANK | uCi/ml | 6.44E-17 | 7.51E-17 | 1.14E-16 | | | | | OK | OK |
| 03 | TH-230 | DUP | OUTSIDE TRAILER | uCi/ml | 1.32E-15 | 4.52E-16 | 1.26E-16 | | | | OK | OK | |
| 04 | TH-230 | DO | OUTSIDE TRAILER | uCi/ml | 1.13E-15 | 4.40E-16 | 1.44E-16 | | | | | OK | |
| 05 | TH-230 | TRG | TRANSFER STATION | uCi/ml | 5.60E-16 | 2.01E-16 | 6.13E-17 | | | | | OK | |

0550

**Preliminary Data Report & Analytical Calculations**

# Work Order: 14-09075-ThISO-1



Client: Feezor Engineering, Inc.
Eberline Services Work Order: 14-09075
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-230 | LCS | 09/16/14 00:00 | 1.00E+00 | 114.46 | 0.00 | 0.00 | | | |
| 02 | TH-230 | MBL | 09/16/14 00:00 | 9.27E+08 | 112.12 | 0.00 | 0.00 | | | |
| 03 | TH-230 | DUP | 09/15/14 14:50 | 5.20E+08 | 118.89 | 0.00 | 0.00 | | | |
| 04 | TH-230 | DO | 09/15/14 14:50 | 5.20E+08 | 80.05 | 0.00 | 0.00 | | | |
| 05 | TH-230 | TRG | 09/15/14 15:15 | 1.74E+09 | 65.26 | 0.00 | 0.00 | | | |

# Preliminary Data Report & Analytical Calculations
# Work Order: 14-09075-ThISO-1



Client: Feezor Engineering, Inc.
Eberline Services Work Order: 14-09075
Analysis Code: ThISO
Run: 1

| Lab Fraction | Nuclide | Sample Desc | Counting Date/Time | Halflife (days) | Detect | Carrier | Count Time | Counts | Bkg CPM | Eff |
|---|---|---|---|---|---|---|---|---|---|---|
| 01 | TH-230 | LCS | 09/26/14 10:36 | | A_Spec | Alpha_012 | 170.02 | 4.16 E+02 | 3.00 E-03 | 19.3 |
| 02 | TH-230 | MBL | 09/26/14 10:36 | | A_Spec | Alpha_014 | 170 | 4.62 E+00 | 1.40 E-02 | 18.3 |
| 03 | TH-230 | DUP | 09/26/14 10:36 | | A_Spec | Alpha_015 | 170.02 | 4.38 E+01 | 1.00 E-03 | 14.3 |
| 04 | TH-230 | DO | 09/26/14 11:22 | | A_Spec | Alpha_039 | 170 | 3.28 E+01 | 1.00 E-03 | 18.5 |
| 05 | TH-230 | TRG | 09/26/14 11:22 | | A_Spec | Alpha_040 | 170 | 4.37 E+01 | 2.00 E-03 | 18.2 |

# Preliminary Data Report & Analytical Calculations
# Work Order: 14-09075-ThISO-1



Client: Feezor Engineering, Inc.
Eberline Services Work Order: 14-09075
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 | 4.80E-06 | 7.29E-07 | 6.78E-08 | 4.87E-06 | 98.62 | OK | | INV | |
| 02 | TH-232 | MBL | BLANK | uCi/ml | -2.65E-18 | 2.99E-17 | 9.17E-17 | | | | | OK | OK |
| 03 | TH-232 | DUP | OUTSIDE TRAILER | uCi/ml | 7.46E-16 | 3.21E-16 | 1.25E-16 | | | | OK | OK | |
| 04 | TH-232 | DO | OUTSIDE TRAILER | uCi/ml | 8.16E-16 | 3.63E-16 | 1.65E-16 | | | | | OK | |
| 05 | TH-232 | TRG | TRANSFER STATION | uCi/ml | 6.28E-16 | 2.17E-16 | 7.68E-17 | | | | | OK | |

# Preliminary Data Report & Analytical Calculations
# Work Order: 14-09075-ThISO-1



Client: Feezor Engineering, Inc.
Eberline Services Work Order: 14-09075
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 | 09/16/14 00:00 | 1.00E+00 | 114.46 | 0.00 | 0.00 | | | |
| 02 | TH-232 | MBL | 09/16/14 00:00 | 9.27E+08 | 112.12 | 0.00 | 0.00 | | | |
| 03 | TH-232 | DUP | 09/15/14 14:50 | 5.20E+08 | 118.89 | 0.00 | 0.00 | | | |
| 04 | TH-232 | DO | 09/15/14 14:50 | 5.20E+08 | 80.05 | 0.00 | 0.00 | | | |
| 05 | TH-232 | TRG | 09/15/14 15:15 | 1.74E+09 | 65.26 | 0.00 | 0.00 | | | |

**Preliminary Data Report & Analytical Calculations**

# Work Order: 14-09075-ThISO-1



Client: Feezor Engineering, Inc.
Eberline Services Work Order: 14-09075
Analysis Code: ThISO
Run: 1

| Lab Fraction | Nuclide | Sample Desc | Counting Date/Time | Halflife (days) | Detect | Carrier | Count Time | Counts | Bkg CPM | Eff |
|---|---|---|---|---|---|---|---|---|---|---|
| 01 | TH-232 | LCS | 09/26/14 10:36 | | A_Spec | Alpha_012 | 170.02 | 3.99 E+02 | 4.00 E-03 | 19.3 |
| 02 | TH-232 | MBL | 09/26/14 10:36 | | A_Spec | Alpha_014 | 170 | -1.90 E-01 | 7.00 E-03 | 18.3 |
| 03 | TH-232 | DUP | 09/26/14 10:36 | | A_Spec | Alpha_015 | 170.02 | 2.48 E+01 | 1.00 E-03 | 14.3 |
| 04 | TH-232 | DO | 09/26/14 11:22 | | A_Spec | Alpha_039 | 170 | 2.37 E+01 | 2.00 E-03 | 18.5 |
| 05 | TH-232 | TRG | 09/26/14 11:22 | | A_Spec | Alpha_040 | 170 | 4.90 E+01 | 0.00 E+00 | 18.2 |

**Count Room Report**
**Client: Feezor Engineering, Inc.**

**14-09075-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 | 09/16/14 00:00 | 1.0000 | 0.4673 | 10.4974 | | 0.00 | | |
| 02 | MBL | BLANK | 09/16/14 00:00 | 927000000.0000 | 0.2334 | 5.2431 | | 0.00 | | |
| 03 | DUP | OUTSIDE TRAILER | 09/15/14 14:50 | 520000000.0000 | 0.2337 | 5.2498 | | 0.00 | | |
| 04 | DO | OUTSIDE TRAILER | 09/15/14 14:50 | 520000000.0000 | 0.2336 | 5.2476 | | 0.00 | | |
| 05 | TRG | TRANSFER STATION | 09/15/14 15:15 | 1740000000.0000 | 0.2331 | 5.2364 | | 0.00 | | |

Eberline Services
Oak Ridge Laboratory

# Spike and Tracer Worksheet


Printed: 9/24/2014 6:28 AM

| Internal Work Order | Run | Analysis Code | Date | Technician | Technician Initials | Witness Initials |
|---|---|---|---|---|---|---|
| 14-09075 | 1 | ThISO | 9/24/2014 6:27 | JWOLFE | JW | |

## LCS & Matrix Spikes

| Isotope | Sol # | Activity dpm/g | Solution Date | Approx Addition | LCS Volume Used (g) | MS Volume Used (g) | LCSD Volume Used (g) | MSD Volume Used (g) | LCS Known pCi | LCS Error Estimate | MS Added pCi | MS Error Estimate | LCSD Known pCi | LCSD Error Estimate | MSD Added pCi | MSD Error Estimate |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Th-228 | Th-8b | 103.560 | 9/24/2014 | 0.100 | 0.1043 | | | | 4.87 | 0.175 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 |
| Th-230 | Th-1b | 23.525 | 9/24/2014 | 0.500 | 0.5123 | | | | 5.43 | 0.147 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 |
| Th-232 | Th-8b | 103.560 | 9/24/2014 | 0.100 | 0.1043 | | | | 4.87 | 0.175 | 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 | 9/24/2014 | 0.4673 | 0.2200 |
| 02 | Th-229 | Th-18a | 22.464 | 9/24/2014 | 0.2334 | 0.2200 |
| 03 | Th-229 | Th-18a | 22.464 | 9/24/2014 | 0.2337 | 0.2200 |
| 04 | Th-229 | Th-18a | 22.464 | 9/24/2014 | 0.2336 | 0.2200 |
| 05 | Th-229 | Th-18a | 22.464 | 9/24/2014 | 0.2331 | 0.2200 |

## Balance Printer Tapes

**Tracer**

0.4673 g
0.2334 g
0.2337 g
0.2336 g
0.2331 g

**LCS**

0.5123 g
0.1043 g

**Matrix Spike**



0057

Eberline Analytical
Oak Ridge Laboratory

# Aliquot Worksheet



| Work Order | Run | Analysis Code | Rpt Units | Lab Deadline | Technician |
|---|---|---|---|---|---|
| 14-09075 | 1 | ThISO | ml | 10/7/2014 | 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 | | | | | 9.2700E+08 | 9.2700E+08 | | | | |
| 03 | OUTSIDE TRAILER | DUP | | | | | 5.2000E+08 | 5.2000E+08 | | | | |
| 04 | OUTSIDE TRAILER | DO | | | | | 5.2000E+08 | 5.2000E+08 | | | | |
| 05 | TRANSFER STATION | TRG | | | | | 1.7400E+09 | 1.7400E+09 | | | | |

| *Comments* | |
|---|---|

Technician: JWOlfe Date: 9/24/14

0058

CB 9/26/14

# Apex-Alpha™

Sample Description: SPIKE
Spectrum File: \\OR-ALPHA1\Canberra\ApexAlpha\Root\Data\00000977
Batch Identification: 1409075A-TH
Sample Identification: 01
Sample Geometry: Shelf 2
Procedure Description: Th iso

Detector Name: Alpha_012
Chamber Serial Number:
Detector Serial Number: 12
Env. Background: System Bkgd 96375
Reagent Blank: <not performed>

Sample Size: 1.000E+000 +/- 0.000E+000 mL
Sample Date/Time: 9/26/2014 6:27:23 AM
Acquisition Date/Time: 9/26/2014 10:36:50 AM
Acquisition Live Time: 170.0 minutes
Acquisition Real Time: 170.0 minutes

Tracer Certificate: Th229_TH-18A
Tracer Quantity: 0.467 mL
Effective Efficiency: 0.2205 +/- 0.0131
Counting Efficiency: 0.1926 +/- 0.0034 on 1/11/2014 12:12:57 PM
Chem. Recovery Factor: 1.1446 +/- 0.0706

Control Certificate Name: NatTh_Th-8
Chem. Recov. of Control: TH-232 0.986217 +/- 0.082013
Peak Match Tolerance: 0.175 MeV

## PEAK AREA REPORT

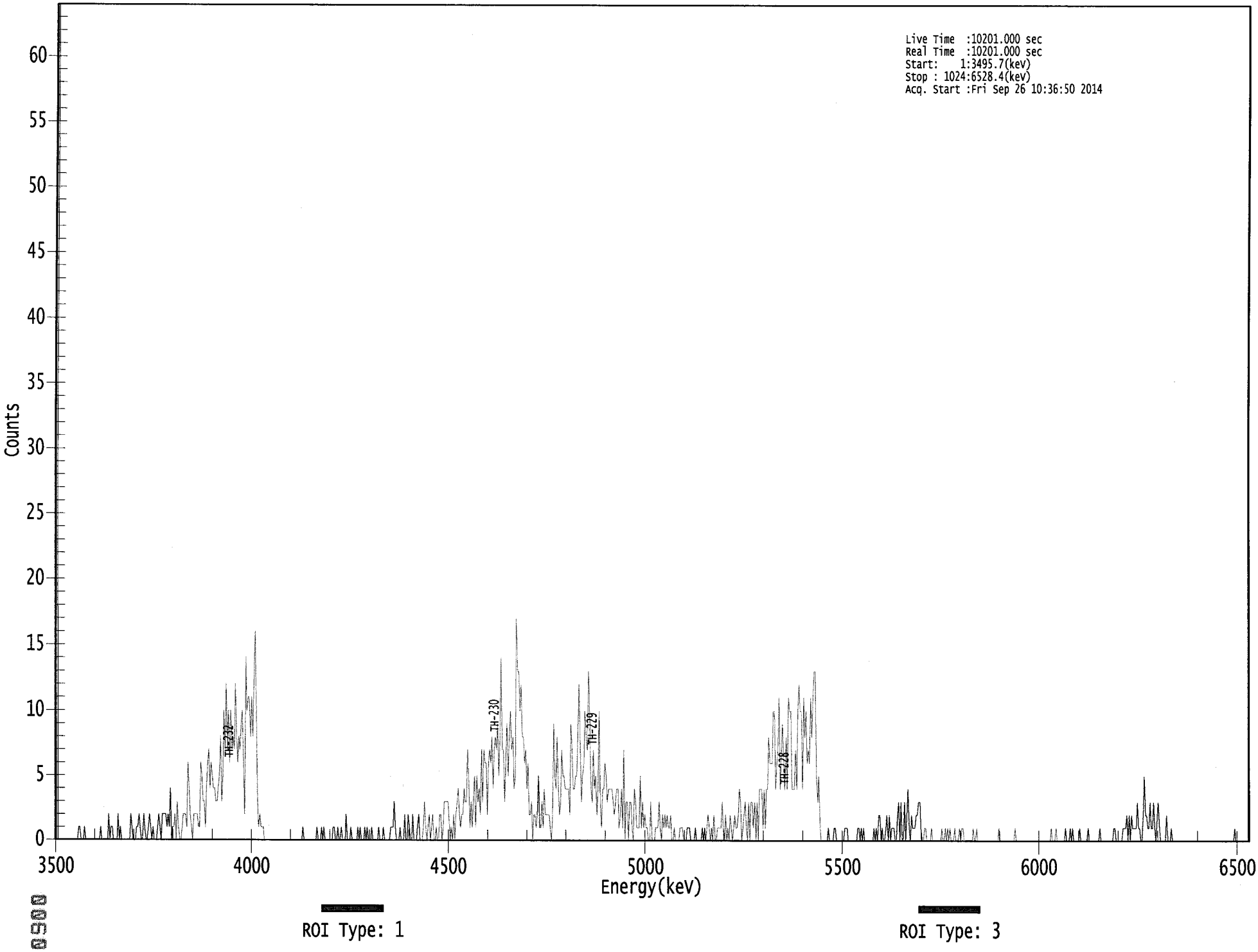
| Nuclide | | Energy (MeV) | Net Pk Area | Pk Area Error % | Ambient Backgnd | Reagent Backgnd | FWHM (keV) |
|---|---|---|---|---|---|---|---|
| TH-227 | | 5.818 | 16.15 | 50.25 | 0.85 | 0.00E+000 | 5.9 |
| TH-228 | | 5.351 | 415.79 | 9.64 | 2.21 | 0.00E+000 | 16.9 |
| TH-229 | T | 4.864 | 393.49 | 9.89 | 0.51 | 0.00E+000 | 15.9 |
| TH-230 | | 4.618 | 416.49 | 9.61 | 0.51 | 0.00E+000 | 16.6 |
| TH-232 | | 3.941 | 399.32 | 9.82 | 0.68 | 0.00E+000 | 10.0 |

T = Tracer Peak used for Effective Efficiency

## NUCLIDE ANALYSIS RESULTS

| Nuclide | Id Conf. | Energy (keV) | Activity (uCi/mL) | MDA (uCi/mL) |
|---|---|---|---|---|
| TH-227 | 0.995 | 5850.00* | 1.99E-007 +/- 1.03E-007 | 7.38E-008 +/- 8.56E-009 |
| TH-228 | 0.987 | 5400.00* | 5.00E-006 +/- 7.54E-007 | 9.62E-008 +/- 1.12E-008 |
| TH-229 | 1.000 | 4872.00* | 4.75E-006 +/- 5.51E-007 | 6.34E-008 +/- 7.35E-009 |
| TH-230 | 0.985 | 4672.00* | 5.01E-006 +/- 7.56E-007 | 6.32E-008 +/- 7.33E-009 |
| TH-232 | 0.984 | 3997.00* | 4.80E-006 +/- 7.29E-007 | 6.78E-008 +/- 7.87E-009 |

0000097795.CNF




0500

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

Sample Title: 01

Elapsed Live time: 10201
Elapsed Real Time: 10201

| Channel | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1: | 10201 | 10201 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17: | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 25: | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 33: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 41: | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 |
| 49: | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 0 |
| 57: | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 65: | 0 | 2 | 1 | 0 | 0 | 0 | 1 | 1 |
| 73: | 2 | 1 | 0 | 0 | 2 | 1 | 0 | 0 |
| 81: | 1 | 2 | 1 | 0 | 1 | 0 | 0 | 0 |
| 89: | 1 | 2 | 1 | 0 | 2 | 2 | 2 | 2 |
| 97: | 1 | 2 | 1 | 4 | 0 | 1 | 1 | 2 |
| 105: | 0 | 3 | 1 | 0 | 0 | 1 | 2 | 2 |
| 113: | 2 | 1 | 6 | 4 | 2 | 1 | 0 | 2 |
| 121: | 2 | 2 | 2 | 1 | 1 | 6 | 5 | 3 |
| 129: | 3 | 1 | 4 | 6 | 7 | 4 | 6 | 5 |
| 137: | 4 | 4 | 3 | 3 | 4 | 5 | 8 | 3 |
| 145: | 5 | 10 | 7 | 12 | 7 | 10 | 6 | 10 |
| 153: | 7 | 8 | 7 | 12 | 8 | 6 | 8 | 7 |
| 161: | 9 | 10 | 6 | 2 | 14 | 10 | 11 | 11 |
| 169: | 8 | 11 | 8 | 12 | 16 | 11 | 3 | 1 |
| 177: | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| 185: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 193: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 201: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 209: | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 217: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 225: | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 |
| 233: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 241: | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| 249: | 0 | 0 | 2 | 0 | 0 | 0 | 1 | 0 |
| 257: | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 265: | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 273: | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 281: | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 289: | 1 | 1 | 1 | 3 | 1 | 0 | 0 | 0 |
| 297: | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 2 |
| 305: | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 1 |
| 313: | 2 | 0 | 0 | 0 | 1 | 3 | 1 | 0 |
| 321: | 1 | 2 | 0 | 1 | 2 | 0 | 0 | 1 |
| 329: | 0 | 0 | 2 | 2 | 0 | 1 | 3 | 3 |
| 337: | 3 | 3 | 2 | 0 | 1 | 0 | 2 | 0 |
| 345: | 2 | 3 | 4 | 2 | 1 | 2 | 2 | 4 |
| 353: | 3 | 3 | 7 | 5 | 1 | 3 | 1 | 3 |
| 361: | 5 | 1 | 5 | 3 | 4 | 2 | 7 | 3 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 369: | 7 | 6 | 6 | 2 | 6 | 7 | 6 | 8 |

Sample Title: 01

| Channel | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 377: | 4 | 7 | 8 | 7 | 9 | 5 | 8 | 14 |
| 385: | 7 | 7 | 3 | 6 | 9 | 5 | 8 | 10 |
| 393: | 7 | 8 | 4 | 5 | 17 | 13 | 13 | 10 |
| 401: | 12 | 8 | 8 | 6 | 7 | 4 | 6 | 2 |
| 409: | 2 | 3 | 0 | 2 | 2 | 1 | 2 | 5 |
| 417: | 1 | 1 | 3 | 1 | 4 | 2 | 2 | 2 |
| 425: | 2 | 1 | 0 | 2 | 9 | 5 | 4 | 8 |
| 433: | 4 | 2 | 3 | 7 | 5 | 5 | 4 | 4 |
| 441: | 4 | 4 | 2 | 9 | 7 | 4 | 4 | 5 |
| 449: | 5 | 8 | 12 | 8 | 3 | 5 | 6 | 10 |
| 457: | 8 | 7 | 13 | 9 | 4 | 3 | 7 | 4 |
| 465: | 5 | 2 | 4 | 10 | 3 | 1 | 4 | 4 |
| 473: | 6 | 5 | 3 | 4 | 4 | 4 | 4 | 3 |
| 481: | 2 | 3 | 4 | 4 | 1 | 2 | 4 | 1 |
| 489: | 7 | 0 | 3 | 3 | 0 | 3 | 3 | 1 |
| 497: | 0 | 4 | 3 | 1 | 1 | 1 | 5 | 1 |
| 505: | 3 | 1 | 2 | 1 | 1 | 0 | 0 | 3 |
| 513: | 0 | 0 | 0 | 1 | 1 | 1 | 3 | 1 |
| 521: | 0 | 2 | 1 | 2 | 1 | 2 | 1 | 1 |
| 529: | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 537: | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 |
| 545: | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 553: | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 |
| 561: | 2 | 1 | 0 | 1 | 0 | 2 | 0 | 0 |
| 569: | 1 | 1 | 1 | 1 | 3 | 1 | 0 | 2 |
| 577: | 0 | 1 | 0 | 2 | 1 | 0 | 1 | 2 |
| 585: | 1 | 1 | 2 | 4 | 3 | 0 | 1 | 2 |
| 593: | 3 | 1 | 0 | 3 | 0 | 3 | 3 | 1 |
| 601: | 3 | 0 | 3 | 0 | 4 | 4 | 4 | 1 |
| 609: | 4 | 1 | 4 | 4 | 8 | 6 | 6 | 6 |
| 617: | 10 | 10 | 4 | 6 | 7 | 11 | 4 | 7 |
| 625: | 9 | 6 | 4 | 8 | 4 | 11 | 10 | 10 |
| 633: | 4 | 4 | 4 | 7 | 4 | 10 | 12 | 10 |
| 641: | 10 | 4 | 11 | 8 | 10 | 6 | 7 | 6 |
| 649: | 11 | 8 | 11 | 13 | 13 | 5 | 3 | 5 |
| 657: | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 665: | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 673: | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| 681: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 689: | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 |
| 697: | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 705: | 1 | 0 | 2 | 2 | 0 | 1 | 0 | 0 |
| 713: | 1 | 2 | 0 | 2 | 0 | 1 | 1 | 1 |
| 721: | 0 | 0 | 2 | 3 | 0 | 3 | 0 | 0 |
| 729: | 3 | 0 | 2 | 4 | 1 | 0 | 2 | 1 |
| 737: | 1 | 1 | 2 | 2 | 3 | 3 | 1 | 0 |
| 745: | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 |
| 753: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 761: | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 |
| 769: | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| 777: | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 785: | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| 793: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 801: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Sample Title: 01

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

Apex-Alpha™

RB 9/26/14

Sample Description: BLANK
Spectrum File: \\OR-ALPHA1\Canberra\ApexAlpha\Root\Data\00000977
Batch Identification: 1409075A-TH
Sample Identification: 02
Sample Geometry: Shelf 2
Procedure Description: Th iso

Detector Name: Alpha_014
Chamber Serial Number:
Detector Serial Number: 14
Env. Background: System Bkgd 96376
Reagent Blank: <not performed>

Sample Size: 9.270E+008 +/- 0.000E+000 mL
Sample Date/Time: 9/26/2014 6:27:23 AM
Acquisition Date/Time: 9/26/2014 10:36:51 AM
Acquisition Live Time: 170.0 minutes
Acquisition Real Time: 170.0 minutes

Tracer Certificate: Th229_TH-18A
Tracer Quantity: 0.233 mL
Effective Efficiency: 0.2053 +/- 0.0165
Counting Efficiency: 0.1831 +/- 0.0032 on 1/11/2014 12:12:59 PM
Chem. Recovery Factor: 1.1212 +/- 0.0925

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 | | 5.823 | 2.09 | 242.10 | 3.91 | 0.00E+000 | 2.9 |
| TH-228 | | 5.367 | 2.05 | 287.01 | 5.95 | 0.00E+000 | 5.9 |
| TH-229 | T | 4.873 | 182.96 | 14.58 | 2.04 | 0.00E+000 | 4.3 |
| TH-230 | | 4.638 | 4.62 | 115.44 | 2.38 | 0.00E+000 | 2.9 |
| TH-232 | | 4.029 | -0.19 | 1131.1 | 1.19 | 0.00E+000 | 2.9 |

T = Tracer Peak used for Effective Efficiency

NUCLIDE ANALYSIS RESULTS

| Nuclide | Id Conf. | Energy (keV) | Activity (uCi/mL) | MDA (uCi/mL) |
|---|---|---|---|---|
| TH-227 | 0.996 | 5850.00* | 2.98E-017 +/- 7.24E-017 | 1.39E-016 +/- 2.20E-017 |
| TH-228 | 0.994 | 5400.00* | 2.86E-017 +/- 8.21E-017 | 1.59E-016 +/- 2.51E-017 |
| TH-229 | 1.000 | 4872.00* | 2.56E-015 +/- 4.04E-016 | 1.09E-016 +/- 1.72E-017 |
| TH-230 | 0.994 | 4672.00* | 6.44E-017 +/- 7.51E-017 | 1.14E-016 +/- 1.81E-017 |
| TH-232 | 0.995 | 3997.00* | -2.65E-018 +/- 2.99E-017 | 9.17E-017 +/- 1.45E-017 |

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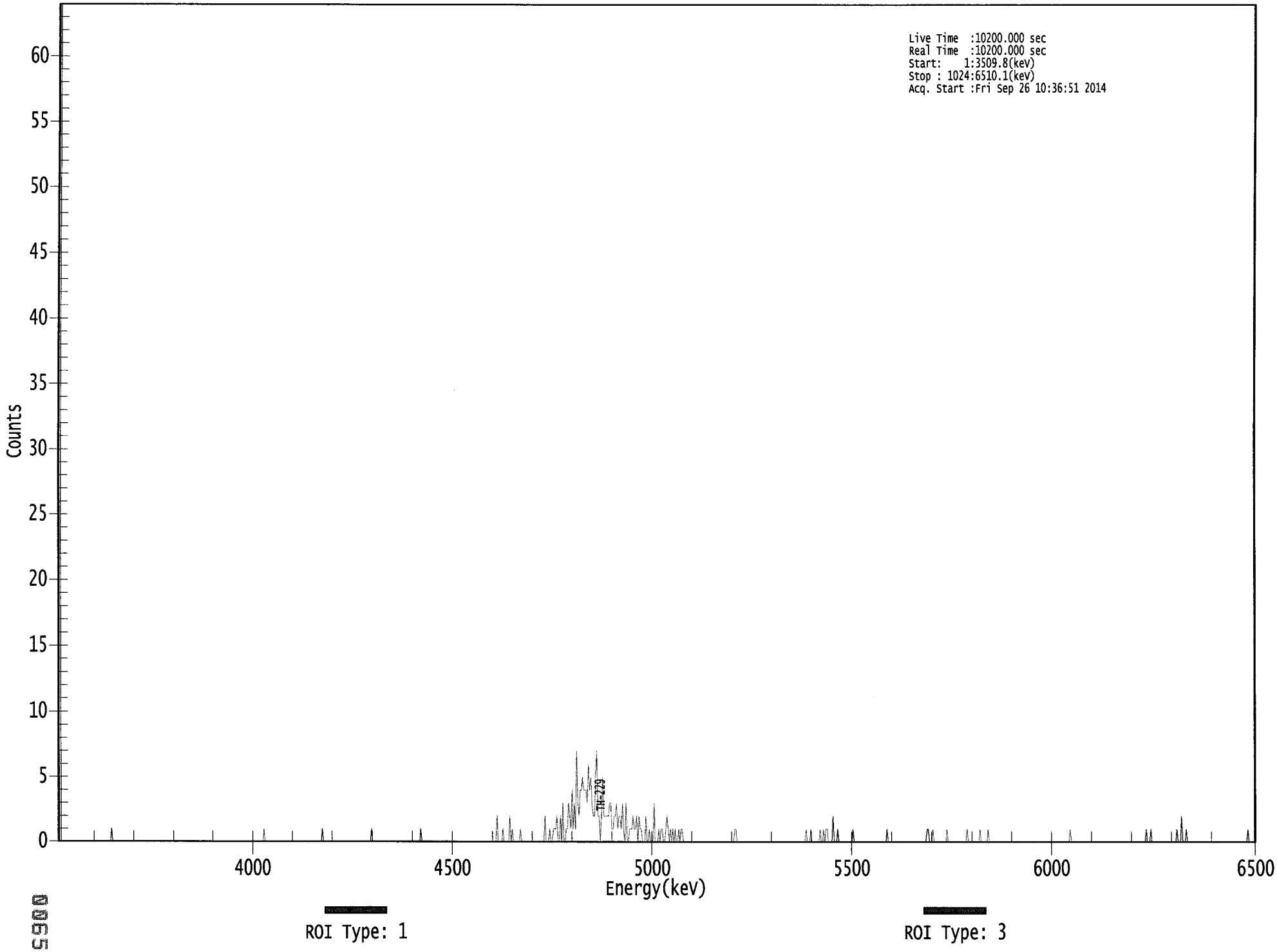



0065

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

Sample Title: 02

Elapsed Live time: 10200
Elapsed Real Time: 10200

| Channel | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1: | 10200 | 10200 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 25: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 33: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 41: | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 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 | 0 |
| 153: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 161: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 169: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 177: | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 185: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 193: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 201: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 209: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 217: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 225: | 0 | 0 | 0 | 1 | 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 | 1 | 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 | 1 |
| 313: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 321: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 329: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 337: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 345: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 353: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 361: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 369: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Sample Title: 02

| Channel | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 377: | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 385: | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 0 |
| 393: | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 401: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 409: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 417: | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 |
| 425: | 1 | 1 | 1 | 2 | 0 | 0 | 2 | 0 |
| 433: | 3 | 0 | 0 | 1 | 1 | 3 | 2 | 1 |
| 441: | 4 | 1 | 3 | 1 | 7 | 3 | 2 | 4 |
| 449: | 4 | 5 | 4 | 4 | 4 | 3 | 6 | 4 |
| 457: | 5 | 3 | 2 | 2 | 5 | 7 | 2 | 2 |
| 465: | 0 | 2 | 5 | 2 | 2 | 2 | 2 | 2 |
| 473: | 3 | 3 | 1 | 1 | 2 | 2 | 3 | 1 |
| 481: | 2 | 2 | 1 | 3 | 1 | 0 | 3 | 0 |
| 489: | 0 | 1 | 1 | 1 | 2 | 1 | 1 | 2 |
| 497: | 0 | 2 | 1 | 1 | 0 | 0 | 0 | 2 |
| 505: | 0 | 0 | 1 | 0 | 0 | 0 | 3 | 0 |
| 513: | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 |
| 521: | 1 | 2 | 1 | 0 | 1 | 0 | 1 | 0 |
| 529: | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 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 | 1 | 1 | 0 | 0 | 0 |
| 585: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 593: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 601: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 609: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 617: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 625: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 633: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 641: | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 649: | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 657: | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 2 |
| 665: | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 673: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 681: | 1 | 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 | 1 | 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 | 1 |
| 745: | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 753: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 761: | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 769: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 777: | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 785: | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 793: | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 801: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Sample Title: 02

| Channel | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 809: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 817: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 825: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 833: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 841: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 849: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 857: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 865: | 0 | 1 | 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 | 1 | 0 | 0 | 0 | 1 | 0 |
| 937: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 945: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 953: | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 961: | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 969: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 977: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 985: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 993: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1001: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1009: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1017: | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Apex-Alpha™

KB 9/26/14

Sample Description: OUTSIDE TRAILER-DUP
Spectrum File: \\OR-ALPHA1\Canberra\ApexAlpha\Root\Data\00000977
Batch Identification: 1409075A-TH
Sample Identification: 03
Sample Geometry: Shelf 2
Procedure Description: Th iso

Detector Name: Alpha_015
Chamber Serial Number:
Detector Serial Number: 15
Env. Background: System Bkgd 96377
Reagent Blank: <not performed>

Sample Size: 5.200E+008 +/- 0.000E+000 mL
Sample Date/Time: 9/15/2014 6:27:23 AM
Acquisition Date/Time: 9/26/2014 10:36:52 AM
Acquisition Live Time: 170.0 minutes
Acquisition Real Time: 170.0 minutes

Tracer Certificate: Th229_TH-18A
Tracer Quantity: 0.234 mL
Effective Efficiency: 0.1695 +/- 0.0148
Counting Efficiency: 0.1426 +/- 0.0026 on 1/11/2014 12:12:56 PM
Chem. Recovery Factor: 1.1889 +/- 0.1059

Peak Match Tolerance: 0.175 MeV

PEAK AREA REPORT

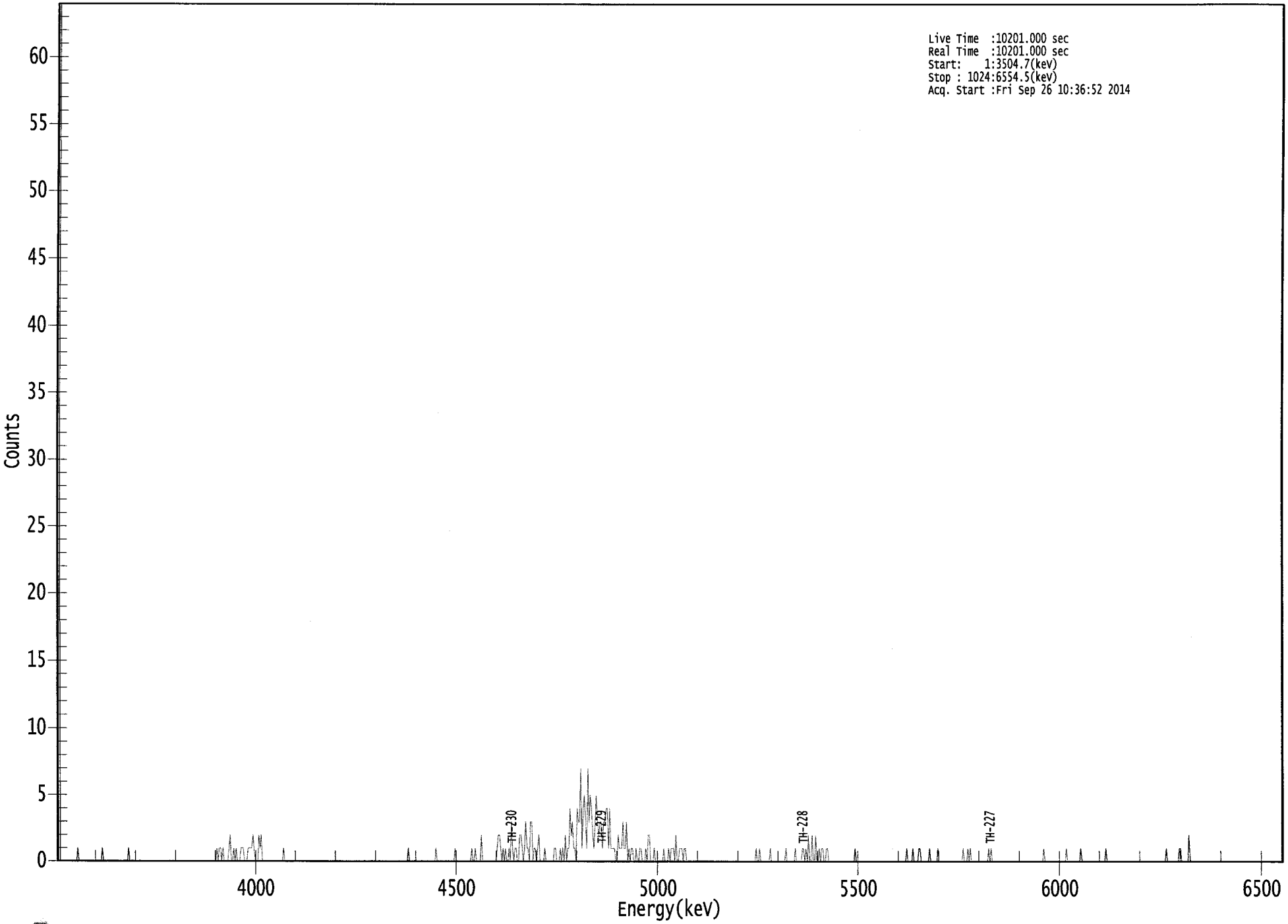
| Nuclide | | Energy (MeV) | Net Pk Area | Pk Area Error % | Ambient Backgnd | Reagent Backgnd | FWHM (keV) |
|---|---|---|---|---|---|---|---|
| TH-227 | | 5.831 | 7.15 | 78.23 | 0.85 | 0.00E+000 | 3.0 |
| TH-228 | | 5.365 | 17.81 | 48.22 | 1.19 | 0.00E+000 | 3.0 |
| TH-229 | T | 4.865 | 151.32 | 15.98 | 0.68 | 0.00E+000 | 4.3 |
| TH-230 | | 4.641 | 43.83 | 29.67 | 0.17 | 0.00E+000 | 3.7 |
| TH-232 | | 3.972 | 24.83 | 39.49 | 0.17 | 0.00E+000 | 4.5 |

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* | 2.21E-016 +/- 1.77E-016 | 1.85E-016 +/- 3.16E-017 |
| TH-228 | 0.994 | 5400.00* | 5.42E-016 +/- 2.77E-016 | 2.00E-016 +/- 3.42E-017 |
| TH-229 | 1.000 | 4872.00* | 4.57E-015 +/- 7.81E-016 | 1.70E-016 +/- 2.91E-017 |
| TH-230 | 0.995 | 4672.00* | 1.32E-015 +/- 4.52E-016 | 1.26E-016 +/- 2.15E-017 |
| TH-232 | 0.997 | 3997.00* | 7.46E-016 +/- 3.21E-016 | 1.25E-016 +/- 2.14E-017 |

0000097793.CNF




0070

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

Sample Title: 03

Elapsed Live time: 10201
Elapsed Real Time: 10201

| Channel | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1: | 10201 | 10201 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17: | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 25: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 33: | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 41: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 49: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 57: | 0 | 0 | 0 | 0 | 1 | 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 | 1 | 0 |
| 137: | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| 145: | 1 | 2 | 0 | 0 | 1 | 0 | 1 | 0 |
| 153: | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 |
| 161: | 1 | 1 | 1 | 1 | 2 | 1 | 0 | 0 |
| 169: | 0 | 2 | 1 | 2 | 0 | 0 | 0 | 0 |
| 177: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 185: | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 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 | 1 | 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 | 1 | 0 | 0 |
| 321: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 329: | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 337: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 345: | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| 353: | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| 361: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 369: | 1 | 2 | 2 | 1 | 0 | 1 | 0 | 1 |

Sample Title: 03

| Channel | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 377: | 0 | 0 | 1 | 0 | 3 | 1 | 0 | 1 |
| 385: | 1 | 0 | 0 | 2 | 2 | 1 | 0 | 1 |
| 393: | 3 | 1 | 1 | 0 | 3 | 3 | 0 | 1 |
| 401: | 1 | 0 | 1 | 2 | 0 | 0 | 0 | 0 |
| 409: | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 417: | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 |
| 425: | 0 | 2 | 0 | 1 | 1 | 4 | 2 | 3 |
| 433: | 1 | 1 | 0 | 4 | 3 | 3 | 7 | 1 |
| 441: | 4 | 5 | 3 | 1 | 7 | 3 | 5 | 4 |
| 449: | 2 | 1 | 3 | 5 | 3 | 2 | 3 | 3 |
| 457: | 1 | 3 | 3 | 4 | 4 | 1 | 4 | 1 |
| 465: | 1 | 1 | 1 | 0 | 0 | 2 | 1 | 1 |
| 473: | 1 | 3 | 1 | 1 | 3 | 0 | 1 | 0 |
| 481: | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 |
| 489: | 1 | 0 | 0 | 0 | 1 | 0 | 2 | 2 |
| 497: | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 505: | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| 513: | 0 | 1 | 1 | 1 | 0 | 2 | 0 | 0 |
| 521: | 1 | 1 | 1 | 0 | 1 | 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: | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 593: | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 601: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 609: | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 617: | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| 625: | 1 | 0 | 1 | 0 | 2 | 0 | 0 | 2 |
| 633: | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 1 |
| 641: | 1 | 0 | 0 | 1 | 1 | 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 | 1 | 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 | 1 | 0 |
| 713: | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 721: | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 729: | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 737: | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 745: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 753: | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 761: | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| 769: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 777: | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 785: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 793: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 801: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Sample Title: 03

| Channel | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 809: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 817: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 825: | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 833: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 841: | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 849: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 857: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 865: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 873: | 0 | 0 | 0 | 0 | 1 | 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 | 1 | 0 |
| 929: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 937: | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 945: | 0 | 2 | 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™

KD 9/26/14

Sample Description: OUTSIDE TRAILER
Spectrum File: \\OR-ALPHA1\Canberra\ApexAlpha\Root\Data\00000977
Batch Identification: 1409075A-TH
Sample Identification: 04
Sample Geometry: Shelf 2
Procedure Description: Th iso

Detector Name: Alpha_039
Chamber Serial Number: 06027396A
Detector Serial Number: 83109
Env. Background: System Bkgd 96386
Reagent Blank: <not performed>

Sample Size: 5.200E+008 +/- 0.000E+000 mL
Sample Date/Time: 9/15/2014 6:27:23 AM
Acquisition Date/Time: 9/26/2014 11:22:50 AM
Acquisition Live Time: 170.0 minutes
Acquisition Real Time: 170.0 minutes

Tracer Certificate: Th229_TH-18A
Tracer Quantity: 0.234 mL
Effective Efficiency: 0.1478 +/- 0.0137
Counting Efficiency: 0.1846 +/- 0.0032 on 1/11/2014 6:35:49 PM
Chem. Recovery Factor: 0.8005 +/- 0.0754

Peak Match Tolerance: 0.175 MeV

PEAK AREA REPORT

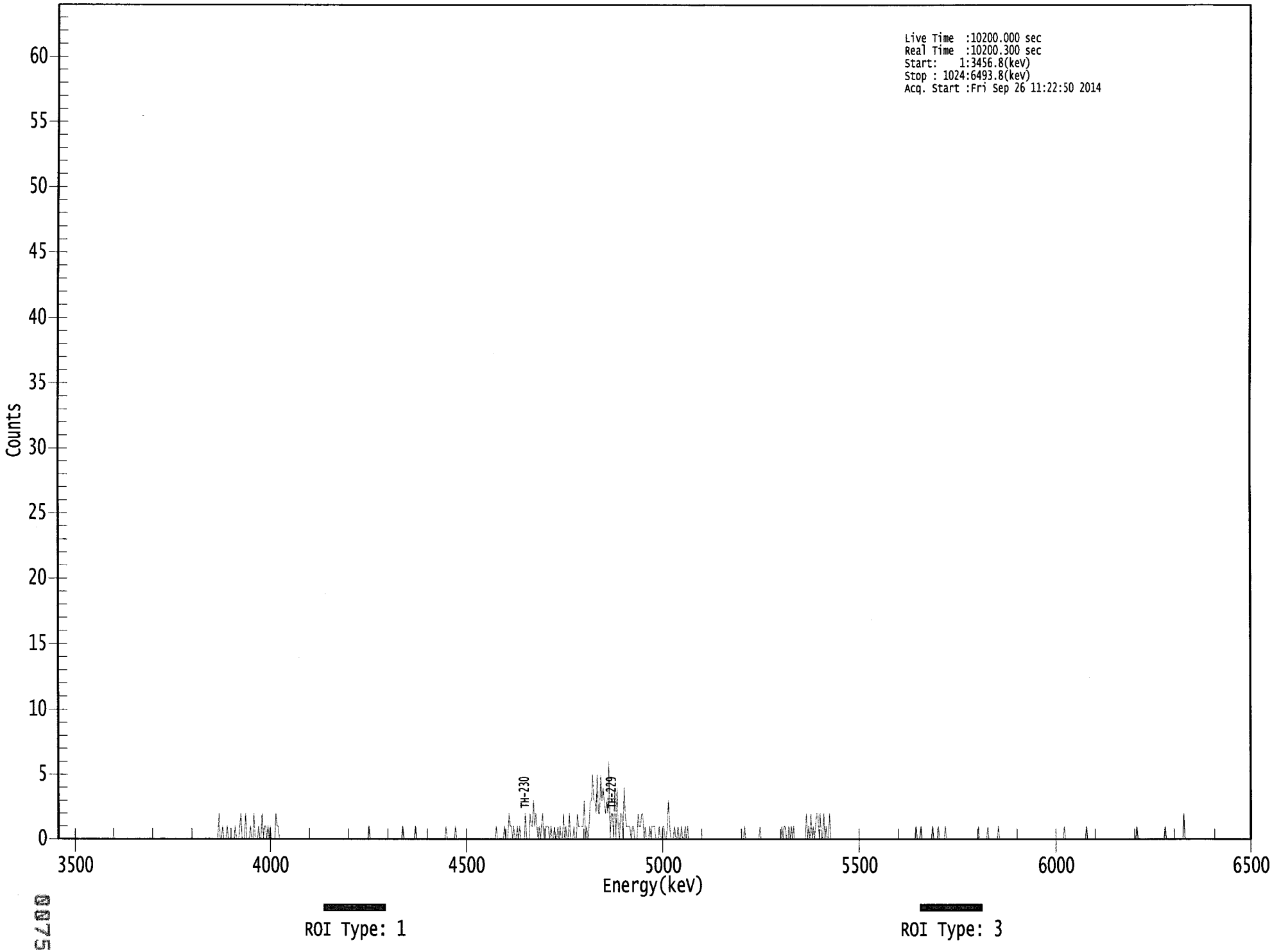
| Nuclide | | Energy (MeV) | Net Pk Area | Pk Area Error % | Ambient Backgnd | Reagent Backgnd | FWHM (keV) |
|---|---|---|---|---|---|---|---|
| TH-227 | | 5.820 | 5.83 | 82.55 | 0.17 | 0.00E+000 | 3.0 |
| TH-228 | | 5.364 | 25.32 | 39.56 | 0.68 | 0.00E+000 | 3.0 |
| TH-229 | T | 4.871 | 131.83 | 17.08 | 0.17 | 0.00E+000 | 3.7 |
| TH-230 | | 4.649 | 32.83 | 34.31 | 0.17 | 0.00E+000 | 4.5 |
| TH-232 | | 3.954 | 23.66 | 40.63 | 0.34 | 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 | 0.995 | 5850.00* | 2.06E-016 +/- 1.74E-016 | 1.48E-016 +/- 2.68E-017 |
| TH-228 | 0.993 | 5400.00* | 8.83E-016 +/- 3.84E-016 | 1.97E-016 +/- 3.57E-017 |
| TH-229 | 1.000 | 4872.00* | 4.57E-015 +/- 8.28E-016 | 1.45E-016 +/- 2.62E-017 |
| TH-230 | 0.997 | 4672.00* | 1.13E-015 +/- 4.40E-016 | 1.44E-016 +/- 2.61E-017 |
| TH-232 | 0.990 | 3997.00* | 8.16E-016 +/- 3.63E-016 | 1.65E-016 +/- 2.99E-017 |

# 0000097798.CNF




0075

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

Sample Title: 04

Elapsed Live time: 10200
Elapsed Real Time: 10200

| Channel | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9: | 0 | 0 | 0 | 0 | 0 | 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 | 2 | 0 | 0 | 1 | 0 |
| 145: | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 153: | 0 | 1 | 0 | 0 | 0 | 1 | 2 | 0 |
| 161: | 0 | 0 | 2 | 0 | 0 | 0 | 1 | 0 |
| 169: | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 |
| 177: | 2 | 0 | 1 | 1 | 0 | 1 | 0 | 1 |
| 185: | 0 | 0 | 0 | 0 | 2 | 1 | 1 | 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 | 1 | 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 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 305: | 0 | 0 | 0 | 0 | 1 | 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 | 1 | 0 |
| 337: | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 345: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 353: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 361: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 369: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Sample Title: 04

| Channel | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 377: | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 385: | 1 | 0 | 0 | 0 | 2 | 1 | 1 | 0 |
| 393: | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 |
| 401: | 0 | 0 | 2 | 0 | 0 | 0 | 2 | 1 |
| 409: | 1 | 3 | 1 | 2 | 1 | 0 | 1 | 0 |
| 417: | 1 | 2 | 0 | 0 | 1 | 1 | 1 | 0 |
| 425: | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| 433: | 1 | 0 | 0 | 2 | 0 | 1 | 0 | 0 |
| 441: | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 2 |
| 449: | 1 | 1 | 1 | 1 | 1 | 3 | 0 | 1 |
| 457: | 0 | 1 | 3 | 3 | 5 | 3 | 3 | 2 |
| 465: | 5 | 2 | 2 | 5 | 3 | 4 | 3 | 2 |
| 473: | 3 | 2 | 6 | 0 | 2 | 2 | 0 | 4 |
| 481: | 0 | 4 | 1 | 0 | 2 | 2 | 0 | 4 |
| 489: | 2 | 1 | 1 | 1 | 1 | 0 | 1 | 1 |
| 497: | 0 | 0 | 0 | 2 | 1 | 1 | 2 | 2 |
| 505: | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 |
| 513: | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| 521: | 1 | 1 | 0 | 0 | 1 | 3 | 1 | 0 |
| 529: | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 537: | 1 | 0 | 0 | 1 | 0 | 1 | 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 | 0 | 0 | 0 | 0 |
| 601: | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 609: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 617: | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 625: | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 633: | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 641: | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 2 |
| 649: | 0 | 1 | 0 | 1 | 2 | 2 | 0 | 2 |
| 657: | 0 | 0 | 2 | 0 | 1 | 0 | 0 | 2 |
| 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 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| 745: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 753: | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 761: | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 769: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 777: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 785: | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 793: | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 801: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

Sample Title: 04

| Channel | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 809: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 817: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 825: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 833: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 841: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 849: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 857: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 865: | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 873: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 881: | 0 | 0 | 0 | 1 | 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 | 1 | 0 |
| 929: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 937: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 945: | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 953: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 961: | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 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 9/26/14

# Apex-Alpha™

Sample Description: TRANSFER STATION
Spectrum File: \\OR-ALPHA1\Canberra\ApexAlpha\Root\Data\00000977
Batch Identification: 1409075A-TH
Sample Identification: 05
Sample Geometry: Shelf 2
Procedure Description: Th iso

Detector Name: Alpha_040
Chamber Serial Number: 06027396B
Detector Serial Number: 91135
Env. Background: System Bkgd 96387
Reagent Blank: <not performed>

Sample Size: 1.740E+009 +/- 0.000E+000 mL
Sample Date/Time: 9/15/2014 6:27:23 AM
Acquisition Date/Time: 9/26/2014 11:22:52 AM
Acquisition Live Time: 170.0 minutes
Acquisition Real Time: 170.0 minutes

Tracer Certificate: Th229_TH-18A
Tracer Quantity: 0.233 mL
Effective Efficiency: 0.1189 +/- 0.0121
Counting Efficiency: 0.1822 +/- 0.0032 on 1/11/2014 6:35:50 PM
Chem. Recovery Factor: 0.6526 +/- 0.0676

Peak Match Tolerance: 0.175 MeV

## PEAK AREA REPORT

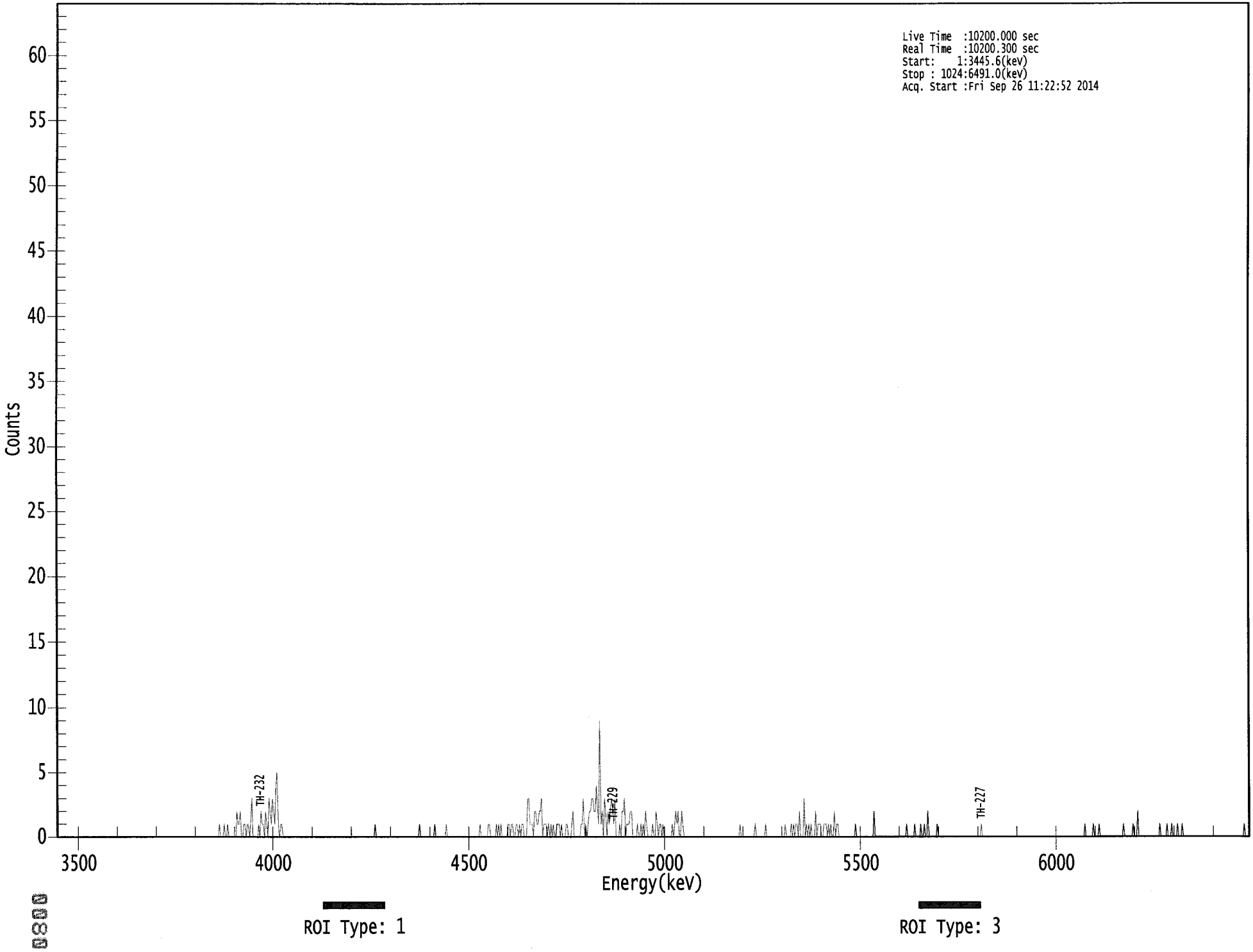
| Nuclide | | Energy (MeV) | Net Pk Area | Pk Area Error % | Ambient Backgnd | Reagent Backgnd | FWHM (keV) |
|---|---|---|---|---|---|---|---|
| TH-227 | | 5.809 | 0.32 | 646.93 | 0.68 | 0.00E+000 | 3.0 |
| TH-228 | | 5.366 | 29.32 | 36.68 | 0.68 | 0.00E+000 | 3.0 |
| TH-229 | T | 4.872 | 105.83 | 19.07 | 0.17 | 0.00E+000 | 3.3 |
| TH-230 | | 4.644 | 43.66 | 29.80 | 0.34 | 0.00E+000 | 6.7 |
| TH-232 | | 3.969 | 49.00 | 28.28 | 0.00 | 0.00E+000 | 6.3 |

T = Tracer Peak used for Effective Efficiency

## NUCLIDE ANALYSIS RESULTS

| Nuclide | Id Conf. | Energy (keV) | Activity (uCi/mL) | MDA (uCi/mL) |
|---|---|---|---|---|
| TH-227 | 0.991 | 5850.00* | 4.21E-018 +/- 2.72E-017 | 7.42E-017 +/- 1.48E-017 |
| TH-228 | 0.994 | 5400.00* | 3.80E-016 +/- 1.59E-016 | 7.31E-017 +/- 1.46E-017 |
| TH-229 | 1.000 | 4872.00* | 1.36E-015 +/- 2.73E-016 | 5.37E-017 +/- 1.08E-017 |
| TH-230 | 0.996 | 4672.00* | 5.60E-016 +/- 2.01E-016 | 6.13E-017 +/- 1.23E-017 |
| TH-232 | 0.996 | 3997.00* | 6.28E-016 +/- 2.17E-016 | 7.68E-017 +/- 1.54E-017 |

0000097799.CNF




0080

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

Sample Title: 05

Elapsed Live time: 10200
Elapsed Real Time: 10200

| Channel | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1: | 0 | 0 | 0 | 0 | 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 | 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 | 1 | 0 | 0 | 0 |
| 145: | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 153: | 0 | 0 | 0 | 2 | 1 | 1 | 2 | 0 |
| 161: | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 |
| 169: | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 177: | 2 | 1 | 1 | 0 | 2 | 1 | 0 | 3 |
| 185: | 2 | 1 | 3 | 2 | 1 | 4 | 5 | 1 |
| 193: | 0 | 1 | 1 | 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 | 1 | 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: | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 321: | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 329: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 337: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 345: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 353: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 361: | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 369: | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |

Sample Title: 05

| Channel | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 377: | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 385: | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| 393: | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 |
| 401: | 1 | 1 | 0 | 0 | 0 | 3 | 3 | 1 |
| 409: | 1 | 1 | 0 | 2 | 2 | 1 | 1 | 2 |
| 417: | 2 | 3 | 0 | 1 | 1 | 1 | 0 | 1 |
| 425: | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 |
| 433: | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 |
| 441: | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 |
| 449: | 0 | 0 | 0 | 1 | 1 | 3 | 0 | 1 |
| 457: | 0 | 1 | 2 | 2 | 3 | 3 | 2 | 2 |
| 465: | 4 | 2 | 1 | 9 | 1 | 2 | 0 | 3 |
| 473: | 2 | 0 | 2 | 1 | 2 | 3 | 2 | 1 |
| 481: | 3 | 0 | 0 | 0 | 1 | 0 | 2 | 2 |
| 489: | 3 | 0 | 1 | 1 | 1 | 2 | 2 | 0 |
| 497: | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| 505: | 1 | 0 | 2 | 1 | 0 | 0 | 0 | 0 |
| 513: | 1 | 0 | 0 | 2 | 1 | 0 | 1 | 1 |
| 521: | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 529: | 0 | 1 | 0 | 1 | 2 | 1 | 2 | 0 |
| 537: | 0 | 2 | 1 | 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 | 1 | 0 | 0 | 0 | 0 |
| 593: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 601: | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 609: | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 617: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 625: | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| 633: | 0 | 1 | 0 | 1 | 1 | 0 | 2 | 0 |
| 641: | 0 | 0 | 3 | 0 | 1 | 0 | 1 | 0 |
| 649: | 1 | 0 | 0 | 0 | 2 | 0 | 1 | 1 |
| 657: | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 |
| 665: | 0 | 1 | 0 | 0 | 2 | 0 | 1 | 1 |
| 673: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 681: | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 689: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 697: | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 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 | 1 | 0 | 0 | 0 | 0 | 0 |
| 737: | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 |
| 745: | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 0 |
| 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 | 1 | 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 | 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 | 1 | 0 | 0 | 0 | 0 |
| 889: | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| 897: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 905: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 913: | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 921: | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 929: | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 937: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 945: | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 953: | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| 961: | 0 | 0 | 1 | 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 | 1 | 0 | 0 | 0 | 0 | 0 |

9/26/2014 5:24:32 AM

Apex-Alpha™

# QA SUMMARY REPORT

## Review Of QA Results - Pulser Check

Date : 9/26/2014
Time : 5:24:32 AM

| CHAMBER | DEVICE | PARAMETER | FLAG | DATE |
|---|---|---|---|---|
| Alpha_001 | 21f | ALL | Not Done | |
| Alpha_002 | 21f | ALL | Not Done | |
| Alpha_003 | 21f | ALL | Passed | 9/26/2014 5:10:22 AM |
| Alpha_004 | 21f | ALL | Passed | 9/26/2014 5:10:23 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 | 9/26/2014 5:10:24 AM |
| Alpha_011 | 21f | ALL | Passed | 9/26/2014 5:10:25 AM |
| Alpha_012 | 21f | ALL | Passed | 9/26/2014 5:10:26 AM |
| Alpha_013 | 21f | ALL | Not Done | |
| Alpha_014 | 21f | ALL | Passed | 9/26/2014 5:10:26 AM |
| Alpha_015 | 21f | Peak Energy | Action | 9/26/2014 5:10:27 AM |
| Alpha_015 | 21f | Peak FWHM | Action | 9/26/2014 5:10:27 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 | 9/26/2014 5:10:28 AM |
| Alpha_025 | AIM730 | ALL | Passed | 9/26/2014 5:10:29 AM |
| Alpha_026 | AIM730 | ALL | Not Done | |
| Alpha_027 | AIM730 | ALL | Not Done | |
| Alpha_028 | AIM730 | ALL | Not Done | |
| Alpha_029 | AIM730 | ALL | Passed | 9/26/2014 5:10:30 AM |
| Alpha_030 | AIM730 | ALL | Not Done | |
| Alpha_031 | AIM730 | ALL | Passed | 9/26/2014 5:10:31 AM |
| Alpha_032 | AIM730 | ALL | Not Done | |
| Alpha_033 | Alpha Analyst100DC | ALL | Passed | 9/26/2014 5:10:32 AM |
| Alpha_034 | Alpha Analyst100DC | ALL | Passed | 9/26/2014 5:10:33 AM |
| Alpha_035 | Alpha Analyst100DC | ALL | Not Done | |
| Alpha_036 | Alpha Analyst100DC | ALL | Not Done | |
| Alpha_037 | Alpha Analyst100DC | ALL | Passed | 9/26/2014 5:10:35 AM |
| Alpha_038 | Alpha Analyst100DC | ALL | Passed | 9/26/2014 5:10:37 AM |
| Alpha_039 | Alpha Analyst100DC | ALL | Passed | 9/26/2014 5:10:39 AM |
| Alpha_040 | Alpha Analyst100DC | ALL | Passed | 9/26/2014 5:10:41 AM |
| Alpha_041 | Alpha Analyst100DC | ALL | Passed | 9/26/2014 5:10:44 AM |

Review of QA Results - Pulser Check

9/26/2014 5:24:32 AM

| CHAMBER | DEVICE | PARAMETER | FLAG | DATE |
|---|---|---|---|---|
| Alpha_042 | Alpha Analyst100DC | ALL | Passed | 9/26/2014 5:10:46 AM |
| Alpha_043 | Alpha Analyst100DC | ALL | Passed | 9/26/2014 5:10:49 AM |
| Alpha_044 | Alpha Analyst100DC | ALL | Passed | 9/26/2014 5:10:51 AM |
| Alpha_045 | Alpha Analyst100DC | ALL | Passed | 9/26/2014 5:10:53 AM |
| Alpha_046 | Alpha Analyst100DC | ALL | Passed | 9/26/2014 5:10:56 AM |
| Alpha_047 | Alpha Analyst100DC | ALL | Passed | 9/26/2014 5:10:59 AM |
| Alpha_048 | Alpha Analyst100DC | ALL | Passed | 9/26/2014 5:11:01 AM |

**APPROVED BY:** _____

**APPROVAL DATE:** 9/26

```
*********************************************************************
*****          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)

# 14-09075
## GaGbT_ThSr
Run 1



| | |
|---|---|
| Work Order | 14-09075 |
| Analysis Code | GaGbT_ThSr |
| Run | 1 |
| Date Received | 9/16/2014 |
| Lab Deadline | 10/7/2014 |
| 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 | | 09/16/14 00:00 | 1.0000E+00 |
| 02 | MBL | BLANK | | 09/16/14 00:00 | 3.4800E+08 |
| 03 | DUP | OUTSIDE TRAILER | 47 | 09/15/14 14:50 | 2.6000E+08 |
| 04 | DO | OUTSIDE TRAILER | 47 | 09/15/14 14:50 | 2.6000E+08 |
| 05 | TRG | TRANSFER STATION | 53 | 09/15/14 15:15 | 4.3500E+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.

# 14-09075
## 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 | | 7.6128 | 7.6131 | 0.0003 | | | 1.00 | 1.00 |
| 02 | MBL | | | | 0.00 | | 7.6326 | 7.6327 | 0.0001 | | | 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.

# 14-09075
## 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 | | | 09/23/14 05:06 | MHIGHTOWER | | | | |
| 02 | MBL | | | 09/23/14 05:06 | MHIGHTOWER | | | | |
| 03 | DUP | | | 09/23/14 05:06 | MHIGHTOWER | | | | |
| 04 | DO | | | 09/23/14 05:06 | MHIGHTOWER | | | | |
| 05 | TRG | | | 09/23/14 05:06 | MHIGHTOWER | | | | |

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

Eberline Services
Oak Ridge Laboratory

**Preliminary Data Report & Analytical Calculations**

# Work Order: 14-09075-GaGbT-1



Client: Feezor Engineering, Inc.
Eberline Services Work Order: 14-09075
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 | 2.87E-04 | 3.84E-06 | 2.27E-07 | 2.70E-04 | 106.37 | OK | | INV | |
| 02 | GROSS ALPHA | MBL | BLANK | uCi/ml | 7.48E-17 | 1.79E-16 | 4.13E-16 | | | | | OK | OK |
| 03 | GROSS ALPHA | DUP | OUTSIDE TRAILER | uCi/ml | 3.06E-15 | 9.59E-16 | 1.28E-15 | | | | NA | OK | |
| 04 | GROSS ALPHA | DO | OUTSIDE TRAILER | uCi/ml | 3.60E-15 | 8.99E-16 | 8.49E-16 | | | | | OK | |
| 05 | GROSS ALPHA | TRG | TRANSFER STATION | uCi/ml | 2.06E-15 | 5.73E-16 | 6.66E-16 | | | | | OK | |

1600

# Preliminary Data Report & Analytical Calculations
# Work Order: 14-09075-GaGbT-1



| Client | Eberline Services Work Order | Analysis Code | Run |
|---|---|---|---|
| Feezor Engineering, Inc. | 14-09075 | 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 | 09/16/14 00:00 | 1.00E+00 | 0.00 | 0.00 | 0.00 | 1.00 | | |
| 02 | GROSS ALPHA | MBL | 09/16/14 00:00 | 3.48E+08 | 0.00 | 0.00 | 0.00 | 1.00 | | |
| 03 | GROSS ALPHA | DUP | 09/15/14 14:50 | 2.60E+08 | 0.00 | 0.00 | 0.00 | 1.00 | | |
| 04 | GROSS ALPHA | DO | 09/15/14 14:50 | 2.60E+08 | 0.00 | 0.00 | 0.00 | 1.00 | | |
| 05 | GROSS ALPHA | TRG | 09/15/14 15:15 | 4.35E+08 | 0.00 | 0.00 | 0.00 | 1.00 | | |

**Preliminary Data Report & Analytical Calculations**

# Work Order: 14-09075-GaGbT-1



Client: Feezor Engineering, Inc.
Eberline Services Work Order: 14-09075
Analysis Code: GaGbT
Run: 1

| Lab Fraction | Nuclide | Sample Desc | Counting Date/Time | Halflife (days) | Detect | Carrier | Count Time | Counts | Bkg CPM | Eff |
|---|---|---|---|---|---|---|---|---|---|---|
| 01 | GROSS ALPHA | LCS | 09/23/14 07:09 | | LB4110R | C1 | 120 | 21473 | 0.05 | 0.2806 |
| 02 | GROSS ALPHA | MBL | 09/23/14 07:09 | | LB4110R | C2 | 120 | 4 | 0.016666667 | 0.2886 |
| 03 | GROSS ALPHA | DUP | 09/23/14 07:09 | | LB4110R | C3 | 120 | 72 | 0.116666667 | 0.2736 |
| 04 | GROSS ALPHA | DO | 09/23/14 09:11 | | LB4110R | A1 | 120 | 78 | 0.05 | 0.2885 |
| 05 | GROSS ALPHA | TRG | 09/23/14 07:09 | | LB4110R | C4 | 120 | 75 | 0.083333333 | 0.2722 |

Eberline Services
Oak Ridge Laboratory

**Preliminary Data Report & Analytical Calculations**

# Work Order: 14-09075-GaGbT-1



Client: Feezor Engineering, Inc.
Eberline Services Work Order: 14-09075
Analysis Code: GaGbT
Run: 1

| Lab Fraction | Nuclide | Sample Desc | Client Identification | Activity Units | Results | Error Estimate | MDA | LCS Known | LCS %R | LCS Flag | RPD Flag | MDA Flag | Blank Flag |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01 | GROSS BETA | LCS | LCS | uCi/ml | 2.67E-04 | 3.07E-06 | 5.28E-07 | 3.01E-04 | 88.68 | OK | | INV | |
| 02 | GROSS BETA | MBL | BLANK | uCi/ml | 4.31E-16 | 8.74E-16 | 1.82E-15 | | | | | OK | OK |
| 03 | GROSS BETA | DUP | OUTSIDE TRAILER | uCi/ml | 2.00E-14 | 1.94E-15 | 2.46E-15 | | | | OK | OK | |
| 04 | GROSS BETA | DO | OUTSIDE TRAILER | uCi/ml | 2.03E-14 | 2.02E-15 | 2.74E-15 | | | | | OK | |
| 05 | GROSS BETA | TRG | TRANSFER STATION | uCi/ml | 1.72E-14 | 1.28E-15 | 1.38E-15 | | | | | OK | |

0094

**Preliminary Data Report & Analytical Calculations**

# Work Order: 14-09075-GaGbT-1



| Client | Eberline Services Work Order | Analysis Code | Run |
|---|---|---|---|
| Feezor Engineering, Inc. | 14-09075 | 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 | 09/16/14 00:00 | 1.00E+00 | 0.00 | 0.00 | 0.00 | 1.00 | | |
| 02 | GROSS BETA | MBL | 09/16/14 00:00 | 3.48E+08 | 0.00 | 0.00 | 0.00 | 1.00 | | |
| 03 | GROSS BETA | DUP | 09/15/14 14:50 | 2.60E+08 | 0.00 | 0.00 | 0.00 | 1.00 | | |
| 04 | GROSS BETA | DO | 09/15/14 14:50 | 2.60E+08 | 0.00 | 0.00 | 0.00 | 1.00 | | |
| 05 | GROSS BETA | TRG | 09/15/14 15:15 | 4.35E+08 | 0.00 | 0.00 | 0.00 | 1.00 | | |

# Preliminary Data Report & Analytical Calculations
# Work Order: 14-09075-GaGbT-1



| Client | Eberline Services Work Order | Analysis Code | Run |
|---|---|---|---|
| Feezor Engineering, Inc. | 14-09075 | 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 | 09/23/14 07:09 | | LB4110R | C1 | 120 | 40009 | 1.066666667 | 0.4795 | 285.59512 |
| 02 | GROSS BETA | MBL | 09/23/14 07:09 | | LB4110R | C2 | 120 | 203 | 1.533333333 | 0.4758 | 1.691666667 |
| 03 | GROSS BETA | DUP | 09/23/14 07:09 | | LB4110R | C3 | 120 | 853 | 1.533333333 | 0.4705 | 6.954913333 |
| 04 | GROSS BETA | DO | 09/23/14 09:11 | | LB4110R | A1 | 120 | 926 | 1.966666667 | 0.4777 | 7.550461667 |
| 05 | GROSS BETA | TRG | 09/23/14 07:09 | | LB4110R | C4 | 120 | 1138 | 1.383333333 | 0.4781 | 9.323520833 |

**Count Room Report**
**Client: Feezor Engineering, Inc.**

**14-09075-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 | 09/16/14 00:00 | 1.0000 | | | | 0.00 | 1.00 | 1.00 |
| 02 | MBL | BLANK | 09/16/14 00:00 | 348000000.0000 | | | | 0.00 | 1.00 | 1.00 |
| 03 | DUP | OUTSIDE TRAILER | 09/15/14 14:50 | 260000000.0000 | | | | 0.00 | 1.00 | 1.00 |
| 04 | DO | OUTSIDE TRAILER | 09/15/14 14:50 | 260000000.0000 | | | | 0.00 | 1.00 | 1.00 |
| 05 | TRG | TRANSFER STATION | 09/15/14 15:15 | 435000000.0000 | | | | 0.00 | 1.00 | 1.00 |

Eberline Services
Oak Ridge Laboratory

# Spike and Tracer Worksheet


Printed: 9/23/2014 5:06 AM

| Internal Work Order | Run | Analysis Code | Date | Technician | Technician Initials | Witness Initials |
|---|---|---|---|---|---|---|
| 14-09075 | 1 | GaGbT_ThSr | 9/23/2014 5:05 | MHIGHTOWER | Mu | |

| 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 | 597.024 | 9/23/2014 | **0.790** | **1.0039** | | | | 269.98 | 11.609 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 |
| **SrY-90** | A/B-07 | 666.497 | 9/23/2014 | **0.830** | **1.0039** | | | | 301.39 | 9.042 | 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

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Eberline Analytical
Oak Ridge Laboratory

# Aliquot Worksheet



| Work Order | Run | Analysis Code | Rpt Units | Lab Deadline | Technician |
|---|---|---|---|---|---|
| 14-09075 | 1 | GaGbT_ThSr | ml | 10/7/2014 | MHIGHTOWER |

| Lab Fraction | Feezor Engineering, Inc. Client ID | Sample Type | Muffle Data Ratio Post/Pre | Dilution Data No of Dils | Dil Factor | Ratio | Aliquot Data Aliquot | Net Equiv | MS Aliquot Data Aliquot | Net Equiv | H-3 Solids Only Water Added (ml) | H3 Dist Aliq |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01 | LCS | LCS | | | | | 1.0000E+00 | 1.0000E+00 | | | | |
| 02 | BLANK | MBL | | | | | 3.4800E+08 | 3.4800E+08 | | | | |
| 03 | OUTSIDE TRAILER | DUP | | | | | 2.6000E+08 | 2.6000E+08 | | | | |
| 04 | OUTSIDE TRAILER | DO | | | | | 2.6000E+08 | 2.6000E+08 | | | | |
| 05 | TRANSFER STATION | TRG | | | | | 4.3500E+08 | 4.3500E+08 | | | | |

| Comments | |
|---|---|

Technician: MH Date: 9/22/14

0099

# Gravimetric Worksheet



| Work Order | Run | Analysis Code | Gravimetric Carrier | Carrier Conc (mg/ml) | Technician |
|---|---|---|---|---|---|
| 14-09075 | 1 | GaGbT_ThSr | | | MHIGHTOWER |

| 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 | | | 7.6128 | 7.6131 | 0.0003 | |
| 02 | BLANK | | | 7.6326 | 7.6327 | 0.0001 | |
| 03 | DUP | | | 1.0000 | 1.0001 | 0.0001 | |
| 04 | OUTSIDE TRAILER | | | 1.0000 | 1.0001 | 0.0001 | |
| 05 | TRANSFER STATION | | | 1.0000 | 1.0001 | 0.0001 | |

Technician: Mh Date: 9 / 22 / 14

0108

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9/29
R

| Detector ID | Sample ID | Alpha | Beta | Count Time | Voltage | TOD |
|---|---|---|---|---|---|---|
| C1 | 1409075-01 | 21473 | 40009 | 120 | 1400 | 9/23/14 9:09 |
| C2 | 1409075-02 | 4 | 203 | 120 | 1400 | 9/23/14 9:09 |
| C3 | 1409075-03 | 72 | 853 | 120 | 1400 | 9/23/14 9:09 |
| C4 | 1409075-05 | 75 | 1138 | 120 | 1400 | 9/23/14 9:09 |



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R
9/23/14
LKB

| Detector ID | Sample ID | Alpha | Beta | Count Time | Voltage | TOD |
|---|---|---|---|---|---|---|
| A1 | 1409075-04 | 78 | 926 | 120 | 1400 | 9/23/14 11:11 |



0102

Eberline Analytical
Oak Ridge Laboratory

GPC Detector Report
(ALL Backgrounds)



9/22

| Detector | Alpha/Beta | Calibration Date | Count Date | Bkg CPM | PFW | LCL | Mean | UCL |
|---|---|---|---|---|---|---|---|---|
| LB4110A - A1 | Alpha | 11/18/2007 | 9/23/2014 | 3.33E-02 | P | -1.96E+01 | 2.46E-01 | 2.01E+01 |
| LB4110A - A2 | Alpha | 11/18/2007 | 9/23/2014 | 5.00E-02 | P | -1.66E+01 | 2.22E-01 | 1.71E+01 |
| LB4110A - A3 | Alpha | 11/18/2007 | 9/23/2014 | 8.33E-02 | P | -1.62E+01 | 1.93E-01 | 1.66E+01 |
| LB4110A - A4 | Alpha | 11/18/2007 | 9/23/2014 | 3.33E-02 | P | -1.72E+01 | 2.06E-01 | 1.76E+01 |
| LB4110A - B1 | Alpha | 11/18/2007 | 9/23/2014 | 3.33E-02 | P | -9.25E-02 | 7.27E-02 | 2.38E-01 |
| LB4110A - B2 | Alpha | 11/18/2007 | 9/23/2014 | 1.50E-01 | P | -7.24E-02 | 7.30E-02 | 2.18E-01 |
| LB4110A - B3 | Alpha | 11/18/2007 | 9/23/2014 | 1.00E-01 | P | -6.24E-02 | 5.51E-02 | 1.72E-01 |
| LB4110A - B4 | Alpha | 11/18/2007 | 9/23/2014 | 0.00E+00 | P | -1.29E-01 | 7.76E-02 | 2.85E-01 |
| LB4110A - C1 | Alpha | 11/18/2007 | 9/23/2014 | 6.67E-02 | P | -1.38E-01 | 8.75E-02 | 3.13E-01 |
| LB4110A - C2 | Alpha | 11/18/2007 | 9/23/2014 | 5.00E-02 | P | -1.67E-01 | 8.07E-02 | 3.29E-01 |
| LB4110A - C3 | Alpha | 11/18/2007 | 9/23/2014 | 6.67E-02 | P | -1.62E-01 | 9.46E-02 | 3.52E-01 |
| LB4110A - C4 | Alpha | 11/18/2007 | 9/23/2014 | 3.33E-02 | P | -6.45E-02 | 6.91E-02 | 2.03E-01 |
| LB4110A - D1 | Alpha | 11/18/2007 | 9/23/2014 | 8.33E-02 | P | -5.47E-02 | 8.06E-02 | 2.16E-01 |
| LB4110A - D2 | Alpha | 11/18/2007 | 9/23/2014 | 3.33E-02 | P | -7.01E-02 | 6.06E-02 | 1.91E-01 |
| LB4110A - D3 | Alpha | 11/18/2007 | 9/23/2014 | 3.33E-02 | P | -5.02E-02 | 6.82E-02 | 1.87E-01 |
| LB4110A - D4 | Alpha | 11/18/2007 | 9/23/2014 | 1.67E-02 | P | -6.75E-02 | 7.04E-02 | 2.08E-01 |
| LB4110R - A1 | Alpha | 11/24/2006 | 9/23/2014 | 5.00E-02 | P | -9.28E-02 | 9.83E-02 | 2.89E-01 |
| LB4110R - A2 | Alpha | 11/24/2006 | 9/23/2014 | 8.33E-02 | P | -8.57E-02 | 7.26E-02 | 2.31E-01 |
| LB4110R - A3 | Alpha | 11/24/2006 | 9/23/2014 | 1.33E-01 | P | -7.14E-02 | 8.13E-02 | 2.34E-01 |
| LB4110R - A4 | Alpha | 11/24/2006 | 9/23/2014 | 1.33E-01 | P | -5.17E-02 | 6.91E-02 | 1.90E-01 |
| LB4110R - B1 | Alpha | 11/24/2006 | 9/23/2014 | 1.67E-02 | P | -9.00E-02 | 6.17E-02 | 2.13E-01 |
| LB4110R - B2 | Alpha | 11/24/2006 | 9/23/2014 | 3.33E-02 | P | -6.87E-02 | 6.04E-02 | 1.89E-01 |
| LB4110R - B3 | Alpha | 11/24/2006 | 9/23/2014 | 2.17E-01 | F | -6.51E-02 | 7.21E-02 | 2.09E-01 |
| LB4110R - B4 | Alpha | 11/24/2006 | 9/23/2014 | 3.33E-02 | P | -6.14E-02 | 6.80E-02 | 1.98E-01 |
| LB4110R - C1 | Alpha | 11/24/2006 | 9/23/2014 | 5.00E-02 | P | -7.52E-02 | 7.27E-02 | 2.21E-01 |
| LB4110R - C2 | Alpha | 11/24/2006 | 9/23/2014 | 1.67E-02 | P | -7.55E-02 | 6.81E-02 | 2.12E-01 |
| LB4110R - C3 | Alpha | 11/24/2006 | 9/23/2014 | 1.17E-01 | P | -8.25E-02 | 8.41E-02 | 2.51E-01 |
| LB4110R - C4 | Alpha | 11/24/2006 | 9/23/2014 | 8.33E-02 | P | -6.01E-02 | 7.85E-02 | 2.17E-01 |
| LB4110R - D1 | Alpha | 11/24/2006 | 8/15/2014 | 0.00E+00 | P | -1.06E-01 | 6.71E-02 | 2.40E-01 |
| LB4110R - D2 | Alpha | 11/24/2006 | 8/15/2014 | 0.00E+00 | P | -8.23E-02 | 6.65E-02 | 2.15E-01 |
| LB4110R - D3 | Alpha | 11/24/2006 | 8/15/2014 | 0.00E+00 | P | -8.70E-02 | 6.63E-02 | 2.20E-01 |
| LB4110R - D4 | Alpha | 11/24/2006 | 8/15/2014 | 0.00E+00 | P | -8.04E-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 |

Eberline Analytical
Oak Ridge Laboratory

GPC Detector Report
(ALL Backgrounds)



9/22

| Detector | Alpha/Beta | Calibration Date | Count Date | Bkg CPM | PFW | LCL | Mean | UCL |
|---|---|---|---|---|---|---|---|---|
| LB4110A - A1 | Beta | 11/18/2007 | 9/23/2014 | 1.23E+00 | P | -2.65E+02 | 7.35E+00 | 2.80E+02 |
| LB4110A - A2 | Beta | 11/18/2007 | 9/23/2014 | 1.22E+00 | P | -2.77E+01 | 2.76E+00 | 3.32E+01 |
| LB4110A - A3 | Beta | 11/18/2007 | 9/23/2014 | 1.48E+00 | P | -4.60E+01 | 2.59E+00 | 5.12E+01 |
| LB4110A - A4 | Beta | 11/18/2007 | 9/23/2014 | 7.47E+00 | P | -2.93E+01 | 3.96E+00 | 3.72E+01 |
| LB4110A - B1 | Beta | 11/18/2007 | 9/23/2014 | 1.85E+00 | P | -9.50E+00 | 3.10E+00 | 1.57E+01 |
| LB4110A - B2 | Beta | 11/18/2007 | 9/23/2014 | 1.73E+00 | P | -6.94E+00 | 1.92E+00 | 1.08E+01 |
| LB4110A - B3 | Beta | 11/18/2007 | 9/23/2014 | 1.40E+00 | P | -4.02E-01 | 1.40E+00 | 3.21E+00 |
| LB4110A - B4 | Beta | 11/18/2007 | 9/23/2014 | 1.28E+00 | P | -7.53E+00 | 1.97E+00 | 1.15E+01 |
| LB4110A - C1 | Beta | 11/18/2007 | 9/23/2014 | 1.28E+00 | P | -4.90E+00 | 2.02E+00 | 8.94E+00 |
| LB4110A - C2 | Beta | 11/18/2007 | 9/23/2014 | 1.45E+00 | P | 3.07E-01 | 1.28E+00 | 2.26E+00 |
| LB4110A - C3 | Beta | 11/18/2007 | 9/23/2014 | 1.90E+00 | P | 2.88E-01 | 1.52E+00 | 2.76E+00 |
| LB4110A - C4 | Beta | 11/18/2007 | 9/23/2014 | 1.37E+00 | P | -1.61E+00 | 2.00E+00 | 5.61E+00 |
| LB4110A - D1 | Beta | 11/18/2007 | 9/23/2014 | 1.55E+00 | P | -2.27E+00 | 2.51E+00 | 7.29E+00 |
| LB4110A - D2 | Beta | 11/18/2007 | 9/23/2014 | 5.53E+00 | P | -3.72E+00 | 1.88E+00 | 7.48E+00 |
| LB4110A - D3 | Beta | 11/18/2007 | 9/23/2014 | 2.27E+00 | P | 8.21E-01 | 4.36E+00 | 7.90E+00 |
| LB4110A - D4 | Beta | 11/18/2007 | 9/23/2014 | 5.62E+00 | P | -7.49E+00 | 1.81E+00 | 1.11E+01 |
| LB4110R - A1 | Beta | 11/24/2006 | 9/23/2014 | 1.97E+00 | P | -5.66E+01 | 3.35E+00 | 6.33E+01 |
| LB4110R - A2 | Beta | 11/24/2006 | 9/23/2014 | 1.92E+00 | P | -4.48E+01 | 1.93E+00 | 4.87E+01 |
| LB4110R - A3 | Beta | 11/24/2006 | 9/23/2014 | 1.47E+00 | P | -4.15E+01 | 2.55E+00 | 4.66E+01 |
| LB4110R - A4 | Beta | 11/24/2006 | 9/23/2014 | 3.60E+00 | P | -4.13E+01 | 2.00E+00 | 4.53E+01 |
| LB4110R - B1 | Beta | 11/24/2006 | 9/23/2014 | 1.72E+00 | P | -4.35E+01 | 1.94E+00 | 4.74E+01 |
| LB4110R - B2 | Beta | 11/24/2006 | 9/23/2014 | 1.45E+01 | P | -4.87E+01 | 3.17E+00 | 5.51E+01 |
| LB4110R - B3 | Beta | 11/24/2006 | 9/23/2014 | 1.37E+00 | P | -4.33E+01 | 2.50E+00 | 4.83E+01 |
| LB4110R - B4 | Beta | 11/24/2006 | 9/23/2014 | 9.00E-01 | P | -4.36E+01 | 1.84E+00 | 4.73E+01 |
| LB4110R - C1 | Beta | 11/24/2006 | 9/23/2014 | 1.07E+00 | P | -4.35E+01 | 2.75E+00 | 4.90E+01 |
| LB4110R - C2 | Beta | 11/24/2006 | 9/23/2014 | 1.53E+00 | P | -4.34E+01 | 2.58E+00 | 4.85E+01 |
| LB4110R - C3 | Beta | 11/24/2006 | 9/23/2014 | 1.53E+00 | P | -4.39E+01 | 2.38E+00 | 4.86E+01 |
| LB4110R - C4 | Beta | 11/24/2006 | 9/23/2014 | 1.38E+00 | P | -4.95E+01 | 2.75E+00 | 5.50E+01 |
| LB4110R - D1 | Beta | 11/24/2006 | 8/15/2014 | 0.00E+00 | P | -4.37E+01 | 5.31E+00 | 5.43E+01 |
| LB4110R - D2 | Beta | 11/24/2006 | 8/15/2014 | 0.00E+00 | P | -4.67E+01 | 1.79E+00 | 5.03E+01 |
| LB4110R - D3 | Beta | 11/24/2006 | 8/15/2014 | 0.00E+00 | P | -5.02E+01 | 5.28E+00 | 6.08E+01 |
| LB4110R - D4 | Beta | 11/24/2006 | 8/15/2014 | 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 |

0107

Eberline Analytical
Oak Ridge Laboratory

# GPC Detector Report
(ALL Efficiencies)



| Detector | Alpha/Beta | Calibration Date | Count Date | Eff | PFW | LCL | Mean | UCL |
|---|---|---|---|---|---|---|---|---|
| LB4110A - A1 | Alpha | 11/18/2007 | 9/23/2014 | 0.2256 | P | 0.0078 | 0.2185 | 0.4293 |
| LB4110A - A2 | Alpha | 11/18/2007 | 9/23/2014 | 0.2030 | P | -0.0295 | 0.1781 | 0.3857 |
| LB4110A - A3 | Alpha | 11/18/2007 | 9/23/2014 | 0.2002 | P | -0.0514 | 0.1691 | 0.3895 |
| LB4110A - A4 | Alpha | 11/18/2007 | 9/23/2014 | 0.2301 | P | -0.0302 | 0.1894 | 0.4089 |
| LB4110A - B1 | Alpha | 11/18/2007 | 9/23/2014 | 0.2207 | P | 0.1952 | 0.2236 | 0.2520 |
| LB4110A - B2 | Alpha | 11/18/2007 | 9/23/2014 | 0.2064 | P | 0.1894 | 0.2192 | 0.2490 |
| LB4110A - B3 | Alpha | 11/18/2007 | 9/23/2014 | 0.2356 | P | 0.1365 | 0.2326 | 0.3287 |
| LB4110A - B4 | Alpha | 11/18/2007 | 9/23/2014 | 0.2259 | P | 0.2063 | 0.2345 | 0.2627 |
| LB4110A - C1 | Alpha | 11/18/2007 | 9/23/2014 | 0.2168 | P | 0.1981 | 0.2202 | 0.2423 |
| LB4110A - C2 | Alpha | 11/18/2007 | 9/23/2014 | 0.2219 | P | 0.1987 | 0.2250 | 0.2513 |
| LB4110A - C3 | Alpha | 11/18/2007 | 9/23/2014 | 0.2462 | P | 0.2241 | 0.2490 | 0.2738 |
| LB4110A - C4 | Alpha | 11/18/2007 | 9/23/2014 | 0.2169 | P | 0.1981 | 0.2250 | 0.2520 |
| LB4110A - D1 | Alpha | 11/18/2007 | 9/23/2014 | 0.2132 | P | 0.1796 | 0.2306 | 0.2816 |
| LB4110A - D2 | Alpha | 11/18/2007 | 9/23/2014 | 0.2427 | P | 0.2015 | 0.2560 | 0.3105 |
| LB4110A - D3 | Alpha | 11/18/2007 | 9/23/2014 | 0.2567 | P | 0.2050 | 0.2613 | 0.3176 |
| LB4110A - D4 | Alpha | 11/18/2007 | 9/23/2014 | 0.1929 | P | 0.1484 | 0.1975 | 0.2465 |
| LB4110R - A1 | Alpha | 11/24/2006 | 9/23/2014 | 0.2281 | P | 0.2000 | 0.2378 | 0.2755 |
| LB4110R - A2 | Alpha | 11/24/2006 | 9/23/2014 | 0.2082 | P | 0.1848 | 0.2187 | 0.2527 |
| LB4110R - A3 | Alpha | 11/24/2006 | 9/23/2014 | 0.2102 | P | 0.1922 | 0.2231 | 0.2540 |
| LB4110R - A4 | Alpha | 11/24/2006 | 9/23/2014 | 0.2344 | P | 0.2129 | 0.2446 | 0.2764 |
| LB4110R - B1 | Alpha | 11/24/2006 | 9/23/2014 | 0.1922 | P | 0.1705 | 0.2228 | 0.2751 |
| LB4110R - B2 | Alpha | 11/24/2006 | 9/23/2014 | 0.1771 | W | 0.1682 | 0.2148 | 0.2614 |
| LB4110R - B3 | Alpha | 11/24/2006 | 9/23/2014 | 0.2293 | P | 0.1970 | 0.2433 | 0.2896 |
| LB4110R - B4 | Alpha | 11/24/2006 | 9/23/2014 | 0.2032 | P | 0.1806 | 0.2288 | 0.2770 |
| LB4110R - C1 | Alpha | 11/24/2006 | 9/23/2014 | 0.2055 | P | 0.1794 | 0.2140 | 0.2485 |
| LB4110R - C2 | Alpha | 11/24/2006 | 9/23/2014 | 0.2096 | P | 0.1900 | 0.2230 | 0.2561 |
| LB4110R - C3 | Alpha | 11/24/2006 | 9/23/2014 | 0.2291 | P | 0.2034 | 0.2382 | 0.2730 |
| LB4110R - C4 | Alpha | 11/24/2006 | 9/23/2014 | 0.2060 | P | 0.1782 | 0.2198 | 0.2614 |
| LB4110R - D1 | Alpha | 11/24/2006 | 8/15/2014 | 0.0000 | W | -0.0277 | 0.1905 | 0.4088 |
| LB4110R - D2 | Alpha | 11/24/2006 | 8/15/2014 | 0.0000 | W | -0.0310 | 0.2166 | 0.4642 |
| LB4110R - D3 | Alpha | 11/24/2006 | 8/15/2014 | 0.0000 | W | -0.0304 | 0.2128 | 0.4560 |
| LB4110R - D4 | Alpha | 11/24/2006 | 8/15/2014 | 0.0000 | W | -0.0257 | 0.1715 | 0.3688 |
| 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)



9/23

| Detector | Alpha/Beta | Calibration Date | Count Date | Eff | PFW | LCL | Mean | UCL |
|---|---|---|---|---|---|---|---|---|
| LB4110A - A1 | Beta | 11/18/2007 | 9/23/2014 | 0.5644 | P | 0.2400 | 0.5629 | 0.8858 |
| LB4110A - A2 | Beta | 11/18/2007 | 9/23/2014 | 0.4617 | P | 0.1888 | 0.4678 | 0.7468 |
| LB4110A - A3 | Beta | 11/18/2007 | 9/23/2014 | 0.4856 | P | 0.1236 | 0.4626 | 0.8017 |
| LB4110A - A4 | Beta | 11/18/2007 | 9/23/2014 | 0.5583 | P | 0.1739 | 0.5014 | 0.8288 |
| LB4110A - B1 | Beta | 11/18/2007 | 9/23/2014 | 0.5467 | P | 0.4660 | 0.5329 | 0.5998 |
| LB4110A - B2 | Beta | 11/18/2007 | 9/23/2014 | 0.5381 | P | 0.4674 | 0.5273 | 0.5871 |
| LB4110A - B3 | Beta | 11/18/2007 | 9/23/2014 | 0.6054 | P | 0.3347 | 0.5405 | 0.7463 |
| LB4110A - B4 | Beta | 11/18/2007 | 9/23/2014 | 0.5648 | P | 0.4950 | 0.5557 | 0.6164 |
| LB4110A - C1 | Beta | 11/18/2007 | 9/23/2014 | 0.5510 | P | 0.4363 | 0.5107 | 0.5852 |
| LB4110A - C2 | Beta | 11/18/2007 | 9/23/2014 | 0.5580 | P | 0.3982 | 0.5150 | 0.6318 |
| LB4110A - C3 | Beta | 11/18/2007 | 9/23/2014 | 0.6164 | P | 0.5251 | 0.5971 | 0.6692 |
| LB4110A - C4 | Beta | 11/18/2007 | 9/23/2014 | 0.5708 | P | 0.4524 | 0.5321 | 0.6117 |
| LB4110A - D1 | Beta | 11/18/2007 | 9/23/2014 | 0.7179 | W | 0.3932 | 0.5605 | 0.7277 |
| LB4110A - D2 | Beta | 11/18/2007 | 9/23/2014 | 0.6820 | P | 0.4360 | 0.5891 | 0.7421 |
| LB4110A - D3 | Beta | 11/18/2007 | 9/23/2014 | 0.6605 | P | 0.4790 | 0.6145 | 0.7500 |
| LB4110A - D4 | Beta | 11/18/2007 | 9/23/2014 | 0.5015 | P | 0.3498 | 0.4708 | 0.5918 |
| LB4110R - A1 | Beta | 11/24/2006 | 9/23/2014 | 0.5700 | P | 0.4808 | 0.5699 | 0.6590 |
| LB4110R - A2 | Beta | 11/24/2006 | 9/23/2014 | 0.5282 | P | 0.4225 | 0.5111 | 0.5997 |
| LB4110R - A3 | Beta | 11/24/2006 | 9/23/2014 | 0.5310 | P | 0.4560 | 0.5386 | 0.6212 |
| LB4110R - A4 | Beta | 11/24/2006 | 9/23/2014 | 0.6169 | P | 0.5090 | 0.5948 | 0.6806 |
| LB4110R - B1 | Beta | 11/24/2006 | 9/23/2014 | 0.4697 | P | 0.4288 | 0.5399 | 0.6511 |
| LB4110R - B2 | Beta | 11/24/2006 | 9/23/2014 | 0.4363 | W | 0.4129 | 0.5181 | 0.6232 |
| LB4110R - B3 | Beta | 11/24/2006 | 9/23/2014 | 0.5996 | P | 0.4816 | 0.5956 | 0.7096 |
| LB4110R - B4 | Beta | 11/24/2006 | 9/23/2014 | 0.5114 | P | 0.4429 | 0.5483 | 0.6536 |
| LB4110R - C1 | Beta | 11/24/2006 | 9/23/2014 | 0.4961 | P | 0.4133 | 0.5018 | 0.5903 |
| LB4110R - C2 | Beta | 11/24/2006 | 9/23/2014 | 0.5421 | P | 0.4327 | 0.5357 | 0.6387 |
| LB4110R - C3 | Beta | 11/24/2006 | 9/23/2014 | 0.5988 | P | 0.4811 | 0.5740 | 0.6669 |
| LB4110R - C4 | Beta | 11/24/2006 | 9/23/2014 | 0.5256 | P | 0.4306 | 0.5259 | 0.6211 |
| LB4110R - D1 | Beta | 11/24/2006 | 8/15/2014 | 0.0000 | W | -0.0670 | 0.4556 | 0.9781 |
| LB4110R - D2 | Beta | 11/24/2006 | 8/15/2014 | 0.0000 | W | -0.0747 | 0.5119 | 1.0985 |
| LB4110R - D3 | Beta | 11/24/2006 | 8/15/2014 | 0.0000 | W | -0.0727 | 0.4972 | 1.0670 |
| LB4110R - D4 | Beta | 11/24/2006 | 8/15/2014 | 0.0000 | W | -0.0622 | 0.4093 | 0.8808 |
| LB5100 - 1 | Beta | 7/10/2006 | 10/26/2007 | 0.4428 | F | 0.4555 | 0.4731 | 0.4906 |

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