

## ANALYTICAL REPORT

Job Number: 160-17563-1

Job Description: HDP RFP-CBA-022 (21 DAY TAT)

For:

Westinghouse Electric Company LLC  
3300 State Road P  
Festus, MO 63028

Attention: Mr. Martin Swanson



Approved for release.  
Ivan H Vania  
Project Manager II  
6/9/2016 5:07 PM

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06/09/2016

The test results in this report meet NELAP requirements for parameters for which accreditation is required or available. Any exceptions to the NELAP requirements are noted. Results pertain only to samples listed in this report. Pursuant to NELAP, this report shall not be reproduced, except in full, without the written approval of the laboratory. This report is confidential and is intended for the sole use of TestAmerica and its client. All questions regarding this report should be directed to the TestAmerica Project Manager.

Louisiana Lab Certification ID (Non-Potable, Solid/Haz. Material): 106151  
Florida Lab Certification ID (Drinking Water): E87689.

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## Definitions/Glossary

Client: Westinghouse Electric Company LLC  
Project/Site: HDP RFP-CBA-022 (21 DAY TAT)

TestAmerica Job ID: 160-17563-1

### Qualifiers

#### Rad

| Qualifier | Qualifier Description                            |
|-----------|--------------------------------------------------|
| U         | Result is less than the sample detection limit.  |
| G         | The Sample MDC is greater than the requested RL. |

### Glossary

| Abbreviation   | These commonly used abbreviations may or may not be present in this report.                                 |
|----------------|-------------------------------------------------------------------------------------------------------------|
| α              | Listed under the "D" column to designate that the result is reported on a dry weight basis                  |
| %R             | Percent Recovery                                                                                            |
| CFL            | Contains Free Liquid                                                                                        |
| CNF            | Contains no Free Liquid                                                                                     |
| DER            | Duplicate error ratio (normalized absolute difference)                                                      |
| Dil Fac        | Dilution Factor                                                                                             |
| DL, RA, RE, IN | Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample |
| DLC            | Decision level concentration                                                                                |
| MDA            | Minimum detectable activity                                                                                 |
| EDL            | Estimated Detection Limit                                                                                   |
| MDC            | Minimum detectable concentration                                                                            |
| MDL            | Method Detection Limit                                                                                      |
| ML             | Minimum Level (Dioxin)                                                                                      |
| NC             | Not Calculated                                                                                              |
| ND             | Not detected at the reporting limit (or MDL or EDL if shown)                                                |
| PQL            | Practical Quantitation Limit                                                                                |
| QC             | Quality Control                                                                                             |
| RER            | Relative error ratio                                                                                        |
| RL             | Reporting Limit or Requested Limit (Radiochemistry)                                                         |
| RPD            | Relative Percent Difference, a measure of the relative difference between two points                        |
| TEF            | Toxicity Equivalent Factor (Dioxin)                                                                         |
| TEQ            | Toxicity Equivalent Quotient (Dioxin)                                                                       |

## CASE NARRATIVE

**Client: Westinghouse Electric Company LLC**

**Project: HDP RFP-CBA-022 (21 DAY TAT)**

**Report Number: 160-17563-1**

With the exceptions noted as flags or footnotes, standard analytical protocols were followed in the analysis of the samples and no problems were encountered or anomalies observed. In addition all laboratory quality control samples were within established control limits, with any exceptions noted below. Each sample was analyzed to achieve the lowest possible reporting limit within the constraints of the method. In some cases, due to interference or analytes present at high concentrations, samples were diluted. For diluted samples, the reporting limits are adjusted relative to the dilution required.

TestAmerica St. Louis attests to the validity of the laboratory data generated by TestAmerica facilities reported herein. All analyses performed by TestAmerica facilities were done using established laboratory SOPs that incorporate QA/QC procedures described in the application methods. TestAmerica's operations groups have reviewed the data for compliance with the laboratory QA/QC plan, and data have been found to be compliant with laboratory protocols unless otherwise noted below.

The test results in this report meet all NELAP requirements for parameters for which accreditation is required or available. Any exceptions to NELAP requirements are noted in this report. Pursuant to NELAP, this report may not be reproduced, except in full, without the written approval of the laboratory.

Calculations are performed before rounding to avoid round-off errors in calculated results.

All holding times were met and proper preservation noted for the methods performed on these samples, unless otherwise detailed in the individual sections below.

All solid sample results for Chemistry analyses are reported on an "as received" basis unless otherwise indicated by the presence of a % solids value in the method header. All soil/sediment sample results for radiochemistry analyses are based upon sample as dried and disaggregated with the exception of tritium, carbon-14, and iodine-129 by gamma spectroscopy unless requested as wet weight by the client."

This laboratory report is confidential and is intended for the sole use of TestAmerica and its client.

### **RECEIPT**

The samples were received on 05/27/2016; the samples arrived in good condition, properly preserved and on ice. The temperature of the coolers at receipt was 20.0 C.

### **ISOTOPIC URANIUM (ALPHA SPECTROMETRY)**

Samples GW-GWW-052616 (160-17563-1), GW-NB34-052616 (160-17563-2), GW-GWY-052616 (160-17563-3) and GW-PZ02-052616 (160-17563-4) were analyzed for Isotopic Uranium (Alpha Spectrometry) in accordance with DOE. The samples were prepared on 06/02/2016 and analyzed on 06/08/2016.

Preparation Batch 160-254505:

The following samples did not meet the detection goal of 0.100 pCi/L due to the reduced sample volume attribute to historic high activity (see Prep NCM 85726). The data have been qualified and reported. GW-NB34-052616 (160-17563-2), GW-PZ02-052616 (160-17563-4) and (MB 160-254505/1-A)

Due to historically high activity a reduced aliquot was prepared for the following samples: GW-GWW-052616 (160-17563-1), GW-NB34-052616 (160-17563-2), GW-GWY-052616 (160-17563-3) and GW-PZ02-052616 (160-17563-4).

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

### **TECHNETIUM-99 (LSC)**

Samples GW-GWW-052616 (160-17563-1), GW-NB34-052616 (160-17563-2), GW-GWY-052616 (160-17563-3) and GW-PZ02-052616 (160-17563-4) were analyzed for Technetium-99 (LSC) in accordance with TC\_02\_RC. The samples were prepared on 06/01/2016 and analyzed on 06/07/2016.

In the initial analysis the following samples had counts off the upper end of the quench curve parameter (tSIE): GW-GWW-052616 (160-17563-1), GW-GWY-052616 (160-17563-3), GW-PZ02-052616 (160-17563-4), (LCS 160-254090/2-A) and (MB 160-254090/1-A). . A small amount (10 uL) of quenching agent (nitromethane) was added to the affected vials and the samples recounted. The recount results were within the quench curve parameters and reported..

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

# Client Sample Results

Client: Westinghouse Electric Company LLC  
Project/Site: HDP RFP-CBA-022 (21 DAY TAT)

TestAmerica Job ID: 160-17563-1

**Client Sample ID: GW-GWW-052616**

**Date Collected: 05/26/16 10:50**

**Date Received: 05/27/16 11:30**

**Lab Sample ID: 160-17563-1**

**Matrix: Water**

## Method: A-01-R - Isotopic Uranium (Alpha Spectrometry)

| Analyte            | Result        | Qualifier        | Count<br>Uncert.<br>(2σ+/-) | Total<br>Uncert.<br>(2σ+/-) | RL    | MDC    | Unit  | Prepared        | Analyzed        | Dil Fac        |
|--------------------|---------------|------------------|-----------------------------|-----------------------------|-------|--------|-------|-----------------|-----------------|----------------|
| Uranium 238        | 0.0138        | U                | 0.0276                      | 0.0276                      | 0.100 | 0.0414 | pCi/L | 06/02/16 14:38  | 06/08/16 14:16  | 1              |
| <b>Uranium 234</b> | <b>0.0691</b> |                  | 0.0618                      | 0.0620                      | 0.100 | 0.0414 | pCi/L | 06/02/16 14:38  | 06/08/16 14:16  | 1              |
| Uranium-235/236    | 0.000         | U                | 0.0143                      | 0.0143                      | 0.100 | 0.0516 | pCi/L | 06/02/16 14:38  | 06/08/16 14:16  | 1              |
| <b>Tracer</b>      | <b>%Yield</b> | <b>Qualifier</b> | <b>Limits</b>               |                             |       |        |       | <b>Prepared</b> | <b>Analyzed</b> | <b>Dil Fac</b> |
| Uranium 232        | 66.7          |                  | 30 - 110                    |                             |       |        |       | 06/02/16 14:38  | 06/08/16 14:16  | 1              |

## Method: TC-02-RC - Technetium-99 (LSC)

| Analyte       | Result        | Qualifier        | Count<br>Uncert.<br>(2σ+/-) | Total<br>Uncert.<br>(2σ+/-) | RL   | MDC  | Unit  | Prepared        | Analyzed        | Dil Fac        |
|---------------|---------------|------------------|-----------------------------|-----------------------------|------|------|-------|-----------------|-----------------|----------------|
| Technetium 99 | 1.17          | U                | 1.36                        | 1.37                        | 3.00 | 2.25 | pCi/L | 06/01/16 10:11  | 06/07/16 01:37  | 1              |
| <b>Tracer</b> | <b>%Yield</b> | <b>Qualifier</b> | <b>Limits</b>               |                             |      |      |       | <b>Prepared</b> | <b>Analyzed</b> | <b>Dil Fac</b> |
| Tc-99m        | 83.5          |                  | 30 - 110                    |                             |      |      |       | 06/01/16 10:11  | 06/07/16 01:37  | 1              |

**Client Sample ID: GW-NB34-052616**

**Date Collected: 05/26/16 14:00**

**Date Received: 05/27/16 11:30**

**Lab Sample ID: 160-17563-2**

**Matrix: Water**

## Method: A-01-R - Isotopic Uranium (Alpha Spectrometry)

| Analyte         | Result        | Qualifier        | Count<br>Uncert.<br>(2σ+/-) | Total<br>Uncert.<br>(2σ+/-) | RL    | MDC   | Unit  | Prepared        | Analyzed        | Dil Fac        |
|-----------------|---------------|------------------|-----------------------------|-----------------------------|-------|-------|-------|-----------------|-----------------|----------------|
| Uranium 238     | 0.0334        | U G              | 0.0564                      | 0.0565                      | 0.100 | 0.101 | pCi/L | 06/02/16 14:38  | 06/08/16 14:17  | 1              |
| Uranium 234     | 0.0580        | U G              | 0.110                       | 0.110                       | 0.100 | 0.198 | pCi/L | 06/02/16 14:38  | 06/08/16 14:17  | 1              |
| Uranium-235/236 | 0.0176        | U G              | 0.0757                      | 0.0757                      | 0.100 | 0.166 | pCi/L | 06/02/16 14:38  | 06/08/16 14:17  | 1              |
| <b>Tracer</b>   | <b>%Yield</b> | <b>Qualifier</b> | <b>Limits</b>               |                             |       |       |       | <b>Prepared</b> | <b>Analyzed</b> | <b>Dil Fac</b> |
| Uranium 232     | 56.3          |                  | 30 - 110                    |                             |       |       |       | 06/02/16 14:38  | 06/08/16 14:17  | 1              |

## Method: TC-02-RC - Technetium-99 (LSC)

| Analyte              | Result        | Qualifier        | Count<br>Uncert.<br>(2σ+/-) | Total<br>Uncert.<br>(2σ+/-) | RL   | MDC  | Unit  | Prepared        | Analyzed        | Dil Fac        |
|----------------------|---------------|------------------|-----------------------------|-----------------------------|------|------|-------|-----------------|-----------------|----------------|
| <b>Technetium 99</b> | <b>2.27</b>   |                  | 1.38                        | 1.40                        | 3.00 | 2.22 | pCi/L | 06/01/16 10:11  | 06/07/16 02:27  | 1              |
| <b>Tracer</b>        | <b>%Yield</b> | <b>Qualifier</b> | <b>Limits</b>               |                             |      |      |       | <b>Prepared</b> | <b>Analyzed</b> | <b>Dil Fac</b> |
| Tc-99m               | 85.0          |                  | 30 - 110                    |                             |      |      |       | 06/01/16 10:11  | 06/07/16 02:27  | 1              |

**Client Sample ID: GW-GWY-052616**

**Date Collected: 05/26/16 15:15**

**Date Received: 05/27/16 11:30**

**Lab Sample ID: 160-17563-3**

**Matrix: Water**

## Method: A-01-R - Isotopic Uranium (Alpha Spectrometry)

| Analyte            | Result       | Qualifier | Count<br>Uncert.<br>(2σ+/-) | Total<br>Uncert.<br>(2σ+/-) | RL    | MDC    | Unit  | Prepared       | Analyzed       | Dil Fac |
|--------------------|--------------|-----------|-----------------------------|-----------------------------|-------|--------|-------|----------------|----------------|---------|
| <b>Uranium 238</b> | <b>0.277</b> |           | 0.127                       | 0.129                       | 0.100 | 0.0437 | pCi/L | 06/02/16 14:38 | 06/08/16 14:17 | 1       |

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# Client Sample Results

Client: Westinghouse Electric Company LLC  
Project/Site: HDP RFP-CBA-022 (21 DAY TAT)

TestAmerica Job ID: 160-17563-1

**Client Sample ID: GW-GWY-052616**

**Date Collected: 05/26/16 15:15**

**Date Received: 05/27/16 11:30**

**Lab Sample ID: 160-17563-3**

**Matrix: Water**

## Method: A-01-R - Isotopic Uranium (Alpha Spectrometry) (Continued)

| Analyte         | Result        | Qualifier        | Count<br>Uncert.<br>(2σ+/-) | Total<br>Uncert.<br>(2σ+/-) | RL    | MDC    | Unit  | Prepared        | Analyzed        | Dil Fac        |
|-----------------|---------------|------------------|-----------------------------|-----------------------------|-------|--------|-------|-----------------|-----------------|----------------|
| Uranium 234     | 0.330         |                  | 0.141                       | 0.143                       | 0.100 | 0.0807 | pCi/L | 06/02/16 14:38  | 06/08/16 14:17  | 1              |
| Uranium-235/236 | 0.000         | U                | 0.0151                      | 0.0151                      | 0.100 | 0.0545 | pCi/L | 06/02/16 14:38  | 06/08/16 14:17  | 1              |
| <b>Tracer</b>   | <b>%Yield</b> | <b>Qualifier</b> | <b>Limits</b>               |                             |       |        |       | <b>Prepared</b> | <b>Analyzed</b> | <b>Dil Fac</b> |
| Uranium 232     | 62.5          |                  | 30 - 110                    |                             |       |        |       | 06/02/16 14:38  | 06/08/16 14:17  | 1              |

## Method: TC-02-RC - Technetium-99 (LSC)

| Analyte       | Result        | Qualifier        | Count<br>Uncert.<br>(2σ+/-) | Total<br>Uncert.<br>(2σ+/-) | RL   | MDC  | Unit  | Prepared        | Analyzed        | Dil Fac        |
|---------------|---------------|------------------|-----------------------------|-----------------------------|------|------|-------|-----------------|-----------------|----------------|
| Technetium 99 | 3.29          |                  | 1.32                        | 1.36                        | 3.00 | 2.04 | pCi/L | 06/01/16 10:11  | 06/07/16 03:16  | 1              |
| <b>Tracer</b> | <b>%Yield</b> | <b>Qualifier</b> | <b>Limits</b>               |                             |      |      |       | <b>Prepared</b> | <b>Analyzed</b> | <b>Dil Fac</b> |
| Tc-99m        | 92.4          |                  | 30 - 110                    |                             |      |      |       | 06/01/16 10:11  | 06/07/16 03:16  | 1              |

**Client Sample ID: GW-PZ02-052616**

**Date Collected: 05/26/16 14:35**

**Date Received: 05/27/16 11:30**

**Lab Sample ID: 160-17563-4**

**Matrix: Water**

## Method: A-01-R - Isotopic Uranium (Alpha Spectrometry)

| Analyte         | Result        | Qualifier        | Count<br>Uncert.<br>(2σ+/-) | Total<br>Uncert.<br>(2σ+/-) | RL    | MDC    | Unit  | Prepared        | Analyzed        | Dil Fac        |
|-----------------|---------------|------------------|-----------------------------|-----------------------------|-------|--------|-------|-----------------|-----------------|----------------|
| Uranium 238     | 0.0286        | U G              | 0.0613                      | 0.0614                      | 0.100 | 0.121  | pCi/L | 06/02/16 14:38  | 06/08/16 14:17  | 1              |
| Uranium 234     | 0.0382        | U G              | 0.0710                      | 0.0710                      | 0.100 | 0.132  | pCi/L | 06/02/16 14:38  | 06/08/16 14:17  | 1              |
| Uranium-235/236 | 0.0204        | U                | 0.0408                      | 0.0408                      | 0.100 | 0.0611 | pCi/L | 06/02/16 14:38  | 06/08/16 14:17  | 1              |
| <b>Tracer</b>   | <b>%Yield</b> | <b>Qualifier</b> | <b>Limits</b>               |                             |       |        |       | <b>Prepared</b> | <b>Analyzed</b> | <b>Dil Fac</b> |
| Uranium 232     | 56.4          |                  | 30 - 110                    |                             |       |        |       | 06/02/16 14:38  | 06/08/16 14:17  | 1              |

## Method: TC-02-RC - Technetium-99 (LSC)

| Analyte       | Result        | Qualifier        | Count<br>Uncert.<br>(2σ+/-) | Total<br>Uncert.<br>(2σ+/-) | RL   | MDC  | Unit  | Prepared        | Analyzed        | Dil Fac        |
|---------------|---------------|------------------|-----------------------------|-----------------------------|------|------|-------|-----------------|-----------------|----------------|
| Technetium 99 | 2.50          |                  | 1.28                        | 1.31                        | 3.00 | 2.03 | pCi/L | 06/01/16 10:11  | 06/07/16 04:06  | 1              |
| <b>Tracer</b> | <b>%Yield</b> | <b>Qualifier</b> | <b>Limits</b>               |                             |      |      |       | <b>Prepared</b> | <b>Analyzed</b> | <b>Dil Fac</b> |
| Tc-99m        | 93.4          |                  | 30 - 110                    |                             |      |      |       | 06/01/16 10:11  | 06/07/16 04:06  | 1              |

## Tracer/Carrier Summary

Client: Westinghouse Electric Company LLC  
Project/Site: HDP RFP-CBA-022 (21 DAY TAT)

TestAmerica Job ID: 160-17563-1

### Method: A-01-R - Isotopic Uranium (Alpha Spectrometry)

Matrix: Water

Prep Type: Total/NA

|                              |                        | Percent Yield (Acceptance Limits) |  |  |  |  |  |
|------------------------------|------------------------|-----------------------------------|--|--|--|--|--|
| Lab Sample ID                | Client Sample ID       | U-232<br>(30-110)                 |  |  |  |  |  |
| 160-17563-1                  | GW-GWW-052616          | 66.7                              |  |  |  |  |  |
| 160-17563-2                  | GW-NB34-052616         | 56.3                              |  |  |  |  |  |
| 160-17563-3                  | GW-GWY-052616          | 62.5                              |  |  |  |  |  |
| 160-17563-4                  | GW-PZ02-052616         | 56.4                              |  |  |  |  |  |
| LCS 160-254505/2-A           | Lab Control Sample     | 76.0                              |  |  |  |  |  |
| LCSD 160-254505/3-A          | Lab Control Sample Dup | 73.6                              |  |  |  |  |  |
| MB 160-254505/1-A            | Method Blank           | 52.7                              |  |  |  |  |  |
| <b>Tracer/Carrier Legend</b> |                        |                                   |  |  |  |  |  |
| U-232 = Uranium 232          |                        |                                   |  |  |  |  |  |

### Method: TC-02-RC - Technetium-99 (LSC)

Matrix: Water

Prep Type: Total/NA

|                              |                    | Percent Yield (Acceptance Limits) |  |  |  |  |  |
|------------------------------|--------------------|-----------------------------------|--|--|--|--|--|
| Lab Sample ID                | Client Sample ID   | Tc-99m<br>(30-110)                |  |  |  |  |  |
| 160-17563-1                  | GW-GWW-052616      | 83.5                              |  |  |  |  |  |
| 160-17563-2                  | GW-NB34-052616     | 85.0                              |  |  |  |  |  |
| 160-17563-3                  | GW-GWY-052616      | 92.4                              |  |  |  |  |  |
| 160-17563-4                  | GW-PZ02-052616     | 93.4                              |  |  |  |  |  |
| 160-17543-AD-1-B DU          | Duplicate          | 100                               |  |  |  |  |  |
| LCS 160-254090/2-A           | Lab Control Sample | 99.0                              |  |  |  |  |  |
| MB 160-254090/1-A            | Method Blank       | 94.5                              |  |  |  |  |  |
| <b>Tracer/Carrier Legend</b> |                    |                                   |  |  |  |  |  |
| Tc-99m = Tc-99m              |                    |                                   |  |  |  |  |  |

# QC Sample Results

Client: Westinghouse Electric Company LLC  
Project/Site: HDP RFP-CBA-022 (21 DAY TAT)

TestAmerica Job ID: 160-17563-1

## Method: A-01-R - Isotopic Uranium (Alpha Spectrometry)

Lab Sample ID: MB 160-254505/1-A

Matrix: Water

Analysis Batch: 255590

Client Sample ID: Method Blank

Prep Type: Total/NA

Prep Batch: 254505

| Analyte         | MB Result | MB Qualifier | Count Uncert. (2σ+/-) | Total Uncert. (2σ+/-) | RL    | MDC    | Unit  | Prepared       | Analyzed       | Dil Fac |
|-----------------|-----------|--------------|-----------------------|-----------------------|-------|--------|-------|----------------|----------------|---------|
| Uranium 238     | 0.04469   | U            | 0.0616                | 0.0618                | 0.100 | 0.0956 | pCi/L | 06/02/16 14:38 | 06/08/16 14:16 | 1       |
| Uranium 234     | 0.07512   | U G          | 0.0897                | 0.0899                | 0.100 | 0.140  | pCi/L | 06/02/16 14:38 | 06/08/16 14:16 | 1       |
| Uranium-235/236 | 0.02157   | U            | 0.0431                | 0.0432                | 0.100 | 0.0647 | pCi/L | 06/02/16 14:38 | 06/08/16 14:16 | 1       |
| Tracer          | MB %Yield | MB Qualifier | Limits                |                       |       |        |       | Prepared       | Analyzed       | Dil Fac |
| Uranium 232     | 52.7      |              | 30 - 110              |                       |       |        |       | 06/02/16 14:38 | 06/08/16 14:16 | 1       |

Lab Sample ID: LCS 160-254505/2-A

Matrix: Water

Analysis Batch: 255591

Client Sample ID: Lab Control Sample

Prep Type: Total/NA

Prep Batch: 254505

| Analyte     | Spike Added | LCS Result    | LCS Qual | Total Uncert. (2σ+/-) | RL    | MDC    | Unit  | %Rec | %Rec. Limits |
|-------------|-------------|---------------|----------|-----------------------|-------|--------|-------|------|--------------|
| Uranium 238 | 6.51        | 6.408         |          | 0.767                 | 0.100 | 0.0350 | pCi/L | 98   | 83 - 121     |
| Uranium 234 | 6.37        | 6.492         |          | 0.775                 | 0.100 | 0.0767 | pCi/L | 102  | 84 - 120     |
| Tracer      | LCS %Yield  | LCS Qualifier | Limits   |                       |       |        |       |      |              |
| Uranium 232 | 76.0        |               | 30 - 110 |                       |       |        |       |      |              |

Lab Sample ID: LCSD 160-254505/3-A

Matrix: Water

Analysis Batch: 255592

Client Sample ID: Lab Control Sample Dup

Prep Type: Total/NA

Prep Batch: 254505

| Analyte     | Spike Added | LCSD Result    | LCSD Qual | Total Uncert. (2σ+/-) | RL    | MDC    | Unit  | %Rec | %Rec. Limits | RER  | RER Limit |
|-------------|-------------|----------------|-----------|-----------------------|-------|--------|-------|------|--------------|------|-----------|
| Uranium 238 | 6.51        | 6.782          |           | 0.803                 | 0.100 | 0.0355 | pCi/L | 104  | 83 - 121     | 0.24 | 1         |
| Uranium 234 | 6.37        | 6.638          |           | 0.792                 | 0.100 | 0.0875 | pCi/L | 104  | 84 - 120     | 0.09 | 1         |
| Tracer      | LCSD %Yield | LCSD Qualifier | Limits    |                       |       |        |       |      |              |      |           |
| Uranium 232 | 73.6        |                | 30 - 110  |                       |       |        |       |      |              |      |           |

## Method: TC-02-RC - Technetium-99 (LSC)

Lab Sample ID: MB 160-254090/1-A

Matrix: Water

Analysis Batch: 255164

Client Sample ID: Method Blank

Prep Type: Total/NA

Prep Batch: 254090

| Analyte       | MB Result | MB Qualifier | Count Uncert. (2σ+/-) | Total Uncert. (2σ+/-) | RL   | MDC  | Unit  | Prepared       | Analyzed       | Dil Fac |
|---------------|-----------|--------------|-----------------------|-----------------------|------|------|-------|----------------|----------------|---------|
| Technetium 99 | 0.7917    | U            | 1.20                  | 1.20                  | 3.00 | 1.99 | pCi/L | 06/01/16 10:11 | 06/06/16 19:47 | 1       |
| Tracer        | MB %Yield | MB Qualifier | Limits                |                       |      |      |       | Prepared       | Analyzed       | Dil Fac |
| Tc-99m        | 94.5      |              | 30 - 110              |                       |      |      |       | 06/01/16 10:11 | 06/06/16 19:47 | 1       |

TestAmerica St. Louis

## QC Sample Results

Client: Westinghouse Electric Company LLC  
Project/Site: HDP RFP-CBA-022 (21 DAY TAT)

TestAmerica Job ID: 160-17563-1

### Method: TC-02-RC - Technetium-99 (LSC) (Continued)

**Lab Sample ID: LCS 160-254090/2-A**

**Matrix: Water**

**Analysis Batch: 255164**

**Client Sample ID: Lab Control Sample**

Prep Type: Total/NA

**Prep Batch: 254090**

| Analyte       | Spike Added | LCS Result | LCS Qual | Total Uncert. (2σ+/-) | RL   | MDC  | Unit  | %Rec | %Rec. Limits |  |  |
|---------------|-------------|------------|----------|-----------------------|------|------|-------|------|--------------|--|--|
|               |             |            |          |                       |      |      |       |      |              |  |  |
| Technetium 99 | 206         | 208.5      |          | 20.5                  | 3.00 | 1.93 | pCi/L | 101  | 75 - 125     |  |  |

|        | LCS    | LCS       |          |
|--------|--------|-----------|----------|
| Tracer | %Yield | Qualifier | Limits   |
| Tc-99m | 99.0   |           | 30 - 110 |

**Lab Sample ID: 160-17543-AD-1-B DU**

**Matrix: Water**

**Analysis Batch: 255164**

**Client Sample ID: Duplicate**

**Prep Type: Total/NA**

**Prep Batch: 254090**

| Analyte       | Sample Result | Sample Qual | Total     |         |                 |      |      | RL    | MDC  | Unit | RER | RER Limit |
|---------------|---------------|-------------|-----------|---------|-----------------|------|------|-------|------|------|-----|-----------|
|               |               |             | DU Result | DU Qual | Uncert. (2σ+/-) |      |      |       |      |      |     |           |
| Technetium 99 | -0.341        | U           | -1.267    | U       | 1.08            | 3.00 | 1.94 | pCi/L | 0.39 | 1    |     |           |

| <i>Tracer</i> | <i>DU</i><br><i>%Yield</i> | <i>DU</i><br><i>Qualifier</i> | <i>Limits</i> |
|---------------|----------------------------|-------------------------------|---------------|
| <i>Tc-99m</i> | 100                        |                               | 30 - 110      |

## QC Association Summary

Client: Westinghouse Electric Company LLC  
Project/Site: HDP RFP-CBA-022 (21 DAY TAT)

TestAmerica Job ID: 160-17563-1

### Rad

#### Prep Batch: 254090

| Lab Sample ID       | Client Sample ID   | Prep Type | Matrix | Method        | Prep Batch |
|---------------------|--------------------|-----------|--------|---------------|------------|
| 160-17563-1         | GW-GWW-052616      | Total/NA  | Water  | Ext_Chrom_LSC |            |
| 160-17563-2         | GW-NB34-052616     | Total/NA  | Water  | Ext_Chrom_LSC |            |
| 160-17563-3         | GW-GWY-052616      | Total/NA  | Water  | Ext_Chrom_LSC |            |
| 160-17563-4         | GW-PZ02-052616     | Total/NA  | Water  | Ext_Chrom_LSC |            |
| 160-17543-AD-1-B DU | Duplicate          | Total/NA  | Water  | Ext_Chrom_LSC |            |
| LCS 160-254090/2-A  | Lab Control Sample | Total/NA  | Water  | Ext_Chrom_LSC |            |
| MB 160-254090/1-A   | Method Blank       | Total/NA  | Water  | Ext_Chrom_LSC |            |

#### Prep Batch: 254505

| Lab Sample ID       | Client Sample ID       | Prep Type | Matrix | Method   | Prep Batch |
|---------------------|------------------------|-----------|--------|----------|------------|
| 160-17563-1         | GW-GWW-052616          | Total/NA  | Water  | ExtChrom |            |
| 160-17563-2         | GW-NB34-052616         | Total/NA  | Water  | ExtChrom |            |
| 160-17563-3         | GW-GWY-052616          | Total/NA  | Water  | ExtChrom |            |
| 160-17563-4         | GW-PZ02-052616         | Total/NA  | Water  | ExtChrom |            |
| LCS 160-254505/2-A  | Lab Control Sample     | Total/NA  | Water  | ExtChrom |            |
| LCSD 160-254505/3-A | Lab Control Sample Dup | Total/NA  | Water  | ExtChrom |            |
| MB 160-254505/1-A   | Method Blank           | Total/NA  | Water  | ExtChrom |            |

# Lab Chronicle

Client: Westinghouse Electric Company LLC  
Project/Site: HDP RFP-CBA-022 (21 DAY TAT)

TestAmerica Job ID: 160-17563-1

## Client Sample ID: GW-GWW-052616

Date Collected: 05/26/16 10:50

Date Received: 05/27/16 11:30

## Lab Sample ID: 160-17563-1

Matrix: Water

| Prep Type | Batch Type | Batch Method  | Run | Dilution Factor | Batch Number | Prepared or Analyzed | Analyst | Lab    |
|-----------|------------|---------------|-----|-----------------|--------------|----------------------|---------|--------|
| Total/NA  | Prep       | ExtChrom      |     |                 | 254505       | 06/02/16 14:38       | SEK     | TAL SL |
| Total/NA  | Analysis   | A-01-R        |     | 1               | 255594       | 06/08/16 14:16       | ALD     | TAL SL |
| Total/NA  | Prep       | Ext_Chrom_LSC |     |                 | 254090       | 06/01/16 10:11       | MFM     | TAL SL |
| Total/NA  | Analysis   | TC-02-RC      |     | 1               | 255164       | 06/07/16 01:37       | ALD     | TAL SL |

## Client Sample ID: GW-NB34-052616

Date Collected: 05/26/16 14:00

Date Received: 05/27/16 11:30

## Lab Sample ID: 160-17563-2

Matrix: Water

| Prep Type | Batch Type | Batch Method  | Run | Dilution Factor | Batch Number | Prepared or Analyzed | Analyst | Lab    |
|-----------|------------|---------------|-----|-----------------|--------------|----------------------|---------|--------|
| Total/NA  | Prep       | ExtChrom      |     |                 | 254505       | 06/02/16 14:38       | SEK     | TAL SL |
| Total/NA  | Analysis   | A-01-R        |     | 1               | 255595       | 06/08/16 14:17       | ALD     | TAL SL |
| Total/NA  | Prep       | Ext_Chrom_LSC |     |                 | 254090       | 06/01/16 10:11       | MFM     | TAL SL |
| Total/NA  | Analysis   | TC-02-RC      |     | 1               | 255164       | 06/07/16 02:27       | ALD     | TAL SL |

## Client Sample ID: GW-GWY-052616

Date Collected: 05/26/16 15:15

Date Received: 05/27/16 11:30

## Lab Sample ID: 160-17563-3

Matrix: Water

| Prep Type | Batch Type | Batch Method  | Run | Dilution Factor | Batch Number | Prepared or Analyzed | Analyst | Lab    |
|-----------|------------|---------------|-----|-----------------|--------------|----------------------|---------|--------|
| Total/NA  | Prep       | ExtChrom      |     |                 | 254505       | 06/02/16 14:38       | SEK     | TAL SL |
| Total/NA  | Analysis   | A-01-R        |     | 1               | 255733       | 06/08/16 14:17       | ALD     | TAL SL |
| Total/NA  | Prep       | Ext_Chrom_LSC |     |                 | 254090       | 06/01/16 10:11       | MFM     | TAL SL |
| Total/NA  | Analysis   | TC-02-RC      |     | 1               | 255164       | 06/07/16 03:16       | ALD     | TAL SL |

## Client Sample ID: GW-PZ02-052616

Date Collected: 05/26/16 14:35

Date Received: 05/27/16 11:30

## Lab Sample ID: 160-17563-4

Matrix: Water

| Prep Type | Batch Type | Batch Method  | Run | Dilution Factor | Batch Number | Prepared or Analyzed | Analyst | Lab    |
|-----------|------------|---------------|-----|-----------------|--------------|----------------------|---------|--------|
| Total/NA  | Prep       | ExtChrom      |     |                 | 254505       | 06/02/16 14:38       | SEK     | TAL SL |
| Total/NA  | Analysis   | A-01-R        |     | 1               | 255596       | 06/08/16 14:17       | ALD     | TAL SL |
| Total/NA  | Prep       | Ext_Chrom_LSC |     |                 | 254090       | 06/01/16 10:11       | MFM     | TAL SL |
| Total/NA  | Analysis   | TC-02-RC      |     | 1               | 255164       | 06/07/16 04:06       | ALD     | TAL SL |

### Laboratory References:

TAL SL = TestAmerica St. Louis, 13715 Rider Trail North, Earth City, MO 63045, TEL (314)298-8566

# Certification Summary

Client: Westinghouse Electric Company LLC  
Project/Site: HDP RFP-CBA-022 (21 DAY TAT)

TestAmerica Job ID: 160-17563-1

## Laboratory: TestAmerica St. Louis

Unless otherwise noted, all analytes for this laboratory were covered under each certification below.

| Authority | Program | EPA Region | Certification ID | Expiration Date |
|-----------|---------|------------|------------------|-----------------|
| Louisiana | NELAP   | 6          | 04080            | 06-30-16 *      |

The following analytes are included in this report, but certification is not offered by the governing authority:

| Analysis Method | Prep Method   | Matrix | Analyte         |
|-----------------|---------------|--------|-----------------|
| A-01-R          | ExtChrom      | Water  | Uranium-235/236 |
| TC-02-RC        | Ext_Chrom_LSC | Water  | Technetium 99   |

|          |               |   |     |            |
|----------|---------------|---|-----|------------|
| Missouri | State Program | 7 | 780 | 06-30-16 * |
|----------|---------------|---|-----|------------|

The following analytes are included in this report, but certification is not offered by the governing authority:

| Analysis Method | Prep Method   | Matrix | Analyte         |
|-----------------|---------------|--------|-----------------|
| A-01-R          | ExtChrom      | Water  | Uranium 234     |
| A-01-R          | ExtChrom      | Water  | Uranium 238     |
| A-01-R          | ExtChrom      | Water  | Uranium-235/236 |
| TC-02-RC        | Ext_Chrom_LSC | Water  | Technetium 99   |

|     |     |  |             |          |
|-----|-----|--|-------------|----------|
| NRC | NRC |  | 24-24817-01 | 12-31-22 |
|-----|-----|--|-------------|----------|

The following analytes are included in this report, but certification is not offered by the governing authority:

| Analysis Method | Prep Method   | Matrix | Analyte         |
|-----------------|---------------|--------|-----------------|
| A-01-R          | ExtChrom      | Water  | Uranium 234     |
| A-01-R          | ExtChrom      | Water  | Uranium 238     |
| A-01-R          | ExtChrom      | Water  | Uranium-235/236 |
| TC-02-RC        | Ext_Chrom_LSC | Water  | Technetium 99   |

\* Certification renewal pending - certification considered valid.

TestAmerica St. Louis

# Method Summary

Client: Westinghouse Electric Company LLC  
Project/Site: HDP RFP-CBA-022 (21 DAY TAT)

TestAmerica Job ID: 160-17563-1

| Method   | Method Description                    | Protocol | Laboratory |
|----------|---------------------------------------|----------|------------|
| A-01-R   | Isotopic Uranium (Alpha Spectrometry) | DOE      | TAL SL     |
| TC-02-RC | Technetium-99 Tracers                 | DOE      | TAL SL     |
| TC-02-RC | Technetium-99 (LSC)                   | DOE      | TAL SL     |

**Protocol References:**

DOE = U.S. Department of Energy

**Laboratory References:**

TAL SL = TestAmerica St. Louis, 13715 Rider Trail North, Earth City, MO 63045, TEL (314)298-8566

## Sample Summary

Client: Westinghouse Electric Company LLC  
Project/Site: HDP RFP-CBA-022 (21 DAY TAT)

TestAmerica Job ID: 160-17563-1

| Lab Sample ID | Client Sample ID | Matrix | Collected      | Received       |
|---------------|------------------|--------|----------------|----------------|
| 160-17563-1   | GW-GWW-052616    | Water  | 05/26/16 10:50 | 05/27/16 11:30 |
| 160-17563-2   | GW-NB34-052616   | Water  | 05/26/16 14:00 | 05/27/16 11:30 |
| 160-17563-3   | GW-GWY-052616    | Water  | 05/26/16 15:15 | 05/27/16 11:30 |
| 160-17563-4   | GW-PZ02-052616   | Water  | 05/26/16 14:35 | 05/27/16 11:30 |

# REAGENT TRACEABILITY SUMMARY

Lab Name: TestAmerica St. Louis Job No.: 160-17563-1

SDG No.: \_\_\_\_\_

| Reagent ID      | Exp Date | Prep Date                       | Dilutant Used        | Reagent Final Volume | Parent Reagent      |              | Analyte    | Concentration |
|-----------------|----------|---------------------------------|----------------------|----------------------|---------------------|--------------|------------|---------------|
|                 |          |                                 |                      |                      | Reagent ID          | Volume Added |            |               |
| 82234-334_00001 | 06/02/60 | Eckert & Zigler, Lot 82234-334  |                      |                      | (Purchased Reagent) |              | Am-241     | 5.652 Bq      |
|                 |          |                                 |                      |                      |                     |              | Pu-239     | 5.936 Bq      |
|                 |          |                                 |                      |                      |                     |              | Th-230     | 5.685 Bq      |
| 82235-334_00001 | 06/04/60 | Eckert & Ziegler, Lot 82235-334 |                      |                      | (Purchased Reagent) |              | Am-241     | 7.466 Bq      |
|                 |          |                                 |                      |                      |                     |              | Pu-239     | 6.897 Bq      |
|                 |          |                                 |                      |                      |                     |              | Th-230     | 7.167 Bq      |
| 82236-334_00001 | 06/02/60 | Eckert & Ziegler, Lot 82236-334 |                      |                      | (Purchased Reagent) |              | Am-241     | 6.891 Bq      |
|                 |          |                                 |                      |                      |                     |              | Pu-239     | 6.664 Bq      |
|                 |          |                                 |                      |                      |                     |              | Th-230     | 7.107 Bq      |
| 82237-334_00003 | 06/01/60 | Eckert & Ziegler, Lot 82237-334 |                      |                      | (Purchased Reagent) |              | Am-241     | 5.608 Bq      |
|                 |          |                                 |                      |                      |                     |              | Pu-239     | 6.424 Bq      |
|                 |          |                                 |                      |                      |                     |              | Th-230     | 5.856 Bq      |
| 82240-334_00001 | 06/08/60 | Eckert & Ziegler, Lot 82240-334 |                      |                      | (Purchased Reagent) |              | Am-241     | 8.298 Bq      |
|                 |          |                                 |                      |                      |                     |              | Pu-239     | 7.163 Bq      |
|                 |          |                                 |                      |                      |                     |              | Th-230     | 6.304 Bq      |
| 82241-334_00001 | 06/08/60 | Eckert & Ziegler, Lot 82241-334 |                      |                      | (Purchased Reagent) |              | Am-241     | 6.638 Bq      |
|                 |          |                                 |                      |                      |                     |              | Pu-239     | 6.797 Bq      |
|                 |          |                                 |                      |                      |                     |              | Th-230     | 6.629 Bq      |
| 82242-334_00001 | 06/08/60 | Eckert & Ziegler, Lot 82242-334 |                      |                      | (Purchased Reagent) |              | Am-241     | 7.145 Bq      |
|                 |          |                                 |                      |                      |                     |              | Pu-239     | 6.414 Bq      |
|                 |          |                                 |                      |                      |                     |              | Th-230     | 6.583 Bq      |
| 82243-334_00001 | 06/09/60 | Eckert & Ziegler, Lot 82243-334 |                      |                      | (Purchased Reagent) |              | Am-241     | 6.39 Bq       |
|                 |          |                                 |                      |                      |                     |              | Pu-239     | 5.979 Bq      |
|                 |          |                                 |                      |                      |                     |              | Th-230     | 5.856 Bq      |
| 82244-334_00001 | 06/09/60 | Eckert & Zigler, Lot 82244-334  |                      |                      | (Purchased Reagent) |              | Am-241     | 6.897 Bq      |
|                 |          |                                 |                      |                      |                     |              | Pu-239     | 6.717 Bq      |
|                 |          |                                 |                      |                      |                     |              | Th-230     | 7.352 Bq      |
| 82245-334_00001 | 06/09/60 | Eckert & Ziegler, Lot 82245-334 |                      |                      | (Purchased Reagent) |              | Am-241     | 5.528 Bq      |
|                 |          |                                 |                      |                      |                     |              | Pu-239     | 5.437 Bq      |
|                 |          |                                 |                      |                      |                     |              | Th-230     | 6.727 Bq      |
| 82246-334_00001 | 06/09/60 | Eckert & Ziegler, Lot 82246-334 |                      |                      | (Purchased Reagent) |              | Am-241     | 6.002 Bq      |
|                 |          |                                 |                      |                      |                     |              | Pu-239     | 5.353 Bq      |
|                 |          |                                 |                      |                      |                     |              | Th-230     | 5.57 Bq       |
| 82247-334_00001 | 06/10/60 | Eckert & Ziegler, Lot 82247-334 |                      |                      | (Purchased Reagent) |              | Am-241     | 6.291 Bq      |
|                 |          |                                 |                      |                      |                     |              | Pu-239     | 5.746 Bq      |
|                 |          |                                 |                      |                      |                     |              | Th-230     | 6.251 Bq      |
| LSC Brown_00002 | 05/04/20 | Perkin Elmer, Lot S/N 189       |                      |                      | (Purchased Reagent) |              | Background | 0 dpm         |
|                 |          |                                 |                      |                      |                     |              | C-14       | 122100 dpm    |
|                 |          |                                 |                      |                      |                     |              | Tritium    | 270300 dpm    |
| Source A_00001  | 04/01/59 | 02/23/11                        | water, Lot 79670-334 | 0.9986 Source        | Gamma Ampuole_00001 | 0.9986 g     | Am-241     | 9.4429 Bq     |
|                 |          |                                 |                      |                      |                     |              | Cd-109     | 132.909 Bq    |
|                 |          |                                 |                      |                      |                     |              | Ce-139     | 4.4538 Bq     |

# REAGENT TRACEABILITY SUMMARY

Lab Name: TestAmerica St. Louis Job No.: 160-17563-1

SDG No.: \_\_\_\_\_

| Reagent ID           | Exp Date | Prep Date               | Dilutant Used        | Reagent Final Volume | Parent Reagent      |              | Analyte | Concentration |
|----------------------|----------|-------------------------|----------------------|----------------------|---------------------|--------------|---------|---------------|
|                      |          |                         |                      |                      | Reagent ID          | Volume Added |         |               |
|                      |          |                         |                      |                      |                     |              | Co-57   | 2.9513 Bq     |
|                      |          |                         |                      |                      |                     |              | Co-60   | 6.2002 Bq     |
|                      |          |                         |                      |                      |                     |              | Cs-137  | 3.7296 Bq     |
|                      |          |                         |                      |                      |                     |              | Hg-203  | 9.6996 Bq     |
|                      |          |                         |                      |                      |                     |              | Sn-113  | 7.6266 Bq     |
|                      |          |                         |                      |                      |                     |              | Y-88    | 12.712 Bq     |
| .Gamma Ampuole_00001 | 04/07/59 | Analytcs, Lot 79670-334 |                      |                      | (Purchased Reagent) |              | Am-241  | 9442.9 Bq     |
|                      |          |                         |                      |                      |                     |              | Cd-109  | 132909 Bq     |
|                      |          |                         |                      |                      |                     |              | Ce-139  | 4453.8 Bq     |
|                      |          |                         |                      |                      |                     |              | Co-57   | 2951.3 Bq     |
|                      |          |                         |                      |                      |                     |              | Co-60   | 6200.2 Bq     |
|                      |          |                         |                      |                      |                     |              | Cs-137  | 3729.6 Bq     |
|                      |          |                         |                      |                      |                     |              | Hg-203  | 9699.6 Bq     |
|                      |          |                         |                      |                      |                     |              | Sn-113  | 7626.6 Bq     |
|                      |          |                         |                      |                      |                     |              | Y-88    | 12712 Bq      |
|                      |          |                         |                      |                      |                     |              |         |               |
| Source C_00001       | 04/01/59 | 02/23/12                | water, Lot 79670-334 | 1.0148 g             | Gamma Ampuole_00001 | 1.0148 g     | Am-241  | 9442.9 Bq     |
|                      |          |                         |                      |                      |                     |              | Cd-109  | 132909 Bq     |
|                      |          |                         |                      |                      |                     |              | Ce-139  | 4453.8 Bq     |
|                      |          |                         |                      |                      |                     |              | Co-57   | 2951.3 Bq     |
|                      |          |                         |                      |                      |                     |              | Co-60   | 6200.2 Bq     |
|                      |          |                         |                      |                      |                     |              | Cs-137  | 3729.6 Bq     |
|                      |          |                         |                      |                      |                     |              | Hg-203  | 9699.6 Bq     |
|                      |          |                         |                      |                      |                     |              | Sn-113  | 7626.6 Bq     |
|                      |          |                         |                      |                      |                     |              | Y-88    | 12712 Bq      |
|                      |          |                         |                      |                      |                     |              |         |               |
| .Gamma Ampuole_00001 | 04/07/59 | Analytcs, Lot 79670-334 |                      |                      | (Purchased Reagent) |              | Am-241  | 9442.9 Bq     |
|                      |          |                         |                      |                      |                     |              | Cd-109  | 132909 Bq     |
|                      |          |                         |                      |                      |                     |              | Ce-139  | 4453.8 Bq     |
|                      |          |                         |                      |                      |                     |              | Co-57   | 2951.3 Bq     |
|                      |          |                         |                      |                      |                     |              | Co-60   | 6200.2 Bq     |
|                      |          |                         |                      |                      |                     |              | Cs-137  | 3729.6 Bq     |
|                      |          |                         |                      |                      |                     |              | Hg-203  | 9699.6 Bq     |
|                      |          |                         |                      |                      |                     |              | Sn-113  | 7626.6 Bq     |
|                      |          |                         |                      |                      |                     |              | Y-88    | 12712 Bq      |
|                      |          |                         |                      |                      |                     |              |         |               |
| Source D_00001       | 04/01/59 | 02/23/11                | water, Lot 79670-334 | 0.9781 g             | Gamma Ampuole_00001 | 0.9781 g     | Am-241  | 9442.9 Bq     |
|                      |          |                         |                      |                      |                     |              | Cd-109  | 132909 Bq     |
|                      |          |                         |                      |                      |                     |              | Ce-139  | 4453.8 Bq     |
|                      |          |                         |                      |                      |                     |              | Co-57   | 2951.3 Bq     |
|                      |          |                         |                      |                      |                     |              | Co-60   | 6200.2 Bq     |
|                      |          |                         |                      |                      |                     |              | Cs-137  | 3729.6 Bq     |
|                      |          |                         |                      |                      |                     |              | Hg-203  | 9699.6 Bq     |
|                      |          |                         |                      |                      |                     |              | Sn-113  | 7626.6 Bq     |
|                      |          |                         |                      |                      |                     |              | Y-88    | 12712 Bq      |
|                      |          |                         |                      |                      |                     |              |         |               |
| .Gamma Ampuole_00001 | 04/07/59 | Analytcs, Lot 79670-334 |                      |                      | (Purchased Reagent) |              | Am-241  | 9442.9 Bq     |
|                      |          |                         |                      |                      |                     |              | Cd-109  | 132909 Bq     |
|                      |          |                         |                      |                      |                     |              | Ce-139  | 4453.8 Bq     |
|                      |          |                         |                      |                      |                     |              | Co-57   | 2951.3 Bq     |
|                      |          |                         |                      |                      |                     |              | Co-60   | 6200.2 Bq     |

# REAGENT TRACEABILITY SUMMARY

Lab Name: TestAmerica St. Louis Job No.: 160-17563-1

SDG No.: \_\_\_\_\_

| Reagent ID                 | Exp Date | Prep Date | Dilutant Used                   | Reagent Final Volume | Parent Reagent      |              | Analyte        | Concentration  |
|----------------------------|----------|-----------|---------------------------------|----------------------|---------------------|--------------|----------------|----------------|
|                            |          |           |                                 |                      | Reagent ID          | Volume Added |                |                |
|                            |          |           |                                 |                      |                     |              | Cs-137         | 3729.6 Bq      |
|                            |          |           |                                 |                      |                     |              | Hg-203         | 9699.6 Bq      |
|                            |          |           |                                 |                      |                     |              | Sn-113         | 7626.6 Bq      |
|                            |          |           |                                 |                      |                     |              | Y-88           | 12712 Bq       |
| <b>Tc (T) Dil #2 00229</b> | 06/05/16 | 06/01/16  | DI Water, Lot 0                 | 100 mL               | Tc (T) Dil #1_00198 | 1 mL         | Tc-99m         | 2000 pCi/ml    |
| .Tc (T) Dil #1_00198       | 06/08/16 | 06/01/16  | Blood Bank Saline, Lot 231454   | 100 mL               | Tc (T) Source_00184 | 1 mL         | Tc-99m         | 200000 pCi/ml  |
| ..Tc (T) Source_00184      | 06/09/16 |           | Triad, Lot 20160601             |                      | (Purchased Reagent) |              | Tc-99m         | 20 uCi/ml      |
| <b>Tc-99_00007</b>         | 01/01/50 | 07/19/06  | DI Water, Lot 0                 | 100 mL               | Tc-99_00003         | 4.9519 g     | Technetium 99  | 22185.5 dpm/mL |
| .Tc-99_00003               | 01/01/50 |           | Isotope Products, Lot 681-78-1  |                      | (Purchased Reagent) |              | Technetium 99  | 7.467 kBq/g    |
| <b>Tc-99_00016</b>         | 03/18/16 | 03/18/15  | 2M HNO3, Lot n/a                | 500 mL               | Tc-99_00015         | 12 mL        | Technetium 99  | 228.819 dpm/mL |
|                            |          |           |                                 |                      |                     |              | Total Activity | 228.819 dpm/mL |
| .Tc-99_00015               | 03/16/17 | 06/28/05  | 2M HNO3, Lot 0                  | 100 mL               | Tc-99_00004         | 10 mL        | Technetium 99  | 9534.11 dpm/mL |
|                            |          |           |                                 |                      |                     |              | Total Activity | 9534.11 dpm/mL |
| ..Tc-99_00004              | 03/16/17 | 02/28/02  | 2M HNO3, Lot 0                  | 100 mL               | Tc-99_00002         | 4.8728 g     | Technetium 99  | 95341.1 dpm/mL |
|                            |          |           |                                 |                      |                     |              | Total Activity | 95341.1 dpm/mL |
| ...Tc-99_00002             | 03/16/17 |           | NIST, Lot SRM 4288A             |                      | (Purchased Reagent) |              | Technetium 99  | 32.61 kBq/g    |
|                            |          |           |                                 |                      |                     |              | Total Activity | 32.61 kBq/g    |
| <b>Tc-99_00019</b>         | 03/15/17 | 03/18/15  | 2M HNO3, Lot n/a                | 500 mL               | Tc-99_00015         | 12 mL        | Technetium 99  | 228.819 dpm/mL |
|                            |          |           |                                 |                      |                     |              | Total Activity | 228.819 dpm/mL |
| .Tc-99_00015               | 03/16/17 | 06/28/05  | 2M HNO3, Lot 0                  | 100 mL               | Tc-99_00004         | 10 mL        | Technetium 99  | 9534.11 dpm/mL |
|                            |          |           |                                 |                      |                     |              | Total Activity | 9534.11 dpm/mL |
| ..Tc-99_00004              | 03/16/17 | 02/28/02  | 2M HNO3, Lot 0                  | 100 mL               | Tc-99_00002         | 4.8728 g     | Technetium 99  | 95341.1 dpm/mL |
|                            |          |           |                                 |                      |                     |              | Total Activity | 95341.1 dpm/mL |
| ...Tc-99_00002             | 03/16/17 |           | NIST, Lot SRM 4288A             |                      | (Purchased Reagent) |              | Technetium 99  | 32.61 kBq/g    |
|                            |          |           |                                 |                      |                     |              | Total Activity | 32.61 kBq/g    |
| <b>Tuna Can LCS_00005</b>  | 10/29/16 |           | Analytics, Lot 74139-334        |                      | (Purchased Reagent) |              | Am-241         | 219 dpm/g      |
|                            |          |           |                                 |                      |                     |              | Co-60          | 136 dpm/g      |
|                            |          |           |                                 |                      |                     |              | Cs-137         | 82.3 dpm/g     |
| <b>Tuna Can_00002</b>      | 02/03/15 |           | Eckert & Ziegler, Lot 81427-334 |                      | (Purchased Reagent) |              | Am-241         | 1164 Bq        |
|                            |          |           |                                 |                      |                     |              | Cd-109         | 16063 Bq       |
|                            |          |           |                                 |                      |                     |              | Ce-139         | 546 Bq         |
|                            |          |           |                                 |                      |                     |              | Co-57          | 357 Bq         |
|                            |          |           |                                 |                      |                     |              | Co-60          | 742 Bq         |

REAGENT TRACEABILITY SUMMARY

Lab Name: TestAmerica St. Louis Job No.: 160-17563-1

SDG No.: \_\_\_\_\_

| Reagent ID            | Exp Date | Prep Date | Dilutant Used                   | Reagent Final Volume | Parent Reagent      |              | Analyte         | Concentration  |
|-----------------------|----------|-----------|---------------------------------|----------------------|---------------------|--------------|-----------------|----------------|
|                       |          |           |                                 |                      | Reagent ID          | Volume Added |                 |                |
|                       |          |           |                                 |                      |                     |              | Cs-137          | 465 Bq         |
|                       |          |           |                                 |                      |                     |              | Hg-203          | 1208 Bq        |
|                       |          |           |                                 |                      |                     |              | Pb-210          | 15186 Bq       |
|                       |          |           |                                 |                      |                     |              | Sn-113          | 943 Bq         |
|                       |          |           |                                 |                      |                     |              | Y-88            | 1571 Bq        |
| <b>Tuna Can_00003</b> | 02/09/17 |           | Eckert & Ziegler, Lot 90099     |                      | (Purchased Reagent) |              | Am-241          | 1164 Bq        |
|                       |          |           |                                 |                      |                     |              | Cd-109          | 16373 Bq       |
|                       |          |           |                                 |                      |                     |              | Ce-139          | 549 Bq         |
|                       |          |           |                                 |                      |                     |              | Co-57           | 362 Bq         |
|                       |          |           |                                 |                      |                     |              | Co-60           | 735 Bq         |
|                       |          |           |                                 |                      |                     |              | Cs-137          | 467 Bq         |
|                       |          |           |                                 |                      |                     |              | Hg-203          | 1171 Bq        |
|                       |          |           |                                 |                      |                     |              | Pb-210          | 14936 Bq       |
|                       |          |           |                                 |                      |                     |              | Sn-113          | 967 Bq         |
|                       |          |           |                                 |                      |                     |              | Y-88            | 1590 Bq        |
| <b>Tuna Can_00006</b> | 03/01/16 |           | Eckert & Ziegler, Lot 83814-334 |                      | (Purchased Reagent) |              | Am-241          | 1195 Bq        |
|                       |          |           |                                 |                      |                     |              | Cd-109          | 16353 Bq       |
|                       |          |           |                                 |                      |                     |              | Ce-139          | 543 Bq         |
|                       |          |           |                                 |                      |                     |              | Co-57           | 354 Bq         |
|                       |          |           |                                 |                      |                     |              | Co-60           | 745 Bq         |
|                       |          |           |                                 |                      |                     |              | Cs-137          | 453 Bq         |
|                       |          |           |                                 |                      |                     |              | Hg-203          | 1175 Bq        |
|                       |          |           |                                 |                      |                     |              | Pb-210          | 14606 Bq       |
|                       |          |           |                                 |                      |                     |              | Sn-113          | 961 Bq         |
|                       |          |           |                                 |                      |                     |              | Y-88            | 1568 Bq        |
| <b>U-232_00032</b>    | 08/06/16 | 07/16/15  | 2M HNO3, Lot n/a                | 500 mL               | U-232_00009         | 4 mL         | Uranium 232     | 82.2457 dpm/mL |
| .U-232_00009          | 03/24/17 | 08/29/11  | 1M HNO3, Lot 0                  | 100 mL               | U-232_00003         | 5.1609 g     | Uranium 232     | 10280.7 dpm/mL |
| ..U-232_00003         | 08/25/61 |           | Eckert & Ziegler, Lot 85539-334 |                      | (Purchased Reagent) |              | Uranium 232     | 3320.07 Bq/g   |
| <b>UNAT_00012</b>     | 05/05/17 | 04/28/15  | 1M HNO3, Lot n/a                | 200 mL               | UNAT Parent_00001   | 20 mL        | Uranium 234     | 70.6912 dpm/mL |
|                       |          |           |                                 |                      |                     |              | Uranium 238     | 72.265 dpm/mL  |
|                       |          |           |                                 |                      |                     |              | Uranium-235/236 | 3.37064 dpm/mL |
| .UNAT Parent_00001    | 05/05/17 | 05/03/13  | 1M HNO3, Lot n/a                | 200 mL               | UNAT Ampoule_00001  | 19.2509 g    | Uranium 234     | 706.912 dpm/mL |
|                       |          |           |                                 |                      |                     |              | Uranium 238     | 722.65 dpm/mL  |
|                       |          |           |                                 |                      |                     |              | Uranium-235/236 | 33.7064 dpm/mL |
| ..UNAT Ampoule_00001  | 03/30/58 |           | New Brunswick Lab, Lot CRM 145  |                      | (Purchased Reagent) |              | Uranium 234     | 7344.2 dpm/g   |
|                       |          |           |                                 |                      |                     |              | Uranium 238     | 7507.7 dpm/g   |
|                       |          |           |                                 |                      |                     |              | Uranium-235/236 | 350.18 dpm/g   |

Reagent

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**82234-334\_00001**

## CERTIFICATE OF CALIBRATION

### Standard Radionuclide Source

82234-334

24.1 mm Diameter x 0.65 mm Thick Stainless Steel Disk

**Customer:** Test America/St. Louis

**P.O. No.:** 2355182, Item 1

This standard radionuclide source was prepared by electrodeposition onto a stainless steel disk. Total alpha activity was determined with a ZnS scintillation detector. Radionuclide activities and impurities were calculated from the total activity and the fraction of activity for each radionuclide determined by alpha spectroscopy. Eckert & Ziegler Analytics (EZA) maintains traceability to the National Institute of Standards and Technology through a Measurements Assurance Program as described in USNRC Regulatory Guide 4.15, Revision 1, February, 1979, and compliance with ANSI N42.22-1995, "Traceability of Radioactive Sources to NIST." EZA is accredited by the Health Physics Society (HPS) for the production of NIST-traceable sources, and this source was produced in accordance with the HPS accreditation requirements. Customers may report any concerns with the accreditation program to the HPS Secretariat, 1313 Dolley Madison Blvd., Ste. 402, McLean, VA 22101.

**Reference Date:** 2-Jun-2010 12:00 PM EST

| Isotope           | Activity (Bq) | Energy Range<br>(keV) | Half-Life,<br>years | Uncertainty* Type (%) |                |     |
|-------------------|---------------|-----------------------|---------------------|-----------------------|----------------|-----|
|                   |               |                       |                     | u <sub>A</sub>        | u <sub>B</sub> | U   |
| Th-230            | 5.685E+00     | 4420-4800             | 7.540E+04           | 0.9                   | 1.1            | 2.8 |
| Pu-239            | 5.936E+00     | 4950-5240             | 2.410E+04           | 0.9                   | 1.1            | 2.8 |
| Am-241            | 5.652E+00     | 5280-5600             | 4.326E+02           | 0.9                   | 1.1            | 2.8 |
| Total<br>Activity | 1.732E+01     | 3000-8000             |                     | 0.5                   | 1.1            | 2.4 |

**\*Uncertainty:** U - Relative expanded uncertainty, k = 2. See NIST Technical Note 1297, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results."

(Certificate continued on reverse side)



**Comments:**

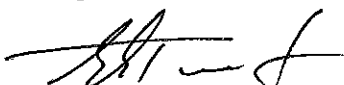
Diameter of active area: 19 mm. Disk mounted on customer supplied disk 31.8 mm diameter x 0.45 mm thick stainless steel disk.

**CAUTION:** Active material deposited on the unmarked surface. Handle carefully to prevent scratching or damaging the active surface of this source (i.e., use Teflon coated forceps). Store in the container provided when not in use.

Source Calibrated by:

  
A. Chen, Spectroscopist

QA Approved:

  
E. A. Taskaev, QA Manager Alternate

Date: 06-24-2010



Reagent

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**82235-334\_00001**

## CERTIFICATE OF CALIBRATION

### Standard Radionuclide Source

82235-334

24.1 mm Diameter x 0.65 mm Thick Stainless Steel Disk

**Customer:** Test America/St. Louis  
**P.O. No.:** 2355182, Item 1

This standard radionuclide source was prepared by electrodeposition onto a stainless steel disk. Total alpha activity was determined with a ZnS scintillation detector. Radionuclide activities and impurities were calculated from the total activity and the fraction of activity for each radionuclide determined by alpha spectroscopy. Eckert & Ziegler Analytics (EZA) maintains traceability to the National Institute of Standards and Technology through a Measurements Assurance Program as described in USNRC Regulatory Guide 4.15, Revision 1, February, 1979, and compliance with ANSI N42.22-1995, "Traceability of Radioactive Sources to NIST." EZA is accredited by the Health Physics Society (HPS) for the production of NIST-traceable sources, and this source was produced in accordance with the HPS accreditation requirements. Customers may report any concerns with the accreditation program to the HPS Secretariat, 1313 Dolley Madison Blvd., Ste. 402, McLean, VA 22101.

**Reference Date:** 4-Jun-2010 12:00 PM EST

| Isotope           | Activity (Bq) | Energy Range<br>(keV) | Half-Life,<br>years | Uncertainty* Type (%) |       |     |
|-------------------|---------------|-----------------------|---------------------|-----------------------|-------|-----|
|                   |               |                       |                     | $u_A$                 | $u_B$ | U   |
| Th-230            | 7.167E+00     | 4420-4800             | 7.540E+04           | 0.8                   | 1.1   | 2.7 |
| Pu-239            | 6.897E+00     | 4950-5240             | 2.410E+04           | 0.8                   | 1.1   | 2.7 |
| Am-241            | 7.466E+00     | 5280-5600             | 4.326E+02           | 0.8                   | 1.1   | 2.7 |
| Total<br>Activity | 2.161E+01     | 3000-8000             |                     | 0.5                   | 1.1   | 2.4 |

**\*Uncertainty:** U - Relative expanded uncertainty,  $k = 2$ . See NIST Technical Note 1297, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results."

(Certificate continued on reverse side)



**Comments:**

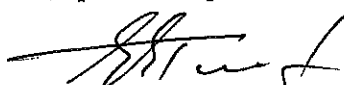
Diameter of active area: 19 mm. Disk mounted on customer supplied disk 31.8 mm diameter x 0.45 mm thick stainless steel disk.

**CAUTION:** Active material deposited on the unmarked surface. Handle carefully to prevent scratching or damaging the active surface of this source (i.e., use Teflon coated forceps). Store in the container provided when not in use.

Source Calibrated by:

  
A. Chen, Spectroscopist

QA Approved:

  
E. A. Taskaev, QA Manager Alternate

Date: 06-24-2010



Reagent

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**82236-334\_00001**

## CERTIFICATE OF CALIBRATION

### Standard Radionuclide Source

82236-334

24.1 mm Diameter x 0.65 mm Thick Stainless Steel Disk

**Customer:** Test America/St. Louis

**P.O. No.:** 2355182, Item 1

This standard radionuclide source was prepared by electrodeposition onto a stainless steel disk. Total alpha activity was determined with a ZnS scintillation detector. Radionuclide activities and impurities were calculated from the total activity and the fraction of activity for each radionuclide determined by alpha spectroscopy. Eckert & Ziegler Analytics (EZA) maintains traceability to the National Institute of Standards and Technology through a Measurements Assurance Program as described in USNRC Regulatory Guide 4.15, Revision 1, February, 1979, and compliance with ANSI N42.22-1995, "Traceability of Radioactive Sources to NIST." EZA is accredited by the Health Physics Society (HPS) for the production of NIST-traceable sources, and this source was produced in accordance with the HPS accreditation requirements. Customers may report any concerns with the accreditation program to the HPS Secretariat, 1313 Dolley Madison Blvd., Ste. 402, McLean, VA 22101.

**Reference Date:** 2-Jun-2010 12:00 PM EST

| Isotope           | Activity (Bq) | Energy Range<br>(keV) | Half-Life,<br>years | Uncertainty* Type (%) |       |     |
|-------------------|---------------|-----------------------|---------------------|-----------------------|-------|-----|
|                   |               |                       |                     | $u_A$                 | $u_B$ | U   |
| Th-230            | 7.107E+00     | 4420-4800             | 7.540E+04           | 0.7                   | 1.1   | 2.6 |
| Pu-239            | 6.664E+00     | 4950-5240             | 2.410E+04           | 0.8                   | 1.1   | 2.7 |
| Am-241            | 6.891E+00     | 5280-5600             | 4.326E+02           | 0.7                   | 1.1   | 2.6 |
| Total<br>Activity | 2.071E+01     | 3000-8000             |                     | 0.4                   | 1.1   | 2.3 |

**\*Uncertainty:** U - Relative expanded uncertainty,  $k = 2$ . See NIST Technical Note 1297, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results."

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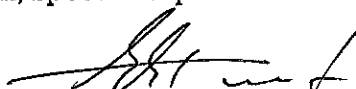


**Comments:**

Diameter of active area: 19 mm. Disk mounted on customer supplied disk 31.8 mm diameter x 0.45 mm thick stainless steel disk.

CAUTION: Active material deposited on the unmarked surface. Handle carefully to prevent scratching or damaging the active surface of this source (i.e., use Teflon coated forceps). Store in the container provided when not in use.

Source Calibrated by:   
A. Chen, Spectroscopist

QA Approved:   
E. A. Taskaev, QA Manager Alternate

Date: 06-24-2010



Reagent

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**82237-334\_00003**

## CERTIFICATE OF CALIBRATION

### Standard Radionuclide Source

82237-334

24.1 mm Diameter x 0.65 mm Thick Stainless Steel Disk

**Customer:** Test America/St. Louis  
**P.O. No.:** 2355182, Item 1

This standard radionuclide source was prepared by electrodeposition onto a stainless steel disk. Total alpha activity was determined with a ZnS scintillation detector. Radionuclide activities and impurities were calculated from the total activity and the fraction of activity for each radionuclide determined by alpha spectroscopy. Eckert & Ziegler Analytics (EZA) maintains traceability to the National Institute of Standards and Technology through a Measurements Assurance Program as described in USNRC Regulatory Guide 4.15, Revision 1, February, 1979, and compliance with ANSI N42.22-1995, "Traceability of Radioactive Sources to NIST." EZA is accredited by the Health Physics Society (HPS) for the production of NIST-traceable sources, and this source was produced in accordance with the HPS accreditation requirements. Customers may report any concerns with the accreditation program to the HPS Secretariat, 1313 Dolley Madison Blvd., Ste. 402, McLean, VA 22101.

**Reference Date:** 1-Jun-2010 12:00 PM EST

| Isotope           | Activity (Bq) | Energy Range<br>(keV) | Half-Life,<br>years | Uncertainty* Type (%) |                |     |
|-------------------|---------------|-----------------------|---------------------|-----------------------|----------------|-----|
|                   |               |                       |                     | u <sub>A</sub>        | u <sub>B</sub> | U   |
| Th-230            | 5.856E+00     | 4420-4800             | 7.540E+04           | 1.0                   | 1.1            | 3.0 |
| Pu-239            | 6.424E+00     | 4950-5240             | 2.410E+04           | 0.9                   | 1.1            | 2.8 |
| Am-241            | 5.608E+00     | 5280-5600             | 4.326E+02           | 1.0                   | 1.1            | 3.0 |
| Total<br>Activity | 1.793E+01     | 3000-8000             |                     | 0.6                   | 1.1            | 2.5 |

**\*Uncertainty:** U - Relative expanded uncertainty, k = 2. See NIST Technical Note 1297, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results."

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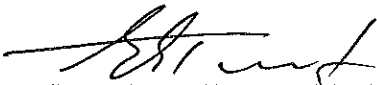


**Comments:**

Diameter of active area: 19 mm. Disk mounted on customer supplied disk 31.8 mm diameter x 0.45 mm thick stainless steel disk.

CAUTION: Active material deposited on the unmarked surface. Handle carefully to prevent scratching or damaging the active surface of this source (i.e., use Teflon coated forceps). Store in the container provided when not in use.

Source Calibrated by:   
A. Chen, Spectroscopist

QA Approved:   
E. A. Taskaev, QA Manager Alternate

Date: 06-24-2010



Reagent

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**82240-334\_00001**

## CERTIFICATE OF CALIBRATION

### Standard Radionuclide Source

82240-334

24.1 mm Diameter x 0.65 mm Thick Stainless Steel Disk

**Customer:** Test America/St. Louis  
**P.O. No.:** 2355182, Item 1

This standard radionuclide source was prepared by electrodeposition onto a stainless steel disk. Total alpha activity was determined with a ZnS scintillation detector. Radionuclide activities and impurities were calculated from the total activity and the fraction of activity for each radionuclide determined by alpha spectroscopy. Eckert & Ziegler Analytics (EZA) maintains traceability to the National Institute of Standards and Technology through a Measurements Assurance Program as described in USNRC Regulatory Guide 4.15, Revision 1, February, 1979, and compliance with ANSI N42.22-1995, "Traceability of Radioactive Sources to NIST." EZA is accredited by the Health Physics Society (HPS) for the production of NIST-traceable sources, and this source was produced in accordance with the HPS accreditation requirements. Customers may report any concerns with the accreditation program to the HPS Secretariat, 1313 Dolley Madison Blvd., Ste. 402, McLean, VA 22101.

**Reference Date:** 8-Jun-2010 12:00 PM EST

| Isotope           | Activity (Bq) | Energy Range<br>(keV) | Half-Life,<br>years | Uncertainty* Type (%) |                |     |
|-------------------|---------------|-----------------------|---------------------|-----------------------|----------------|-----|
|                   |               |                       |                     | u <sub>A</sub>        | u <sub>B</sub> | U   |
| Th-230            | 6.304E+00     | 4420-4800             | 7.540E+04           | 0.9                   | 1.1            | 2.8 |
| Pu-239            | 7.163E+00     | 4950-5240             | 2.410E+04           | 0.8                   | 1.1            | 2.7 |
| Am-241            | 8.298E+00     | 5280-5600             | 4.326E+02           | 0.8                   | 1.1            | 2.7 |
| Total<br>Activity | 2.182E+01     | 3000-8000             |                     | 0.5                   | 1.1            | 2.4 |

\*Uncertainty: U - Relative expanded uncertainty, k = 2. See NIST Technical Note 1297, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results."

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**Comments:**

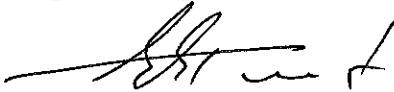
Diameter of active area: 19 mm. Disk mounted on customer supplied disk 31.8 mm diameter x 0.45 mm thick stainless steel disk.

CAUTION: Active material deposited on the unmarked surface. Handle carefully to prevent scratching or damaging the active surface of this source (i.e., use Teflon coated forceps). Store in the container provided when not in use.

Source Calibrated by:

  
A. Chen, Spectroscopist

QA Approved:

  
E. A. Taskaev, QA Manager Alternate

Date: 06-24-2010



Reagent

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**82241-334\_00001**

## CERTIFICATE OF CALIBRATION

### Standard Radionuclide Source

82241-334

24.1 mm Diameter x 0.65 mm Thick Stainless Steel Disk

**Customer:** Test America/St. Louis  
**P.O. No.:** 2355182, Item 1

This standard radionuclide source was prepared by electrodeposition onto a stainless steel disk. Total alpha activity was determined with a ZnS scintillation detector. Radionuclide activities and impurities were calculated from the total activity and the fraction of activity for each radionuclide determined by alpha spectroscopy. Eckert & Ziegler Analytics (EZA) maintains traceability to the National Institute of Standards and Technology through a Measurements Assurance Program as described in USNRC Regulatory Guide 4.15, Revision 1, February, 1979, and compliance with ANSI N42.22-1995, "Traceability of Radioactive Sources to NIST." EZA is accredited by the Health Physics Society (HPS) for the production of NIST-traceable sources, and this source was produced in accordance with the HPS accreditation requirements. Customers may report any concerns with the accreditation program to the HPS Secretariat, 1313 Dolley Madison Blvd., Ste. 402, McLean, VA 22101.

**Reference Date:** 8-Jun-2010 12:00 PM EST

| Isotope           | Activity (Bq) | Energy Range<br>(keV) | Half-Life,<br>years | Uncertainty* Type (%) |       |     |
|-------------------|---------------|-----------------------|---------------------|-----------------------|-------|-----|
|                   |               |                       |                     | $u_A$                 | $u_B$ | U   |
| Th-230            | 6.629E+00     | 4420-4800             | 7.540E+04           | 0.8                   | 1.1   | 2.7 |
| Pu-239            | 6.797E+00     | 4950-5240             | 2.410E+04           | 0.8                   | 1.1   | 2.7 |
| Am-241            | 6.638E+00     | 5280-5600             | 4.326E+02           | 0.8                   | 1.1   | 2.7 |
| Total<br>Activity | 2.011E+01     | 3000-8000             |                     | 0.4                   | 1.1   | 2.3 |

\*Uncertainty: U - Relative expanded uncertainty,  $k = 2$ . See NIST Technical Note 1297, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results."

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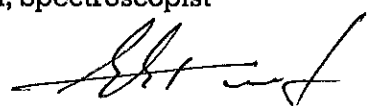


**Comments:**

Diameter of active area: 19 mm. Disk mounted on customer supplied disk 31.8 mm diameter x 0.45 mm thick stainless steel disk.

**CAUTION:** Active material deposited on the unmarked surface. Handle carefully to prevent scratching or damaging the active surface of this source (i.e., use Teflon coated forceps). Store in the container provided when not in use.

Source Calibrated by:   
A. Chen, Spectroscopist

QA Approved:   
E. A. Taskaev, QA Manager Alternate

Date: 06-24-2010



Reagent

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**82242-334\_00001**

## CERTIFICATE OF CALIBRATION

### Standard Radionuclide Source

82242-334

24.1 mm Diameter x 0.65 mm Thick Stainless Steel Disk

**Customer:** Test America/St. Louis

**P.O. No.:** 2355182, Item 1

This standard radionuclide source was prepared by electrodeposition onto a stainless steel disk. Total alpha activity was determined with a ZnS scintillation detector. Radionuclide activities and impurities were calculated from the total activity and the fraction of activity for each radionuclide determined by alpha spectroscopy. Eckert & Ziegler Analytics (EZA) maintains traceability to the National Institute of Standards and Technology through a Measurements Assurance Program as described in USNRC Regulatory Guide 4.15, Revision 1, February, 1979, and compliance with ANSI N42.22-1995, "Traceability of Radioactive Sources to NIST." EZA is accredited by the Health Physics Society (HPS) for the production of NIST-traceable sources, and this source was produced in accordance with the HPS accreditation requirements. Customers may report any concerns with the accreditation program to the HPS Secretariat, 1313 Dolley Madison Blvd., Ste. 402, McLean, VA 22101.

**Reference Date:** 8-Jun-2010 12:00 PM EST

| Isotope           | Activity (Bq) | Energy Range<br>(keV) | Half-Life,<br>years | Uncertainty* Type (%) |       |     |
|-------------------|---------------|-----------------------|---------------------|-----------------------|-------|-----|
|                   |               |                       |                     | $u_A$                 | $u_B$ | U   |
| Th-230            | 6.583E+00     | 4420-4800             | 7.540E+04           | 0.9                   | 1.1   | 2.8 |
| Pu-239            | 6.414E+00     | 4950-5240             | 2.410E+04           | 0.9                   | 1.1   | 2.8 |
| Am-241            | 7.145E+00     | 5280-5600             | 4.326E+02           | 0.9                   | 1.1   | 2.8 |
| Total<br>Activity | 2.018E+01     | 3000-8000             |                     | 0.6                   | 1.1   | 2.5 |

\***Uncertainty:** U - Relative expanded uncertainty,  $k = 2$ . See NIST Technical Note 1297, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results."

(Certificate continued on reverse side)



**Comments:**

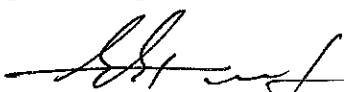
Diameter of active area: 19 mm. Disk mounted on customer supplied disk 31.8 mm diameter x 0.45 mm thick stainless steel disk.

CAUTION: Active material deposited on the unmarked surface. Handle carefully to prevent scratching or damaging the active surface of this source (i.e., use Teflon coated forceps). Store in the container provided when not in use.

Source Calibrated by:

  
A. Chen, Spectroscopist

QA Approved:

  
E. A. Taskaev, QA Manager Alternate

Date: 06-24-2010



Reagent

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**82243-334\_00001**

## CERTIFICATE OF CALIBRATION

### Standard Radionuclide Source

82243-334

24.1 mm Diameter x 0.65 mm Thick Stainless Steel Disk

**Customer:** Test America/St. Louis  
**P.O. No.:** 2355182, Item 1

This standard radionuclide source was prepared by electrodeposition onto a stainless steel disk. Total alpha activity was determined with a ZnS scintillation detector. Radionuclide activities and impurities were calculated from the total activity and the fraction of activity for each radionuclide determined by alpha spectroscopy. Eckert & Ziegler Analytics (EZA) maintains traceability to the National Institute of Standards and Technology through a Measurements Assurance Program as described in USNRC Regulatory Guide 4.15, Revision 1, February, 1979, and compliance with ANSI N42.22-1995, "Traceability of Radioactive Sources to NIST." EZA is accredited by the Health Physics Society (HPS) for the production of NIST-traceable sources, and this source was produced in accordance with the HPS accreditation requirements. Customers may report any concerns with the accreditation program to the HPS Secretariat, 1313 Dolley Madison Blvd., Ste. 402, McLean, VA 22101.

**Reference Date:** 9-Jun-2010 12:00 PM EST

| Isotope           | Activity (Bq) | Energy Range<br>(keV) | Half-Life,<br>years | Uncertainty* Type (%) |       |     |
|-------------------|---------------|-----------------------|---------------------|-----------------------|-------|-----|
|                   |               |                       |                     | $u_A$                 | $u_B$ | U   |
| Th-230            | 5.856E+00     | 4420-4800             | 7.540E+04           | 0.8                   | 1.1   | 2.7 |
| Pu-239            | 5.979E+00     | 4950-5240             | 2.410E+04           | 0.8                   | 1.1   | 2.7 |
| Am-241            | 6.390E+00     | 5280-5600             | 4.326E+02           | 0.8                   | 1.1   | 2.7 |
| Total<br>Activity | 1.827E+01     | 3000-8000             |                     | 0.3                   | 1.1   | 2.3 |

\***Uncertainty:** U - Relative expanded uncertainty,  $k = 2$ . See NIST Technical Note 1297, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results."

(Certificate continued on reverse side)

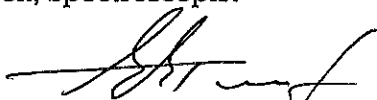


**Comments:**

Diameter of active area: 19 mm. Disk mounted on customer supplied disk 31.8 mm diameter x 0.45 mm thick stainless steel disk.

CAUTION: Active material deposited on the unmarked surface. Handle carefully to prevent scratching or damaging the active surface of this source (i.e., use Teflon coated forceps). Store in the container provided when not in use.

Source Calibrated by:   
A. Chen, Spectroscopist

QA Approved:   
E. A. Taskaev, QA Manager Alternate

Date: 06-24-2010



Reagent

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**82244-334\_00001**

## CERTIFICATE OF CALIBRATION

### Standard Radionuclide Source

82244-334

24.1 mm Diameter x 0.65 mm Thick Stainless Steel Disk

**Customer:** Test America/St. Louis  
**P.O. No.:** 2355182, Item 1

This standard radionuclide source was prepared by electrodeposition onto a stainless steel disk. Total alpha activity was determined with a ZnS scintillation detector. Radionuclide activities and impurities were calculated from the total activity and the fraction of activity for each radionuclide determined by alpha spectroscopy. Eckert & Ziegler Analytics (EZA) maintains traceability to the National Institute of Standards and Technology through a Measurements Assurance Program as described in USNRC Regulatory Guide 4.15, Revision 1, February, 1979, and compliance with ANSI N42.22-1995, "Traceability of Radioactive Sources to NIST." EZA is accredited by the Health Physics Society (HPS) for the production of NIST-traceable sources, and this source was produced in accordance with the HPS accreditation requirements. Customers may report any concerns with the accreditation program to the HPS Secretariat, 1313 Dolley Madison Blvd., Ste. 402, McLean, VA 22101.

**Reference Date:** 9-Jun-2010 12:00 PM EST

| Isotope           | Activity (Bq) | Energy Range<br>(keV) | Half-Life,<br>years | Uncertainty* Type (%) |       |     |
|-------------------|---------------|-----------------------|---------------------|-----------------------|-------|-----|
|                   |               |                       |                     | $u_A$                 | $u_B$ | U   |
| Th-230            | 7.352E+00     | 4420-4800             | 7.540E+04           | 0.8                   | 1.1   | 2.7 |
| Pu-239            | 6.717E+00     | 4950-5240             | 2.410E+04           | 0.9                   | 1.1   | 2.8 |
| Am-241            | 6.897E+00     | 5280-5600             | 4.326E+02           | 0.9                   | 1.1   | 2.8 |
| Total<br>Activity | 2.101E+01     | 3000-8000             |                     | 0.6                   | 1.1   | 2.5 |

\*Uncertainty: U - Relative expanded uncertainty,  $k = 2$ . See NIST Technical Note 1297, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results."

(Certificate continued on reverse side)

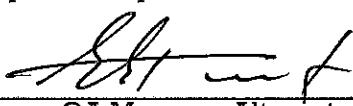


**Comments:**

Diameter of active area: 19 mm. Disk mounted on customer supplied disk 31.8 mm diameter x 0.45 mm thick stainless steel disk.

CAUTION: Active material deposited on the unmarked surface. Handle carefully to prevent scratching or damaging the active surface of this source (i.e., use Teflon coated forceps). Store in the container provided when not in use.

Source Calibrated by:   
A. Chen, Spectroscopist

QA Approved:   
E. A. Taskaev, QA Manager Alternate

Date: 06-24-2010



Reagent

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**82245-334\_00001**

## CERTIFICATE OF CALIBRATION

### Standard Radionuclide Source

82245-334

24.1 mm Diameter x 0.65 mm Thick Stainless Steel Disk

**Customer:** Test America/St. Louis  
**P.O. No.:** 2355182, Item 1

This standard radionuclide source was prepared by electrodeposition onto a stainless steel disk. Total alpha activity was determined with a ZnS scintillation detector. Radionuclide activities and impurities were calculated from the total activity and the fraction of activity for each radionuclide determined by alpha spectroscopy. Eckert & Ziegler Analytics (EZA) maintains traceability to the National Institute of Standards and Technology through a Measurements Assurance Program as described in USNRC Regulatory Guide 4.15, Revision 1, February, 1979, and compliance with ANSI N42.22-1995, "Traceability of Radioactive Sources to NIST." EZA is accredited by the Health Physics Society (HPS) for the production of NIST-traceable sources, and this source was produced in accordance with the HPS accreditation requirements. Customers may report any concerns with the accreditation program to the HPS Secretariat, 1313 Dolley Madison Blvd., Ste. 402, McLean, VA 22101.

**Reference Date:** 9-Jun-2010 12:00 PM EST

| Isotope           | Activity (Bq) | Energy Range<br>(keV) | Half-Life,<br>years | Uncertainty* Type (%) |       |     |
|-------------------|---------------|-----------------------|---------------------|-----------------------|-------|-----|
|                   |               |                       |                     | $u_A$                 | $u_B$ | U   |
| Th-230            | 6.727E+00     | 4420-4800             | 7.540E+04           | 1.0                   | 1.1   | 3.0 |
| Pu-239            | 5.437E+00     | 4950-5240             | 2.410E+04           | 1.1                   | 1.1   | 3.1 |
| Am-241            | 5.528E+00     | 5280-5600             | 4.326E+02           | 1.1                   | 1.1   | 3.1 |
| Total<br>Activity | 1.773E+01     | 3000-8000             |                     | 0.8                   | 1.1   | 2.7 |

\*Uncertainty: U - Relative expanded uncertainty,  $k = 2$ . See NIST Technical Note 1297, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results."

(Certificate continued on reverse side)



**Comments:**

Diameter of active area: 19 mm. Disk mounted on customer supplied disk 31.8 mm diameter x 0.45 mm thick stainless steel disk.

CAUTION: Active material deposited on the unmarked surface. Handle carefully to prevent scratching or damaging the active surface of this source (i.e., use Teflon coated forceps). Store in the container provided when not in use.

Source Calibrated by:

  
A. Chen, Spectroscopist

QA Approved:

  
E. A. Taskaev, QA Manager Alternate

Date: 06-24-2010



Reagent

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**82246-334\_00001**

## CERTIFICATE OF CALIBRATION

### Standard Radionuclide Source

82246-334

24.1 mm Diameter x 0.65 mm Thick Stainless Steel Disk

**Customer:** Test America/St. Louis  
**P.O. No.:** 2355182, Item 1

This standard radionuclide source was prepared by electrodeposition onto a stainless steel disk. Total alpha activity was determined with a ZnS scintillation detector. Radionuclide activities and impurities were calculated from the total activity and the fraction of activity for each radionuclide determined by alpha spectroscopy. Eckert & Ziegler Analytics (EZA) maintains traceability to the National Institute of Standards and Technology through a Measurements Assurance Program as described in USNRC Regulatory Guide 4.15, Revision 1, February, 1979, and compliance with ANSI N42.22-1995, "Traceability of Radioactive Sources to NIST." EZA is accredited by the Health Physics Society (HPS) for the production of NIST-traceable sources, and this source was produced in accordance with the HPS accreditation requirements. Customers may report any concerns with the accreditation program to the HPS Secretariat, 1313 Dolley Madison Blvd., Ste. 402, McLean, VA 22101.

**Reference Date:** 9-Jun-2010 12:00 PM EST

| Isotope           | Activity (Bq) | Energy Range<br>(keV) | Half-Life,<br>years | Uncertainty* Type (%) |       |     |
|-------------------|---------------|-----------------------|---------------------|-----------------------|-------|-----|
|                   |               |                       |                     | $u_A$                 | $u_B$ | U   |
| Th-230            | 5.570E+00     | 4420-4800             | 7.540E+04           | 1.0                   | 1.1   | 3.0 |
| Pu-239            | 5.353E+00     | 4950-5240             | 2.410E+04           | 1.0                   | 1.1   | 3.0 |
| Am-241            | 6.002E+00     | 5280-5600             | 4.326E+02           | 1.0                   | 1.1   | 3.0 |
| Total<br>Activity | 1.696E+01     | 3000-8000             |                     | 0.7                   | 1.1   | 2.6 |

\***Uncertainty:** U - Relative expanded uncertainty,  $k = 2$ . See NIST Technical Note 1297, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results."

(Certificate continued on reverse side)



**Comments:**

Diameter of active area: 19 mm. Disk mounted on customer supplied disk 31.8 mm diameter x 0.45 mm thick stainless steel disk.

CAUTION: Active material deposited on the unmarked surface. Handle carefully to prevent scratching or damaging the active surface of this source (i.e., use Teflon coated forceps). Store in the container provided when not in use.

Source Calibrated by: \_\_\_\_\_

A. Chen, Spectroscopist

QA Approved: \_\_\_\_\_

E. A. Taskaev, QA Manager Alternate

Date: 06.24.2010



Reagent

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**82247-334\_00001**

## CERTIFICATE OF CALIBRATION

### Standard Radionuclide Source

82247-334

24.1 mm Diameter x 0.65 mm Thick Stainless Steel Disk

**Customer:** Test America/St. Louis  
**P.O. No.:** 2355182, Item 1

This standard radionuclide source was prepared by electrodeposition onto a stainless steel disk. Total alpha activity was determined with a ZnS scintillation detector. Radionuclide activities and impurities were calculated from the total activity and the fraction of activity for each radionuclide determined by alpha spectroscopy. Eckert & Ziegler Analytics (EZA) maintains traceability to the National Institute of Standards and Technology through a Measurements Assurance Program as described in USNRC Regulatory Guide 4.15, Revision 1, February, 1979, and compliance with ANSI N42.22-1995, "Traceability of Radioactive Sources to NIST." EZA is accredited by the Health Physics Society (HPS) for the production of NIST-traceable sources, and this source was produced in accordance with the HPS accreditation requirements. Customers may report any concerns with the accreditation program to the HPS Secretariat, 1313 Dolley Madison Blvd., Ste. 402, McLean, VA 22101.

**Reference Date:** 10-Jun-2010 12:00 PM EST

| Isotope           | Activity (Bq) | Energy Range<br>(keV) | Half-Life,<br>years | Uncertainty* Type (%) |       |     |
|-------------------|---------------|-----------------------|---------------------|-----------------------|-------|-----|
|                   |               |                       |                     | $u_A$                 | $u_B$ | U   |
| Th-230            | 6.251E+00     | 4420-4800             | 7.540E+04           | 0.9                   | 1.1   | 2.8 |
| Pu-239            | 5.746E+00     | 4950-5240             | 2.410E+04           | 0.9                   | 1.1   | 2.8 |
| Am-241            | 6.291E+00     | 5280-5600             | 4.326E+02           | 0.9                   | 1.1   | 2.8 |
| Total<br>Activity | 1.832E+01     | 3000-8000             |                     | 0.6                   | 1.1   | 2.5 |

\*Uncertainty: U - Relative expanded uncertainty,  $k = 2$ . See NIST Technical Note 1297, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results."

(Certificate continued on reverse side)

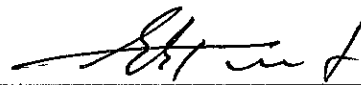


**Comments:**

Diameter of active area: 19 mm. Disk mounted on customer supplied disk 31.8 mm diameter x 0.45 mm thick stainless steel disk.

CAUTION: Active material deposited on the unmarked surface. Handle carefully to prevent scratching or damaging the active surface of this source (i.e., use Teflon coated forceps). Store in the container provided when not in use.

Source Calibrated by:   
A. Chen, Spectroscopist

QA Approved:   
E. A. Taskaev, QA Manager Alternate

Date: 06-24-2010



Reagent

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**Gamma Ampuole\_00001**



# Eckert & Ziegler

## Analytics

1380 Seaboard Industrial Blvd.  
Atlanta, Georgia 30318  
Tel 404-352-8677  
Fax 404-352-2837  
www.analyticsinc.com

### CERTIFICATE OF CALIBRATION

Standard Radionuclide Source

79670-334

5 mL Liquid in Flame Sealed Vial

**Customer:** TestAmerica St. Louis

**P.O. No.:** 2303925, Item 1

**Calibration Date:** 01-Apr-2009 12:00 EST **Grams of Master Source:** 0.028371

This standard radionuclide source was prepared using aliquots measured gravimetrically from master radionuclide solutions. Calibration and purity were checked using a germanium gamma spectrometer system. At the time of calibration no interfering gamma-ray emitting impurities were detected. The gamma-ray emission rates for the most intense gamma-ray lines are given. Analytics maintains traceability to the National Institute of Standards and Technology through a Measurements Assurance Program as described in USNRC Regulatory Guide 4.15, Revision 1, February, 1979, and compliance with ANSI N42.22-1995, "Traceability of Radioactive Sources to NIST."

| Nuclide | Gamma-Ray<br>Energy (keV) | Half-Life,<br>Days | Master<br>Source*<br>yps/gram | This Source<br>yps | Uncertainty, % |       |     | Calibration<br>Method |
|---------|---------------------------|--------------------|-------------------------------|--------------------|----------------|-------|-----|-----------------------|
|         |                           |                    |                               |                    | $u_A$          | $u_B$ | U   |                       |
| Am-241  | 59.5                      | 157860             | —                             | 3.390E+03          | 0.1            | 0.9   | 1.8 | 4 $\pi$ LS            |
| Cd-109  | 88.0                      | 462.60             | 1.691E+05                     | 4.798E+03          | 0.4            | 1.7   | 3.5 | HPGe                  |
| Co-57   | 122.1                     | 271.79             | 8.904E+04                     | 2.526E+03          | 0.5            | 1.3   | 2.8 | HPGe                  |
| Ce-139  | 165.9                     | 137.6              | 1.256E+05                     | 3.563E+03          | 0.4            | 1.1   | 2.3 | HPGe                  |
| Hg-203  | 279.2                     | 46.61              | 2.788E+05                     | 7.910E+03          | 0.3            | 1.1   | 2.3 | HPGe                  |
| Sn-113  | 391.7                     | 115.1              | 1.725E+05                     | 4.894E+03          | 0.5            | 1.1   | 2.4 | HPGe                  |
| Cs-137  | 661.7                     | 10983              | 1.120E+05                     | 3.178E+03          | 0.7            | 1.2   | 2.8 | HPGe                  |
| Y-88    | 898.0                     | 106.6              | 4.205E+05                     | 1.193E+04          | 0.8            | 1.1   | 2.7 | HPGe                  |
| Co-60   | 1173.2                    | 1925.4             | 2.184E+05                     | 6.196E+03          | 0.7            | 1.1   | 2.6 | HPGe                  |
| Cd-60   | 1332.5                    | 1925.4             | 2.185E+05                     | 6.199E+03          | 0.7            | 1.1   | 2.6 | HPGe                  |
| Y-88    | 1836.1                    | 106.6              | 4.444E+05                     | 1.261E+04          | 0.7            | 1.1   | 2.6 | HPGe                  |

\* Master Source refers to Analytics' 8-isotope mixture which is calibrated quarterly.

**Calibration Methods:** 4 $\pi$  LS - 4 pi Liquid Scintillation Counting, HPGe - High Purity Germanium Gamma-Ray Spectrometer, IC - Ionization Chamber. **Uncertainty:** U - Relative expanded uncertainty, k = 2. See NIST Technical Note 1297, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results."

#### Comments:

5.31740 grams 4M HCl solution with approximately 30 microg/g each of Cd, Co, Ce, Hg, Sn, Cs, and Y carriers.

This standard will expire one year after the calibration date.

Source Prepared by: W. Mao for  
W. Mao, Radiochemist

QA Approved: D. M. Montgomery  
D. M. Montgomery, QA Manager

Date: 5-13-09

End of Certificate

Reagent

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**LSC Brown\_00002**



# 728552

LSC Brown\_00002



728552

ID: LSC Brown\_00002

Exp:05/04/20 Ppd:JLW Opn:08/31/15

LSC Daily Check Source Br

## Certificate of Radioactivity / Traceability

**Product** Unquenched Toluene Standard for Liquid Scintillation Counting

**Part Number** 6008500

| Radionuclide               | Average Activity Assay |                    | Lot No. = Assay Date | Serial No. |
|----------------------------|------------------------|--------------------|----------------------|------------|
| <sup>3</sup> H (Tritium) - | 270,300                | DPM/Std. $\pm 3\%$ | May 4, 2015          | 189        |
| Toluene                    | 0.122                  | $\mu$ Ci           |                      |            |
| Carbon 14 -                | 122,100                | DPM/Std. $\pm 2\%$ | May 4, 2015          | 189        |
| Toluene                    | 0.055                  | $\mu$ Ci           |                      |            |

**Expiration Date** May 4, 2020

**REFERENCE STANDARD:** National Institute of Standards and Technology SRM 4947C (3H) and SRM 4222C (14C)

### METHOD OF STANDARDIZATION:

The <sup>3</sup>H bulk solution is standardized by liquid scintillation counting using SRM 4947C as the reference material. The total uncertainty of the assay is  $\pm 1.6\%$

The <sup>14</sup>C bulk solution is standardized by liquid scintillation counting using SRM 4222C as the reference material. The total uncertainty of the assay is  $\pm 1.3\%$

The glass vial may have some imperfections due to the vendor's manufacturing process. These imperfections do not affect the performance of the product.

I hereby certify that the above information is accurate.

**Approved by:** Donna Novi **Date:** May 20, 2015  
Chemist

CN 8845270

2.

**Use**

Even low activity exempt quantity licensed products containing radioactive material are to be used only as intended by the manufacturer and in accordance with the instructions provided with the products. Any other usage is likely to be in noncompliance with regulations.

3.

**Storage**

Any product labeled as "Radioactive Material" is to be secured in safe storage when not in use. Even when actual hazard does not exist, the general public has an apprehension against seeing such labeled items in non-controlled environments. In addition, there is always danger of loss or theft when sources are unsecured.

4.

**Disposal**

These license-exempt quantity radioactive standards may be disposed of without regard to their radioactive content provided all radiation symbols have been removed or defaced; however, these products must be disposed of according to applicable Federal, State and Local regulations governing the toxic and hazardous properties of the products.

The user instructions with this product are very specific for nuclear detection equipment quality control purposes. It is therefore reasonable to assume that the user has already been trained in radiation safety precautions or is operating under the supervision of a person with such training. In the event there are any questions relating to the handling, use, storage, and disposal of a license-exempt quantities contained in this product, please feel free to call the Regulatory Affairs Specialist at PerkinElmer, Downers Grove, Illinois. Phone No. (800) 323-5891 or (630) 969-6000. You may call the Nuclear Regulatory Commission, Agreement State (Health Department), or Licensing State for assistance in unusual cases.

**CERTIFICATION**

PerkinElmer certifies that the standards it produces are at the activity stated on the label at the time of calibration, within the limits of uncertainty stated in this booklet.

| TRITIUM DECAY TABLE (FRACTION REMAINING) |        |       |       |       |       |       |       |       |       |       |       |       |
|------------------------------------------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Half-life 12.43 Years <sup>1</sup>       |        |       |       |       |       |       |       |       |       |       |       |       |
|                                          | 0      | 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8     | 9     | 10    | 11    |
| 0                                        | 1.0000 | .9964 | .9908 | .9862 | .9816 | .9770 | .9725 | .9680 | .9635 | .9590 | .9546 | .9502 |
| 1                                        | .9458  | .9414 | .9370 | .9327 | .9284 | .9241 | .9198 | .9155 | .9113 | .9070 | .9028 | .8986 |
| 2                                        | .8945  | .8903 | .8862 | .8821 | .8780 | .8739 | .8699 | .8659 | .8618 | .8578 | .8539 | .8499 |
| 3                                        | .8460  | .8420 | .8381 | .8343 | .8304 | .8265 | .8227 | .8189 | .8151 | .8113 | .8076 | .8038 |
| 4                                        | .8001  | .7964 | .7927 | .7890 | .7854 | .7817 | .7781 | .7745 | .7709 | .7673 | .7638 | .7602 |
| 5                                        | .7567  | .7532 | .7497 | .7462 | .7428 | .7393 | .7359 | .7325 | .7291 | .7257 | .7223 | .7190 |
| 6                                        | .7157  | .7123 | .7090 | .7058 | .7025 | .6992 | .6960 | .6928 | .6896 | .6864 | .6832 | .6800 |
| 7                                        | .6769  | .6737 | .6706 | .6675 | .6644 | .6613 | .6582 | .6552 | .6522 | .6491 | .6461 | .6431 |
| 8                                        | .6401  | .6372 | .6342 | .6313 | .6284 | .6254 | .6225 | .6197 | .6168 | .6139 | .6111 | .6083 |
| 9                                        | .6054  | .6026 | .5998 | .5971 | .5943 | .5915 | .5888 | .5861 | .5833 | .5806 | .5779 | .5753 |
| 10                                       | .5726  | .5699 | .5673 | .5647 | .5621 | .5595 | .5569 | .5543 | .5517 | .5491 | .5466 | .5441 |
| 11                                       | .5415  | .5390 | .5365 | .5341 | .5316 | .5291 | .5267 | .5242 | .5218 | .5194 | .5170 | .5146 |
| 12                                       | .5122  | .5098 | .5074 | .5051 | .5027 | .5004 | .4981 | .4958 | .4935 | .4912 | .4889 | .4867 |

<sup>1</sup>Unterwiesing, M.P., B.M. Coursey, F.J. Schima and W.B. Mann, Int. J. Appl. Radiat. And Isot. 31,611 (1980)

<sup>2</sup>1 Year = 365.25 days

<sup>3</sup>1 month = 365/12 = 30.44 days

**LICENSING AND LABELING INFORMATION**

PerkinElmer is authorized to distribute these sealed standards to persons exempt from licensing and licensing requirements as provided in 30.18 of 10 CFR Part 30.

The contents of these standards are exempt from NRC or Agreement State licensing requirements. "Radioactive Material" - Not for Human Use - Introduction into Foods, Beverages, Cosmetics, Drugs or Medicinal, or Into Products Manufactured for Commercial Distribution is prohibited. Exempt Quantities Should Not Be Combined."

09/11

8842004 Rev R

4

# SEALED STANDARDS FOR LIQUID SCINTILLATION COUNTERS

PerkinElmer manufacture the following types of sealed standards for liquid scintillation counters:

| PART #   | TYPE                                  | RADIONUCLIDE             | VIAL SIZE | VOL   | # OF VIALS |
|----------|---------------------------------------|--------------------------|-----------|-------|------------|
| 6008400  | Unquenched Standard Set               | 3H Toluene & 14C Toluene | 7 ml      | 5 ml  | 3          |
| 6008401  | Quenched Series                       | Tritiated Toluene        | 7 ml      | 5 ml  | 10         |
| 6008402  | Quenched Series                       | Carbon-14 Toluene        | 7 ml      | 5 ml  | 10         |
| 6008411  | Unquenched Std.-Argon Purged          | None                     | 7 ml      | 5 ml  | 1          |
| 6008412  | Unquenched Std.-Argon Purged          | Tritiated Toluene        | 7 ml      | 5 ml  | 1          |
| 6008413  | Unquenched Std.-Argon Purged          | Carbon-14 Toluene        | 7 ml      | 5 ml  | 1          |
| 6008500  | Unquenched Standard Set               | 3H Toluene & 14C Toluene | 20 ml     | 15 ml | 3          |
| 6008501  | Quenched Series                       | Tritiated Toluene        | 20 ml     | 15 ml | 10         |
| 6008502  | Quenched Series                       | Carbon-14 Toluene        | 20 ml     | 15 ml | 10         |
| 6008511  | Unquenched Std.-Argon Purged          | None                     | 20 ml     | 15 ml | 1          |
| 6008512  | Unquenched Std.-Argon Purged          | Tritiated Toluene        | 20 ml     | 15 ml | 1          |
| 6008513  | Unquenched Std.-Argon Purged          | Carbon-14 Toluene        | 20 ml     | 15 ml | 1          |
| 6018551  | Quenched Series-Extended Range        | Tritiated Toluene        | 7 ml      | 5 ml  | 10         |
| 6018552  | Quenched Series-Extended Range        | Carbon-14 Toluene        | 7 ml      | 5 ml  | 10         |
| 6018594  | Quenched Series-Extended Range        | Tritiated Toluene        | 20 ml     | 15 ml | 10         |
| 6018595  | Quenched Series-Extended Range        | Carbon-14 Toluene        | 20 ml     | 15 ml | 10         |
| 6018911  | Unquenched Low Level Standard         | Tritiated Toluene        | 20 ml     | 10 ml | 1          |
| 6018912  | Non-purged                            | Carbon-14 Toluene        | 20 ml     | 10 ml | 1          |
| 6018913  | Unquenched Low Level Standard         | None                     | 20 ml     | 10 ml | 1          |
| 6018914  | Unquenched Low Level Std Set          | 3H Toluene & 14C Toluene | 20 ml     | 10 ml | 3          |
| 6018917  | Low Level Quenched Series             | Tritiated Toluene        | 20 ml     | 15 ml | 10         |
| 6018918  | Low Level Quenched Series             | Carbon-14 Toluene        | 20 ml     | 15 ml | 10         |
| 6007600  | Ultima Gold Quenched Series           | Tritiated Toluene        | 20 ml     | 15 ml | 10         |
| 6007601  | Ultima Gold Quenched Series           | Carbon-14 Toluene        | 20 ml     | 15 ml | 10         |
| 6007603  | Ultima Gold Quenched Series           | Tritiated Toluene        | 7 ml      | 5 ml  | 10         |
| 6007604  | Ultima Gold Quenched Series           | Carbon-14 Toluene        | 7 ml      | 5 ml  | 10         |
| 6010704  | Ultima Gold Low Level Quenched Series | Tritiated Toluene        | 20 ml     | 15 ml | 8          |
| 6010705  | Ultima Gold Low Level Quenched Series | Carbon-14 Toluene        | 20 ml     | 15 ml | 8          |
| 1215-111 | Unquenched Standard Set               | 3H Toluene & 14C Toluene | 20 ml     | 10 ml | 3          |
|          | For 1220 Quantulus                    |                          |           |       |            |

The scintillator solution in these standards contains 4 grams of PPO and 0.25 grams of Dimethyl-POPOP per liter of toluene, except for the Ultima Gold (U.G.) Quenched Series which contains Aklomphthalene, PPO, and bis-MSB. The solution is flame-sealed in low activity borosilicate glass ampoules. Nitromethane is used as the quenching agent in the quenched standards sets.

For 1215-111 the scintillator solution contains 5 grams of PPO and 0.30 grams of bis-MSB per liter of xylene.



**PerkinElmer®**

PerkinElmer, Inc.  
549 Albany St. Boston MA 02118  
Toll Free: 1-800-762-4000

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Reagent

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**Source A\_00001**



# Eckert & Ziegler

## Analytics

1380 Seaboard Industrial Blvd.  
Atlanta, Georgia 30318  
Tel 404-352-8677  
Fax 404-352-2837  
www.analyticsinc.com

### CERTIFICATE OF CALIBRATION

Standard Radionuclide Source

79670-334

5 mL Liquid in Flame Sealed Vial

**Customer:** TestAmerica St. Louis

**P.O. No.:** 2303925, Item 1

**Calibration Date:** 01-Apr-2009 12:00 EST **Grams of Master Source:** 0.028371

This standard radionuclide source was prepared using aliquots measured gravimetrically from master radionuclide solutions. Calibration and purity were checked using a germanium gamma spectrometer system. At the time of calibration no interfering gamma-ray emitting impurities were detected. The gamma-ray emission rates for the most intense gamma-ray lines are given. Analytics maintains traceability to the National Institute of Standards and Technology through a Measurements Assurance Program as described in USNRC Regulatory Guide 4.15, Revision 1, February, 1979, and compliance with ANSI N42.22-1995, "Traceability of Radioactive Sources to NIST."

| Nuclide | Gamma-Ray<br>Energy (keV) | Half-Life,<br>Days | Master<br>Source*<br>γps/gram | This Source<br>γps | Uncertainty , % |                |                | Calibration<br>Method |
|---------|---------------------------|--------------------|-------------------------------|--------------------|-----------------|----------------|----------------|-----------------------|
|         |                           |                    |                               |                    | Type            | u <sub>A</sub> | u <sub>B</sub> |                       |
| Am-241  | 59.5                      | 157860             | —                             | 3.390E+03          | 0.1             | 0.9            | 1.8            | 4π LS                 |
| Cd-109  | 88.0                      | 462.60             | 1.691E+05                     | 4.798E+03          | 0.4             | 1.7            | 3.5            | HPGe                  |
| Co-57   | 122.1                     | 271.79             | 8.904E+04                     | 2.526E+03          | 0.5             | 1.3            | 2.8            | HPGe                  |
| Ce-139  | 165.9                     | 137.6              | 1.256E+05                     | 3.563E+03          | 0.4             | 1.1            | 2.3            | HPGe                  |
| Hg-203  | 279.2                     | 46.61              | 2.788E+05                     | 7.910E+03          | 0.3             | 1.1            | 2.3            | HPGe                  |
| Sn-113  | 391.7                     | 115.1              | 1.725E+05                     | 4.894E+03          | 0.5             | 1.1            | 2.4            | HPGe                  |
| Cs-137  | 661.7                     | 10983              | 1.120E+05                     | 3.178E+03          | 0.7             | 1.2            | 2.8            | HPGe                  |
| Y-88    | 898.0                     | 106.6              | 4.205E+05                     | 1.193E+04          | 0.8             | 1.1            | 2.7            | HPGe                  |
| Co-60   | 1173.2                    | 1925.4             | 2.184E+05                     | 6.196E+03          | 0.7             | 1.1            | 2.6            | HPGe                  |
| Cd-60   | 1332.5                    | 1925.4             | 2.185E+05                     | 6.199E+03          | 0.7             | 1.1            | 2.6            | HPGe                  |
| Y-88    | 1836.1                    | 106.6              | 4.444E+05                     | 1.261E+04          | 0.7             | 1.1            | 2.6            | HPGe                  |

\* Master Source refers to Analytics' 8-isotope mixture which is calibrated quarterly.

**Calibration Methods:** 4 $\pi$  LS - 4 pi Liquid Scintillation Counting, HPGe - High Purity Germanium Gamma-Ray Spectrometer, IC - Ionization Chamber. **Uncertainty:** U - Relative expanded uncertainty, k = 2. See NIST Technical Note 1297, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results."

#### Comments:

5.31740 grams 4M HCl solution with approximately 30 microg/g each of Cd, Co, Ce, Hg, Sn, Cs, and Y carriers.

This standard will expire one year after the calibration date.

Source Prepared by: W. Mao for  
W. Mao, Radiochemist

QA Approved: D. M. Montgomery  
D. M. Montgomery, QA Manager

Date: 5-13-09

End of Certificate

Reagent

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**Source C\_00001**



# Eckert & Ziegler

## Analytics

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### CERTIFICATE OF CALIBRATION

Standard Radionuclide Source

79670-334

5 mL Liquid in Flame Sealed Vial

**Customer:** TestAmerica St. Louis

**P.O. No.:** 2303925, Item 1

**Calibration Date:** 01-Apr-2009 12:00 EST **Grams of Master Source:** 0.028371

This standard radionuclide source was prepared using aliquots measured gravimetrically from master radionuclide solutions. Calibration and purity were checked using a germanium gamma spectrometer system. At the time of calibration no interfering gamma-ray emitting impurities were detected. The gamma-ray emission rates for the most intense gamma-ray lines are given. Analytics maintains traceability to the National Institute of Standards and Technology through a Measurements Assurance Program as described in USNRC Regulatory Guide 4.15, Revision 1, February, 1979, and compliance with ANSI N42.22-1995, "Traceability of Radioactive Sources to NIST."

| Nuclide | Gamma-Ray<br>Energy (keV) | Half-Life,<br>Days | Master<br>Source*<br>yps/gram | This Source<br>yps | Uncertainty, % |       |     | Calibration<br>Method |
|---------|---------------------------|--------------------|-------------------------------|--------------------|----------------|-------|-----|-----------------------|
|         |                           |                    |                               |                    | $u_A$          | $u_B$ | U   |                       |
| Am-241  | 59.5                      | 157860             | —                             | 3.390E+03          | 0.1            | 0.9   | 1.8 | 4 $\pi$ LS            |
| Cd-109  | 88.0                      | 462.60             | 1.691E+05                     | 4.798E+03          | 0.4            | 1.7   | 3.5 | HPGe                  |
| Co-57   | 122.1                     | 271.79             | 8.904E+04                     | 2.526E+03          | 0.5            | 1.3   | 2.8 | HPGe                  |
| Ce-139  | 165.9                     | 137.6              | 1.256E+05                     | 3.563E+03          | 0.4            | 1.1   | 2.3 | HPGe                  |
| Hg-203  | 279.2                     | 46.61              | 2.788E+05                     | 7.910E+03          | 0.3            | 1.1   | 2.3 | HPGe                  |
| Sn-113  | 391.7                     | 115.1              | 1.725E+05                     | 4.894E+03          | 0.5            | 1.1   | 2.4 | HPGe                  |
| Cs-137  | 661.7                     | 10983              | 1.120E+05                     | 3.178E+03          | 0.7            | 1.2   | 2.8 | HPGe                  |
| Y-88    | 898.0                     | 106.6              | 4.205E+05                     | 1.193E+04          | 0.8            | 1.1   | 2.7 | HPGe                  |
| Co-60   | 1173.2                    | 1925.4             | 2.184E+05                     | 6.196E+03          | 0.7            | 1.1   | 2.6 | HPGe                  |
| Cq-60   | 1332.5                    | 1925.4             | 2.185E+05                     | 6.199E+03          | 0.7            | 1.1   | 2.6 | HPGe                  |
| Y-88    | 1836.1                    | 106.6              | 4.444E+05                     | 1.261E+04          | 0.7            | 1.1   | 2.6 | HPGe                  |

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Source Prepared by: W. Mao for  
W. Mao, Radiochemist

QA Approved: D. M. Montgomery  
D. M. Montgomery, QA Manager

Date: 5-13-09

End of Certificate

Reagent

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**Source D\_00001**



# Eckert & Ziegler

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### CERTIFICATE OF CALIBRATION

Standard Radionuclide Source

79670-334

5 mL Liquid in Flame Sealed Vial

**Customer:** TestAmerica St. Louis

**P.O. No.:** 2303925, Item 1

**Calibration Date:** 01-Apr-2009 12:00 EST **Grams of Master Source:** 0.028371

This standard radionuclide source was prepared using aliquots measured gravimetrically from master radionuclide solutions. Calibration and purity were checked using a germanium gamma spectrometer system. At the time of calibration no interfering gamma-ray emitting impurities were detected. The gamma-ray emission rates for the most intense gamma-ray lines are given. Analytics maintains traceability to the National Institute of Standards and Technology through a Measurements Assurance Program as described in USNRC Regulatory Guide 4.15, Revision 1, February, 1979, and compliance with ANSI N42.22-1995, "Traceability of Radioactive Sources to NIST."

| Nuclide | Gamma-Ray<br>Energy (keV) | Half-Life,<br>Days | Master<br>Source*<br>yps/gram | This Source<br>yps | Uncertainty, % |       |     | Calibration<br>Method |
|---------|---------------------------|--------------------|-------------------------------|--------------------|----------------|-------|-----|-----------------------|
|         |                           |                    |                               |                    | $u_A$          | $u_B$ | U   |                       |
| Am-241  | 59.5                      | 157860             | —                             | 3.390E+03          | 0.1            | 0.9   | 1.8 | 4 $\pi$ LS            |
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| Hg-203  | 279.2                     | 46.61              | 2.788E+05                     | 7.910E+03          | 0.3            | 1.1   | 2.3 | HPGe                  |
| Sn-113  | 391.7                     | 115.1              | 1.725E+05                     | 4.894E+03          | 0.5            | 1.1   | 2.4 | HPGe                  |
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Source Prepared by: W. Mao for  
W. Mao, Radiochemist

QA Approved: D. M. Montgomery  
D. M. Montgomery, QA Manager

Date: 5-13-09

End of Certificate

Reagent

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**Tc-99\_00002**



# National Institute of Standards & Technology

## Certificate

### Standard Reference Material 4288A Technetium-99 Radioactivity Standard

This Standard Reference Material (SRM) consists of radioactive technetium-99, as potassium pertechnetate, and potassium hydroxide dissolved in 5 mL of distilled water. The solution is contained in a flame-sealed NIST borosilicate-glass ampoule. The SRM is intended for the calibration of beta-particle counting instruments and for the monitoring of radiochemical procedures.

#### Radiological Hazard

The SRM ampoule contains technetium-99 with a total activity of approximately 166 kBq. Technetium-99 decays by beta-particle emission. None of the beta particles escape from the SRM ampoule. During the decay process no photons are emitted. Approximate unshielded dose rates at several distances (as of the reference time) are given in note (a)\*. There is no detectable external radiation. The SRM should be used only by persons qualified to handle radioactive material.

#### Chemical Hazard

The SRM ampoule contains potassium hydroxide (KOH) with a concentration of 0.001 moles per liter of water. The solution is mildly corrosive and could represent a health hazard if it comes in contact with eyes or skin. If the ampoule is to be opened to transfer the solution, the recommended procedure is given on page 2.

#### Storage and Handling

The SRM should be stored and used at a temperature between 5 and 65 °C. The solution in an unopened ampoule should remain stable and homogeneous until at least September 2006.

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

#### Preparation

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

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

Gaithersburg, Maryland 20899  
October 1996

Thomas E. Gills, Chief  
Standard Reference Materials Program

#### Recommended Procedure for Opening the SRM Ampoule

- 1) If the SRM solution is to be diluted, it is recommended that the diluting solution have a composition comparable to that of the SRM solution.
- 2) Wear eye protection, gloves, and protective clothing and work over a tray with absorbent paper in it.
- 3) Shake the ampoule to wet all of the inside surface of the ampoule. Return the ampoule to the upright position.
- 4) Check that all of the liquid has drained out of the neck of the ampoule. If necessary, gently tap the neck to speed the process.
- 5) Holding the ampoule upright, score the narrowest part of the neck with a scribe or diamond pencil.
- 6) Lightly wet the scored line. This reduces the crack propagation velocity and makes for a cleaner break.
- 7) Hold the ampoule upright with a paper towel, a wiper, or a support jig. Position the scored line away from you. Using a paper towel or wiper to avoid contamination, snap off the top of the ampoule by pressing the narrowest part of the neck away from you while pulling the tip of the ampoule towards you.
- 8) Transfer the solution from the ampoule using a pycnometer or a pipet with dispenser handle. **NEVER PIPETTE BY MOUTH.**
- 9) Seal any unused SRM solution in a flame-sealed glass ampoule, if possible, to minimize the evaporation loss. See also reference [4]\*.

PROPERTIES OF SRM 4288A  
(Certified values are shown in bold type)

|                                          |                                                                                                                                                                        |                                      |                                    |
|------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|------------------------------------|
| Source identification number             | NIST SRM 4288A                                                                                                                                                         |                                      |                                    |
| Physical Properties:                     |                                                                                                                                                                        |                                      |                                    |
| Source description                       | Liquid in flame-sealed NIST <sup>®</sup> borosilicate-glass ampoule                                                                                                    |                                      |                                    |
| Ampoule specifications                   | Body outside diameter                                                                                                                                                  | (16.5 ± 0.5) mm                      |                                    |
|                                          | Wall Thickness                                                                                                                                                         | (0.60 ± 0.04) mm                     |                                    |
|                                          | Barium content                                                                                                                                                         | Less than 2.5%                       |                                    |
|                                          | Lead-oxide content                                                                                                                                                     | Less than 0.02%                      |                                    |
|                                          | Other heavy elements                                                                                                                                                   | Trace quantities                     |                                    |
| Solution density                         | (0.998 ± 0.002) g·mL <sup>-1</sup> at 21 °C [b]*                                                                                                                       |                                      |                                    |
| Solution mass                            | (4.998 ± 0.002) g [b]                                                                                                                                                  |                                      |                                    |
| Chemical Properties:                     |                                                                                                                                                                        |                                      |                                    |
| Solution composition                     | Chemical Formula                                                                                                                                                       | Concentration (mol·L <sup>-1</sup> ) | Mass Fraction (g·g <sup>-1</sup> ) |
|                                          | H <sub>2</sub> O<br>KOH<br>K <sup>99</sup> TcO <sub>4</sub>                                                                                                            | 55<br>0.001<br>0.0005                | 1.00<br>0.00006<br>0.0001          |
| Radiological Properties:                 |                                                                                                                                                                        |                                      |                                    |
| Radionuclide                             | Technetium-99                                                                                                                                                          |                                      |                                    |
| Reference time                           | 1200 EST, 1 September 1996                                                                                                                                             |                                      |                                    |
| Massic activity of the solution [c]      | 32.61 kBq·g <sup>-1</sup>                                                                                                                                              |                                      |                                    |
| Relative expanded uncertainty (k=2)      | 1.14% [d] [e]                                                                                                                                                          |                                      |                                    |
| Photon-emitting impurities               | None detected [f]                                                                                                                                                      |                                      |                                    |
| Half lives used in the decay corrections | Cobalt-60: (5.2714 ± 0.0005) a [g]<br>Technetium-99: (2.111 ± 0.012) × 10 <sup>5</sup> a [g]                                                                           |                                      |                                    |
| Measuring instrument                     | NIST 4πβ(LS)-γ-anticoincidence counting system using cobalt-60 as the efficiency-tracing radionuclide. The efficiency was varied electronically from 50 to 93 percent. |                                      |                                    |

EVALUATION OF THE UNCERTAINTY OF THE MASSIC ACTIVITY [d]\*

| Input Quantity $x_i$ ,<br>the source of uncertainty<br>(and individual uncertainty components<br>where appropriate)                                | Method Used To Evaluate $u(x_i)$ ,<br>the standard uncertainty of $x_i$<br>(A) denotes evaluation by statistical methods<br>(B) denotes evaluation by other methods | Relative<br>Uncertainty<br>Of Input<br>Quantity,<br>$u(x_i)/x_i$ ,<br>(%) [1] | Relative<br>Sensitivity<br>Factor,<br>$ \partial y/\partial x_i  \cdot$<br>( $x_i/y$ )<br>[1] | Relative<br>Uncertainty<br>Of Output<br>Quantity,<br>$u(y)/y$ ,<br>(%) [1] |
|----------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|
| Extrapolated massic liquid-scintillation count rate<br>of the Tc-99 solution, corrected for background,<br>cobalt-60 tracer count rate, and decay. | Standard deviation of the mean for 4 sets of<br>repeated measurements on each of 3 samples<br>(A)                                                                   | 0.10                                                                          | 1.0                                                                                           | 0.10                                                                       |
| Decay corrections<br>for cobalt-60<br>for technetium-99                                                                                            | Standard uncertainty of the half life (A)<br>Standard uncertainty of the half life (A)                                                                              | 0.01<br>0.6                                                                   | 0.00001<br>0.000005                                                                           | 0.00001<br>0.000003                                                        |
| Decay scheme data                                                                                                                                  | Standard uncertainty of the probability of<br>decay by beta-particle emission (A)                                                                                   | 0.01                                                                          | 1.0                                                                                           | 0.01                                                                       |
| Extrapolation of the beta-particle-count-rate<br>versus anticoincidence-gamma-ray-count-rate to<br>zero anticoincidence-gamma-ray-count-rate       | Estimated (B)                                                                                                                                                       | 0.40                                                                          | 1.0                                                                                           | 0.40                                                                       |
| Calibration of the cobalt-60 tracer solution using<br>the 4πβ(LS)-γ-anticoincidence counting system                                                | Standard uncertainty of the extrapolated massic<br>count rate (B)                                                                                                   | 0.25                                                                          | 1.0                                                                                           | 0.25                                                                       |
| Gravimetric measurements                                                                                                                           | Estimated (B)                                                                                                                                                       | 0.20                                                                          | 1.0                                                                                           | 0.20                                                                       |
| Live-time measurements [n]                                                                                                                         | Estimated (B)                                                                                                                                                       | 0.10                                                                          | 1.0                                                                                           | 0.10                                                                       |
| Variability between ampoules                                                                                                                       | Estimated (B)                                                                                                                                                       | 0.20                                                                          | 1.0                                                                                           | 0.20                                                                       |
| Photon-emitting impurities                                                                                                                         | Limit of detection (B) [p]                                                                                                                                          | 100.                                                                          | 0.00004                                                                                       | 0.004                                                                      |
| Relative Combined Standard Uncertainty of the Output Quantity, $u_c(y)/y$ , (%)                                                                    |                                                                                                                                                                     |                                                                               |                                                                                               | 0.57                                                                       |
| Coverage Factor, $k$                                                                                                                               |                                                                                                                                                                     |                                                                               |                                                                                               | $\frac{x_2}{x_1}$                                                          |
| Relative Expanded Uncertainty of the Output Quantity, $U(y)$ , (%)                                                                                 |                                                                                                                                                                     |                                                                               |                                                                                               | 1.14                                                                       |

\* Notes and references are on pages 5 and 6.

SRM 4288a, page 4 of 6

## NOTES

- [a] The Sievert is the SI unit for dose equivalent. See reference [1]. One  $\mu\text{Sv}$  is equal to 0.1 mrem.  
 Distance from Ampoule (cm): 1 30 100  
 Approximate Dose Rate ( $\mu\text{Sv/h}$ ): <0.1 (Not detectable)

- [b] The stated uncertainty is two times the standard uncertainty.

- [c] Massic activity is the preferred name for the quantity activity divided by the total mass of the sample. See reference [1].

- [d] The reported value,  $y$ , of massic activity (activity per unit mass) at the reference time was not measured directly but was derived from measurements and calculations of other quantities. This can be expressed as  $y = f(x_1, x_2, x_3, \dots, x_n)$ , where  $f$  is a mathematical function derived from the assumed model of the measurement process.

The value,  $x_i$ , used for each input quantity  $i$  has a standard uncertainty,  $u(x_i)$ , that generates a corresponding uncertainty in  $y$ ,  $u_i(y) = |\partial y / \partial x_i| \cdot u(x_i)$ , called a component of combined standard uncertainty of  $y$ .

The combined standard uncertainty of  $y$ ,  $u_c(y)$ , is the positive square root of the sum of the squares of the components of combined standard uncertainty.

The combined standard uncertainty is multiplied by a coverage factor of  $k = 2$  to obtain  $U$ , the expanded uncertainty of  $y$ .

Since it can be assumed that the possible estimated values of the massic activity are approximately normally distributed with approximate standard deviation  $u_c(y)$ , the unknown value of the massic activity is believed to lie in the interval  $\pm U$  with a level of confidence of approximately 95 percent.

For further information on the expression of uncertainties, see references [2] and [3].

- [e] The value of each standard uncertainty component, and hence the value of the expanded uncertainty itself, is a best estimate based upon all available information, but is only approximately known. That is to say, the "uncertainty of the uncertainty" is large and not well known. This is true for uncertainties evaluated by statistical methods (e.g., the relative standard deviation of the standard deviation of the mean for the liquid-scintillation counting is approximately 50%) and for uncertainties evaluated by other methods (which could easily be over estimated or under estimated by substantial amounts). The unknown value of the expanded uncertainty is believed to lie in the interval  $U/2$  to  $2U$  (i.e., within a factor of 2 of the estimated value).

- [f] Estimated limits of detection for photon-emitting impurities are:  
 $2 \times 10^{-4} \text{ y} \cdot \text{s}^{-1} \cdot \text{g}^{-1}$  for energies between 20 and 85 keV,  
 $2 \times 10^{-5} \text{ y} \cdot \text{s}^{-1} \cdot \text{g}^{-1}$  for energies between 93 and 503 keV,  
 $1 \times 10^{-5} \text{ y} \cdot \text{s}^{-1} \cdot \text{g}^{-1}$  for energies between 519 and 1457 keV, and  
 $5 \times 10^{-6} \text{ y} \cdot \text{s}^{-1} \cdot \text{g}^{-1}$  for energies between 1465 and 3250 keV.

- [g] The stated uncertainty is the standard uncertainty. See reference [5].

- [h] Relative standard uncertainty of the input quantity  $x_i$ .
- [i] The relative change in the output quantity  $y$  divided by the relative change in the input quantity  $x_i$ . If  $|\partial y / \partial x_i| \cdot (x_i / y) = 1.0$ , then a 1% change in  $x_i$  results in a 1% change in  $y$ . If  $|\partial y / \partial x_i| \cdot (x_i / y) = 0.05$ , then a 1% change in  $x_i$  results in a 0.05% change in  $y$ .
- [j] Relative component of combined standard uncertainty of output quantity  $y$ , rounded to two significant figures or less. The relative component of combined standard uncertainty of  $y$  is given by  $u_i(y) / y = |\partial y / \partial x_i| \cdot u(x_i) / y = |\partial y / \partial x_i| \cdot (x_i / y) \cdot u(x_i) / x_i$ . The numerical values of  $u(x_i) / x_i$ ,  $|\partial y / \partial x_i| \cdot (x_i / y)$ , and  $u_i(y) / y$ , all dimensionless quantities, are listed in columns 3, 4, and 5, respectively. Thus, the value in column 5 is equal to the value in column 4 multiplied by the value in column 3. The input quantities are independent, or very nearly so. Hence the covariances are zero or negligible.
- [k] The relative standard uncertainty of  $\lambda \cdot t$  is determined by the relative standard uncertainty of  $\lambda$  (i.e., of the half life). The relative standard uncertainty of  $t$  is negligible.
- [m]  $|\partial y / \partial x_i| \cdot (x_i / y) = |\lambda \cdot t|$ , multiplied by other sensitivity factors where appropriate.
- [n] The live time is determined by counting the pulses from a gated crystal-controlled oscillator.
- [p] The standard uncertainty for each undetected impurity that might reasonably be expected to be present is estimated to be equal to the estimated limit of detection for that impurity, i.e.  $u(x_i) / x_i = 100\%$ .  $|\partial y / \partial x_i| \cdot (x_i / y) = \{(\text{response per Bq of impurity}) / (\text{response per Bq of } ^{99}\text{Tc})\} \cdot \{(\text{Bq of impurity}) / (\text{Bq of } ^{99}\text{Tc})\}$ . Thus  $u_i(y) / y$  is the relative change in  $y$  if the impurity were present with a massic activity equal to the estimated limit of detection.

#### REFERENCES

- [1] International Organization for Standardization (ISO), *ISO Standards Handbook - Quantities and Units*, 1993. Available from the American National Standards Institute, 11 West 42nd Street, New York, NY 10036, U.S.A. 1-212-642-4900.
- [2] International Organization for Standardization (ISO), *Guide to the Expression of Uncertainty in Measurement*, 1993. Available from the American National Standards Institute, 11 West 42nd Street, New York, NY 10036, U.S.A. 1-212-642-4900. (Listed under ISO miscellaneous publications as "ISO Guide to the Expression 1993".)
- [3] B. N. Taylor and C. E. Kuyatt, *Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results*, NIST Technical Note 1297, 1994. Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20407, U.S.A.
- [4] National Council on Radiation Protection and Measurements Report No. 58, *A Handbook of Radioactivity Measurements Procedures*, Second Edition, 1985. Available from the National Council on Radiation Protection and Measurements, 7910 Woodmont Avenue, Bethesda, MD 20814 U.S.A.
- [5] Evaluated Nuclear Structure Data File (ENSDF), September 1996.

Reagent

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**Tc-99\_00003**

# NIST TRACEABLE CERTIFICATE

## BETA STANDARD SOLUTION

|               |                         |                          |                           |       |           |
|---------------|-------------------------|--------------------------|---------------------------|-------|-----------|
| Radionuclide: | Tc-99                   | Customer:                | SEVERN TRENT LABORATORIES |       |           |
| Half-life:    | (2.13 ± 0.05)E+05 years | P.O. No.:                | NJ14830                   |       |           |
| Catalog No.:  | 7099                    | Reference Date:          | 1-Jan-00                  | 12:00 | PST       |
| Source No.:   | 681-78-1                | Contained Radioactivity: | 1.009                     | µCi,  | 37.33 kBq |

### Physical description:

|                      |                                                      |
|----------------------|------------------------------------------------------|
| A. Mass of solution: | 5.00077 g in 5 mL flame-sealed ampoule               |
| B. Chemical form:    | NH <sub>4</sub> TcO <sub>4</sub> in H <sub>2</sub> O |
| C. Carrier content:  | None                                                 |
| D. Density:          | 0.9982 g/mL @ 20°C                                   |

Radioimpurities: None detected

Radionuclide concentration: 0.2018 µCi/g, 7.467 kBq/g

### Method of Calibration:

This source was prepared from a weighed aliquot of solution whose activity in µCi/g was determined using a liquid scintillation counter.

### Uncertainty of Measurement:

|                                                   |         |
|---------------------------------------------------|---------|
| A. Type A (random) uncertainty:                   | ± 1.3 % |
| B. Type B (systematic) uncertainty:               | ± 1.5 % |
| C. Uncertainty in aliquot weighing:               | ± 0.0 % |
| D. Total uncertainty at the 99% confidence level: | ± 2.0 % |

### Notes:

- See reverse side for leak tests performed on this source.
- 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).
- Nuclear data was taken from "Table of Radioactive Isotopes", edited by Virginia Shirley, 1986.

*Daniel James Van Dalsem*  
Quality Control

10-Dec-99

Date Signed



ISOTOPE PRODUCTS LABORATORIES

1800 N. KEYSTONE STREET  
BURBANK, CALIFORNIA 91504

818-843-7000 FAX 818-843-6168

IPL Reference Number: 681-78

Reagent

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**Tc-99\_00004**



# National Institute of Standards & Technology Certificate

## Standard Reference Material 4288A Technetium-99 Radioactivity Standard

This Standard Reference Material (SRM) consists of radioactive technetium-99, as potassium pertechnetate, and potassium hydroxide dissolved in 5 mL of distilled water. The solution is contained in a flame-sealed NIST borosilicate-glass ampoule. The SRM is intended for the calibration of beta-particle counting instruments and for the monitoring of radiochemical procedures.

### Radiological Hazard

The SRM ampoule contains technetium-99 with a total activity of approximately 160 kBq. Technetium-99 decays by beta-particle emission. None of the beta particles escape from the SRM ampoule. During the decay process no photons are emitted. Approximate unshielded dose rates at several distances (as of the reference time) are given in note [a]\*. There is no detectable external radiation. The SRM should be used only by persons qualified to handle radioactive material.

### Chemical Hazard

The SRM ampoule contains potassium hydroxide (KOH) with a concentration of 0.001 moles per liter of water. The solution is mildly corrosive and could represent a health hazard if it comes in contact with eyes or skin. If the ampoule is to be opened to transfer the solution, the recommended procedure is given on page 2.

### Storage and Handling

The SRM should be stored and used at a temperature between 5 and 65 °C. The solution in an unopened ampoule should remain stable and homogeneous until at least September 2006.

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

### Preparation

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

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

Gaithersburg, Maryland 20899  
October 1996

Thomas E. Gills, Chief  
Standard Reference Materials Program

## Recommended Procedure for Opening the SRM Ampoule

- 1) If the SRM solution is to be diluted, it is recommended that the diluting solution have a composition comparable to that of the SRM solution.
- 2) Wear eye protection, gloves, and protective clothing and work over a tray with absorbent paper in it.
- 3) Shake the ampoule to wet all of the inside surface of the ampoule. Return the ampoule to the upright position.
- 4) Check that all of the liquid has drained out of the neck of the ampoule. If necessary, gently tap the neck to speed the process.
- 5) Holding the ampoule upright, score the narrowest part of the neck with a scribe or diamond pencil.
- 6) Lightly wet the scored line. This reduces the crack propagation velocity and makes for a cleaner break.
- 7) Hold the ampoule upright with a paper towel, a wiper, or a support jig. Position the scored line away from you. Using a paper towel or wiper to avoid contamination, snap off the top of the ampoule by pressing the narrowest part of the neck away from you while pulling the tip of the ampoule towards you.
- 8) Transfer the solution from the ampoule using a pycnometer or a pipet with dispenser handle. NEVER PIPETTE BY MOUTH.
- 9) Seal any unused SRM solution in a flame-sealed glass ampoule, if possible, to minimize the evaporation loss. See also reference [4]\*.

PROPERTIES OF SRM 4288A  
(Certified values are shown in bold type)

|                                          |                                                                                                                                                                        |                                      |                                    |
|------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|------------------------------------|
| Source identification number             | NIST SRM 4288A                                                                                                                                                         |                                      |                                    |
| Physical Properties:                     |                                                                                                                                                                        |                                      |                                    |
| Source description                       | Liquid in flame-sealed NIST borosilicate-glass ampoule                                                                                                                 |                                      |                                    |
| Ampoule specifications                   | Body outside diameter                                                                                                                                                  | (16.5 ± 0.5) mm                      |                                    |
|                                          | Wall Thickness                                                                                                                                                         | (0.60 ± 0.04) mm                     |                                    |
|                                          | Barium content                                                                                                                                                         | Less than 2.5%                       |                                    |
|                                          | Lead-oxide content                                                                                                                                                     | Less than 0.02%                      |                                    |
|                                          | Other heavy elements                                                                                                                                                   | Trace quantities                     |                                    |
| Solution density                         | (0.998 ± 0.002) g•mL <sup>-1</sup> at 21 °C [b]*                                                                                                                       |                                      |                                    |
| Solution mass                            | (4.998 ± 0.002) g [b]                                                                                                                                                  |                                      |                                    |
| Chemical Properties:                     |                                                                                                                                                                        |                                      |                                    |
| Solution composition                     | Chemical Formula                                                                                                                                                       | Concentration (mol•L <sup>-1</sup> ) | Mass Fraction (g•g <sup>-1</sup> ) |
|                                          | H <sub>2</sub> O                                                                                                                                                       | 55                                   | 1.00                               |
|                                          | KOH                                                                                                                                                                    | 0.001                                | 0.00006                            |
|                                          | K <sup>99</sup> TcO <sub>4</sub>                                                                                                                                       | 0.0005                               | 0.0001                             |
| Radiological Properties:                 |                                                                                                                                                                        |                                      |                                    |
| Radionuclide                             | Technetium-99                                                                                                                                                          |                                      |                                    |
| Reference time                           | 1200 EST, 1 September 1996                                                                                                                                             |                                      |                                    |
| Massic activity of the solution [c]      | 32.61 kBq•g <sup>-1</sup>                                                                                                                                              |                                      |                                    |
| Relative expanded uncertainty (k=2)      | 1.14% [d] [e]                                                                                                                                                          |                                      |                                    |
| Photon-emitting impurities               | None detected [f]                                                                                                                                                      |                                      |                                    |
| Half lives used in the decay corrections | Cobalt-60: (5.2714 ± 0.0005) a [g]<br>Technetium-99: (2.111 ± 0.012) × 10 <sup>5</sup> a [g]                                                                           |                                      |                                    |
| Measuring instrument                     | NIST 4πβ(LS)-γ-anticoincidence counting system using cobalt-60 as the efficiency-tracing radionuclide. The efficiency was varied electronically from 50 to 93 percent. |                                      |                                    |

## EVALUATION OF THE UNCERTAINTY OF THE MASSIC ACTIVITY [d]\*

| Input Quantity $x_i$ ,<br>the source of uncertainty<br>(and individual uncertainty components<br>where appropriate)                                | Method Used To Evaluate $u(x_i)$ ,<br>the standard uncertainty of $x_i$<br>(A) denotes evaluation by statistical methods<br>(B) denotes evaluation by other methods | Relative<br>Uncertainty<br>Of Input<br>Quantity,<br>$u(x_i)/x_i$ ,<br>(%) [h] | Relative<br>Sensitivity<br>Factor,<br>$ \partial y/\partial x_i  \cdot (x_i/x_j)$<br>[i] | Relative<br>Uncertainty<br>Of Output<br>Quantity,<br>$u(y)/y$ ,<br>(%) [j] |
|----------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|
| Extrapolated massic liquid-scintillation count rate<br>of the Tc-99 solution, corrected for background,<br>cobalt-60 tracer count rate, and decay. | Standard deviation of the mean for 4 sets of<br>repeated measurements on each of 3 samples<br>(A)                                                                   | 0.10                                                                          | 1.0                                                                                      | 0.10                                                                       |
| Decay corrections<br>for cobalt-60<br>for technetium-99                                                                                            | Standard uncertainty of the half life (A)<br>Standard uncertainty of the half life (A)                                                                              | [k]<br>0.01<br>0.6                                                            | [m]<br>0.01<br>0.000005                                                                  | 0.0001<br>0.000003                                                         |
| Decay scheme data                                                                                                                                  | Standard uncertainty of the probability of<br>decay by beta-particle emission (A)                                                                                   | 0.01                                                                          | 1.0                                                                                      | 0.01                                                                       |
| Extrapolation of the beta-particle-count-rate<br>versus anticoincidence-gamma-ray-count-rate to<br>zero anticoincidence-gamma-ray-count-rate       | Estimated (B)                                                                                                                                                       | 0.40                                                                          | 1.0                                                                                      | 0.40                                                                       |
| Calibration of the cobalt-60 tracer solution using<br>the 4πB(LS)-γ anticoincidence counting system                                                | Standard uncertainty of the extrapolated massic<br>count rate (B)                                                                                                   | 0.25                                                                          | 1.0                                                                                      | 0.25                                                                       |
| Gravimetric measurements                                                                                                                           | Estimated (B)                                                                                                                                                       | 0.20                                                                          | 1.0                                                                                      | 0.20                                                                       |
| Live-time measurements [n]                                                                                                                         | Estimated (B)                                                                                                                                                       | 0.10                                                                          | 1.0                                                                                      | 0.10                                                                       |
| Variability between ampoules                                                                                                                       | Estimated (B)                                                                                                                                                       | 0.20                                                                          | 1.0                                                                                      | 0.20                                                                       |
| Photon-emitting impurities                                                                                                                         | Limit of detection (B) [p]                                                                                                                                          | 100.                                                                          | 0.00004                                                                                  | 0.004                                                                      |
| Relative Combined Standard Uncertainty of the Output Quantity, $u_c(y)/y$ , (%)                                                                    |                                                                                                                                                                     |                                                                               |                                                                                          | 0.57                                                                       |
| Coverage Factor, k                                                                                                                                 |                                                                                                                                                                     |                                                                               |                                                                                          | $\times 2$                                                                 |
| Relative Expanded Uncertainty of the Output Quantity, $U(y)$ , (%)                                                                                 |                                                                                                                                                                     |                                                                               |                                                                                          | 1.14                                                                       |

\* Notes and references are on pages 5 and 6.

SRM 4288a, page 4 of 6

## NOTES

- [a] The Sievert is the SI unit for dose equivalent. See reference [1]. One  $\mu\text{Sv}$  is equal to 0.1 mrem.  
 Distance from Ampoule (cm): 1 30 100  
 Approximate Dose Rate ( $\mu\text{Sv/h}$ ): <0.1 (Not detectable)
- [b] The stated uncertainty is two times the standard uncertainty.
- [c] Massic activity is the preferred name for the quantity activity divided by the total mass of the sample. See reference [1].
- [d] The reported value,  $y$ , of massic activity (activity per unit mass) at the reference time was not measured directly but was derived from measurements and calculations of other quantities. This can be expressed as  $y = f(x_1, x_2, x_3, \dots, x_n)$ , where  $f$  is a mathematical function derived from the assumed model of the measurement process.
- The value,  $x_i$ , used for each input quantity  $i$  has a standard uncertainty,  $u(x_i)$ , that generates a corresponding uncertainty in  $y$ ,  $u_i(y) = |\partial y / \partial x_i| \cdot u(x_i)$ , called a component of combined standard uncertainty of  $y$ .
- The combined standard uncertainty of  $y$ ,  $u_c(y)$ , is the positive square root of the sum of the squares of the components of combined standard uncertainty.
- The combined standard uncertainty is multiplied by a coverage factor of  $k = 2$  to obtain  $U$ , the expanded uncertainty of  $y$ .
- Since it can be assumed that the possible estimated values of the massic activity are approximately normally distributed with approximate standard deviation  $u_c(y)$ , the unknown value of the massic activity is believed to lie in the interval  $y \pm U$  with a level of confidence of approximately 95 percent.
- For further information on the expression of uncertainties, see references [2] and [3].
- [e] The value of each standard uncertainty component, and hence the value of the expanded uncertainty itself, is a best estimate based upon all available information, but is only approximately known. That is to say, the "uncertainty of the uncertainty" is large and not well known. This is true for uncertainties evaluated by statistical methods (e.g., the relative standard deviation of the standard deviation of the mean for the liquid-scintillation counting is approximately 50%) and for uncertainties evaluated by other methods (which could easily be over estimated or under estimated by substantial amounts). The unknown value of the expanded uncertainty is believed to lie in the interval  $U/2$  to  $2U$  (i.e., within a factor of 2 of the estimated value).
- [f] Estimated limits of detection for photon-emitting impurities are:  
 $2 \times 10^{-4} \text{ y} \cdot \text{s}^{-1} \cdot \text{g}^{-1}$  for energies between 20 and 85 keV,  
 $2 \times 10^{-5} \text{ y} \cdot \text{s}^{-1} \cdot \text{g}^{-1}$  for energies between 93 and 503 keV,  
 $1 \times 10^{-3} \text{ y} \cdot \text{s}^{-1} \cdot \text{g}^{-1}$  for energies between 519 and 1457 keV, and  
 $5 \times 10^{-6} \text{ y} \cdot \text{s}^{-1} \cdot \text{g}^{-1}$  for energies between 1463 and 3250 keV.
- [g] The stated uncertainty is the standard uncertainty. See reference [5].

- [h] Relative standard uncertainty of the input quantity  $x_i$ .
- [i] The relative change in the output quantity  $y$  divided by the relative change in the input quantity  $x_i$ . If  $|\partial y / \partial x_i| \cdot (x_i/y) = 1.0$ , then a 1% change in  $x_i$  results in a 1% change in  $y$ . If  $|\partial y / \partial x_i| \cdot (x_i/y) = 0.05$ , then a 1% change in  $x_i$  results in a 0.05% change in  $y$ .
- [j] Relative component of combined standard uncertainty of output quantity  $y$ , rounded to two significant figures or less. The relative component of combined standard uncertainty of  $y$  is given by  $u_i(y)/y = |\partial y / \partial x_i| \cdot u(x_i)/y = |\partial y / \partial x_i| \cdot (x_i/y) \cdot u(x_i)/x_i$ . The numerical values of  $u(x_i)/x_i$ ,  $|\partial y / \partial x_i| \cdot (x_i/y)$ , and  $u_i(y)/y$ , all dimensionless quantities, are listed in columns 3, 4, and 5, respectively. Thus, the value in column 5 is equal to the value in column 4 multiplied by the value in column 3. The input quantities are independent, or very nearly so. Hence the covariances are zero or negligible.
- [k] The relative standard uncertainty of  $\lambda \cdot t$  is determined by the relative standard uncertainty of  $\lambda$  (i.e., of the half life). The relative standard uncertainty of  $t$  is negligible.
- [m]  $|\partial y / \partial x_i| \cdot (x_i/y) = |\lambda \cdot t|$ , multiplied by other sensitivity factors where appropriate.
- [n] The live time is determined by counting the pulses from a gated crystal-controlled oscillator.
- [p] The standard uncertainty for each undetected impurity that might reasonably be expected to be present is estimated to be equal to the estimated limit of detection for that impurity, i.e.  $u(x_i)/x_i = 100\%$ .  $|\partial y / \partial x_i| \cdot (x_i/y) = \{(\text{response per Bq of impurity})/(\text{response per Bq of Te-99})\} \cdot \{(\text{Bq of impurity})/(\text{Bq of Te-99})\}$ . Thus  $u_i(y)/y$  is the relative change in  $y$  if the impurity were present with a massic activity equal to the estimated limit of detection.

## REFERENCES

- [1] International Organization for Standardization (ISO), *ISO Standards Handbook - Quantities and Units*, 1993. Available from the American National Standards Institute, 11 West 42nd Street, New York, NY 10036, U.S.A. 1-212-642-4900.
- [2] International Organization for Standardization (ISO), *Guide to the Expression of Uncertainty in Measurement*, 1993. Available from the American National Standards Institute, 11 West 42nd Street, New York, NY 10036, U.S.A. 1-212-642-4900. (Listed under ISO miscellaneous publications as "ISO Guide to the Expression 1993".)
- [3] B. N. Taylor and C. E. Kuyatt, *Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results*, NIST Technical Note 1297, 1994. Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20407, U.S.A.
- [4] National Council on Radiation Protection and Measurements Report No. 58, *A Handbook of Radioactivity Measurements Procedures*, Second Edition, 1985. Available from the National Council on Radiation Protection and Measurements, 7910 Woodmont Avenue, Bethesda, MD 20814 U.S.A.
- [5] Evaluated Nuclear Structure Data File (ENSDF), September 1996.

Reagent

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**Tc-99\_00016**



**Reagent ID:** Tc-99\_00016

Description: Tc-99 Spike  
No. of Bottles: 1  
Storage Location: RAD Actinide STDs  
Reagent Volume: 500.000 mL  
Creation Date: 03/18/2015  
Open Date:  
Container(s): 582609  
Comment:

Expiration Date: 03/18/2016  
Laboratory: TestAmerica St. Louis  
Prepared By: Bernsen, Sarah C  
Solvent: 2M HNO3  
Solvent Lot: n/a

### Reagent Analyte Information

| Analyte        | Source ID   | Source Exp. Date | Source Conc. | Source Conc. Units | Final Conc. | Final Conc. Units |
|----------------|-------------|------------------|--------------|--------------------|-------------|-------------------|
| Tc-99          | Tc-99_00015 | 09/01/2046       | 9534.11100   | dpm/mL             | 228.81866   | dpm/mL            |
| Total Activity | Tc-99_00015 | 09/01/2046       | 9534.11100   | dpm/mL             | 228.81866   | dpm/mL            |

### Source Reagents

| Reagent     | Description              | Type | Expiration | Vendor | Vendor Lot # | Vendor Cat Lot # | Volume Used | Volume Units |
|-------------|--------------------------|------|------------|--------|--------------|------------------|-------------|--------------|
| Tc-99_00015 | Tc-99 Secondary Dilution |      | 09/01/46   |        |              |                  | 12.00000    | mL           |

**St. Louis Radiological Standard Reverification Form**

Standard ID Number: Tc-99 00016 (5826309)  
True Value = 228.82 DPM/L or g  
Date Analyzed: 3/18/2015

Radionuclide:

Tc-99

|    | Replicates    |            |
|----|---------------|------------|
| #1 | <u>226.02</u> | DPM/L or g |
| #2 | <u>227.02</u> | DPM/L or g |
| #3 | <u>226.02</u> | DPM/L or g |

Mean = 226.3533

1 sigma = 0.57735

1.96 sigma = 1.131607

True Value minus 5% = 217.379  
True Value plus 5% = 240.261

(True Value - 5%)  
(True Value + 5%)

**Accuracy:**

Mean value within 5% of Certified (True) Value? Yes (Acceptance Criteria)

**Precision:**

1.96 sigma Value Within 10% of Mean Value? Yes (Acceptance Criteria)

**Standard Reverification Acceptable?**

Yes

Note: Criteria for reverification of radiological standards is taken from the DOE QSAS and LANL Statements of Work

Reviewed By/Date: Micha L. Korrinhizer 3/20/2015

SOP Reference: STL-QA-0002, Current Revision

# TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

## Tc-99 Standard Verification:

Std #: 355913  
Activity: 228.82dpm/mL  
Reference Date: 9/1/1996

-00014

| Vial # | InstaGel<br>(mL) | Teva<br>Column | Tc99_00042<br>(mL) | DI Water<br>(mL) |
|--------|------------------|----------------|--------------------|------------------|
| 1      | 10               | 2              | 1                  | 4                |
| 2      | 10               | 2              | 1                  | 4                |
| 3      | 10               | 2              | 1                  | 4                |

0.25mL of 2M HNO<sub>3</sub> was added to vials to mimic the tracer amount added to counting standards (A, B, C).

BKG was made with 5 mL of DI water, 10 mL of InstaGel, 0.25 mL of 2M HNO<sub>3</sub>, and a conditioned teva column.

Teva column: conditioned with 5mL 0.01M HNO<sub>3</sub>.

Prepared By: Justin Price  
Date: 5/8/2014

PINK  
Prot. 17  
30mins.



**Reagent ID: Tc-99\_00016**

|                   |                   |                  |                       |
|-------------------|-------------------|------------------|-----------------------|
| Description:      | Tc-99 Spike       | Expiration Date: | 05/12/2015            |
| No. of Bottles:   | 1                 | Laboratory:      | TestAmerica St. Louis |
| Storage Location: | RAD Actinide STDs | Prepared By:     | Bernsen, Sarah C      |
| Reagent Volume:   | 500.000 mL        | Solvent:         | 2M HNO3               |
| Creation Date:    | 04/30/2014        | Solvent Lot:     | n/a                   |
| Open Date:        |                   |                  |                       |
| Container(s):     | 582609            |                  |                       |
| Comment:          |                   |                  |                       |

### Reagent Analyte Information

| Analyte        | Source ID   | Source Exp. Date | Source Conc. | Source Conc. Units | Final Conc. | Final Conc. Units |
|----------------|-------------|------------------|--------------|--------------------|-------------|-------------------|
| Tc-99          | Tc-99_00015 | 09/01/2046       | 9534.11100   | dpm/mL             | 228.81866   | dpm/mL            |
| Total Activity | Tc-99_00015 | 09/01/2046       | 9534.11100   | dpm/mL             | 228.81866   | dpm/mL            |

### Source Reagents

| Reagent     | Description              | Type | Expiration | Vendor | Vendor Lot # | Vendor Cat Lot # | Volume Used | Volume Units |
|-------------|--------------------------|------|------------|--------|--------------|------------------|-------------|--------------|
| Tc-99_00015 | Tc-99 Secondary Dilution |      | 09/01/46   |        |              |                  | 12.00000    | mL           |

Protocol# 19 - Tc99\_2013 Protocol 19.lsa

User: Default

Tc99\_2013 Protocol 19

Assay Definition

## Assay Description:

Assay Type: DPM (Single)

Report Name: Tc99\_Protocol 19

Output Data Path: \Slsvr01\RAD\Upload\PACK\_LSC\_Teal

Raw Results Path: C:\Packard\Tricarb\Results\Default\Tc99\_2013 Protocol 19\20140512\_0948  
\20140512\_0948.results

Assay File Name: C:\Packard\TriCarb\Assays\Tc99\_2013 Protocol 19.lsa

## Additional Data Files Generated with this Protocol:

19Tc99

[Auto]

19Tc99.001

Count Conditions

Nuclide: Tc99\_2013

Quench Indicator: tSIE

External Std Terminator (sec): 15 sec

Pre-Count Delay (min): 0.00

Quench Set:

Low Energy: Tc99\_2013

Count Time (min): 30.00

Count Mode: Normal

Assay Count Cycles: 1

Repeat Sample Count: 1

#Vials/Sample: 1

Calculate % Reference: Off

Background Subtract

Background Subtract: Off

Low CPM Threshold: Off

2 Sigma % Terminator: On - Any Region

| Regions | LL    | UL    | 2Sigma % Terminator |
|---------|-------|-------|---------------------|
| A       | 0.0   | 292.0 | 1.50                |
| B       | 2.0   | 292.0 | 0.00                |
| C       | 292.1 | 450.0 | 0.00                |

Count Corrections

Static Controller: On

Luminescence Correction: Off

Colored Samples: On

Heterogeneity Monitor: Off

Coincidence Time (nsec): 18

Delay Before Burst (nsec): 75

## Cycle 1 Results

Quench Curve Block Data



**Reagent ID: Tc-99\_00014**

|                   |                   |                  |                       |
|-------------------|-------------------|------------------|-----------------------|
| Description:      | Tc-99 Spike       | Expiration Date: | 05/12/2015            |
| No. of Bottles:   | 1                 | Laboratory:      | TestAmerica St. Louis |
| Storage Location: | RAD Actinide STDs | Prepared By:     | Bernsen, Sarah C      |
| Reagent Volume:   | 250.000 mL        | Solvent:         | 2M HNO3               |
| Creation Date:    | 04/30/2014        | Solvent Lot:     | n/a                   |
| Open Date:        |                   |                  |                       |
| Container(s):     | 355913            |                  |                       |
| Comment:          |                   |                  |                       |

**Reagent Analyte Information**

| Analyte        | Source ID   | Source Exp. Date | Source Conc. | Source Conc. Units | Final Conc. | Final Conc. Units |
|----------------|-------------|------------------|--------------|--------------------|-------------|-------------------|
| Tc-99          | Tc-99_00015 | 09/01/2046       | 9534.11100   | dpm/mL             | 228.81866   | dpm/mL            |
| Total Activity | Tc-99_00015 | 09/01/2046       | 9534.11100   | dpm/mL             | 228.81866   | dpm/mL            |

**Source Reagents**

| Reagent     | Description              | Type | Expiration | Vendor | Vendor Lot # | Vendor Cat Lot # | Volume Used | Volume Units |
|-------------|--------------------------|------|------------|--------|--------------|------------------|-------------|--------------|
| Tc-99_00015 | Tc-99 Secondary Dilution |      | 09/01/46   |        |              |                  | 6.00000     | mL           |

↑  
12mL

# TC\_02\_RC\_T\_Prep Analysis Sheet

(To Accompany Samples to Instruments)

Batch Number: 160-179772

Analyst: Burt, Matthew R

Batch Open: 3/18/2015 11:07:38AM

Batch End: 3/18/2015 11:10:00AM

## Technetium-99 Tracers Prep

| Input Sample Lab ID<br>(Analytical Method) | SDG | Matrix | Initial<br>Amount | Final<br>Amount | Due Date | Analytical<br>TAT | Div<br>Rank | Comments | Output Sample Lab ID  |
|--------------------------------------------|-----|--------|-------------------|-----------------|----------|-------------------|-------------|----------|-----------------------|
| TCCLBA~160-179772/1<br>N/A                 | N/A |        |                   |                 | N/A      | N/A               | N/A         |          | TCCLBA 160-179772/1-A |
| TCCLBB~160-179772/2<br>N/A                 | N/A |        |                   |                 | N/A      | N/A               | N/A         |          | TCCLBB 160-179772/2-A |
| TCCLBC~160-179772/3<br>N/A                 | N/A |        |                   |                 | N/A      | N/A               | N/A         |          | TCCLBC 160-179772/3-A |

Spike

Cert.

# TC\_02\_RC\_T\_Prep Analysis Sheet

(To Accompany Samples to Instruments)

Batch Number: 160-179772

Analyst: Burt, Matthew R

Batch Open: 3/18/2015 11:07:38AM

Batch End: 3/18/2015 11:10:00AM

|   | Input Sample Lab ID<br>(Analytical Method) | (Sub-List) | Analytes |
|---|--------------------------------------------|------------|----------|
| 1 | TCCLBA 160-179772/1<br>N/A                 | N/A        | N/A      |
| 2 | TCCLBB 160-179772/2<br>N/A                 | N/A        | N/A      |
| 3 | TCCLBC 160-179772/3<br>N/A                 | N/A        | N/A      |

⚠Analytes that are not being reported with be displayed in [...] brackets. Analytes that are not being reported but are on the spike list with be displayed in (...) parentheses.

**TC\_02\_RC\_T\_Prep Analysis Sheet**  
(To Accompany Samples to Instruments)

Batch Number: 160-179772

Analyst: Burt, Matthew R

Batch Open: 3/18/2015 11:07:38AM

Batch End: 3/18/2015 11:10:00AM

**Batch Notes**

Batch Comment

**Comments**

(To Accompany Samples to Instruments)

Batch End: 3/18/2015 11:10:00AM

## Reagent Additions Worksheet

| Lab ID              | Reagent Code  | Amount Added | Final Amount | y | Witness |
|---------------------|---------------|--------------|--------------|---|---------|
| TCCLBA 160-179772/1 | 2N HNO3_00010 | 0.25 mL      |              |   |         |
| TCCLBB 160-179772/2 | 2N HNO3_00010 | 0.25 mL      |              |   |         |
| TCCLBC 160-179772/3 | 2N HNO3_00010 | 0.25 mL      |              |   |         |

[illegible]

Reagent

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**Tc-99\_00019**

**St. Louis Radiological Standard Reverification Form**

Standard ID Number: Tc-99\_00019  
True Value = 228.82 DPM/L or g  
Date Analyzed: 3/16/2016

Radionuclide:

Tc-99

|    | Replicates    |            |
|----|---------------|------------|
| #1 | <u>231.67</u> | DPM/L or g |
| #2 | <u>231.67</u> | DPM/L or g |
| #3 | <u>234.67</u> | DPM/L or g |

Mean = 232.67

1 sigma = 1.732051

1.96 sigma = 3.39482

True Value minus 5% = 217.379

(True Value - 5%)

True Value plus 5% = 240.261

(True Value + 5%)

**Accuracy:**

Mean value within 5% of Certified (True) Value? Yes (Acceptance Criteria)

**Precision:**

1.96 sigma Value Within 10% of Mean Value? Yes (Acceptance Criteria)

**Standard Reverification Acceptable?**

Yes

Note: Criteria for reverification of radiological standards is taken from the DOE QSAS and LANL Statements of Work

Reviewed By/Date: Amanda Leigh Dick 03/16/2016

SOP Reference: STL-QA-0002, Current Revision

Pink  
Prot. 19  
45 min

# TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

## Tc-99 Standard Verification:

Std #: 355913  
Activity: 228,82dpm/mL  
Reference Date: 9/1/1996

-00014

| Vial # | InstaGel (mL) | Teva Column | Tc99_00042 (mL) | DI Water (mL) |
|--------|---------------|-------------|-----------------|---------------|
| 1      | 10            | 2           | 1               | 4             |
| 2      | 10            | 2           | 1               | 4             |
| 3      | 10            | 2           | 1               | 4             |

0.25mL of 2M HNO<sub>3</sub> was added to vials to mimic the tracer amount added to counting standards (A, B, C).

BKG was made with 5 mL of DI water, 10 mL of InstaGel, 0.25 mL of 2M HNO<sub>3</sub>, and a conditioned teva column.

Teva column: conditioned with 5mL 0.01M HNO<sub>3</sub>.

Prepared By: Justin Price

Date: 5/8/2014

mm 3/15/16

Mark Miner

3/15/16

mm 3/15/16

~~Pink~~ mm 3/15/16  
~~Prot. 19~~ mm 3/15/16  
~~30mins~~ mm 3/15/16



**Reagent ID: Tc-99\_00016**

Description: Tc-99 Spike  
No. of Bottles: 1  
Storage Location: RAD Actinide STDs  
Reagent Volume: 500.000 mL  
Creation Date: 04/30/2014  
Open Date:  
Container(s): 582609  
Comment:

Expiration Date: 05/12/2015  
Laboratory: TestAmerica St. Louis  
Prepared By: Bernsen, Sarah C  
Solvent: 2M HNO3  
Solvent Lot: n/a

### Reagent Analyte Information

| Analyte        | Source ID   | Source Exp. Date | Source Conc. | Source Conc. Units | Final Conc. | Final Conc. Units |
|----------------|-------------|------------------|--------------|--------------------|-------------|-------------------|
| Tc-99          | Tc-99_00015 | 09/01/2046       | 9534.11100   | dpm/mL             | 228.81866   | dpm/mL            |
| Total Activity | Tc-99_00015 | 09/01/2046       | 9534.11100   | dpm/mL             | 228.81866   | dpm/mL            |

### Source Reagents

| Reagent     | Description              | Type | Expiration | Vendor | Vendor Lot # | Vendor Cat Lot # | Volume Used | Volume Units |
|-------------|--------------------------|------|------------|--------|--------------|------------------|-------------|--------------|
| Tc-99_00015 | Tc-99 Secondary Dilution |      | 09/01/46   |        |              |                  | 12.00000    | mL           |

# Assay Definition

## Assay Description:

Assay Type: DPM (Single)  
 Report Name: Tc99\_Protocol 19  
 Output Data Path: \Slsvr01\Rad\Upload\PACK\_LSC\_Pink  
 Raw Results Path: C:\Packard\Tricarb\Results\Default\Tc99\_2015 Protocol 19\20160315\_1535  
 \20160315\_1535.results  
 Assay File Name: C:\Packard\TriCarb\Assays\Tc99\_2015 Protocol 19.1sa

Additional Data Files Generated with this Protocol:  
 19Tc99

[Auto] 19Tc99.001

# Count Conditions

Nuclide: Tc99\_2015  
 Quench Indicator: tSIE  
 External Std Terminator (sec): 15 sec  
 Pre-Count Delay (min): 0.00  
 Quench Set:  
 Low Energy: Tc99\_2015  
 Count Time (min): 45.00  
 Count Mode: Normal  
 Assay Count Cycles: 1 Repeat Sample Count: 1  
 #Vials/Sample: 1 Calculate % Reference: Off

# Background Subtract

Background Subtract: Off  
 Low CPM Threshold: Off  
 2 Sigma % Terminator: On - Any Region

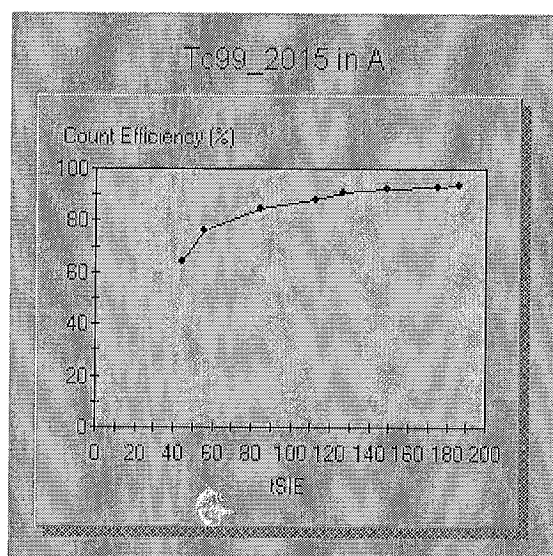
| Regions | LL    | UL    | 2Sigma % Terminator |
|---------|-------|-------|---------------------|
| A       | 0.0   | 292.0 | 1.50                |
| B       | 2.0   | 292.0 | 0.00                |
| C       | 292.1 | 450.0 | 0.00                |

# Count Corrections

Static Controller: On Luminescence Correction: Off  
 Colored Samples: Off Heterogeneity Monitor: Off  
 Coincidence Time (nsec): 18 Delay Before Burst (nsec): 75

Cycle 1 Results

## Quench Curve Block Data



Date Acquired: 08/23/2015

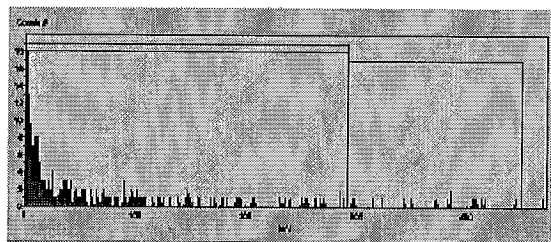
Date Modified:

Tc99\_2015 in A

| tSIE   | Count Efficiency (%) |
|--------|----------------------|
| 185.95 | 93.82                |
| 175.23 | 93.08                |
| 148.66 | 92.15                |
| 126.06 | 91.00                |
| 112.84 | 88.16                |
| 84.69  | 84.43                |
| 55.45  | 76.30                |
| 44.33  | 63.88                |

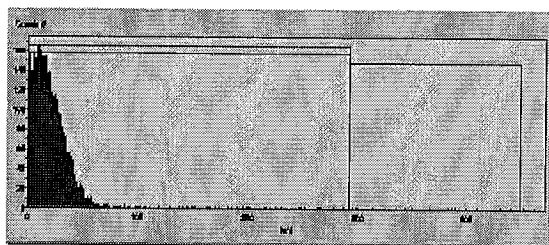
| S#        | SMPL ID | Count Time | CPMA      | DPM1      | TIME       |
|-----------|---------|------------|-----------|-----------|------------|
| 1         | BKG     | 45.00      | 8.73e+000 | 9.33e+000 | 3:35:56 PM |
| 3/15/2016 | 0.936   | 182.24     | 100       |           |            |

SpectraView Block Data



|           |                |        |           |           |            |
|-----------|----------------|--------|-----------|-----------|------------|
| 2         | Verification 1 | 45.00  | 2.10e+002 | 2.41e+002 | 4:26:13 PM |
| 3/15/2016 | 0.872          | 105.43 | 100       |           |            |

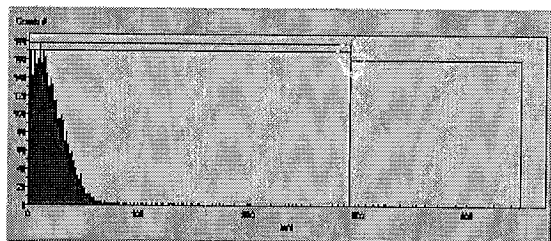
SpectraView Block Data



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| 3         | Verification 2   | 45.00 | 2.11e+002 | 2.41e+002 | 5:16:33 PM |
|-----------|------------------|-------|-----------|-----------|------------|
| 3/15/2016 | 0.875 107.49 100 |       |           |           |            |

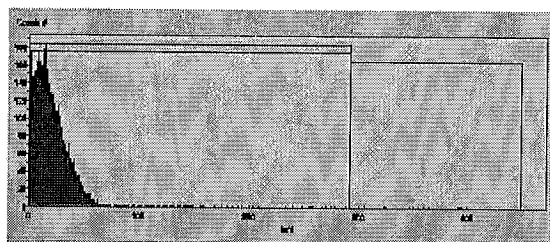
SpectraView Block Data



---

| 4         | Verification 3   | 45.00 | 2.14e+002 | 2.44e+002 | 6:06:53 PM |
|-----------|------------------|-------|-----------|-----------|------------|
| 3/15/2016 | 0.878 109.76 100 |       |           |           |            |

SpectraView Block Data



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3/16/2016 12:01:50 AM: The network path was not found. : '\\slsvr01\Rad\Upload  
\\PACK\_LSC\_Pink\19Tc99.001' redirected to 'C:\Packard\Tricarb\Results\Default\Tc99\_2015  
Protocol 19\20160315\_1535\19Tc99.001'

Reagent

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**Tuna Can LCS\_00005**

**St. Louis Radiological Standard Reverification Form**

Standard ID Number: Tuna Can LCS\_00005 (776670)  
True Value = 30.08 pCi/g  
Date Analyzed: 10/25/2015

Radionuclide:  
Gamma LCS Cs-137

|    | Replicates   |       |
|----|--------------|-------|
| #1 | <u>30</u>    | pCi/g |
| #2 | <u>29.42</u> | pCi/g |
| #3 | <u>28.95</u> | pCi/g |

Mean = 29.45667

1 sigma = 0.525959

1.96 sigma = 1.030881

True Value minus 5% = 28.576

(True Value - 5%)

True Value plus 5% = 31.584

(True Value + 5%)

**Accuracy:**

Mean value within 5% of Certified (True) Value?

Yes (Acceptance Criteria)

**Precision:**

1.96 sigma Value Within 10% of Mean Value?

Yes (Acceptance Criteria)

Standard Reverification Acceptable?

Yes

Note: Criteria for reverification of radiological standards is taken from the DOE QSAS and LANL Statements of Work

Reviewed By/Date: Jody Watson 10/29/15

SOP Reference: STL-QA-0002, Current Revision

**St. Louis Radiological Standard Reverification Form**

Standard ID Number: Tuna Can LCS\_00005 (776670)  
True Value = 97.23 pCi/g  
Date Analyzed: 10/25/2015

Radionuclide:  
Gamma LCS Am-241

|    | Replicates   |       |
|----|--------------|-------|
| #1 | <u>96.82</u> | pCi/g |
| #2 | <u>97.14</u> | pCi/g |
| #3 | <u>97.26</u> | pCi/g |

Mean = 97.07333

1 sigma = 0.22745

1.96 sigma = 0.445801

True Value minus 5% = 92.3685

(True Value - 5%)

True Value plus 5% = 102.0915

(True Value + 5%)

**Accuracy:**

Mean value within 5% of Certified (True) Value?

Yes (Acceptance Criteria)

**Precision:**

1.96 sigma Value Within 10% of Mean Value?

Yes (Acceptance Criteria)

Standard Reverification Acceptable?

Yes

Note: Criteria for reverification of radiological standards is taken from the DOE QSAS and LANL Statements of Work

Reviewed By/Date: Jody Watson 10/29/15

SOP Reference: STL-QA-0002, Current Revision

**St. Louis Radiological Standard Reverification Form**

Standard ID Number: Tuna Can LCS\_00005 (776670)  
True Value = 18.6 pCi/g  
Date Analyzed: 10/25/2015

Radionuclide:  
Gamma LCS Co-60

|    | Replicates   |       |
|----|--------------|-------|
| #1 | <u>17.74</u> | pCi/g |
| #2 | <u>18.7</u>  | pCi/g |
| #3 | <u>17.74</u> | pCi/g |

Mean = 18.06

1 sigma = 0.554256

1.96 sigma = 1.086342

True Value minus 5% = 17.67  
True Value plus 5% = 19.53

(True Value - 5%)

(True Value + 5%)

**Accuracy:**

Mean value within 5% of Certified (True) Value?

Yes (Acceptance Criteria)

**Precision:**

1.96 sigma Value Within 10% of Mean Value?

Yes (Acceptance Criteria)

Standard Reverification Acceptable?

Yes

Note: Criteria for reverification of radiological standards is taken from the DOE QSAS and LANL Statements of Work

Reviewed By/Date: Jody Watson 10/29/15

SOP Reference: STL-QA-0002, Current Revision

| SampleID          | WRKNO   | Aliquot          | Sigma      | Instrument  | Detector   | CountDate    | Time    | CountDuration |
|-------------------|---------|------------------|------------|-------------|------------|--------------|---------|---------------|
| LCS 160-217910~2- | LCS     | 341.90g          | 1.00       | GammaVision | GV01       | 10 / 25 / 15 | 16:00   | 30            |
| Analyte           | Compnd# | Activity         | TotalUnc   | CountUnc    | MDA        | MLCC         | Act/MDA |               |
| AC-228            | 11136   | 6.771E-001pCi/g  | 2.800E-001 | 2.778E-001  | 1.003E+000 | 4.849E-001   | 0.68    |               |
| AG-108M           | 10982   | -6.779E-003pCi/g | 1.235E-002 | 1.235E-002  | 2.560E-001 | 1.249E-001   | -0.03   |               |
| AG-110M           | 10973   | 8.663E-003pCi/g  | 1.112E-001 | 1.112E-001  | 3.788E-001 | 1.830E-001   | 0.02    |               |
| AM-241            | 10818   | 9.682E+001pCi/g  | 5.076E+000 | 7.243E-001  | 1.019E+000 | 5.045E-001   | 95.00   |               |
| BA-133            | 10469   | 1.494E-002pCi/g  | 8.071E-002 | 8.071E-002  | 2.729E-001 | 1.325E-001   | 0.05    |               |
| BA-140            | 10463   | 1.374E-001pCi/g  | 2.240E-001 | 2.238E-001  | 7.542E-001 | 3.638E-001   | 0.18    |               |
| BE-7              | 10435   | 0.000E+000pCi/g  | 3.925E-001 | 3.925E-001  | 2.266E+000 | 1.104E+000   | 0.00    |               |
| BI-207            | 10195   | -2.705E-003pCi/g | 5.167E-002 | 5.167E-002  | 1.770E-001 | 8.502E-002   | -0.02   |               |
| BI-210M           | 10173   | 8.461E-002pCi/g  | 9.172E-002 | 9.158E-002  | 3.052E-001 | 1.486E-001   | 0.28    |               |
| BI-212            | 10160   | 5.691E-002pCi/g  | 6.570E-001 | 6.570E-001  | 2.266E+000 | 1.080E+000   | 0.03    |               |
| BI-214            | 10154   | 5.973E-001pCi/g  | 1.858E-001 | 1.832E-001  | 3.511E-001 | 1.678E-001   | 1.70    |               |
| CD-109            | 9254    | 9.357E+000pCi/g  | 3.288E+000 | 3.246E+000  | 3.163E+000 | 1.546E+000   | 2.96    |               |
| CD-113M           | 17462   | -1.418E+002pCi/g | 7.297E+002 | 7.296E+002  | 2.462E+003 | 1.198E+003   | -0.06   |               |
| CE-139            | 9241    | -3.471E-002pCi/g | 4.795E-002 | 4.783E-002  | 1.596E-001 | 7.801E-002   | -0.22   |               |
| CE-141            | 9235    | 1.101E-001pCi/g  | 6.681E-002 | 6.657E-002  | 2.193E-001 | 1.068E-001   | 0.50    |               |
| CE-144            | 9221    | -1.962E-001pCi/g | 3.271E-001 | 3.269E-001  | 1.092E+000 | 5.343E-001   | -0.18   |               |
| CF-249            | 9215    | -9.471E-002pCi/g | 9.312E-002 | 9.299E-002  | 3.094E-001 | 1.508E-001   | -0.31   |               |
| CF-251            | 13690   | 9.783E-002pCi/g  | 2.187E-001 | 2.185E-001  | 7.329E-001 | 3.576E-001   | 0.13    |               |
| CO-56             | 8704    | -4.255E-002pCi/g | 7.343E-002 | 7.340E-002  | 2.477E-001 | 1.193E-001   | -0.17   |               |
| CO-57             | 13694   | 3.299E-002pCi/g  | 4.336E-002 | 4.333E-002  | 1.444E-001 | 7.069E-002   | 0.23    |               |
| CO-58             | 8698    | -4.234E-003pCi/g | 6.516E-002 | 6.516E-002  | 2.232E-001 | 1.072E-001   | -0.02   |               |
| CO-60             | 8692    | 1.774E+001pCi/g  | 9.138E-001 | 2.049E-001  | 6.716E-002 | 2.728E-002   | 264.12  |               |
| CR-51             | 8604    | 3.076E-001pCi/g  | 4.401E-001 | 4.398E-001  | 1.475E+000 | 7.149E-001   | 0.21    |               |
| CS-134            | 8553    | 2.831E-002pCi/g  | 5.517E-002 | 5.515E-002  | 1.867E-001 | 8.973E-002   | 0.15    |               |
| CS-136            | 8546    | -1.109E-001pCi/g | 7.217E-002 | 7.189E-002  | 2.373E-001 | 1.142E-001   | -0.47   |               |
| CS-137            | 8539    | 3.000E+001pCi/g  | 1.596E+000 | 3.338E-001  | 2.346E-001 | 1.129E-001   | 127.87  |               |
| EU-152            | 7145    | 2.877E-001pCi/g  | 2.421E-001 | 2.417E-001  | 6.269E-001 | 3.045E-001   | 0.46    |               |
| EU-154            | 7138    | 1.536E-001pCi/g  | 1.711E-001 | 1.709E-001  | 2.192E+000 | 1.058E+000   | 0.07    |               |
| EU-155            | 7131    | 4.023E-002pCi/g  | 1.795E-001 | 1.795E-001  | 6.019E-001 | 2.949E-001   | 0.07    |               |
| FE-59             | 7073    | 5.086E-002pCi/g  | 8.161E-002 | 8.157E-002  | 4.958E-001 | 2.382E-001   | 0.10    |               |
| GA-68             | 18005   | -1.209E+000pCi/g | 2.759E+000 | 2.758E+000  | 9.368E+000 | 4.493E+000   | -0.13   |               |
| GD-153            | 6824    | -3.997E-003pCi/g | 1.316E-001 | 1.316E-001  | 4.420E-001 | 2.167E-001   | -0.01   |               |
| HF-181            | 6495    | 9.445E-002pCi/g  | 6.542E-002 | 6.524E-002  | 2.322E-001 | 1.124E-001   | 0.41    |               |
| HG-203            | 6466    | -3.305E-002pCi/g | 5.989E-002 | 5.986E-002  | 2.006E-001 | 9.778E-002   | -0.16   |               |
| I-131             | 6380    | 6.854E-002pCi/g  | 6.647E-002 | 6.638E-002  | 2.080E-001 | 1.010E-001   | 0.33    |               |
| IR-192            | 6303    | -3.750E-002pCi/g | 5.981E-002 | 5.977E-002  | 2.001E-001 | 9.748E-002   | -0.19   |               |
| K-40              | 6148    | -1.766E-002pCi/g | 3.281E-001 | 3.281E-001  | 1.273E+000 | 5.734E-001   | -0.01   |               |
| LA-140            | 6096    | 5.379E-002pCi/g  | 4.255E-002 | 4.246E-002  | 1.212E-001 | 5.304E-002   | 0.44    |               |
| MN-54             | 5382    | 3.726E-002pCi/g  | 6.608E-002 | 6.605E-002  | 2.235E-001 | 1.073E-001   | 0.17    |               |
| NA-22             | 5201    | 2.193E-002pCi/g  | 3.156E-002 | 3.154E-002  | 1.109E-001 | 4.933E-002   | 0.20    |               |
| NB-94             | 5160    | -7.036E-002pCi/g | 5.947E-002 | 5.936E-002  | 1.977E-001 | 9.485E-002   | -0.36   |               |
| NB-95             | 5154    | 3.994E-002pCi/g  | 5.496E-002 | 5.493E-002  | 1.856E-001 | 8.861E-002   | 0.22    |               |
| ND-147            | 5083    | -4.022E-002pCi/g | 4.368E-001 | 4.368E-001  | 1.486E+000 | 7.183E-001   | -0.03   |               |
| NP-237            | 4757    | -4.170E-001pCi/g | 3.829E-001 | 3.821E-001  | 1.266E+000 | 6.228E-001   | -0.33   |               |
| NP-239            | 4751    | -3.998E-004pCi/g | 1.579E-001 | 1.579E-001  | 5.314E-001 | 2.601E-001   | 0.00    |               |
| PA-231            | 4541    | 1.362E+000pCi/g  | 8.851E-001 | 8.820E-001  | 4.992E+000 | 2.420E+000   | 0.27    |               |
| PA-233            | 4535    | 1.538E-001pCi/g  | 1.053E-001 | 1.050E-001  | 4.596E-001 | 2.236E-001   | 0.33    |               |
| PA-234            | 4528    | -1.000E-001pCi/g | 2.035E-001 | 2.034E-001  | 6.804E-001 | 3.330E-001   | -0.15   |               |
| PA-234M           | 19453   | -4.676E-001pCi/g | 9.603E+000 | 9.603E+000  | 3.283E+001 | 1.580E+001   | -0.01   |               |
| PB-210            | 4467    | 8.549E+002pCi/g  | 5.089E+001 | 8.359E+000  | 1.428E+001 | 7.079E+000   | 59.88   |               |

|        |       |                  |            |            |            |            |       |
|--------|-------|------------------|------------|------------|------------|------------|-------|
| PB-212 | 4454  | 3.866E-001pCi/g  | 1.254E-001 | 1.229E-001 | 3.210E-001 | 1.563E-001 | 1.20  |
| PB-214 | 4448  | 3.785E-001pCi/g  | 1.361E-001 | 1.347E-001 | 4.828E-001 | 2.350E-001 | 0.78  |
| PM-144 | 19585 | 4.119E-002pCi/g  | 3.554E-002 | 3.548E-002 | 1.884E-001 | 9.023E-002 | 0.22  |
| PM-146 | 2464  | 3.014E-002pCi/g  | 1.161E-001 | 1.161E-001 | 5.435E-001 | 2.596E-001 | 0.06  |
| RH-106 | 1882  | -2.180E-001pCi/g | 1.994E-001 | 1.991E-001 | 2.012E+000 | 9.694E-001 | -0.11 |
| RU-103 | 1828  | 0.000E+000pCi/g  | 5.216E-002 | 5.216E-002 | 2.468E-001 | 1.200E-001 | 0.00  |
| SB-124 | 1784  | 4.494E-003pCi/g  | 5.524E-002 | 5.524E-002 | 1.889E-001 | 9.084E-002 | 0.02  |
| SB-125 | 1777  | 2.356E-001pCi/g  | 2.342E-001 | 2.338E-001 | 7.180E-001 | 3.497E-001 | 0.33  |
| SC-46  | 1739  | 9.344E-002pCi/g  | 5.627E-002 | 5.606E-002 | 2.546E-001 | 1.226E-001 | 0.37  |
| SN-113 | 1570  | -5.143E-002pCi/g | 9.312E-002 | 9.309E-002 | 3.121E-001 | 1.520E-001 | -0.16 |
| SN-126 | 17459 | 5.835E-002pCi/g  | 5.783E-001 | 5.783E-001 | 1.938E+000 | 9.517E-001 | 0.03  |
| TA-182 | 1301  | 1.840E-003pCi/g  | 2.175E-001 | 2.175E-001 | 7.482E-001 | 3.582E-001 | 0.00  |
| TC-99M | 17412 | 2.645E-002pCi/g  | 4.239E-002 | 4.236E-002 | 1.415E-001 | 6.920E-002 | 0.19  |
| TH-227 | 1058  | 2.617E+000pCi/g  | 1.856E+000 | 1.850E+000 | 6.105E+000 | 3.024E+000 | 0.43  |
| TH-229 | 1046  | 9.577E-002pCi/g  | 1.073E-001 | 1.070E-001 | 3.470E+000 | 1.699E+000 | 0.03  |
| TH-234 | 1027  | 7.930E-002pCi/g  | 7.788E-002 | 7.777E-002 | 5.067E+000 | 2.489E+000 | 0.02  |
| TL-208 | 929   | 1.848E-001pCi/g  | 8.785E-002 | 8.733E-002 | 2.310E-001 | 1.114E-001 | 0.80  |
| U-235  | 281   | 8.439E-002pCi/g  | 1.008E-001 | 1.007E-001 | 9.972E-001 | 4.863E-001 | 0.08  |
| Y-88   | 74    | -2.520E-002pCi/g | 8.904E-002 | 8.903E-002 | 3.017E-001 | 1.458E-001 | -0.08 |
| ZN-65  | 31    | -9.888E-002pCi/g | 1.701E-001 | 1.700E-001 | 5.742E-001 | 2.762E-001 | -0.17 |
| ZR-95  | 7     | 8.948E-002pCi/g  | 8.129E-002 | 8.116E-002 | 3.492E-001 | 1.669E-001 | 0.26  |

#### Laboratory Control Sample Information

| Sample ID          | WRKNO              | Analyte | Activity         | StdAdded   | Recovery | ZFactor |
|--------------------|--------------------|---------|------------------|------------|----------|---------|
| LCS 160-217910~2-A | LCS 160-217910~2-A | CS-137  | 3.000E+001 pCi/g | 3.008E+001 | 99.72%   | -0.0379 |
|                    |                    | CO-60   | 1.774E+001 pCi/g | 1.860E+001 | 95.37%   | -0.6506 |
|                    |                    | AM-241  | 9.682E+001 pCi/g | 9.723E+001 | 99.68%   | -0.0565 |

#### Sample Duplicate Information

| Sample ID | Dup Sample ID | Analyte | Samp Activity | Dup Activity | RPD | RER | DER | Flag | ZFactor |
|-----------|---------------|---------|---------------|--------------|-----|-----|-----|------|---------|
|-----------|---------------|---------|---------------|--------------|-----|-----|-----|------|---------|

**Blanks Information**

| <u>SampleID</u>   | <u>WRKNO</u> | <u>Analyte</u> | <u>Activity</u> | <u>UncTotal</u> | <u>ZFactor</u> |
|-------------------|--------------|----------------|-----------------|-----------------|----------------|
| MB 160-217910~1-A | MB           | AC-228         | 4.303E-002      | 4.671E-002      | 0.9214         |
| MB 160-217910~1-A | MB           | AG-108M        | 5.251E-003      | 5.684E-003      | 0.9238         |
| MB 160-217910~1-A | MB           | AG-110M        | -1.714E-002     | 2.621E-002      | -0.6542        |
| MB 160-217910~1-A | MB           | AM-241         | -1.074E-002     | 2.656E-002      | -0.4043        |
| MB 160-217910~1-A | MB           | BA-133         | 8.629E-003      | 1.742E-002      | 0.4954         |
| MB 160-217910~1-A | MB           | BA-140         | 1.558E-002      | 5.153E-002      | 0.3023         |
| MB 160-217910~1-A | MB           | BE-7           | 2.157E-003      | 9.785E-002      | 0.0220         |
| MB 160-217910~1-A | MB           | BI-207         | 1.116E-002      | 1.404E-002      | 0.7947         |
| MB 160-217910~1-A | MB           | BI-210M        | 1.161E-002      | 2.003E-002      | 0.5795         |
| MB 160-217910~1-A | MB           | BI-212         | -6.519E-004     | 1.749E-001      | -0.0037        |
| MB 160-217910~1-A | MB           | BI-214         | -3.620E-002     | 1.629E-001      | -0.2222        |
| MB 160-217910~1-A | MB           | CD-109         | 1.434E-001      | 1.674E-001      | 0.8566         |
| MB 160-217910~1-A | MB           | CD-113M        | 0.000E+000      | 1.045E+002      | 0.0000         |
| MB 160-217910~1-A | MB           | CE-139         | 1.578E-003      | 8.340E-003      | 0.1892         |
| MB 160-217910~1-A | MB           | CE-141         | 1.422E-002      | 1.284E-002      | 1.1075         |
| MB 160-217910~1-A | MB           | CE-144         | 4.109E-002      | 5.187E-002      | 0.7922         |
| MB 160-217910~1-A | MB           | CF-249         | -5.027E-003     | 1.126E-002      | -0.4467        |
| MB 160-217910~1-A | MB           | CF-251         | 4.859E-003      | 5.226E-002      | 0.0930         |
| MB 160-217910~1-A | MB           | CO-56          | 8.053E-003      | 1.466E-002      | 0.5492         |
| MB 160-217910~1-A | MB           | CO-57          | 0.000E+000      | 3.213E-003      | 0.0000         |
| MB 160-217910~1-A | MB           | CO-58          | 0.000E+000      | 1.250E-002      | 0.0000         |
| MB 160-217910~1-A | MB           | CO-60          | -1.064E-002     | 2.053E-002      | -0.5180        |
| MB 160-217910~1-A | MB           | CR-51          | 1.172E-001      | 6.390E-002      | 1.8350         |
| MB 160-217910~1-A | MB           | CS-134         | 9.570E-003      | 1.221E-002      | 0.7837         |
| MB 160-217910~1-A | MB           | CS-136         | 3.486E-003      | 1.564E-002      | 0.2228         |
| MB 160-217910~1-A | MB           | CS-137         | 9.350E-003      | 1.111E-002      | 0.8412         |
| MB 160-217910~1-A | MB           | EU-152         | 2.175E-002      | 4.360E-002      | 0.4989         |
| MB 160-217910~1-A | MB           | EU-154         | 4.973E-002      | 3.892E-002      | 1.2779         |
| MB 160-217910~1-A | MB           | EU-155         | 1.249E-002      | 1.540E-002      | 0.8106         |
| MB 160-217910~1-A | MB           | FE-59          | 1.620E-002      | 2.388E-002      | 0.6781         |
| MB 160-217910~1-A | MB           | GA-68          | 0.000E+000      | 1.259E-001      | 0.0000         |
| MB 160-217910~1-A | MB           | GD-153         | -7.436E-003     | 2.145E-002      | -0.3466        |
| MB 160-217910~1-A | MB           | HF-181         | 3.207E-003      | 4.689E-003      | 0.6839         |
| MB 160-217910~1-A | MB           | HG-203         | -1.192E-003     | 1.116E-002      | -0.1067        |
| MB 160-217910~1-A | MB           | I-131          | 2.131E-002      | 1.517E-002      | 1.4047         |
| MB 160-217910~1-A | MB           | IR-192         | 1.091E-003      | 6.973E-003      | 0.1565         |
| MB 160-217910~1-A | MB           | K-40           | -4.508E-001     | 8.911E+000      | -0.0506        |
| MB 160-217910~1-A | MB           | LA-140         | 0.000E+000      | 5.961E-003      | 0.0000         |
| MB 160-217910~1-A | MB           | MN-54          | -1.135E-002     | 1.784E-002      | -0.6362        |
| MB 160-217910~1-A | MB           | NA-22          | 0.000E+000      | 4.741E-003      | 0.0000         |
| MB 160-217910~1-A | MB           | NB-94          | 2.773E-004      | 1.092E-002      | 0.0254         |
| MB 160-217910~1-A | MB           | NB-95          | 7.816E-004      | 1.302E-002      | 0.0600         |
| MB 160-217910~1-A | MB           | ND-147         | 4.997E-002      | 8.625E-002      | 0.5794         |
| MB 160-217910~1-A | MB           | NP-237         | 1.411E-002      | 3.697E-002      | 0.3816         |
| MB 160-217910~1-A | MB           | NP-239         | 1.903E-002      | 2.441E-002      | 0.7798         |
| MB 160-217910~1-A | MB           | PA-231         | 5.945E-002      | 5.603E-002      | 1.0610         |
| MB 160-217910~1-A | MB           | PA-233         | 2.561E-002      | 2.422E-002      | 1.0574         |
| MB 160-217910~1-A | MB           | PA-234         | 2.390E-002      | 2.381E-002      | 1.0038         |
| MB 160-217910~1-A | MB           | PA-234M        | -1.176E+000     | 2.117E+000      | -0.5557        |
| MB 160-217910~1-A | MB           | PB-210         | 0.000E+000      | 1.332E-001      | 0.0000         |
| MB 160-217910~1-A | MB           | PB-212         | 0.000E+000      | 1.627E-002      | 0.0000         |
| MB 160-217910~1-A | MB           | PB-214         | 5.054E-002      | 1.994E-002      | 2.5345         |

|                   |    |        |             |            |         |
|-------------------|----|--------|-------------|------------|---------|
| MB 160-217910~1-A | MB | PM-144 | 7.657E-003  | 1.530E-002 | 0.5006  |
| MB 160-217910~1-A | MB | PM-146 | -3.061E-002 | 4.827E-002 | -0.6342 |
| MB 160-217910~1-A | MB | RA-226 | -8.578E-002 | 2.376E-001 | -0.3610 |
| MB 160-217910~1-A | MB | RH-106 | -3.627E-003 | 1.343E-001 | -0.0270 |
| MB 160-217910~1-A | MB | RU-103 | -4.735E-003 | 1.118E-002 | -0.4237 |
| MB 160-217910~1-A | MB | SB-124 | 4.616E-003  | 1.522E-002 | 0.3032  |
| MB 160-217910~1-A | MB | SB-125 | 1.047E-002  | 2.186E-002 | 0.4787  |
| MB 160-217910~1-A | MB | SC-46  | 0.000E+000  | 7.139E-003 | 0.0000  |
| MB 160-217910~1-A | MB | SN-113 | 6.694E-003  | 1.727E-002 | 0.3875  |
| MB 160-217910~1-A | MB | SN-126 | 9.094E-003  | 7.322E-002 | 0.1242  |
| MB 160-217910~1-A | MB | TA-182 | 9.043E-003  | 1.445E-002 | 0.6258  |
| MB 160-217910~1-A | MB | TC-99M | -1.255E-003 | 8.033E-003 | -0.1562 |
| MB 160-217910~1-A | MB | TH-227 | 5.670E-003  | 1.499E-001 | 0.0378  |
| MB 160-217910~1-A | MB | TH-229 | -7.369E-002 | 1.885E-001 | -0.3910 |
| MB 160-217910~1-A | MB | TH-234 | 1.446E-002  | 1.018E-001 | 0.1420  |
| MB 160-217910~1-A | MB | TL-208 | 1.346E-002  | 1.077E-002 | 1.2495  |
| MB 160-217910~1-A | MB | U-235  | 7.507E-002  | 5.910E-002 | 1.2704  |
| MB 160-217910~1-A | MB | Y-88   | 0.000E+000  | 3.838E-003 | 0.0000  |
| MB 160-217910~1-A | MB | ZN-65  | -1.025E-002 | 3.666E-002 | -0.2797 |
| MB 160-217910~1-A | MB | ZR-95  | 3.371E-003  | 1.189E-002 | 0.2836  |

| SampID            | WRKNO  | Aliquot          | Sigma      | Instrument  | Detector   | CountDate    | Time    | CountDuration |
|-------------------|--------|------------------|------------|-------------|------------|--------------|---------|---------------|
| LCS 160-218441~2- | LCS    | 341.90g          | 1.00       | GammaVision | GV08       | 10 / 27 / 15 | 15:25   | 30            |
| Analyte           | Cmpnd# | Activity         | TotalUnc   | CountUnc    | MDA        | MLCC         | Act/MDA |               |
| AC-228            | 11136  | 7.359E-002pCi/g  | 1.183E-001 | 1.183E-001  | 1.351E+000 | 6.534E-001   | 0.05    |               |
| AG-108M           | 10982  | -1.250E-001pCi/g | 9.830E-002 | 9.810E-002  | 3.249E-001 | 1.586E-001   | -0.38   |               |
| AG-110M           | 10973  | -2.165E-001pCi/g | 1.350E-001 | 1.346E-001  | 4.435E-001 | 2.131E-001   | -0.49   |               |
| AM-241            | 10818  | 9.714E+001pCi/g  | 5.131E+000 | 9.547E-001  | 1.461E+000 | 7.246E-001   | 66.50   |               |
| BA-133            | 10469  | -1.434E-001pCi/g | 1.166E-001 | 1.163E-001  | 3.856E-001 | 1.880E-001   | -0.37   |               |
| BA-140            | 10463  | 3.008E-001pCi/g  | 3.866E-001 | 3.863E-001  | 8.898E-001 | 4.279E-001   | 0.34    |               |
| BE-7              | 10435  | 1.764E-001pCi/g  | 8.364E-001 | 8.364E-001  | 2.818E+000 | 1.373E+000   | 0.06    |               |
| BI-207            | 10195  | -3.983E-002pCi/g | 7.303E-002 | 7.300E-002  | 2.465E-001 | 1.188E-001   | -0.16   |               |
| BI-210M           | 10173  | 4.829E-002pCi/g  | 6.207E-002 | 6.201E-002  | 3.950E-001 | 1.928E-001   | 0.12    |               |
| BI-212            | 10160  | 1.191E+000pCi/g  | 9.269E-001 | 9.248E-001  | 3.076E+000 | 1.467E+000   | 0.39    |               |
| BI-214            | 10154  | 1.600E-001pCi/g  | 1.464E-001 | 1.462E-001  | 4.902E-001 | 2.351E-001   | 0.33    |               |
| CD-109            | 9254   | 2.361E+000pCi/g  | 4.441E+000 | 4.439E+000  | 4.063E+000 | 1.992E+000   | 0.58    |               |
| CD-113M           | 17462  | -3.716E+001pCi/g | 9.021E+002 | 9.021E+002  | 3.049E+003 | 1.485E+003   | -0.01   |               |
| CE-139            | 9241   | 3.182E-002pCi/g  | 5.820E-002 | 5.812E-002  | 1.942E-001 | 9.506E-002   | 0.16    |               |
| CE-141            | 9235   | 4.980E-002pCi/g  | 8.364E-002 | 8.361E-002  | 2.795E-001 | 1.366E-001   | 0.18    |               |
| CE-144            | 9221   | 2.569E-002pCi/g  | 4.004E-001 | 4.004E-001  | 1.345E+000 | 6.591E-001   | 0.02    |               |
| CF-249            | 9215   | 5.942E-002pCi/g  | 1.163E-001 | 1.162E-001  | 3.177E-001 | 1.540E-001   | 0.19    |               |
| CF-251            | 13690  | 3.966E-001pCi/g  | 2.757E-001 | 2.735E-001  | 9.033E-001 | 4.415E-001   | 0.44    |               |
| CO-56             | 8704   | 8.557E-002pCi/g  | 8.063E-002 | 8.051E-002  | 2.695E-001 | 1.287E-001   | 0.32    |               |
| CO-57             | 13694  | 3.076E-002pCi/g  | 5.134E-002 | 5.131E-002  | 1.712E-001 | 8.393E-002   | 0.18    |               |
| CO-58             | 8698   | 1.346E-002pCi/g  | 8.405E-002 | 8.405E-002  | 2.875E-001 | 1.379E-001   | 0.05    |               |
| CO-60             | 8692   | 1.870E+001pCi/g  | 1.007E+000 | 3.639E-001  | 1.870E-001 | 8.459E-002   | 100.02  |               |
| CR-51             | 8604   | -4.740E-001pCi/g | 6.167E-001 | 6.162E-001  | 2.059E+000 | 1.002E+000   | -0.23   |               |
| CS-134            | 8553   | 9.391E-002pCi/g  | 6.368E-002 | 6.349E-002  | 1.526E-001 | 7.164E-002   | 0.62    |               |
| CS-136            | 8546   | 3.304E-002pCi/g  | 3.799E-002 | 3.794E-002  | 3.085E-001 | 1.484E-001   | 0.11    |               |
| CS-137            | 8539   | 2.942E+001pCi/g  | 1.582E+000 | 3.998E-001  | 3.497E-001 | 1.691E-001   | 84.15   |               |
| EU-152            | 7145   | 1.912E-001pCi/g  | 2.554E-001 | 2.552E-001  | 8.302E-001 | 4.042E-001   | 0.23    |               |
| EU-154            | 7138   | 6.956E-002pCi/g  | 1.146E-001 | 1.146E-001  | 2.351E+000 | 1.125E+000   | 0.03    |               |
| EU-155            | 7131   | 2.888E-002pCi/g  | 2.199E-001 | 2.199E-001  | 7.370E-001 | 3.618E-001   | 0.04    |               |
| FE-59             | 7073   | -1.833E-001pCi/g | 1.818E-001 | 1.815E-001  | 6.083E-001 | 2.908E-001   | -0.30   |               |
| GA-68             | 18005  | 4.764E+000pCi/g  | 2.454E+000 | 2.440E+000  | 7.914E+000 | 3.694E+000   | 0.60    |               |
| GD-153            | 6824   | 7.978E-002pCi/g  | 1.552E-001 | 1.551E-001  | 5.177E-001 | 2.540E-001   | 0.15    |               |
| HF-181            | 6495   | 2.335E-002pCi/g  | 1.043E-001 | 1.043E-001  | 3.518E-001 | 1.712E-001   | 0.07    |               |
| HG-203            | 6466   | 6.698E-003pCi/g  | 6.497E-002 | 6.497E-002  | 2.197E-001 | 1.068E-001   | 0.03    |               |
| I-131             | 6380   | -1.610E-002pCi/g | 8.500E-002 | 8.500E-002  | 2.866E-001 | 1.396E-001   | -0.06   |               |
| IR-192            | 6303   | 1.018E-001pCi/g  | 9.042E-002 | 9.022E-002  | 2.283E-001 | 1.111E-001   | 0.45    |               |
| K-40              | 6148   | 1.623E-001pCi/g  | 3.950E-001 | 3.949E-001  | 1.502E+000 | 6.607E-001   | 0.11    |               |
| LA-140            | 6096   | 6.191E-003pCi/g  | 4.179E-002 | 4.179E-002  | 5.946E-002 | 1.880E-002   | 0.10    |               |
| MN-54             | 5382   | 1.822E-002pCi/g  | 9.095E-002 | 9.094E-002  | 3.102E-001 | 1.491E-001   | 0.06    |               |
| NA-22             | 5201   | 1.507E-002pCi/g  | 4.555E-002 | 4.554E-002  | 1.637E-001 | 7.329E-002   | 0.09    |               |
| NB-94             | 5160   | 6.019E-002pCi/g  | 3.912E-002 | 3.899E-002  | 2.572E-001 | 1.233E-001   | 0.23    |               |
| NB-95             | 5154   | 2.541E-002pCi/g  | 7.560E-002 | 7.559E-002  | 2.579E-001 | 1.234E-001   | 0.10    |               |
| ND-147            | 5083   | 4.071E-001pCi/g  | 4.877E-001 | 4.871E-001  | 1.636E+000 | 7.863E-001   | 0.25    |               |
| NP-237            | 4757   | 0.000E+000pCi/g  | 4.510E-001 | 4.510E-001  | 1.509E+000 | 7.430E-001   | 0.00    |               |
| NP-239            | 4751   | -1.622E-002pCi/g | 2.061E-001 | 2.061E-001  | 6.910E-001 | 3.393E-001   | -0.02   |               |
| PA-231            | 4541   | -2.797E-001pCi/g | 6.016E-001 | 6.014E-001  | 7.388E+000 | 3.603E+000   | -0.04   |               |
| PA-233            | 4535   | 1.354E-001pCi/g  | 2.200E-001 | 2.199E-001  | 5.917E-001 | 2.884E-001   | 0.23    |               |
| PA-234            | 4528   | 2.370E-002pCi/g  | 7.301E-002 | 7.300E-002  | 8.496E-001 | 4.166E-001   | 0.03    |               |
| PA-234M           | 19453  | 2.685E+000pCi/g  | 3.731E+000 | 3.729E+000  | 3.935E+001 | 1.884E+001   | 0.07    |               |
| PB-210            | 4467   | 8.385E+002pCi/g  | 5.067E+001 | 1.196E+001  | 2.132E+001 | 1.059E+001   | 39.34   |               |

|        |       |                  |            |            |            |            |       |
|--------|-------|------------------|------------|------------|------------|------------|-------|
| PB-212 | 4454  | 2.569E-001pCi/g  | 1.484E-001 | 1.475E-001 | 4.865E-001 | 2.382E-001 | 0.53  |
| PB-214 | 4448  | -1.187E-001pCi/g | 2.062E-001 | 2.061E-001 | 4.941E-001 | 2.392E-001 | -0.24 |
| PM-144 | 19585 | -1.104E-002pCi/g | 1.584E-002 | 1.583E-002 | 2.412E-001 | 1.154E-001 | -0.05 |
| PM-146 | 2464  | 1.016E-001pCi/g  | 1.134E-001 | 1.133E-001 | 6.877E-001 | 3.278E-001 | 0.15  |
| RH-106 | 1882  | 9.849E-001pCi/g  | 7.318E-001 | 7.301E-001 | 1.785E+000 | 8.453E-001 | 0.55  |
| RU-103 | 1828  | -7.826E-003pCi/g | 8.182E-002 | 8.182E-002 | 2.777E-001 | 1.346E-001 | -0.03 |
| SB-124 | 1784  | 1.264E-001pCi/g  | 7.595E-002 | 7.567E-002 | 1.582E-001 | 7.445E-002 | 0.80  |
| SB-125 | 1777  | 2.237E-001pCi/g  | 1.965E-001 | 1.962E-001 | 9.608E-001 | 4.688E-001 | 0.23  |
| SC-46  | 1739  | 6.651E-002pCi/g  | 9.525E-002 | 9.519E-002 | 3.209E-001 | 1.541E-001 | 0.21  |
| SN-113 | 1570  | 2.166E-002pCi/g  | 1.160E-001 | 1.160E-001 | 3.912E-001 | 1.906E-001 | 0.06  |
| SN-126 | 17459 | -6.991E+000pCi/g | 1.044E+000 | 9.772E-001 | 3.085E+000 | 1.523E+000 | -2.27 |
| TA-182 | 1301  | 2.287E-001pCi/g  | 2.419E-001 | 2.416E-001 | 9.149E-001 | 4.354E-001 | 0.25  |
| TC-99M | 17412 | -3.499E-002pCi/g | 5.302E-002 | 5.298E-002 | 1.767E-001 | 8.659E-002 | -0.20 |
| TH-227 | 1058  | -3.701E+001pCi/g | 4.063E+000 | 3.522E+000 | 1.124E+001 | 5.589E+000 | -3.29 |
| TH-229 | 1046  | -1.190E+000pCi/g | 1.295E+000 | 1.291E+000 | 4.291E+000 | 2.104E+000 | -0.28 |
| TH-234 | 1027  | -5.199E+001pCi/g | 5.252E+000 | 4.493E+000 | 1.365E+001 | 6.775E+000 | -3.81 |
| TL-208 | 929   | 1.496E-001pCi/g  | 8.481E-002 | 8.445E-002 | 2.772E-001 | 1.334E-001 | 0.54  |
| U-235  | 281   | -6.184E-002pCi/g | 1.918E+001 | 1.918E+001 | 1.442E+000 | 7.072E-001 | -0.04 |
| Y-88   | 74    | -1.169E-001pCi/g | 1.223E-001 | 1.221E-001 | 4.080E-001 | 1.972E-001 | -0.29 |
| ZN-65  | 31    | -6.060E-002pCi/g | 2.169E-001 | 2.169E-001 | 7.398E-001 | 3.548E-001 | -0.08 |
| ZR-95  | 7     | 1.074E-001pCi/g  | 1.365E-001 | 1.364E-001 | 4.600E-001 | 2.199E-001 | 0.23  |

#### Laboratory Control Sample Information

| Sample ID          | WRKNO              | Analyte | Activity         | StdAdded   | Recovery | ZFactor |
|--------------------|--------------------|---------|------------------|------------|----------|---------|
| LCS 160-218441~2-A | LCS 160-218441~2-A | CS-137  | 2.942E+001 pCi/g | 3.008E+001 | 97.82%   | -0.2899 |
|                    |                    | CO-60   | 1.870E+001 pCi/g | 1.859E+001 | 100.64%  | 0.0836  |
|                    |                    | AM-241  | 9.714E+001 pCi/g | 9.723E+001 | 99.92%   | -0.0112 |

#### Sample Duplicate Information

| Sample ID | Dup Sample ID | Analyte | Samp Activity | Dup Activity | RPD | RER | DER | Flag | ZFactor |
|-----------|---------------|---------|---------------|--------------|-----|-----|-----|------|---------|
|-----------|---------------|---------|---------------|--------------|-----|-----|-----|------|---------|

**Blanks Information**

| <u>SampleID</u>   | <u>WRKNO</u> | <u>Analyte</u> | <u>Activity</u> | <u>UncTotal</u> | <u>ZFactor</u> |
|-------------------|--------------|----------------|-----------------|-----------------|----------------|
| MB 160-218441~1-A | MB           | AC-228         | 3.987E-002      | 4.560E-002      | 0.8743         |
| MB 160-218441~1-A | MB           | AG-108M        | 5.451E-003      | 8.527E-003      | 0.6393         |
| MB 160-218441~1-A | MB           | AG-110M        | -1.473E-002     | 2.625E-002      | -0.5612        |
| MB 160-218441~1-A | MB           | AM-241         | -1.477E-002     | 2.928E-002      | -0.5047        |
| MB 160-218441~1-A | MB           | BA-133         | 3.407E-003      | 1.959E-002      | 0.1740         |
| MB 160-218441~1-A | MB           | BA-140         | 6.525E-002      | 6.139E-002      | 1.0630         |
| MB 160-218441~1-A | MB           | BE-7           | 0.000E+000      | 6.035E-002      | 0.0000         |
| MB 160-218441~1-A | MB           | BI-207         | 8.121E-003      | 1.544E-002      | 0.5258         |
| MB 160-218441~1-A | MB           | BI-210M        | 1.934E-002      | 1.581E-002      | 1.2233         |
| MB 160-218441~1-A | MB           | BI-212         | 0.000E+000      | 1.856E-001      | 0.0000         |
| MB 160-218441~1-A | MB           | BI-214         | -1.133E-002     | 5.880E-002      | -0.1926        |
| MB 160-218441~1-A | MB           | CD-109         | 9.453E-002      | 2.288E-001      | 0.4132         |
| MB 160-218441~1-A | MB           | CD-113M        | -1.366E+002     | 2.218E+002      | -0.6159        |
| MB 160-218441~1-A | MB           | CE-139         | -3.140E-003     | 9.986E-003      | -0.3145        |
| MB 160-218441~1-A | MB           | CE-141         | -6.169E-003     | 1.570E-002      | -0.3929        |
| MB 160-218441~1-A | MB           | CE-144         | 4.904E-003      | 4.662E-002      | 0.1052         |
| MB 160-218441~1-A | MB           | CF-249         | 8.754E-003      | 1.572E-002      | 0.5569         |
| MB 160-218441~1-A | MB           | CF-251         | -2.594E-002     | 5.279E-002      | -0.4914        |
| MB 160-218441~1-A | MB           | CO-56          | -6.736E-003     | 1.135E-002      | -0.5936        |
| MB 160-218441~1-A | MB           | CO-57          | 4.406E-003      | 9.298E-003      | 0.4738         |
| MB 160-218441~1-A | MB           | CO-58          | 1.276E-002      | 1.914E-002      | 0.6662         |
| MB 160-218441~1-A | MB           | CO-60          | -3.371E-003     | 2.082E-002      | -0.1619        |
| MB 160-218441~1-A | MB           | CR-51          | 6.564E-002      | 1.182E-001      | 0.5552         |
| MB 160-218441~1-A | MB           | CS-134         | -7.518E-004     | 1.083E-003      | -0.6945        |
| MB 160-218441~1-A | MB           | CS-136         | 0.000E+000      | 5.399E-003      | 0.0000         |
| MB 160-218441~1-A | MB           | CS-137         | 1.650E-002      | 1.844E-002      | 0.8946         |
| MB 160-218441~1-A | MB           | EU-152         | -8.619E-004     | 1.441E-003      | -0.5979        |
| MB 160-218441~1-A | MB           | EU-154         | 1.149E-001      | 1.445E-001      | 0.7954         |
| MB 160-218441~1-A | MB           | EU-155         | -2.026E-002     | 3.719E-002      | -0.5447        |
| MB 160-218441~1-A | MB           | FE-59          | 9.255E-003      | 1.826E-002      | 0.5070         |
| MB 160-218441~1-A | MB           | GA-68          | 0.000E+000      | 1.430E-001      | 0.0000         |
| MB 160-218441~1-A | MB           | GD-153         | -2.088E-002     | 3.165E-002      | -0.6598        |
| MB 160-218441~1-A | MB           | HF-181         | -1.476E-003     | 1.865E-003      | -0.7914        |
| MB 160-218441~1-A | MB           | HG-203         | 1.656E-002      | 9.732E-003      | 1.7013         |
| MB 160-218441~1-A | MB           | I-131          | 6.142E-003      | 2.344E-002      | 0.2620         |
| MB 160-218441~1-A | MB           | IR-192         | 3.418E-003      | 1.317E-002      | 0.2595         |
| MB 160-218441~1-A | MB           | K-40           | -6.451E-001     | 1.290E+001      | -0.0500        |
| MB 160-218441~1-A | MB           | LA-140         | 2.528E-003      | 2.485E-002      | 0.1017         |
| MB 160-218441~1-A | MB           | MN-54          | -2.351E-003     | 1.657E-002      | -0.1419        |
| MB 160-218441~1-A | MB           | NA-22          | 0.000E+000      | 5.287E-003      | 0.0000         |
| MB 160-218441~1-A | MB           | NB-94          | 1.400E-003      | 7.442E-003      | 0.1881         |
| MB 160-218441~1-A | MB           | NB-95          | -2.221E-003     | 1.672E-002      | -0.1328        |
| MB 160-218441~1-A | MB           | ND-147         | 2.932E-002      | 2.819E-002      | 1.0401         |
| MB 160-218441~1-A | MB           | NP-237         | -1.201E-002     | 7.433E-002      | -0.1615        |
| MB 160-218441~1-A | MB           | NP-239         | 4.366E-002      | 2.736E-002      | 1.5962         |
| MB 160-218441~1-A | MB           | PA-231         | 3.079E-001      | 2.831E-001      | 1.0876         |
| MB 160-218441~1-A | MB           | PA-233         | 2.077E-002      | 3.041E-002      | 0.6831         |
| MB 160-218441~1-A | MB           | PA-234         | 5.537E-002      | 5.645E-002      | 0.9808         |
| MB 160-218441~1-A | MB           | PA-234M        | -7.028E-001     | 1.816E+000      | -0.3870        |
| MB 160-218441~1-A | MB           | PB-210         | 4.463E-001      | 4.306E-001      | 1.0364         |
| MB 160-218441~1-A | MB           | PB-212         | 4.711E-003      | 2.788E-002      | 0.1690         |
| MB 160-218441~1-A | MB           | PB-214         | 4.377E-002      | 3.189E-002      | 1.3727         |

|                   |    |        |             |            |         |
|-------------------|----|--------|-------------|------------|---------|
| MB 160-218441~1-A | MB | PM-144 | 9.554E-004  | 6.357E-003 | 0.1503  |
| MB 160-218441~1-A | MB | PM-146 | -3.544E-002 | 4.841E-002 | -0.7319 |
| MB 160-218441~1-A | MB | RH-106 | 4.655E-002  | 1.634E-001 | 0.2849  |
| MB 160-218441~1-A | MB | RU-103 | 6.210E-003  | 1.531E-002 | 0.4057  |
| MB 160-218441~1-A | MB | SB-124 | -1.006E-002 | 1.857E-002 | -0.5418 |
| MB 160-218441~1-A | MB | SB-125 | 1.305E-003  | 4.143E-003 | 0.3151  |
| MB 160-218441~1-A | MB | SC-46  | -1.594E-004 | 1.758E-002 | -0.0091 |
| MB 160-218441~1-A | MB | SN-113 | 3.684E-002  | 1.998E-002 | 1.8437  |
| MB 160-218441~1-A | MB | SN-126 | 2.933E-001  | 1.237E-001 | 2.3710  |
| MB 160-218441~1-A | MB | TA-182 | 2.383E-002  | 4.528E-002 | 0.5262  |
| MB 160-218441~1-A | MB | TC-99M | 3.169E-003  | 8.389E-003 | 0.3778  |
| MB 160-218441~1-A | MB | TH-227 | 2.179E-001  | 1.503E-001 | 1.4498  |
| MB 160-218441~1-A | MB | TH-229 | -9.602E-002 | 2.482E-001 | -0.3868 |
| MB 160-218441~1-A | MB | TH-234 | -6.219E-001 | 8.472E-001 | -0.7341 |
| MB 160-218441~1-A | MB | TL-208 | 1.433E-002  | 2.289E-002 | 0.6260  |
| MB 160-218441~1-A | MB | U-235  | 1.116E-001  | 8.413E-002 | 1.3268  |
| MB 160-218441~1-A | MB | Y-88   | 0.000E+000  | 6.164E-003 | 0.0000  |
| MB 160-218441~1-A | MB | ZN-65  | 0.000E+000  | 9.463E-003 | 0.0000  |
| MB 160-218441~1-A | MB | ZR-95  | -8.939E-004 | 1.210E-003 | -0.7385 |

| SampID            | WRKNO  | Aliquot          | Sigma      | Instrument  | Detector   | CountDate    | Time    | CountDuration |
|-------------------|--------|------------------|------------|-------------|------------|--------------|---------|---------------|
| LCS 160-218442~2- | LCS    | 341.90g          | 1.00       | GammaVision | GV09       | 10 / 27 / 15 | 14:09   | 30            |
| Analyte           | Cmpnd# | Activity         | TotalUnc   | CountUnc    | MDA        | MLCC         | Act/MDA |               |
| AC-228            | 11136  | 5.980E-001pCi/g  | 2.506E-001 | 2.488E-001  | 1.014E+000 | 4.923E-001   | 0.59    |               |
| AG-108M           | 10982  | 6.362E-006pCi/g  | 7.135E-002 | 7.135E-002  | 2.404E-001 | 1.175E-001   | 0.00    |               |
| AG-110M           | 10973  | -4.015E-003pCi/g | 1.009E-001 | 1.009E-001  | 3.435E-001 | 1.661E-001   | -0.01   |               |
| AM-241            | 10818  | 9.726E+001pCi/g  | 5.101E+000 | 7.368E-001  | 1.053E+000 | 5.222E-001   | 92.32   |               |
| BA-133            | 10469  | 8.644E-004pCi/g  | 8.695E-002 | 8.695E-002  | 2.932E-001 | 1.432E-001   | 0.00    |               |
| BA-140            | 10463  | 2.814E-001pCi/g  | 2.308E-001 | 2.303E-001  | 7.647E-001 | 3.708E-001   | 0.37    |               |
| BE-7              | 10435  | 5.425E-001pCi/g  | 6.400E-001 | 6.394E-001  | 2.131E+000 | 1.041E+000   | 0.25    |               |
| BI-207            | 10195  | -2.984E-002pCi/g | 5.728E-002 | 5.726E-002  | 1.928E-001 | 9.338E-002   | -0.15   |               |
| BI-210M           | 10173  | 2.463E-002pCi/g  | 9.686E-002 | 9.684E-002  | 3.249E-001 | 1.590E-001   | 0.08    |               |
| BI-212            | 10160  | 4.340E-001pCi/g  | 7.169E-001 | 7.165E-001  | 2.420E+000 | 1.163E+000   | 0.18    |               |
| BI-214            | 10154  | 8.273E-001pCi/g  | 1.845E-001 | 1.794E-001  | 3.533E-001 | 1.700E-001   | 2.34    |               |
| CD-109            | 9254   | 5.485E+000pCi/g  | 3.401E+000 | 3.387E+000  | 3.143E+000 | 1.540E+000   | 1.75    |               |
| CD-113M           | 17462  | 8.114E+000pCi/g  | 7.905E+002 | 7.905E+002  | 2.661E+003 | 1.302E+003   | 0.00    |               |
| CE-139            | 9241   | -3.089E-002pCi/g | 5.178E-002 | 5.170E-002  | 1.723E-001 | 8.460E-002   | -0.18   |               |
| CE-141            | 9235   | -3.579E-003pCi/g | 6.317E-002 | 6.317E-002  | 2.129E-001 | 1.040E-001   | -0.02   |               |
| CE-144            | 9221   | 1.068E-001pCi/g  | 3.278E-001 | 3.277E-001  | 1.096E+000 | 5.379E-001   | 0.10    |               |
| CF-249            | 9215   | 1.007E-001pCi/g  | 1.004E-001 | 1.002E-001  | 2.876E-001 | 1.404E-001   | 0.35    |               |
| CF-251            | 13690  | -2.639E-001pCi/g | 2.511E-001 | 2.500E-001  | 8.293E-001 | 4.069E-001   | -0.32   |               |
| CO-56             | 8704   | 1.134E-001pCi/g  | 8.881E-002 | 8.861E-002  | 2.341E-001 | 1.131E-001   | 0.48    |               |
| CO-57             | 13694  | 5.717E-003pCi/g  | 4.406E-002 | 4.406E-002  | 1.476E-001 | 7.249E-002   | 0.04    |               |
| CO-58             | 8698   | 5.129E-002pCi/g  | 6.155E-002 | 6.150E-002  | 2.064E-001 | 9.935E-002   | 0.25    |               |
| CO-60             | 8692   | 1.774E+001pCi/g  | 9.122E-001 | 1.984E-001  | 9.851E-002 | 4.359E-002   | 180.05  |               |
| CR-51             | 8604   | -2.572E-002pCi/g | 5.332E-001 | 5.332E-001  | 1.795E+000 | 8.779E-001   | -0.01   |               |
| CS-134            | 8553   | 5.920E-002pCi/g  | 4.059E-002 | 4.047E-002  | 2.764E-001 | 1.350E-001   | 0.21    |               |
| CS-136            | 8546   | 4.051E-002pCi/g  | 4.705E-002 | 4.700E-002  | 1.989E-001 | 9.561E-002   | 0.20    |               |
| CS-137            | 8539   | 2.895E+001pCi/g  | 1.537E+000 | 3.066E-001  | 2.184E-001 | 1.053E-001   | 132.57  |               |
| EU-152            | 7145   | 1.210E-001pCi/g  | 1.140E-001 | 1.138E-001  | 6.662E-001 | 3.254E-001   | 0.18    |               |
| EU-154            | 7138   | 1.536E-001pCi/g  | 2.903E-001 | 2.902E-001  | 2.035E+000 | 9.844E-001   | 0.08    |               |
| EU-155            | 7131   | -2.215E-001pCi/g | 1.885E-001 | 1.881E-001  | 6.227E-001 | 3.061E-001   | -0.36   |               |
| FE-59             | 7073   | -2.347E-001pCi/g | 1.656E-001 | 1.651E-001  | 5.463E-001 | 2.646E-001   | -0.43   |               |
| GA-68             | 18005  | -1.959E+000pCi/g | 2.934E+000 | 2.932E+000  | 9.861E+000 | 4.761E+000   | -0.20   |               |
| GD-153            | 6824   | 1.074E-001pCi/g  | 5.604E-002 | 5.566E-002  | 4.253E-001 | 2.089E-001   | 0.25    |               |
| HF-181            | 6495   | 7.655E-003pCi/g  | 2.864E-002 | 2.863E-002  | 2.832E-001 | 1.384E-001   | 0.03    |               |
| HG-203            | 6466   | -5.635E-002pCi/g | 6.273E-002 | 6.264E-002  | 2.084E-001 | 1.020E-001   | -0.27   |               |
| I-131             | 6380   | 7.130E-002pCi/g  | 8.246E-002 | 8.238E-002  | 2.211E-001 | 1.079E-001   | 0.32    |               |
| IR-192            | 6303   | 6.154E-002pCi/g  | 5.067E-002 | 5.054E-002  | 2.010E-001 | 9.829E-002   | 0.31    |               |
| K-40              | 6148   | -1.447E-001pCi/g | 7.481E-001 | 7.481E-001  | 1.284E+000 | 5.849E-001   | -0.11   |               |
| LA-140            | 6096   | 1.563E-002pCi/g  | 2.812E-002 | 2.811E-002  | 1.016E-001 | 4.393E-002   | 0.15    |               |
| MN-54             | 5382   | -2.832E-002pCi/g | 6.926E-002 | 6.925E-002  | 2.341E-001 | 1.131E-001   | -0.12   |               |
| NA-22             | 5201   | -2.471E-002pCi/g | 3.987E-002 | 3.985E-002  | 1.381E-001 | 6.356E-002   | -0.18   |               |
| NB-94             | 5160   | 4.992E-002pCi/g  | 4.304E-002 | 4.296E-002  | 1.435E-001 | 6.826E-002   | 0.35    |               |
| NB-95             | 5154   | -8.541E-002pCi/g | 6.319E-002 | 6.303E-002  | 2.089E-001 | 1.008E-001   | -0.41   |               |
| ND-147            | 5083   | -5.970E-002pCi/g | 4.393E-001 | 4.392E-001  | 1.487E+000 | 7.219E-001   | -0.04   |               |
| NP-237            | 4757   | -4.152E-001pCi/g | 3.778E-001 | 3.771E-001  | 1.248E+000 | 6.152E-001   | -0.33   |               |
| NP-239            | 4751   | 1.422E-001pCi/g  | 1.425E-001 | 1.422E-001  | 4.725E-001 | 2.313E-001   | 0.30    |               |
| PA-231            | 4541   | 7.897E-001pCi/g  | 5.588E-001 | 5.571E-001  | 6.014E+000 | 2.942E+000   | 0.13    |               |
| PA-233            | 4535   | 1.659E-001pCi/g  | 1.174E-001 | 1.170E-001  | 4.817E-001 | 2.355E-001   | 0.34    |               |
| PA-234            | 4528   | 7.379E-003pCi/g  | 1.848E-001 | 1.848E-001  | 6.212E-001 | 3.043E-001   | 0.01    |               |
| PA-234M           | 19453  | -3.849E+000pCi/g | 1.050E+001 | 1.050E+001  | 3.544E+001 | 1.718E+001   | -0.11   |               |
| PB-210            | 4467   | 8.556E+002pCi/g  | 5.093E+001 | 8.354E+000  | 1.399E+001 | 6.939E+000   | 61.17   |               |

|        |       |                  |            |            |            |            |       |
|--------|-------|------------------|------------|------------|------------|------------|-------|
| PB-212 | 4454  | 4.747E-001pCi/g  | 1.198E-001 | 1.158E-001 | 2.884E-001 | 1.405E-001 | 1.65  |
| PB-214 | 4448  | 2.527E-001pCi/g  | 1.397E-001 | 1.390E-001 | 4.865E-001 | 2.377E-001 | 0.52  |
| PM-144 | 19585 | 5.467E-002pCi/g  | 5.088E-002 | 5.080E-002 | 1.697E-001 | 8.140E-002 | 0.32  |
| PM-146 | 2464  | -1.121E-001pCi/g | 1.694E-001 | 1.693E-001 | 5.705E-001 | 2.747E-001 | -0.20 |
| RH-106 | 1882  | 2.453E-001pCi/g  | 5.500E-001 | 5.499E-001 | 1.858E+000 | 8.973E-001 | 0.13  |
| RU-103 | 1828  | 3.179E-003pCi/g  | 6.795E-002 | 6.795E-002 | 2.296E-001 | 1.119E-001 | 0.01  |
| SB-124 | 1784  | 6.871E-002pCi/g  | 5.491E-002 | 5.479E-002 | 1.820E-001 | 8.786E-002 | 0.38  |
| SB-125 | 1777  | 7.725E-002pCi/g  | 1.204E-001 | 1.203E-001 | 7.192E-001 | 3.515E-001 | 0.11  |
| SC-46  | 1739  | 6.865E-002pCi/g  | 3.773E-002 | 3.756E-002 | 2.744E-001 | 1.331E-001 | 0.25  |
| SN-113 | 1570  | -5.988E-002pCi/g | 9.283E-002 | 9.278E-002 | 3.100E-001 | 1.515E-001 | -0.19 |
| SN-126 | 17459 | 4.728E-001pCi/g  | 6.187E-001 | 6.182E-001 | 2.053E+000 | 1.011E+000 | 0.23  |
| TA-182 | 1301  | 2.190E-001pCi/g  | 1.744E-001 | 1.740E-001 | 6.078E-001 | 2.897E-001 | 0.36  |
| TC-99M | 17412 | 4.814E-002pCi/g  | 4.538E-002 | 4.530E-002 | 1.502E-001 | 7.375E-002 | 0.32  |
| TH-227 | 1058  | 5.812E-001pCi/g  | 8.496E-001 | 8.490E-001 | 7.338E+000 | 3.643E+000 | 0.08  |
| TH-229 | 1046  | 3.346E-001pCi/g  | 9.867E-001 | 9.864E-001 | 3.300E+000 | 1.619E+000 | 0.10  |
| TH-234 | 1027  | -3.012E+001pCi/g | 2.825E+000 | 2.346E+000 | 7.161E+000 | 3.541E+000 | -4.21 |
| TL-208 | 929   | 1.402E-001pCi/g  | 7.085E-002 | 7.047E-002 | 2.180E-001 | 1.055E-001 | 0.64  |
| U-235  | 281   | 1.225E-001pCi/g  | 2.509E-001 | 2.508E-001 | 1.165E+000 | 5.718E-001 | 0.11  |
| Y-88   | 74    | -5.977E-002pCi/g | 8.913E-002 | 8.908E-002 | 2.987E-001 | 1.449E-001 | -0.20 |
| ZN-65  | 31    | 1.053E-001pCi/g  | 9.011E-002 | 8.995E-002 | 3.017E-001 | 1.411E-001 | 0.35  |
| ZR-95  | 7     | 3.603E-002pCi/g  | 1.120E-001 | 1.120E-001 | 3.799E-001 | 1.833E-001 | 0.09  |

#### Laboratory Control Sample Information

| Sample ID          | WRKNO              | Analyte | Activity         | StdAdded   | Recovery | ZFactor |
|--------------------|--------------------|---------|------------------|------------|----------|---------|
| LCS 160-218442~2-A | LCS 160-218442~2-A | CS-137  | 2.895E+001 pCi/g | 3.008E+001 | 96.24%   | -0.5100 |
|                    |                    | CO-60   | 1.774E+001 pCi/g | 1.859E+001 | 95.42%   | -0.6439 |
|                    |                    | AM-241  | 9.726E+001 pCi/g | 9.723E+001 | 100.04%  | 0.0052  |

#### Sample Duplicate Information

| Sample ID | Dup Sample ID | Analyte | Samp Activity | Dup Activity | RPD | RER | DER | Flag | ZFactor |
|-----------|---------------|---------|---------------|--------------|-----|-----|-----|------|---------|
|-----------|---------------|---------|---------------|--------------|-----|-----|-----|------|---------|

**Blanks Information**

| <u>SampleID</u>   | <u>WRKNO</u> | <u>Analyte</u> | <u>Activity</u> | <u>UncTotal</u> | <u>ZFactor</u> |
|-------------------|--------------|----------------|-----------------|-----------------|----------------|
| MB 160-218442~1-A | MB           | AC-228         | 4.629E-002      | 5.406E-002      | 0.8562         |
| MB 160-218442~1-A | MB           | AG-108M        | 5.830E-003      | 1.413E-002      | 0.4125         |
| MB 160-218442~1-A | MB           | AG-110M        | 1.867E-002      | 2.797E-002      | 0.6674         |
| MB 160-218442~1-A | MB           | AM-241         | 4.337E-002      | 3.562E-002      | 1.2178         |
| MB 160-218442~1-A | MB           | BA-133         | 3.213E-003      | 1.707E-002      | 0.1882         |
| MB 160-218442~1-A | MB           | BA-140         | 7.074E-002      | 6.022E-002      | 1.1747         |
| MB 160-218442~1-A | MB           | BE-7           | 2.063E-003      | 1.089E-001      | 0.0189         |
| MB 160-218442~1-A | MB           | BI-207         | -8.550E-003     | 1.554E-002      | -0.5500        |
| MB 160-218442~1-A | MB           | BI-210M        | -5.240E-005     | 2.134E-002      | -0.0025        |
| MB 160-218442~1-A | MB           | BI-212         | 1.891E-001      | 2.106E-001      | 0.8980         |
| MB 160-218442~1-A | MB           | BI-214         | 5.878E-002      | 4.257E-002      | 1.3807         |
| MB 160-218442~1-A | MB           | CD-109         | -3.780E-002     | 2.773E-001      | -0.1363        |
| MB 160-218442~1-A | MB           | CD-113M        | -1.209E+002     | 2.006E+002      | -0.6023        |
| MB 160-218442~1-A | MB           | CE-139         | -2.638E-003     | 1.098E-002      | -0.2403        |
| MB 160-218442~1-A | MB           | CE-141         | 0.000E+000      | 1.549E-002      | 0.0000         |
| MB 160-218442~1-A | MB           | CE-144         | 2.685E-004      | 7.314E-002      | 0.0037         |
| MB 160-218442~1-A | MB           | CF-249         | 1.313E-003      | 1.950E-002      | 0.0673         |
| MB 160-218442~1-A | MB           | CF-251         | -3.857E-003     | 5.706E-002      | -0.0676        |
| MB 160-218442~1-A | MB           | CO-56          | 1.232E-004      | 1.804E-004      | 0.6833         |
| MB 160-218442~1-A | MB           | CO-57          | 2.443E-003      | 8.085E-003      | 0.3022         |
| MB 160-218442~1-A | MB           | CO-58          | -1.180E-003     | 2.037E-002      | -0.0579        |
| MB 160-218442~1-A | MB           | CO-60          | 6.900E-003      | 9.579E-003      | 0.7203         |
| MB 160-218442~1-A | MB           | CR-51          | 1.599E-003      | 1.074E-001      | 0.0149         |
| MB 160-218442~1-A | MB           | CS-134         | 3.207E-002      | 2.395E-002      | 1.3391         |
| MB 160-218442~1-A | MB           | CS-136         | 5.803E-003      | 1.781E-002      | 0.3257         |
| MB 160-218442~1-A | MB           | CS-137         | 0.000E+000      | 1.138E-002      | 0.0000         |
| MB 160-218442~1-A | MB           | EU-152         | -3.093E-005     | 4.932E-002      | -0.0006        |
| MB 160-218442~1-A | MB           | EU-154         | -1.070E-001     | 1.707E-001      | -0.6272        |
| MB 160-218442~1-A | MB           | EU-155         | 2.380E-002      | 1.887E-002      | 1.2612         |
| MB 160-218442~1-A | MB           | FE-59          | 0.000E+000      | 8.903E-003      | 0.0000         |
| MB 160-218442~1-A | MB           | GA-68          | 0.000E+000      | 1.515E-001      | 0.0000         |
| MB 160-218442~1-A | MB           | GD-153         | 0.000E+000      | 1.067E-002      | 0.0000         |
| MB 160-218442~1-A | MB           | HF-181         | 1.261E-002      | 1.480E-002      | 0.8522         |
| MB 160-218442~1-A | MB           | HG-203         | 3.510E-003      | 1.144E-002      | 0.3067         |
| MB 160-218442~1-A | MB           | I-131          | 0.000E+000      | 6.680E-003      | 0.0000         |
| MB 160-218442~1-A | MB           | IR-192         | 1.578E-003      | 1.452E-002      | 0.1086         |
| MB 160-218442~1-A | MB           | K-40           | -2.137E-001     | 7.006E-001      | -0.3050        |
| MB 160-218442~1-A | MB           | LA-140         | 0.000E+000      | 7.055E-003      | 0.0000         |
| MB 160-218442~1-A | MB           | MN-54          | 0.000E+000      | 5.770E-003      | 0.0000         |
| MB 160-218442~1-A | MB           | NA-22          | -2.879E-004     | 1.602E-002      | -0.0180        |
| MB 160-218442~1-A | MB           | NB-94          | 1.568E-003      | 1.741E-002      | 0.0901         |
| MB 160-218442~1-A | MB           | NB-95          | 2.922E-003      | 1.554E-002      | 0.1880         |
| MB 160-218442~1-A | MB           | ND-147         | 7.112E-002      | 1.032E-001      | 0.6894         |
| MB 160-218442~1-A | MB           | NP-237         | 5.092E-003      | 7.332E-002      | 0.0695         |
| MB 160-218442~1-A | MB           | NP-239         | 1.565E-002      | 3.200E-002      | 0.4890         |
| MB 160-218442~1-A | MB           | PA-231         | -1.854E-001     | 3.961E-001      | -0.4681        |
| MB 160-218442~1-A | MB           | PA-233         | 7.432E-003      | 1.916E-002      | 0.3879         |
| MB 160-218442~1-A | MB           | PA-234         | 1.231E-002      | 3.411E-002      | 0.3608         |
| MB 160-218442~1-A | MB           | PA-234M        | 0.000E+000      | 7.911E-001      | 0.0000         |
| MB 160-218442~1-A | MB           | PB-210         | 3.880E-001      | 4.487E-001      | 0.8648         |
| MB 160-218442~1-A | MB           | PB-212         | -2.440E-002     | 9.674E-002      | -0.2522        |
| MB 160-218442~1-A | MB           | PB-214         | -2.424E-002     | 8.010E-002      | -0.3026        |

|                   |    |        |             |            |         |
|-------------------|----|--------|-------------|------------|---------|
| MB 160-218442~1-A | MB | PM-144 | 2.715E-003  | 1.733E-002 | 0.1567  |
| MB 160-218442~1-A | MB | PM-146 | 1.519E-002  | 1.570E-002 | 0.9676  |
| MB 160-218442~1-A | MB | RH-106 | -2.995E-002 | 1.833E-001 | -0.1634 |
| MB 160-218442~1-A | MB | RU-103 | -5.540E-003 | 1.385E-002 | -0.4000 |
| MB 160-218442~1-A | MB | SB-124 | 3.566E-003  | 1.681E-002 | 0.2121  |
| MB 160-218442~1-A | MB | SB-125 | -3.271E-002 | 4.871E-002 | -0.6716 |
| MB 160-218442~1-A | MB | SC-46  | 1.794E-002  | 1.459E-002 | 1.2302  |
| MB 160-218442~1-A | MB | SN-113 | 5.033E-004  | 1.899E-002 | 0.0265  |
| MB 160-218442~1-A | MB | SN-126 | 2.542E-002  | 1.062E-001 | 0.2393  |
| MB 160-218442~1-A | MB | TA-182 | 5.091E-002  | 6.392E-002 | 0.7965  |
| MB 160-218442~1-A | MB | TC-99M | 4.412E-003  | 8.994E-003 | 0.4906  |
| MB 160-218442~1-A | MB | TH-227 | 0.000E+000  | 6.308E-002 | 0.0000  |
| MB 160-218442~1-A | MB | TH-229 | 1.425E-001  | 1.928E-001 | 0.7391  |
| MB 160-218442~1-A | MB | TH-234 | -5.703E-002 | 3.530E-001 | -0.1616 |
| MB 160-218442~1-A | MB | TL-208 | -2.982E-003 | 2.496E-002 | -0.1195 |
| MB 160-218442~1-A | MB | U-235  | -6.134E-003 | 8.135E-003 | -0.7541 |
| MB 160-218442~1-A | MB | Y-88   | 1.099E-002  | 2.017E-002 | 0.5449  |
| MB 160-218442~1-A | MB | ZN-65  | 0.000E+000  | 1.005E-002 | 0.0000  |
| MB 160-218442~1-A | MB | ZR-95  | -1.630E-002 | 3.169E-002 | -0.5142 |

Reagent

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**Tuna Can\_00002**

## CERTIFICATE OF CALIBRATION

### Standard Radionuclide Source

81427-334

1.0 Liter Sand in 1 Liter HDPE Silgan Jar

**Customer:** TestAmerica/St. Louis, MO

**P.O. No.:** 2339090, Item 1

**Reference Date:** 01-Jan-2010      12:00 PM EST      **Grams of Master Source:** 0.017570

This standard radionuclide source was prepared using aliquots measured gravimetrically from master radionuclide solutions. Calibration and purity were checked using a germanium gamma spectrometer system. At the time of calibration no interfering gamma-ray emitting impurities were detected. The gamma-ray emission rates for the most intense gamma-ray lines are given. Eckert & Ziegler Analytics (EZA) maintains traceability to the National Institute of Standards and Technology through a Measurements Assurance Program as described in USNRC Regulatory Guide 4.15, Revision 1, February, 1979, and compliance with ANSI N42.22-1995, "Traceability of Radioactive Sources to NIST." EZA is accredited by the Health Physics Society (HPS) for the production of NIST-traceable sources, and this source was produced in accordance with the HPS accreditation requirements. Customers may report any concerns with the accreditation program to the HPS Secretariat, 1313 Dolley Madison Blvd., Ste. 402, McLean, VA 22101.

| Nuclide | Gamma-Ray<br>Energy (keV) | Half-Life,<br>Days | Master<br>Source*<br>yps/gram | This Source<br>yps | Uncertainty, % |                |     | Calibration<br>Method |
|---------|---------------------------|--------------------|-------------------------------|--------------------|----------------|----------------|-----|-----------------------|
|         |                           |                    |                               |                    | u <sub>A</sub> | u <sub>B</sub> | U   |                       |
| Pb-210  | 46.5                      | 8.120E+03          | —                             | 3.141E+03          | 0.1            | 2.1            | 4.1 | 4π LS                 |
| Am-241  | 59.5                      | 1.580E+05          | —                             | 2.034E+03          | 0.1            | 1.7            | 3.5 | 4π LS                 |
| Cd-109  | 88.0                      | 4.626E+02          | 1.606E+05                     | 2.822E+03          | 0.4            | 2.3            | 4.7 | HPGe                  |
| Co-57   | 122.1                     | 2.718E+02          | 8.471E+04                     | 1.488E+03          | 0.5            | 2.0            | 4.1 | HPGe                  |
| Ce-139  | 165.9                     | 1.376E+02          | 1.209E+05                     | 2.124E+03          | 0.4            | 1.9            | 3.9 | HPGe                  |
| Hg-203  | 279.2                     | 4.661E+01          | 2.726E+05                     | 4.790E+03          | 0.4            | 1.9            | 3.9 | HPGe                  |
| Sn-113  | 391.7                     | 1.151E+02          | 1.672E+05                     | 2.938E+03          | 0.5            | 1.9            | 3.9 | HPGe                  |
| Cs-137  | 661.7                     | 1.098E+04          | 1.096E+05                     | 1.926E+03          | 0.6            | 1.9            | 4.0 | HPGe                  |
| Y-88    | 898.0                     | 1.066E+02          | 4.077E+05                     | 7.163E+03          | 0.4            | 1.9            | 3.9 | HPGe                  |
| Co-60   | 1173.2                    | 1.925E+03          | 2.055E+05                     | 3.611E+03          | 0.5            | 1.9            | 3.9 | HPGe                  |
| Co-60   | 1332.5                    | 1.925E+03          | 2.056E+05                     | 3.612E+03          | 0.7            | 1.9            | 4.0 | HPGe                  |
| Y-88    | 1836.1                    | 1.066E+02          | 4.308E+05                     | 7.569E+03          | 0.5            | 1.9            | 3.9 | HPGe                  |

\* Master Source refers to Analytics' 8-isotope mixture which is calibrated quarterly.

**Calibration Methods:** 4π LS - 4 pi Liquid Scintillation Counting, HPGe - High Purity Germanium Gamma-Ray Spectrometer, IC - Ionization Chamber. **Uncertainty:** U - Relative expanded uncertainty, k = 2. See NIST Technical Note 1297, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results."

(Certificate continued on reverse side)



**Comments:**

1550 grams of sand.

This standard will expire one year after the reference date.

Source Prepared by: W. Mao  
W. Mao, Radiochemist

QA Approved: J. D. McCorvey  
J. D. McCorvey, QA Manager Alternate

Date: 2/1/10

Reagent

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**Tuna Can\_00003**



# Eckert & Ziegler

## Analytics

1380 Seaboard Industrial Blvd.  
Atlanta, Georgia 30318  
Tel 404-352-8677  
Fax 404-352-2837  
www.analyticsinc.com

### CERTIFICATE OF CALIBRATION

#### Standard Radionuclide Source

90099

1.0 Liter Sand in 1 Liter Wide Mouth HDPE Silgan Jar

**Customer:** TestAmerica St. Louis / Earth City, MO

**P.O. No.:** 2454150, Item 1

**Reference Date:** 01-Jan-2012 12:00 PM EST **Grams of Master Source:** 0.017180

This standard radionuclide source was prepared using aliquots measured gravimetrically from master radionuclide solutions. Additional radionuclides were added gravimetrically from solutions calibrated by gamma-ray spectrometry, ionization chamber, or liquid scintillation counting. Calibration and purity were checked using a germanium gamma spectrometer system. At the time of calibration no interfering gamma-ray emitting impurities were detected. The gamma-ray emission rates for the most intense gamma-ray lines are given. Eckert & Ziegler Analytics (EZA) maintains traceability to the National Institute of Standards and Technology through a Measurements Assurance Program as described in USNRC Regulatory Guide 4.15, Revision 2, July 2007, and compliance with ANSI N42.22-1995, "Traceability of Radioactive Sources to NIST." EZA is accredited by the Health Physics Society (HPS) for the production of NIST-traceable sources, and this source was produced in accordance with the HPS accreditation requirements. Customers may report any concerns with the accreditation program to the HPS Secretariat, 1313 Dolley Madison Blvd., Ste. 402, McLean, VA 22101.

| Nuclide | Gamma-Ray<br>Energy (keV) | Half-Life,<br>Days | Master    | This Source | Uncertainty*, % |                |     | Calibration |
|---------|---------------------------|--------------------|-----------|-------------|-----------------|----------------|-----|-------------|
|         |                           |                    | Source*   |             | Type            |                |     |             |
|         |                           |                    | yps/gram  | yps         | u <sub>A</sub>  | u <sub>B</sub> | U   | Method*     |
| Pb-210  | 46.5                      | 8.109E+03          | ————      | 3.094E+03   | 0.1             | 2.1            | 4.1 | 4π LS       |
| Am-241  | 59.5                      | 1.580E+05          | ————      | 2.037E+03   | 0.1             | 1.7            | 3.5 | 4π LS       |
| Cd-109  | 88.0                      | 4.626E+02          | 1.677E+05 | 2.881E+03   | 0.5             | 2.3            | 4.7 | HPGe        |
| Co-57   | 122.1                     | 2.718E+02          | 8.795E+04 | 1.511E+03   | 0.4             | 2.0            | 4.1 | HPGe        |
| Ce-139  | 165.9                     | 1.376E+02          | 1.245E+05 | 2.139E+03   | 0.4             | 1.9            | 3.9 | HPGe        |
| Hg-203  | 279.2                     | 4.661E+01          | 2.707E+05 | 4.651E+03   | 0.3             | 1.9            | 3.8 | HPGe        |
| Sn-113  | 391.7                     | 1.151E+02          | 1.755E+05 | 3.015E+03   | 0.4             | 1.9            | 3.9 | HPGe        |
| Cs-137  | 661.7                     | 1.098E+04          | 1.128E+05 | 1.938E+03   | 0.7             | 1.9            | 4.0 | HPGe        |
| Y-88    | 898.0                     | 1.066E+02          | 4.228E+05 | 7.264E+03   | 0.5             | 1.9            | 3.9 | HPGe        |
| Co-60   | 1173.2                    | 1.925E+03          | 2.084E+05 | 3.580E+03   | 0.6             | 1.9            | 4.0 | HPGe        |
| Co-60   | 1332.5                    | 1.925E+03          | 2.084E+05 | 3.581E+03   | 0.7             | 1.9            | 4.0 | HPGe        |
| Y-88    | 1836.1                    | 1.066E+02          | 4.476E+05 | 7.690E+03   | 0.7             | 1.9            | 4.0 | HPGe        |

\* Master Source refers to Analytics' 8-isotope mixture which is calibrated quarterly.

**Calibration Methods:** 4π LS - 4 pi Liquid Scintillation Counting, HPGe - High Purity Germanium Gamma-Ray Spectrometer, IC - Ionization Chamber. **Uncertainty:** U - Relative expanded uncertainty, k = 2. See NIST Technical Note 1297, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results."

(Certificate continued on reverse side)



**Comments:**

1550 grams of sand. Homogenous down to 10 grams aliquot.  
This standard will expire one year after the reference date.

Source Prepared by: \_\_\_\_\_

Z. Dimitrova, Radiochemist

QA Approved: \_\_\_\_\_

J.D. McCorvey, Counting Room Manager

Date: \_\_\_\_\_

30 JAN 12



Reagent

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**Tuna Can\_00006**

## CERTIFICATE OF CALIBRATION

Standard Radionuclide Source

**83814-334**

1.0 Liter Sand in 1 Liter Wide Mouth HDPE Silgan Jar

**Customer:** Test America St. Louis

**P.O. No.:** 2395112, Item 1

**Reference Date:** 01-Jan-2011      12:00 PM EST      **Grams of Master Source:** 0.016927

This standard radionuclide source was prepared using aliquots measured gravimetrically from master radionuclide solutions. Calibration and purity were checked using a germanium gamma spectrometer system. At the time of calibration no interfering gamma-ray emitting impurities were detected. The gamma-ray emission rates for the most intense gamma-ray lines are given. Eckert & Ziegler Analytics (EZA) maintains traceability to the National Institute of Standards and Technology through a Measurements Assurance Program as described in USNRC Regulatory Guide 4.15, Revision 1, February, 1979, and compliance with ANSI N42.22-1995, "Traceability of Radioactive Sources to NIST." EZA is accredited by the Health Physics Society (HPS) for the production of NIST-traceable sources, and this source was produced in accordance with the HPS accreditation requirements. Customers may report any concerns with the accreditation program to the HPS Secretariat, 1313 Dolley Madison Blvd., Ste. 402, McLean, VA 22101.

| Nuclide | Gamma-Ray Energy (keV) | Half-Life, Days | Master Source*<br>yps/gram | This Source<br>yps | Uncertainty, % |       |       | Calibration Method |
|---------|------------------------|-----------------|----------------------------|--------------------|----------------|-------|-------|--------------------|
|         |                        |                 |                            |                    | Type           | $u_A$ | $u_B$ | U                  |
| Pb-210  | 46.5                   | 8.120E+03       | —                          | 3.021E+03          | 0.1            | 2.1   | 4.1   | 4π LS              |
| Am-241  | 59.5                   | 1.580E+05       | —                          | 2.090E+03          | 0.1            | 1.7   | 3.5   | 4π LS              |
| Cd-109  | 88.0                   | 4.626E+02       | 1.697E+05                  | 2.873E+03          | 0.8            | 2.3   | 4.9   | HPGe               |
| Co-57   | 122.1                  | 2.718E+02       | 8.711E+04                  | 1.475E+03          | 0.5            | 2.0   | 4.1   | HPGe               |
| Ce-139  | 165.9                  | 1.376E+02       | 1.247E+05                  | 2.111E+03          | 0.5            | 1.9   | 3.9   | HPGe               |
| Hg-203  | 279.2                  | 4.661E+01       | 2.753E+05                  | 4.660E+03          | 0.4            | 1.9   | 3.9   | HPGe               |
| Sn-113  | 391.7                  | 1.151E+02       | 1.769E+05                  | 2.994E+03          | 0.5            | 1.9   | 3.9   | HPGe               |
| Cs-137  | 661.7                  | 1.098E+04       | 1.109E+05                  | 1.877E+03          | 0.7            | 1.9   | 4.0   | HPGe               |
| Y-88    | 898.0                  | 1.066E+02       | 4.224E+05                  | 7.150E+03          | 0.5            | 1.9   | 3.9   | HPGe               |
| Co-60   | 1173.2                 | 1.925E+03       | 2.142E+05                  | 3.626E+03          | 0.6            | 1.9   | 4.0   | HPGe               |
| Co-60   | 1332.5                 | 1.925E+03       | 2.143E+05                  | 3.627E+03          | 0.6            | 1.9   | 4.0   | HPGe               |
| Y-88    | 1836.1                 | 1.066E+02       | 4.472E+05                  | 7.570E+03          | 0.5            | 1.9   | 3.9   | HPGe               |

\* Master Source refers to Analytics' 8-isotope mixture which is calibrated quarterly.

**Calibration Methods:** 4π LS - 4 pi Liquid Scintillation Counting, HPGe - High Purity Germanium Gamma-Ray Spectrometer, IC - Ionization Chamber. **Uncertainty:** U - Relative expanded uncertainty,  $k = 2$ . See NIST Technical Note 1297, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results."

(Certificate continued on reverse side)



**Comments:**

1550 grams of sand. Homogeneous down to 10 gram aliquot.  
This standard will expire one year after the reference date.

Source Prepared by: \_\_\_\_\_

*Z. Dimitrova*  
Z. Dimitrova, Radiochemist

QA Approved: \_\_\_\_\_

*J. D. McCorvey*  
J. D. McCorvey, QA Manager Alternate

Date: \_\_\_\_\_

*2/11/11*



Reagent

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**U-232\_00003**



# Eckert & Ziegler

## Analytics

1380 Seaboard Industrial Blvd.  
Atlanta, Georgia 30318  
Tel 404-352-8677  
Fax 404-352-2837  
www.analyticsinc.com

### CERTIFICATE OF CALIBRATION

#### Standard Radionuclide Source

85539-334

5 mL Liquid in Flame Sealed Vial

**Customer:** Test America/Earth City, MO

**P.O. No.:** 2434448, Item 1

This standard radionuclide source was prepared gravimetrically from a master solution, calibrated by Eckert & Ziegler Analytics. The master solution was calibrated by liquid scintillation counting. Radionuclide purity and calibration were checked by germanium gamma-ray spectrometry and liquid scintillation counting. The nuclear decay rate and reference date for this source are given below. Eckert & Ziegler Analytics (EZA) maintains traceability to the National Institute of Standards and Technology through a Measurements Assurance Program as described in USNRC Regulatory Guide 4.15, Revision 1, February, 1979, and compliance with ANSI N42.22-1995, "Traceability of Radioactive Sources to NIST." EZA is accredited by the Health Physics Society (HPS) for the production of NIST-traceable sources, and this source was produced in accordance with the HPS accreditation requirements. Customers may report any concerns with the accreditation program to the HPS Secretariat, 1313 Dolley Madison Blvd., Ste. 402, McLean, VA 22101.

| Isotope | Half-Life,<br>Days | Activity<br>(Bq) | Uncertainty*, % |                |     | Reference Date<br>(12:00 PM EST) |
|---------|--------------------|------------------|-----------------|----------------|-----|----------------------------------|
|         |                    |                  | u <sub>A</sub>  | u <sub>B</sub> | U   |                                  |
| U-232   | 2.517E+04          | 1.725E+04        | 0.5             | 2.4            | 4.9 | 08/25/2011                       |

\*Uncertainty: U - Relative expanded uncertainty, k = 2. See NIST Technical Note 1297, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results."

**Comments:**

Impurities: U-232 daughters,  $\gamma$ -impurities (other than decay products) < 0.1 %.

Source Prepared by:

*M. I. Taskaeva*  
M. I. Taskaeva, Radiochemist

QA Approved:

*J. D. McCorvey*  
J. D. McCorvey, QA Manager Alternate

Date:

*8/25/11*



Reagent

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**U-232\_00032**

**St. Louis Radiological Standard Reverification Form**

Standard ID Number: U-232\_00032  
True Value = 79.043 DPM/L or g  
Date Analyzed: 8/6/2015

Radionuclide: U-232

|    | Replicates    |            |
|----|---------------|------------|
| #1 | <u>79.144</u> | DPM/L or g |
| #2 | <u>80.793</u> | DPM/L or g |
| #3 | <u>81.267</u> | DPM/L or g |

Mean = 80.40133

1 sigma = 1.114376

1.96 sigma = 2.184177

True Value minus 5% = 75.09085

(True Value - 5%)

True Value plus 5% = 82.99515

(True Value + 5%)

**Accuracy:**

Mean value within 5% of Certified (True) Value? Yes (Acceptance Criteria)

**Precision:**

1.96 sigma Value Within 10% of Mean Value? Yes (Acceptance Criteria)

Standard Reverification Acceptable?

Yes

Note: Criteria for reverification of radiological standards is taken from the DOE QSAS and LANL Statements of Work

Reviewed By/Date: Rachel T. Mueller

SOP Reference: STL-QA-0002, Current Revision

Sample Name: Verification 1  
SampleType: Sample

Sample Collection Date:

Batch Name: U-232\_00032  
AnalysisID: 650918

Tracer Name: UNAT Spike\_00001  
Tracer Activity: 72.27 DPM/mL x (Vol.)0.10 mL = 7.23 DPM  
Tracer Ref. Date: 3/30/2008 11:00:22AM

### Sample

Spectrum #1 Analysis #1  
Sample Volume : 0.1000mL  
Aliquot: N/A Aliquot Fraction: N/A

### Batch

Analyst: 60040

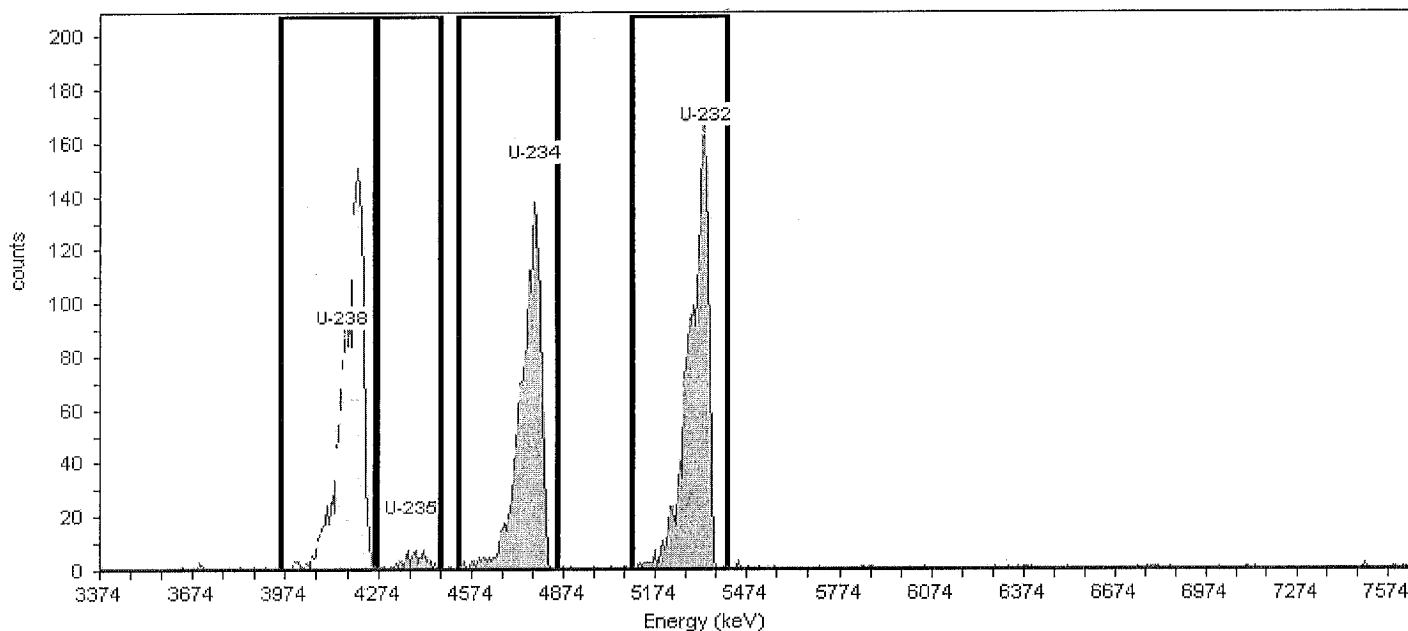
### Tracer

Tracer Nuclide: U-238  
Tracer Recovery: 83.45%

### Acquisition

Detector: AV115  
Serial Number: 49-037E4  
Acquisition Start Date: 8/6/2015 3:46:33PM  
Live Time: 960.00 min.  
Real Time: 960.02 min.  
Background Date: 7/17/2015 12:56:42PM  
Background Info: Sample: ICB;AV115; Det: AV115; Spectrum #1;  
Jul-17-2015 12:56

Calibration Name: IC-9817;AV115-20150603  
Calibration Date: 6/4/2015 1:31:22AM  
Gain = 7.4575 keV / Ch  
Offset = 3,366.95 keV  
Energy Cal: Quadratic = 0.0000 keV / Ch<sup>2</sup>  
Efficiency: 25.44% +/- 0.31% TPU(2 sigma)



### General Analysis

Analysis Method: Absolute ROI Analysis, Set Name = U\_Verify  
Decay Correction: 8/6/2015 3:43:19PM  
MDA Constants:  $K\alpha = 1.65$ ,  $K\beta = 1.65$

Nuclide Library: Uranium  
MDA Source: Background

### Nuclide Summary (ROI)

| Nuclide | Peak Energy keV | Peak Expected keV | Peak Diff keV | ROI Start keV | ROI End keV | FWHM keV | B.R. % | Gross Counts | Bkgd Counts | Net Counts | Activity | Units  |
|---------|-----------------|-------------------|---------------|---------------|-------------|----------|--------|--------------|-------------|------------|----------|--------|
| U-238   | 4157.5          | 4,196.0           | -38.5         | 3956.1        | 4261.9      | 54.1     | 100.0  | 1475         | 2.0000      | 1473.00    | 60.302   | DPM/mL |
| U-235   | 4381.2          | 4,396.0           | -14.8         | 4269.3        | 4470.7      | 79.4     | 91.1   | 61           | 1.0000      | 60.00      | 3.231    | DPM/mL |
| U-234   | 4776.4          | 4,775.8           | 0.6           | 4530.3        | 4851.0      | 76.4     | 99.8   | 1376         | 4.0000      | 1372.00    | 67.445   | DPM/mL |
| U-232   | 5343.2          | 5,320.3           | 22.9          | 5097.1        | 5410.3      | 78.5     | 100.4  | 1623         | 3.0000      | 1620.00    | 79.144   | DPM/mL |

Sample Name: Verification 2  
SampleType: Sample

Sample Collection Date:

Batch Name: U-232\_00032  
AnalysisID: 650919

Tracer Name: UNAT Spike\_00001  
Tracer Activity: 72.27 DPM/mL x (Vol.)0.10 mL = 7.23 DPM  
Tracer Ref. Date: 3/30/2008 11:00:22AM

### Sample

Spectrum #1 Analysis #1  
Sample Volume : 0.1000mL  
Aliquot: N/A Aliquot Fraction: N/A

### Batch

Analyst: 60040

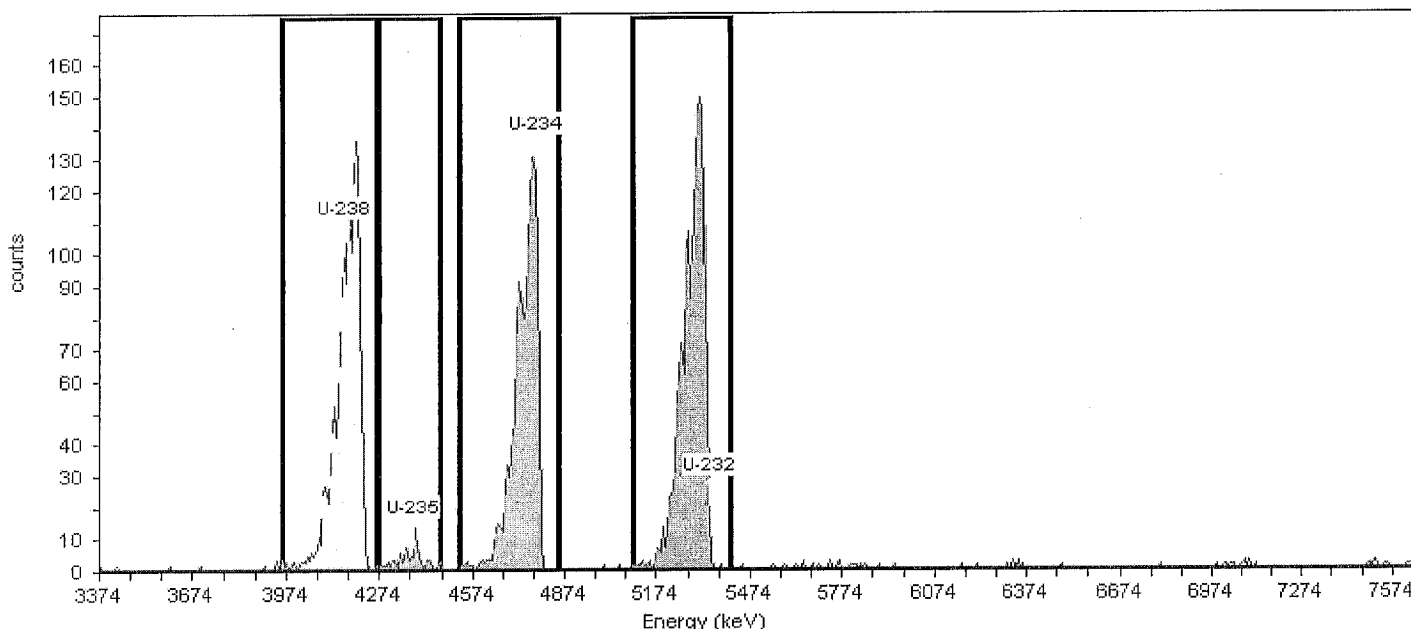
### Tracer

Tracer Nuclide: U-238  
Tracer Recovery: 78.91%

### Acquisition

Detector: AV116  
Serial Number: 49-034G1  
Acquisition Start Date: 8/6/2015 3:46:34PM  
Live Time: 960.00 min.  
Real Time: 960.02 min.  
Background Date: 7/17/2015 12:56:44PM  
Background Info: Sample: ICB;AV116; Det: AV116; Spectrum #1;  
Jul-17-2015 12:56

Calibration Name: IC-9884;AV116-20150603  
Calibration Date: 6/4/2015 1:31:31AM  
Gain = 7.4575 keV / Ch  
Energy Cal: Offset = 3,366.95 keV  
Quadratic = 0.0000 keV / Ch<sup>2</sup>  
Efficiency: 24.86% +/- 0.36% TPU(2 sigma)



### General Analysis

Analysis Method: Absolute ROI Analysis, Set Name = U\_Verify  
Decay Correction: 8/6/2015 3:43:19PM  
MDA Constants:  $K\alpha = 1.65$ ,  $K\beta = 1.65$

Nuclide Library: Uranium  
MDA Source: Background

### Nuclide Summary (ROI)

| Nuclide | Peak Energy keV | Peak Expected keV | Peak Diff keV | ROI Start keV | ROI End keV | FWHM keV | B.R. % | Gross Counts | Bkgd Counts | Net Counts | Activity | Units  |
|---------|-----------------|-------------------|---------------|---------------|-------------|----------|--------|--------------|-------------|------------|----------|--------|
| U-238   | 4157.5          | 4,196.0           | -38.5         | 3956.1        | 4261.9      | 75.5     | 100.0  | 1364         | 3.0000      | 1361.00    | 57.027   | DPM/mL |
| U-235   | 4381.2          | 4,396.0           | -14.8         | 4269.3        | 4470.7      | 43.8     | 91.1   | 72           | 2.0000      | 70.00      | 4.080    | DPM/mL |
| U-234   | 4776.4          | 4,775.8           | 0.6           | 4530.3        | 4851.0      | 82.1     | 99.8   | 1309         | 4.0000      | 1305.00    | 69.430   | DPM/mL |
| U-232   | 5343.2          | 5,320.3           | 22.9          | 5097.1        | 5410.3      | 83.1     | 100.4  | 1532         | 4.0000      | 1528.00    | 80.793   | DPM/mL |

Sample Name: Verification 3  
SampleType: Sample

Sample Collection Date:

Batch Name: U-232\_00032  
AnalysisID: 650920

Tracer Name: UNAT Spike\_00001  
Tracer Activity: 72.27 DPM/mL x (Vol.)0.10 mL = 7.23 DPM  
Tracer Ref. Date: 3/30/2008 11:00:22AM

### Sample

Spectrum #1 Analysis #1  
Sample Volume : 0.1000mL  
Aliquot: N/A Aliquot Fraction: N/A

### Batch

Analyst: 60040

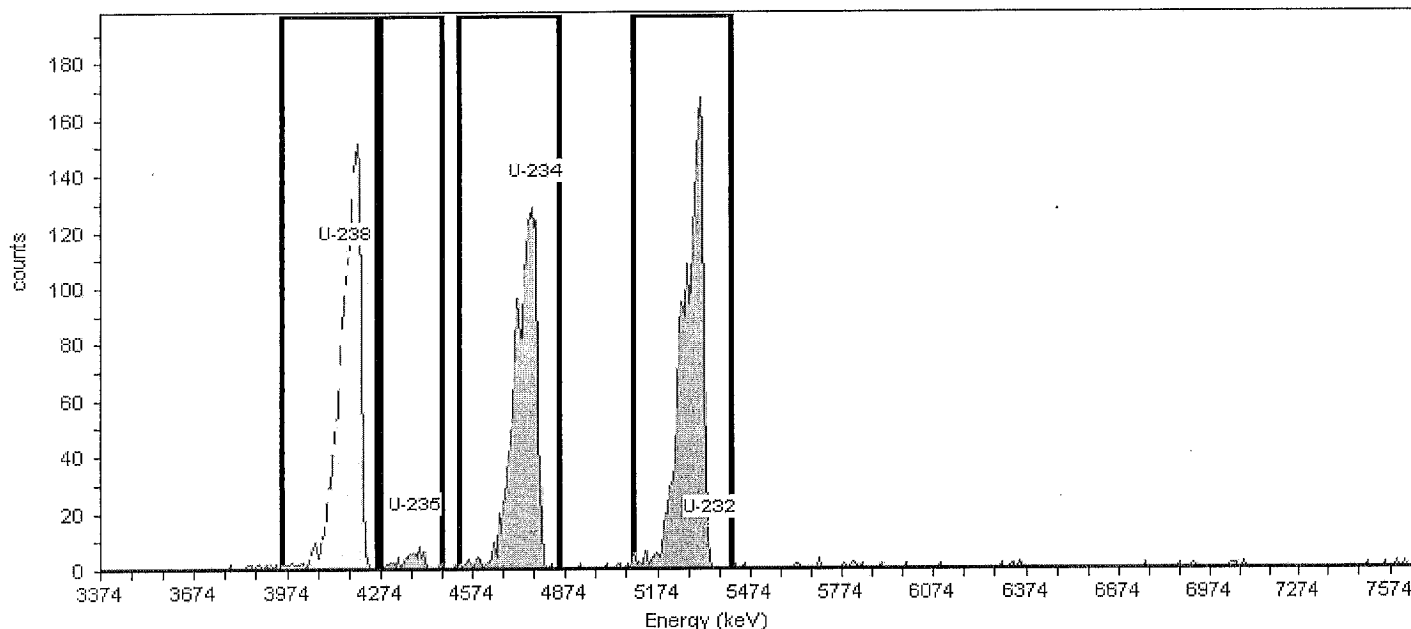
### Tracer

Tracer Nuclide: U-238  
Tracer Recovery: 84.22%

### Acquisition

Detector: AV117  
Serial Number: 49-037X4  
Acquisition Start Date: 8/6/2015 3:46:35PM  
Live Time: 960.00 min.  
Real Time: 960.02 min.  
Background Date: 7/19/2015 5:26:41PM  
Background Info: Sample: ICB;AV117; Det: AV117; Spectrum #1;  
Jul-19-2015 17:26

Calibration Name: IC-9885;AV117-20150603  
Calibration Date: 6/4/2015 1:31:41AM  
Gain = 7.4575 keV / Ch  
Energy Cal: Offset = 3,366.95 keV  
Quadratic = 0.0000 keV / Ch<sup>2</sup>  
Efficiency: 24.89% +/- 0.37% TPU(2 sigma)



### General Analysis

Analysis Method: Absolute ROI Analysis, Set Name = U\_Verify  
Decay Correction: 8/6/2015 3:43:19PM  
MDA Constants:  $K\alpha = 1.65$ ,  $K\beta = 1.65$

Nuclide Library: Uranium  
MDA Source: Background

### Nuclide Summary (ROI)

| Nuclide | Peak Energy keV | Peak Expected keV | Peak Diff keV | ROI Start keV | ROI End keV | FWHM keV | B.R. % | Gross Counts | Bkgd Counts | Net Counts | Activity | Units  |
|---------|-----------------|-------------------|---------------|---------------|-------------|----------|--------|--------------|-------------|------------|----------|--------|
| U-238   | 4157.5          | 4,196.0           | -38.5         | 3956.1        | 4261.9      | 73.1     | 100.0  | 1456         | 2.0000      | 1454.00    | 60.860   | DPM/mL |
| U-235   | 4381.2          | 4,396.0           | -14.8         | 4269.3        | 4470.7      | 62.1     | 91.1   | 60           | 1.0000      | 59.00      | 3.219    | DPM/mL |
| U-234   | 4776.4          | 4,775.8           | 0.6           | 4530.3        | 4851.0      | 81.2     | 99.8   | 1390         | 0.0000      | 1390.00    | 69.223   | DPM/mL |
| U-232   | 5343.2          | 5,320.3           | 22.9          | 5097.1        | 5410.3      | 83.9     | 100.4  | 1644         | 2.0000      | 1642.00    | 81.267   | DPM/mL |

| No. | Sample Number | Aliquot<br>(g / mL) | Crucible<br>ID | Dilution |
|-----|---------------|---------------------|----------------|----------|
| 1   | VER 1         | 0.1                 | W5             |          |
| 2   | 12            | 1                   | 116            |          |
| 3   | 13            |                     | 117            |          |
| 4   |               |                     |                |          |
| 5   |               |                     |                |          |
| 6   |               |                     |                |          |
| 7   |               |                     |                |          |
| 8   |               |                     |                |          |
| 9   |               |                     |                |          |
| 10  |               |                     |                |          |
| 11  |               |                     |                |          |
| 12  |               |                     |                |          |
| 13  |               |                     |                |          |
| 14  |               |                     |                |          |
| 15  |               |                     |                |          |
| 16  |               |                     |                |          |
| 17  |               |                     |                |          |
| 18  |               |                     |                |          |
| 19  |               |                     |                |          |
| 20  |               |                     |                |          |
| 21  |               |                     |                |          |
| 22  |               |                     |                |          |
| 23  |               |                     |                |          |
| 24  |               |                     |                |          |

Balance ID :  
Note: If a service below is not used, marked the N/A box and initial & date next to the N/A.  
ie Mark the N/A box if a tracer is not added to the samples; then  
initial and date next to the N/A

Tracer ☐ N/A

Isotope : U-232

Std Sol'n No. : U-232-0001

Vol (mL) : 0.1

Ref Activity (dpm/mL) : 235

Act Ref Date : 238

Samples Spiked and Traced By: \_\_\_\_\_

Initials / Date

Verification Signature & Date: NW 8-3-15

Initials / Date

LCS Standard ☐ N/A

Isotope : U-232 unclean

Std Sol'n ID. : U-232-00032

Vol (mL) : 0.1

Ref Activity (dpm/mL) : 79.043

Act Ref Date : 08-25-11

SOP's applied in preparing these samples. Mark box to left for all that apply:

|                                          |                                          |                                          |
|------------------------------------------|------------------------------------------|------------------------------------------|
| <input type="checkbox"/> ST-RC-0003 Rev. | <input type="checkbox"/> ST-RC-0040 Rev. | <input type="checkbox"/> ST-RC-0110 Rev. |
| <input type="checkbox"/> ST-RC-0004 Rev. | <input type="checkbox"/> ST-RC-0041 Rev. | <input type="checkbox"/> ST-RC-0120 Rev. |
| <input type="checkbox"/> ST-RC-0014 Rev. | <input type="checkbox"/> ST-RC-0050 Rev. | <input type="checkbox"/> ST-RC-0232 Rev. |
| <input type="checkbox"/> ST-RC-0020 Rev. | <input type="checkbox"/> ST-RC-0090 Rev. | <input type="checkbox"/> ST-RC-0238 Rev. |
| <input type="checkbox"/> ST-RC-0021 Rev. | <input type="checkbox"/> ST-RC-0100 Rev. | <input type="checkbox"/> ST-RC-0240 Rev. |
|                                          |                                          | <input type="checkbox"/> ST-RC-0241 Rev. |
|                                          |                                          | <input type="checkbox"/> ST-RC-0242 Rev. |
|                                          |                                          | <input type="checkbox"/> ST-RC-5016 Rev. |
|                                          |                                          | <input type="checkbox"/>                 |
|                                          |                                          | <input type="checkbox"/>                 |

Isotope(s)

|                                        |                                 |                                           |                                 |
|----------------------------------------|---------------------------------|-------------------------------------------|---------------------------------|
| <input type="checkbox"/> $\alpha\beta$ | <input type="checkbox"/> Iso Pu | <input type="checkbox"/> Tc-99            | <input type="checkbox"/> Iso Cm |
| <input type="checkbox"/> Iso Am        | <input type="checkbox"/> Ra     | <input type="checkbox"/> Iso Th           | <input type="checkbox"/> Pu-241 |
| <input type="checkbox"/> KPA           | <input type="checkbox"/> Sr     | <input checked="" type="checkbox"/> Iso U | <input type="checkbox"/> Th-229 |
| <input type="checkbox"/> Np            | <input type="checkbox"/> TAR    | <input type="checkbox"/> C-14             | <input type="checkbox"/> Cf-253 |

| Count Time                                     | Matrix                                    |
|------------------------------------------------|-------------------------------------------|
| Long Count <input checked="" type="checkbox"/> | Soil <input type="checkbox"/>             |
| Short Count <input type="checkbox"/>           | H <sub>2</sub> O <input type="checkbox"/> |



**Reagent ID: U-232\_00032**

Description: U-232 Unclean tracer  
No. of Bottles: 1  
Storage Location: RAD Actinide STDs  
Reagent Volume: 500.000 mL  
Creation Date: 07/16/2015  
Open Date:  
Container(s): 684064  
Comment:

Expiration Date: 04/20/2016  
Laboratory: TestAmerica St. Louis  
Prepared By: Bernsen, Sarah C  
Solvent: 2M HNO3  
Solvent Lot: n/a

### Reagent Analyte Information

| Analyte | Source ID   | Source Exp. Date | Source Conc. | Source Conc. Units | Final Conc. | Final Conc. Units |
|---------|-------------|------------------|--------------|--------------------|-------------|-------------------|
| U-232   | U-232_00009 | 08/25/2061       | 10280.70700  | dpm/mL             | 82.24566    | dpm/mL            |

### Source Reagents

| Reagent     | Description  | Type | Expiration | Vendor | Vendor Lot # | Vendor Cat Lot # | Volume Used | Volume Units |
|-------------|--------------|------|------------|--------|--------------|------------------|-------------|--------------|
| U-232_00009 | U-232 Parent |      | 08/25/61   |        |              |                  | 4.00000     | mL           |

# Uranium only via UTEVA

ST-RC-0238

Batch: \_\_\_\_\_

\*All rinses should flow at 1 mL/minute (only 3M HNO<sub>3</sub> may be done at 3 mL/minute)

|                  |                     |                                           |                                    |
|------------------|---------------------|-------------------------------------------|------------------------------------|
| UTEVA lot: _____ | 11.4.4              | UTEVA cartridge                           |                                    |
|                  |                     | ↓                                         |                                    |
|                  | 11.4.5              | 5mL 3M HNO <sub>3</sub>                   | COMPLETED <input type="checkbox"/> |
|                  |                     | ↓                                         |                                    |
|                  | 11.4.6              | Load sample                               |                                    |
|                  |                     | ↓                                         |                                    |
|                  | 11.4.7              | 25mL 3M HNO <sub>3</sub>                  | COMPLETED <input type="checkbox"/> |
|                  |                     | ↓                                         |                                    |
|                  | 11.4.8              | 5mL 9M HCl                                | COMPLETED <input type="checkbox"/> |
|                  |                     | ↓                                         |                                    |
|                  | 11.4.9              | 20mL<br>5M HCl / 0.05M oxalic             | COMPLETED <input type="checkbox"/> |
|                  |                     | ↓                                         |                                    |
|                  | 11.4.10-<br>11.4.11 | Elute into clean tube<br>with 15mL 1M HCl | COMPLETED <input type="checkbox"/> |

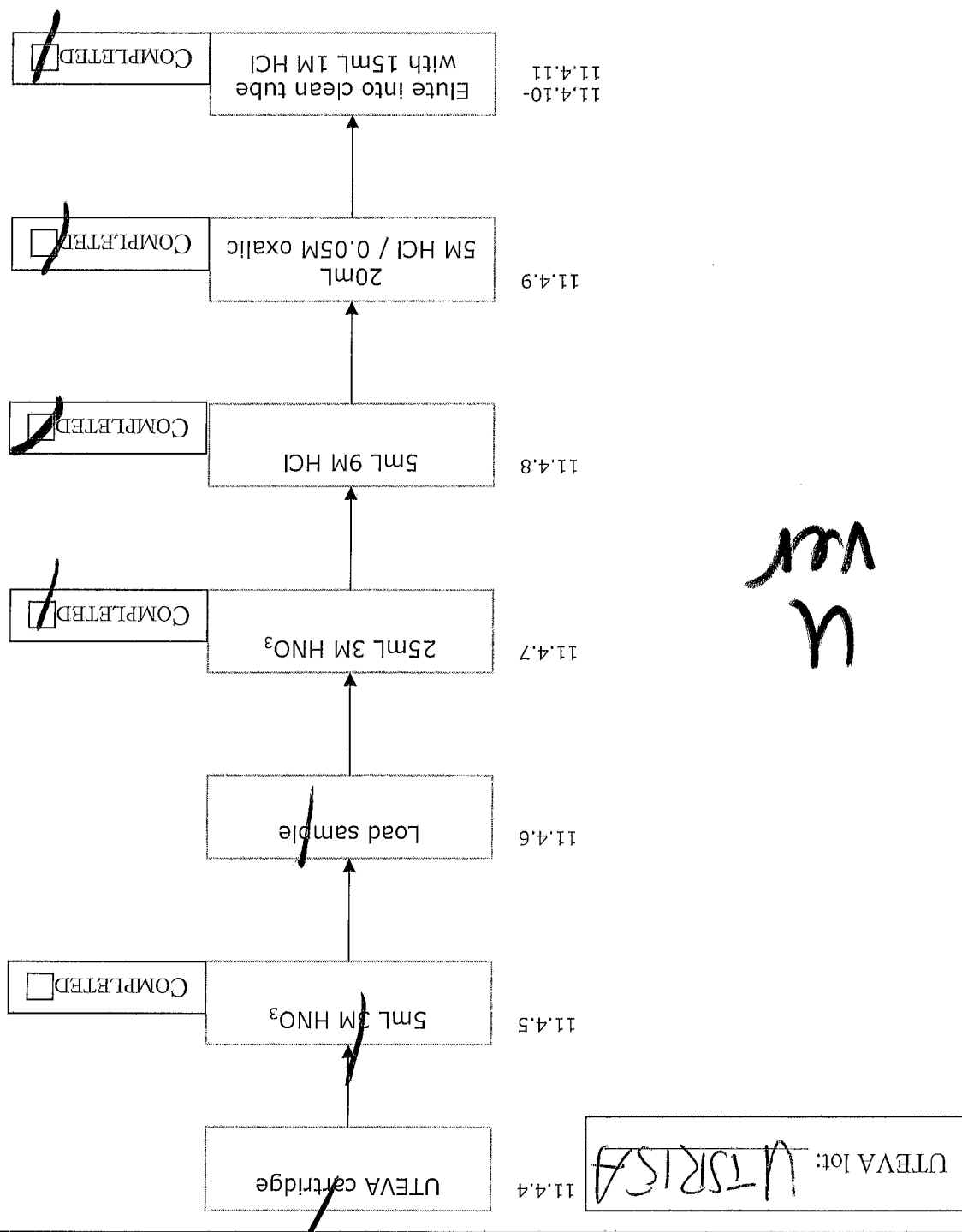
# Uranium only via UTEVA

ST-RC-0238

Page 137 of 455

Batch: \_\_\_\_\_

\*All rinses should flow at 1 mL/minute (only 3M HNO<sub>3</sub> may be done at 3 mL/minute)



Reagent

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**UNAT Ampoule\_00001**



**New Brunswick Laboratory**  
U.S. Department of Energy

# Certificate of Analysis

## CRM 145

### Uranyl (Normal) Nitrate Assay and Isotopic Solution

Uranium Mass Fraction: 0.0101356 g U/g solution  $\pm$  0.0000011 g U/g solution  
[ 10.1356 mg U/g solution  $\pm$  0.0011 mg U/g solution ]

|                                     |                                 |                                 |                  |
|-------------------------------------|---------------------------------|---------------------------------|------------------|
|                                     | $^{234}\text{U}/^{238}\text{U}$ | $^{235}\text{U}/^{238}\text{U}$ |                  |
| Atom Ratio:                         | 0.000052841                     | 0.0072543                       |                  |
| Atom Ratio Uncertainty:             | 0.000000082                     | 0.0000040                       |                  |
|                                     | $^{234}\text{U}$                | $^{235}\text{U}$                | $^{238}\text{U}$ |
| Atom Percent:                       | 0.0052458                       | 0.72017                         | 99.27458         |
| Atom Percent Uncertainty:           | 0.0000081                       | 0.00039                         | 0.00039          |
| Weight Percent:                     | 0.0051579                       | 0.71114                         | 99.28370         |
| Weight Percent Uncertainty:         | 0.0000080                       | 0.00038                         | 0.00038          |
| Relative Atomic Weight:             | 238.028918                      |                                 |                  |
| Relative Atomic Weight Uncertainty: | 0.000012                        |                                 |                  |

Note:  $^{233}\text{U}$  and  $^{236}\text{U}$  were not detected. The detection limit of uranium ratios for the technique used is  $5 \times 10^{-9}$ .

This Certified Reference Material (CRM) is a uranium concentration and isotopic solution standard intended for use in calibration of and/or quality control for uranium analysis methods. Each unit of CRM 145 consists of approximately 20-mL of uranyl nitrate solution in 1M nitric acid, contained in a sealed glass ampoule.

**NOTE:** The vial should be handled under proper radiologically-controlled conditions at all times.

The certified uranium content value is based on the mass of high-purity metal dissolved and diluted to a known solution mass. The stated uranium concentration was calculated as the prepared value and verified experimentally by the NBL-modified Davies and Gray titration. The certified uranium isotopic composition and atomic weight is based upon measurements performed on multiple samples by two different measurement techniques on a Thermal Ionization Mass Spectrometer (TIMS), calibrated using CRM U030-A as primary comparator and CRM 129-A as a quality control sample. The isotopic values are shared with CRM 112-A, uranium (normal) metal standard which was the source of uranium used to produce the solutions.

RAD13-0018  
UNAT Spike  
marrrs  
None  
Prep/Opened: 5/3/2013  
Exp(1): 5/10/2014  
Exp(2): 5/10/2014

All uncertainties for the certified values are expressed as expanded uncertainties (U) where  $U = k \cdot u_c$ , where  $u_c$  is the

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Argonne, Illinois

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Jon Neuhoﬀ, Director  
New Brunswick Laboratory

(Revision of Certificate dated March 30, 2008)



127971  
ID: UNAT\_00008  
Exp: 05/10/14 Prpd: SB Crt: 05/03/13  
UNAT spike

combined standard uncertainty and the coverage factor  $k = 2$ . Uncertainties were determined according to the JCGM 100:2008 *Guide to the Expression of Uncertainty in Measurement*. The coverage factor of 2 was chosen to provide an approximate 95% level of confidence. The input quantities associated with the uranium content included uncertainties due to weighing, CRM 112-A purity, and buoyancy factors. The input quantities associated with the uranium isotopic composition included uncertainties from the certified value for CRM U030-A, measurement precision, and background corrections associated with the analytical techniques.

The CRM was produced by dissolving uranium metal in a single batch and container, with extensive mixing of the resultant solution followed by dispensation into individual bottles. Subsequent measurements of a random sampling of the total lot produced did not indicate any inhomogeneity in uranium concentration or isotopic composition. The minimum sample sizes taken from packaged units and measured were 30 mg U by titration and 1  $\mu\text{g}$  U by TIMS. The NBL makes no recommendation as to the minimum sample size to be used to ensure concentration or isotopic homogeneity.

Users are cautioned that once the vial is opened, the uranium concentration and/or isotopic composition of the material may be affected by evaporative losses or environmental contamination. User's should take appropriate precautions to safeguard the material before, during and after use to ensure valid certificate values.

#### **Recommended Procedure for Ampoule Handling and Dispensing of Solution**

1. The ampoule contains a strongly acidic solution of uranium. Appropriate precautions should be taken.
2. Before opening the ampoule, ensure that any dried uranium or condensed liquid in the neck or body of the ampoule is re-dissolved into solution. This can be accomplished by inverting the ampoule repeatedly.
3. The glass ampoules are scored at the neck for ease of opening. However, glass burrs and fragments pose a cut hazard to anyone opening the ampoules. Appropriate precautions should be taken.
4. Lightly moisten the scored line on the neck with distilled water to help ensure a clean break at the score.
5. Because of the narrow neck of the ampoule it may be difficult or impossible to pour the solution out. Here is one possible method:
  - a. Obtain approximately 12-cm length of plastic capillary tubing (e.g. i.d. 0f 0.1", o.d. of 0.16").
  - b. Insert one end of the capillary tubing fully into the ampoule
  - c. Fold the remaining length of tubing along the outside of the ampoule, ensuring that the tube is not crimped and will allow the free flow of air through the tube and into the ampoule.
  - d. Holding the ampoule and tubing in one hand, and a beaker or dispensing bottle in another, invert the ampoule over the container allowing the solution to drain into it.
  - e. The capillary tubing allows air to flow into the ampoule, eliminating the "airlock" created by the narrow neck of the open ampoule.
6. The user should be wary of evaporative losses once the ampoule is opened, and prevent uranium contamination of the sample. It is recommended that the entire solution be accurately weighed and aliquanted as soon as possible after opening the sample. Precautions should be taken (clean glass/plastic ware, air filtration, etc) to prevent uranium contamination of the CRM with subsequent perturbation of the isotopic composition.

September 30, 2010  
Argonne, Illinois

www.nbl.doe.gov  
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Jon Neuhoff, Director  
New Brunswick Laboratory

(Revision of Certificate dated March 30, 2008)

Reagent

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**UNAT\_00012**

**St. Louis Radiological Standard Reverification Form**

Standard ID Number: UNAT\_00011  
True Value = 70.69 DPM/L or g  
Date Analyzed: 5/5/2016

Radionuclide: U-234

|    | Replicates   |            |
|----|--------------|------------|
| #1 | <u>66.49</u> | DPM/L or g |
| #2 | <u>71.93</u> | DPM/L or g |
| #3 | <u>67.79</u> | DPM/L or g |

Mean = 68.73667

1 sigma = 2.840868

1.96 sigma = 5.568102

True Value minus 5% = 67.1555

(True Value - 5%)

True Value plus 5% = 74.2245

(True Value + 5%)

**Accuracy:**

Mean value within 5% of Certified (True) Value? Yes (Acceptance Criteria)

**Precision:**

1.96 sigma Value Within 10% of Mean Value? Yes (Acceptance Criteria)

**Standard Reverification Acceptable?**

Yes

Note: Criteria for reverification of radiological standards is taken from the DOE QSAS and LANL Statements of Work

Reviewed By/Date: Amanda Dick 05/09/2016

SOP Reference: STL-QA-0002, Current Revision

Sample Name: Verification 1  
Spectrum #1 Analysis #1

Type: Sample

### Sample

Sample Volume : 0.10 Sample Units: mL  
First Stage Dilution: N/A  
Aliquot: N/A Aliquot Fraction: N/A  
Dilution 2: N/A  
Lab Preparation:

Sample Collection Date:  
Comment:

### Batch

Batch Name: UNAT\_00011

Description:

Client Name: Undefined  
Client Contact:  
Analyst: 60040

### Tracer

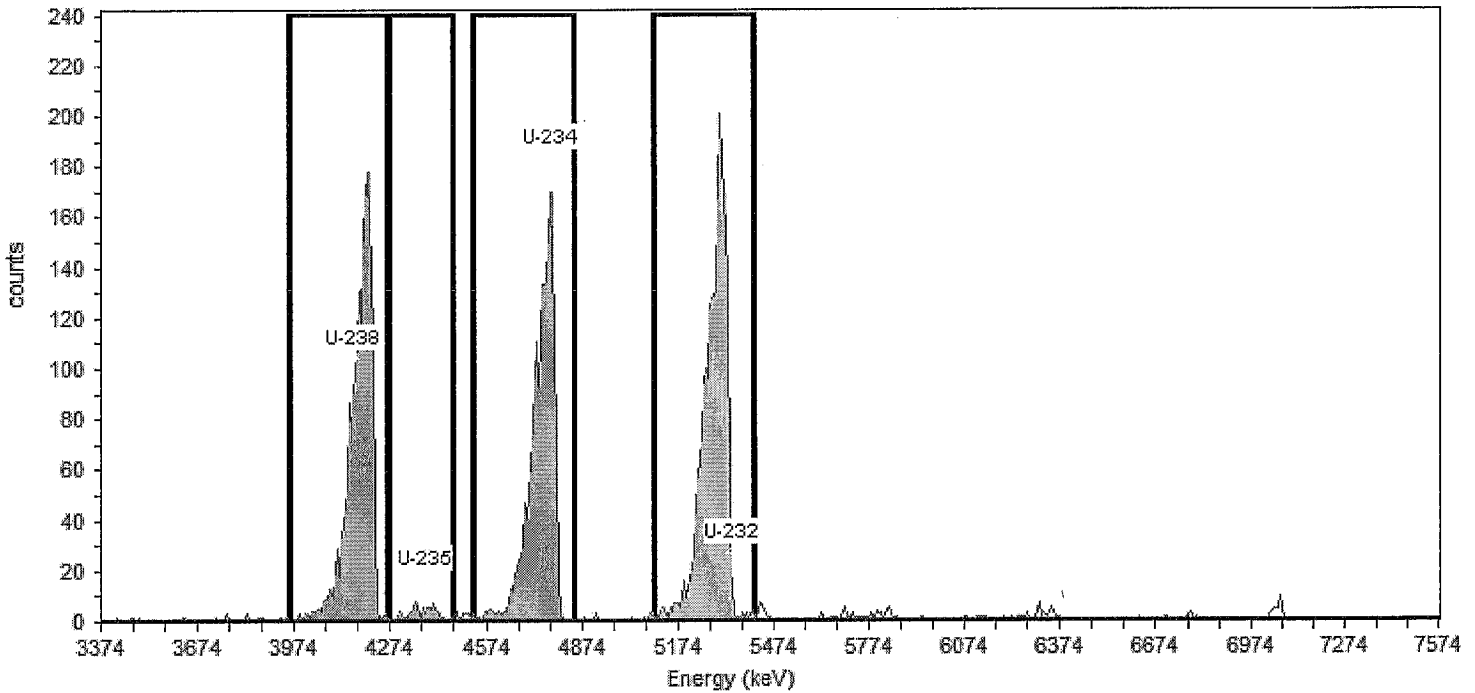
Tracer Name: U-232\_00032  
Tracer Activity: 82.25 DPM / mL x (Vol.) 0.10 mL = 8.22 DPM  
Tracer Ref. Date: 8/25/2011 12:03:08PM

Tracer Nuclide: U-232  
Tracer Recovery: 100.46%

### Acquisition

Detector: AV194 SN: 50-119J2  
Acquisition Start Date: 5/5/2016 10:51:35AM  
Live Time: 960.00 min.  
Real Time: 960.00 min.  
Background Date: 4/22/2016 10:41:10AM  
Bkgd Info: Sample: ICB;AV194; Det: AV194; Spectrum #1; 4/22/2016 10:41:10 AM

Energy Calibration: IC-9520;AV194-20151017  
Efficiency Calibration:IC-9520;AV194-20151017  
Calibration Date: 10/18/2015 3:55:14PM  
Energy Cal: Gain = 7.4575 keV / Ch  
Offset = 3,366.95 keV  
Quadratic = 0.0000 keV / Ch<sup>2</sup>  
Efficiency: 24.83% +/- 0.35% TPU(2 sigma)



### General Analysis

Analysis Method: ROI Analysis, Set Name = UROI  
Decay Correction:5/5/2016 10:49:41AM  
MDA Constants:  $K\alpha = 1.64$ ,  $K\beta = 1.64$

Nuclide Library: Uranium  
MDA Source: Background

### Nuclide Summary (ROI)

| Nuclide | Peak Energy keV | Peak Expected keV | Peak Diff keV | ROI Start keV | ROI End keV | FWHM keV | B.R. % | Gross Counts | Bkgd Counts | Net Counts | Activity   | Units  |
|---------|-----------------|-------------------|---------------|---------------|-------------|----------|--------|--------------|-------------|------------|------------|--------|
| U-238   | 4157.5          | 4,196.0           | -38.5         | 3956.1        | 4261.9      | 77.8     | 100.0  | 1645         | 1.0000      | 1644.00    | 6.865E+001 | DPM/mL |
| U-235   | 4381.2          | 4,396.0           | -14.8         | 4269.3        | 4470.7      | 22.2     | 80.2   | 60           | 3.0000      | 57.00      | 2.968E+000 | DPM/mL |
| U-234   | 4776.4          | 4,775.8           | 0.6           | 4530.3        | 4851.0      | 74.8     | 99.8   | 1590         | 1.0000      | 1589.00    | 6.649E+001 | DPM/mL |
| U-232   | 5343.2          | 5,320.3           | 22.9          | 5097.1        | 5410.3      | 76.2     | 100.1  | 1892         | 8.0000      | 1884.00    | 8.262E+001 | DPM/mL |

Sample Name: Verification 2  
Spectrum #1 Analysis #1  
Sample Collection Date:  
Comment:

### Sample

Sample Volume : 0.10  
First Stage Dilution: N/A  
Aliquot: N/A Aliquot Fraction: N/A  
Dilution 2: N/A  
Lab Preparation:

### Batch

Batch Name: UNAT\_00011

Description:

Client Name: Undefined  
Client Contact:  
Analyst: 60040

### Tracer

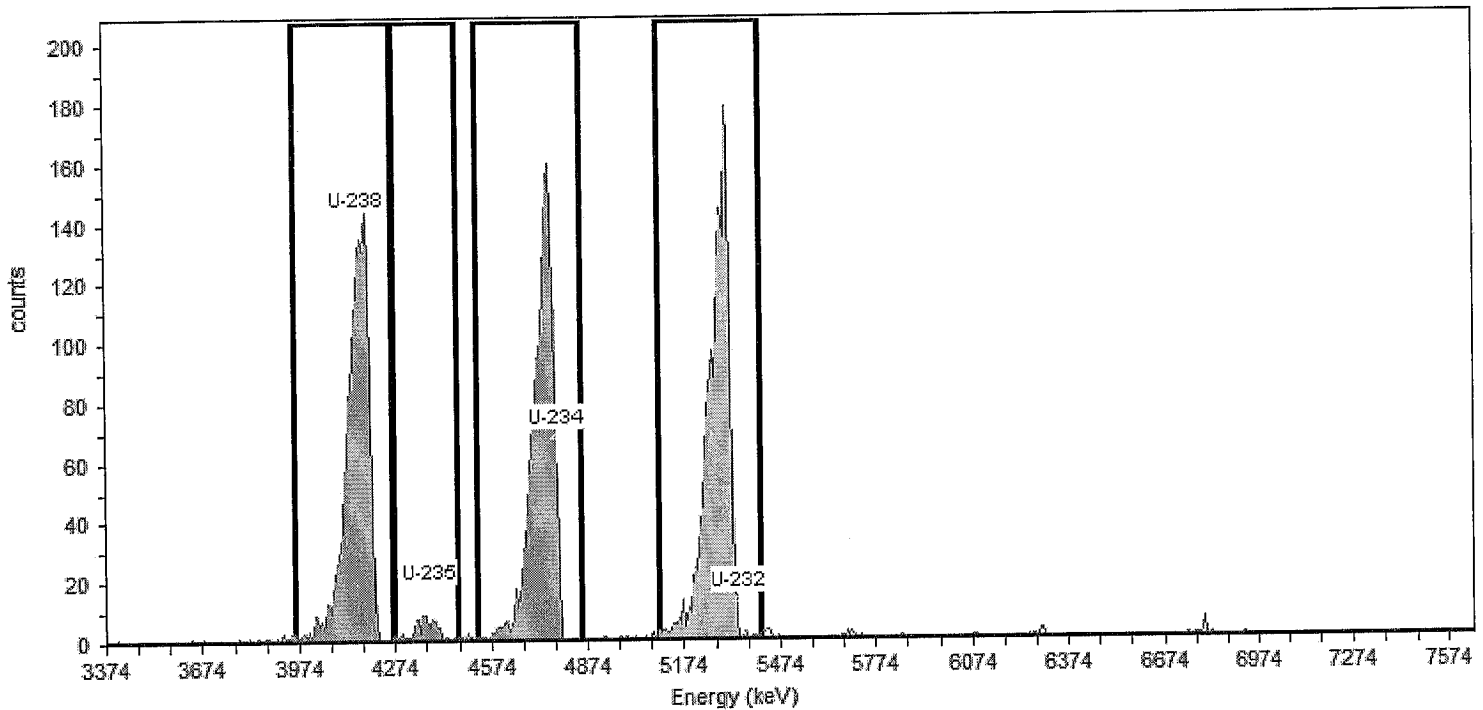
Tracer Name: U-232\_00032  
Tracer Activity: 82.25 DPM / mL x (Vol.) 0.10 mL = 8.22 DPM  
Tracer Ref. Date: 8/25/2011 12:03:08PM

Tracer Nuclide: U-232  
Tracer Recovery: 83.14%

### Acquisition

Detector: AV195 SN: 50-117AA2  
Acquisition Start Date: 5/5/2016 10:51:35AM  
Live Time: 960.00 min.  
Real Time: 960.00 min.  
Background Date: 4/22/2016 10:41:10AM  
Bkgd Info: Sample: ICB;AV195; Det: AV195; Spectrum #1; 4/22/2016 10:41:10 AM

Energy Calibration: IC-9792;AV195-20151017a  
Efficiency Calibration:IC-9792;AV195-20151017a  
Calibration Date: 10/18/2015 3:55:41PM  
Energy Cal: Gain = 7.4575 keV / Ch  
Offset = 3,366.95 keV  
Quadratic = 0.0000 keV / Ch<sup>2</sup>  
Efficiency: 25.85% +/- 0.30% TPU(2 sigma)



### General Analysis

Analysis Method: ROI Analysis, Set Name = UROI  
Decay Correction:5/5/2016 10:49:41AM  
MDA Constants:  $K\alpha = 1.64$ ,  $K\beta = 1.64$

Nuclide Library: Uranium  
MDA Source: Background

### Nuclide Summary (ROI)

| Nuclide | Peak Energy keV | Peak Expected keV | Peak Diff keV | ROI Start keV | ROI End keV | FWHM keV | B.R. % | Gross Counts | Bkgd Counts | Net Counts | Activity   | Units  |
|---------|-----------------|-------------------|---------------|---------------|-------------|----------|--------|--------------|-------------|------------|------------|--------|
| U-238   | 4157.5          | 4,196.0           | -38.5         | 3956.1        | 4261.9      | 73.6     | 100.0  | 1490         | 0.0000      | 1490.00    | 7.223E+001 | DPM/mL |
| U-235   | 4381.2          | 4,396.0           | -14.8         | 4269.3        | 4470.7      | 78.5     | 80.2   | 77           | 0.0000      | 77.00      | 4.654E+000 | DPM/mL |
| U-234   | 4776.4          | 4,775.8           | 0.6           | 4530.3        | 4851.0      | 69.4     | 99.8   | 1484         | 3.0000      | 1481.00    | 7.193E+001 | DPM/mL |
| U-232   | 5343.2          | 5,320.3           | 22.9          | 5097.1        | 5410.3      | 73.2     | 100.1  | 1633         | 10.0000     | 1623.00    | 6.838E+001 | DPM/mL |

Sample Name: Verification 3  
Spectrum #1 Analysis #1

Type: Sample

Sample Collection Date:  
Comment:

### Sample

Sample Volume : 0.10 Sample Units: mL  
First Stage Dilution: N/A  
Aliquot: N/A Aliquot Fraction: N/A  
Dilution 2: N/A  
Lab Preparation:

Batch Name: UNAT\_00011

### Batch

Client Name: Undefined  
Client Contact:  
Analyst: 60040

Description:

### Tracer

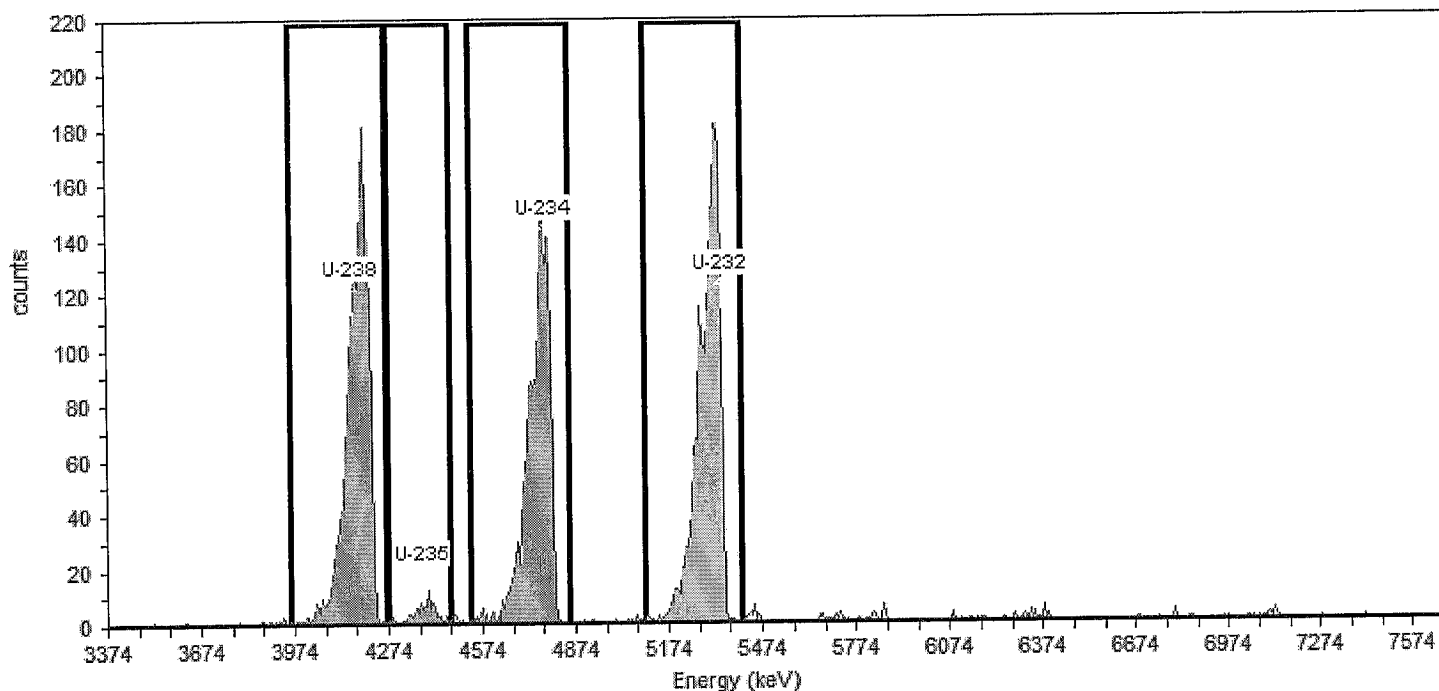
Tracer Name: U-232\_00032  
Tracer Activity: 82.25 DPM / mL x (Vol.) 0.10 mL = 8.22 DPM  
Tracer Ref. Date: 8/25/2011 12:03:08PM

Tracer Nuclide: U-232  
Tracer Recovery: 95.37%

### Acquisition

Detector: AV197 SN: 50-117Z5  
Acquisition Start Date: 5/5/2016 10:51:35AM  
Live Time: 960.00 min.  
Real Time: 960.01 min.  
Background Date: 4/25/2016 9:56:18AM  
Bkgd Info: Sample: ICB;AV197; Det: AV197; Spectrum #1; 4/25/2016 9:56:18 AM

Energy Calibration: IC-9794;AV197-20151017  
Efficiency Calibration:IC-9794;AV197-20151017  
Calibration Date: 10/18/2015 3:55:22PM  
Energy Cal: Gain = 7.4575 keV / Ch  
Offset = 3,366.95 keV  
Quadratic = 0.0000 keV / Ch<sup>2</sup>  
Efficiency: 24.48% +/- 0.31% TPU(2 sigma)



### General Analysis

Analysis Method: ROI Analysis, Set Name = UROI  
Decay Correction:5/5/2016 10:49:41AM  
MDA Constants:  $K_{\alpha} = 1.64$ ,  $K_{\beta} = 1.64$

Nuclide Library: Uranium  
MDA Source: Background

### Nuclide Summary (ROI)

| Nuclide | Peak Energy keV | Peak Expected keV | Peak Diff keV | ROI Start keV | ROI End keV | FWHM keV | B.R. % | Gross Counts | Bkgd Counts | Net Counts | Activity   | Units  |
|---------|-----------------|-------------------|---------------|---------------|-------------|----------|--------|--------------|-------------|------------|------------|--------|
| U-234   | 4776.4          | 4,775.8           | 0.6           | 4530.3        | 4851.0      | 73.5     | 99.8   | 1519         | 3.0000      | 1516.00    | 6.779E+001 | DPM/mL |
| U-232   | 5343.2          | 5,320.3           | 22.9          | 5097.1        | 5410.3      | 78.8     | 100.1  | 1769         | 6.0000      | 1763.00    | 7.844E+001 | DPM/mL |
| U-238   | 4157.5          | 4,196.0           | -38.5         | 3956.1        | 4261.9      | 72.8     | 100.0  | 1655         | 0.0000      | 1655.00    | 7.385E+001 | DPM/mL |
| U-235   | 4381.2          | 4,396.0           | -14.8         | 4269.3        | 4470.7      | 62.5     | 80.2   | 77           | 0.0000      | 77.00      | 4.284E+000 | DPM/mL |

UNWAT Verification  
Aliquot Only

Batch No.:

Balance ID:

Note: If a section below is not used, marked the N/A box and initial & date next to the N/A.  
i.e. Mark the N/A box if a tracer is not added to the sample(s); then initial and date next to the N/A

| Sample Number  | Aliquot (g / mL) | Crucible ID | Dilution |
|----------------|------------------|-------------|----------|
| Verification-1 | 0.1              | 194         | 20:199   |
| 2              | 1                | 195         | 20:200   |
| 3              | 1                | 197         | 20:201   |
| 4              |                  |             |          |
| 5              |                  |             |          |
| 6              |                  |             |          |
| 7              |                  |             |          |
| 8              |                  |             |          |
| 9              |                  |             |          |
| 10             |                  |             |          |
| 11             |                  |             |          |
| 12             |                  |             |          |
| 13             |                  |             |          |
| 14             |                  |             |          |
| 15             |                  |             |          |
| 16             |                  |             |          |
| 17             |                  |             |          |
| 18             |                  |             |          |
| 19             |                  |             |          |
| 20             |                  |             |          |
| 21             |                  |             |          |
| 22             |                  |             |          |
| 23             |                  |             |          |
| 24             |                  |             |          |

Samples Spiked and Traced By: SJB / 5/21/16  
Initials / Date

Verification Signature & Date: JML / 5/21/16  
Initials / Date

Tracer ☐ N/A ☒ Isotope: U-232 Initials / Date

Std Sol'n No.: U-232-00032

Vol (mL): 0.1

Ref Activity (dpm/mL):

Act Ref Date:

LCS Standard ☐ N/A ☒ Initials / Date

Isotope: UNWAT

Std Sol'n ID.: UNWAT-00011

Vol (mL): 0.1

Ref Activity (dpm/mL): 235-72.2649

Act Ref Date: 03-30-08

SOP's applied in preparing these samples. Mark box to left for all that apply:

|                                                     |                                                     |                                                     |
|-----------------------------------------------------|-----------------------------------------------------|-----------------------------------------------------|
| <input checked="" type="checkbox"/> ST-RC-0003 Rev. | <input type="checkbox"/> ST-RC-0040 Rev.            | <input type="checkbox"/> ST-RC-0110 Rev.            |
| <input type="checkbox"/> ST-RC-0004 Rev.            | <input type="checkbox"/> ST-RC-0041 Rev.            | <input type="checkbox"/> ST-RC-0120 Rev.            |
| <input type="checkbox"/> ST-RC-0014 Rev.            | <input type="checkbox"/> ST-RC-0050 Rev.            | <input type="checkbox"/> ST-RC-0232 Rev.            |
| <input type="checkbox"/> ST-RC-0020 Rev.            | <input type="checkbox"/> ST-RC-0090 Rev.            | <input checked="" type="checkbox"/> ST-RC-0238 Rev. |
| <input type="checkbox"/> ST-RC-0021 Rev.            | <input checked="" type="checkbox"/> ST-RC-0100 Rev. | <input type="checkbox"/> ST-RC-0240 Rev.            |
|                                                     |                                                     | <input type="checkbox"/> ST-RC-0241 Rev.            |
|                                                     |                                                     | <input type="checkbox"/> ST-RC-0242 Rev.            |
|                                                     |                                                     | <input type="checkbox"/> ST-RC-5016 Rev.            |
|                                                     |                                                     | <input type="checkbox"/>                            |
|                                                     |                                                     | <input type="checkbox"/>                            |

| Count Time                                     | Matrix                                    |
|------------------------------------------------|-------------------------------------------|
| Long Count <input checked="" type="checkbox"/> | Soil <input type="checkbox"/>             |
| Short Count <input type="checkbox"/>           | H <sub>2</sub> O <input type="checkbox"/> |

Isotope(s)

|                                 |                                 |                                           |                                 |
|---------------------------------|---------------------------------|-------------------------------------------|---------------------------------|
| <input type="checkbox"/> αβ     | <input type="checkbox"/> Iso Pu | <input type="checkbox"/> Tc-99            | <input type="checkbox"/> Iso Cm |
| <input type="checkbox"/> Iso Am | <input type="checkbox"/> Ra     | <input type="checkbox"/> Iso Th           | <input type="checkbox"/> Pu-241 |
| <input type="checkbox"/> KPA    | <input type="checkbox"/> Sr     | <input checked="" type="checkbox"/> Iso U | <input type="checkbox"/> Th-229 |
| <input type="checkbox"/> Np     | <input type="checkbox"/> TAR    | <input type="checkbox"/> C-14             | <input type="checkbox"/> Cl-36  |

Prepared By:

SJB

Date:

Reviewed by:

Date:

Page 1



**Reagent ID: UNAT\_00011**

Description: UNAT spike  
No. of Bottles: 1  
Storage Location: RAD Actinide STDs  
Reagent Volume: 200.000 mL  
Creation Date: 04/28/2015  
Open Date:  
Container(s): 622074  
Comment:

Expiration Date: 05/20/2016  
Laboratory: TestAmerica St. Louis  
Prepared By: Bernsen, Sarah C  
Solvent: 1M HNO3  
Solvent Lot: n/a

### Reagent Analyte Information

| Analyte | Source ID         | Source Exp. Date | Source Conc. | Source Conc. Units | Final Conc. | Final Conc. Units |
|---------|-------------------|------------------|--------------|--------------------|-------------|-------------------|
| U-234   | UNAT Parent_00001 | 05/20/2016       | 706.91200    | dpm/mL             | 70.69123    | dpm/mL            |
| U-235   | UNAT Parent_00001 | 05/20/2016       | 33.70600     | dpm/mL             | 3.37064     | dpm/mL            |
| U-238   | UNAT Parent_00001 | 05/20/2016       | 722.65000    | dpm/mL             | 72.26499    | dpm/mL            |

### Source Reagents

| Reagent           | Description | Type | Expiration | Vendor | Vendor Lot # | Vendor Cat Lot # | Volume Used | Volume Units |
|-------------------|-------------|------|------------|--------|--------------|------------------|-------------|--------------|
| UNAT Parent_00001 | UNAT Parent |      | 05/20/16   |        |              |                  | 20.00000    | mL           |

# Uranium only via UTEVA

ST-RC-0238

Batch: \_\_\_\_\_

\*All rinses should flow at 1 mL/minute (only 3M HNO<sub>3</sub> may be done at 3 mL/minute)

|                           |        |                                           |                                               |
|---------------------------|--------|-------------------------------------------|-----------------------------------------------|
| UTEVA lot: <u>UTSR156</u> | 11.4.4 | <del>UTEVA cartridge</del>                |                                               |
|                           | 11.4.5 | <del>5mL 3M HNO<sub>3</sub></del>         | COMPLETED <input type="checkbox"/>            |
|                           | 11.4.6 | <del>Load sample</del>                    |                                               |
|                           | 11.4.7 | 25mL 3M HNO <sub>3</sub>                  | COMPLETED <input checked="" type="checkbox"/> |
|                           | 11.4.8 | 5mL 9M HCl                                | COMPLETED <input checked="" type="checkbox"/> |
|                           | 11.4.9 | 20mL<br>5M HCl / 0.05M oxalic             | COMPLETED <input checked="" type="checkbox"/> |
| 11.4.10-<br>11.4.11       |        | Elute into clean tube<br>with 15mL 1M HCl | COMPLETED <input checked="" type="checkbox"/> |

**St. Louis Radiological Standard Reverification Form**

Standard ID Number: UNAT\_00011  
True Value = 72.2649 DPM/L or g  
Date Analyzed: 5/5/2016

Radionuclide: U-238

|    | Replicates   |            |
|----|--------------|------------|
| #1 | <u>68.65</u> | DPM/L or g |
| #2 | <u>72.23</u> | DPM/L or g |
| #3 | <u>73.85</u> | DPM/L or g |

Mean = 71.57667

1 sigma = 2.660852

1.96 sigma = 5.21527

True Value minus 5% = 68.65166

(True Value - 5%)

True Value plus 5% = 75.87815

(True Value + 5%)

**Accuracy:**

Mean value within 5% of Certified (True) Value? Yes (Acceptance Criteria)

**Precision:**

1.96 sigma Value Within 10% of Mean Value? Yes (Acceptance Criteria)

**Standard Reverification Acceptable?**

Yes

Note: Criteria for reverification of radiological standards is taken from the DOE QSAS and LANL Statements of Work

Reviewed By/Date: Amanda Dick 05/09/2016

SOP Reference: STL-QA-0002, Current Revision

Sample Name: Verification 1  
Spectrum #1 Analysis #1

Type: Sample

## Sample

Sample Volume : 0.10 Sample Units: mL  
First Stage Dilution: N/A  
Aliquot: N/A Aliquot Fraction: N/A  
Dilution 2: N/A  
Lab Preparation:Sample Collection Date:  
Comment:

## Batch

Batch Name: UNAT\_00011

Description:

Client Name: Undefined  
Client Contact:  
Analyst: 60040

## Tracer

Tracer Name: U-232\_00032

Tracer Activity: 82.25 DPM / mL x (Vol.) 0.10 mL = 8.22 DPM

Tracer Ref. Date: 8/25/2011 12:03:08PM

Tracer Nuclide: U-232  
Tracer Recovery: 100.46%

## Acquisition

Detector: AV194

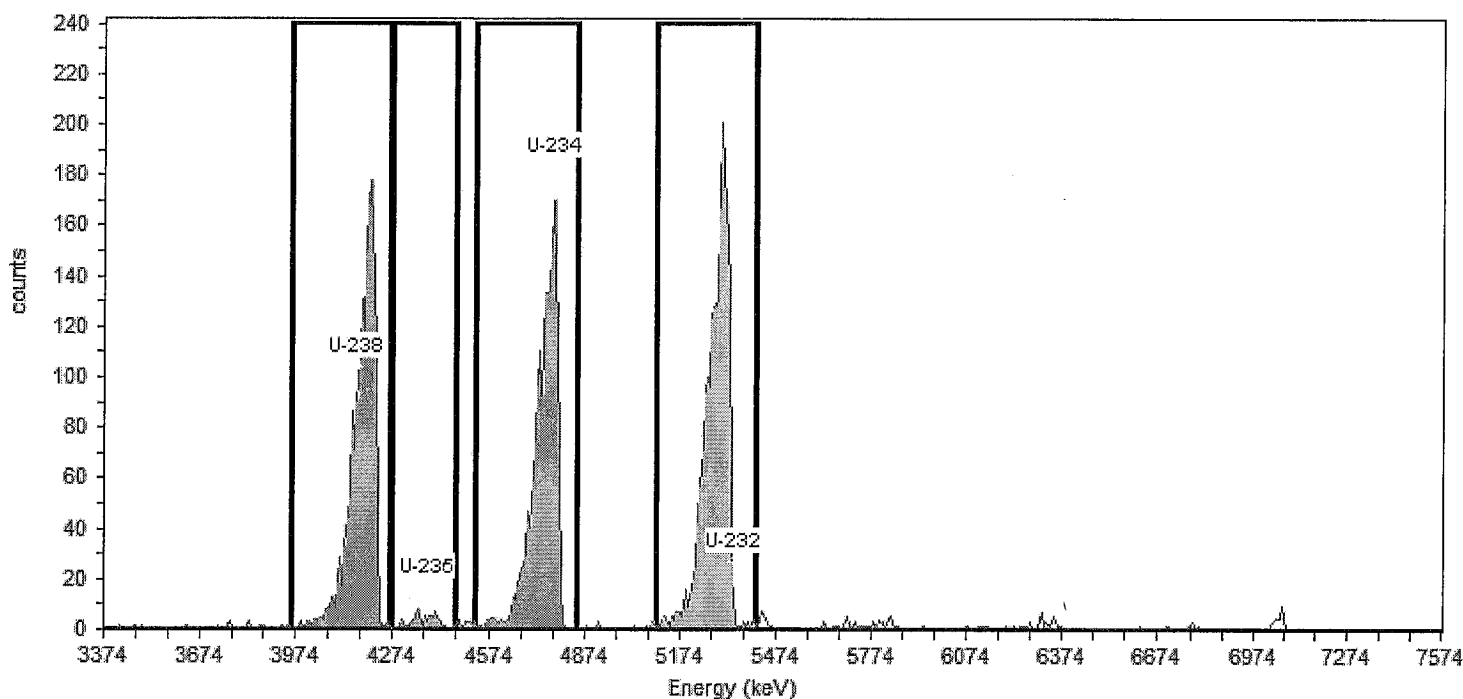
SN: 50-119J2

Acquisition Start Date: 5/5/2016 10:51:35AM

Live Time: 960.00 min.

Real Time: 960.00 min.

Background Date: 4/22/2016 10:41:10AM

Bkgd Info: Sample: ICB;AV194; Det: AV194; Spectrum #1; 4/22/2016  
10:41:10 AMEnergy Calibration: IC-9520;AV194-20151017  
Efficiency Calibration:IC-9520;AV194-20151017  
Calibration Date: 10/18/2015 3:55:14PM  
Energy Cal: Gain = 7.4575 keV / Ch  
Offset = 3,366.95 keV  
Quadratic = 0.0000 keV / Ch<sup>2</sup>  
Efficiency: 24.83% +/- 0.35% TPU(2 sigma)

## General Analysis

Analysis Method: ROI Analysis, Set Name = UROI

Decay Correction:5/5/2016 10:49:41AM

MDA Constants:  $K\alpha = 1.64$ ,  $K\beta = 1.64$ 

Nuclide Library: Uranium

MDA Source: Background

## Nuclide Summary (ROI)

| Nuclide | Peak Energy keV | Peak Expected keV | Peak Diff keV | ROI Start keV | ROI End keV | FWHM keV | B.R. % | Gross Counts | Bkgd Counts | Net Counts | Activity   | Units  |
|---------|-----------------|-------------------|---------------|---------------|-------------|----------|--------|--------------|-------------|------------|------------|--------|
| U-238   | 4157.5          | 4,196.0           | -38.5         | 3956.1        | 4261.9      | 77.8     | 100.0  | 1645         | 1.0000      | 1644.00    | 6.865E+001 | DPM/mL |
| U-235   | 4381.2          | 4,396.0           | -14.8         | 4269.3        | 4470.7      | 22.2     | 80.2   | 60           | 3.0000      | 57.00      | 2.968E+000 | DPM/mL |
| U-234   | 4776.4          | 4,775.8           | 0.6           | 4530.3        | 4851.0      | 74.8     | 99.8   | 1590         | 1.0000      | 1589.00    | 6.649E+001 | DPM/mL |
| U-232   | 5343.2          | 5,320.3           | 22.9          | 5097.1        | 5410.3      | 76.2     | 100.1  | 1892         | 8.0000      | 1884.00    | 8.262E+001 | DPM/mL |

Sample Name: Verification 2  
Spectrum #1 Analysis #1

Type: Sample

## Sample

Sample Volume : 0.10

Sample Units: mL

First Stage Dilution: N/A

Aliquot: N/A Aliquot Fraction: N/A

Dilution 2: N/A

Lab Preparation:

Sample Collection Date:

Comment:

## Batch

Batch Name: UNAT\_00011

Description:

## Tracer

Tracer Name: U-232\_00032

Tracer Activity: 82.25 DPM / mL x (Vol.) 0.10 mL = 8.22 DPM

Tracer Ref. Date: 8/25/2011 12:03:08PM

Client Name: Undefined

Client Contact:

Analyst: 60040

Tracer Nuclide: U-232

Tracer Recovery: 83.14%

## Acquisition

Detector: AV195

SN: 50-117AA2

Acquisition Start Date: 5/5/2016 10:51:35AM

Live Time: 960.00 min.

Real Time: 960.00 min.

Background Date: 4/22/2016 10:41:10AM

Bkgd Info: Sample: ICB;AV195; Det: AV195; Spectrum #1; 4/22/2016  
10:41:10 AM

Energy Calibration: IC-9792;AV195-20151017a

Efficiency Calibration:IC-9792;AV195-20151017a

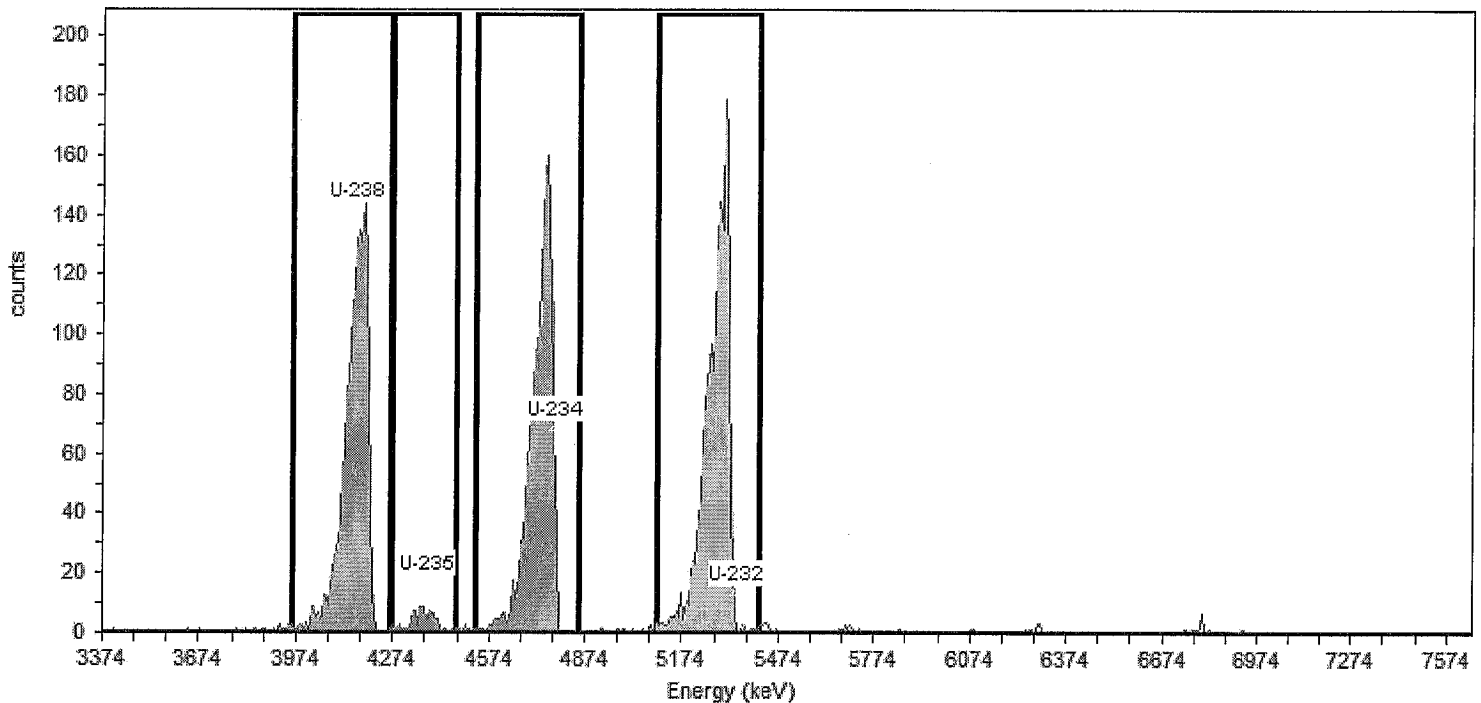
Calibration Date: 10/18/2015 3:55:41PM

Energy Cal: Gain = 7.4575 keV / Ch

Offset = 3,366.95 keV

Quadratic = 0.0000 keV / Ch<sup>2</sup>

Efficiency: 25.85% +/- 0.30% TPU(2 sigma)



## General Analysis

Analysis Method: ROI Analysis, Set Name = UROI

Decay Correction:5/5/2016 10:49:41AM

MDA Constants:  $K\alpha = 1.64$ ,  $K\beta = 1.64$ 

Nuclide Library: Uranium

MDA Source: Background

## Nuclide Summary (ROI)

| Nuclide | Peak Energy keV | Peak Expected keV | Peak Diff keV | ROI Start keV | ROI End keV | FWHM keV | B.R. % | Gross Counts | Bkgd Counts | Net Counts | Activity   | Units  |
|---------|-----------------|-------------------|---------------|---------------|-------------|----------|--------|--------------|-------------|------------|------------|--------|
| U-238   | 4157.5          | 4,196.0           | -38.5         | 3956.1        | 4261.9      | 73.6     | 100.0  | 1490         | 0.0000      | 1490.00    | 7.223E+001 | DPM/mL |
| U-235   | 4381.2          | 4,396.0           | -14.8         | 4269.3        | 4470.7      | 78.5     | 80.2   | 77           | 0.0000      | 77.00      | 4.654E+000 | DPM/mL |
| U-234   | 4776.4          | 4,775.8           | 0.6           | 4530.3        | 4851.0      | 69.4     | 99.8   | 1484         | 3.0000      | 1481.00    | 7.193E+001 | DPM/mL |
| U-232   | 5343.2          | 5,320.3           | 22.9          | 5097.1        | 5410.3      | 73.2     | 100.1  | 1633         | 10.0000     | 1623.00    | 6.838E+001 | DPM/mL |

Sample Name: Verification 3  
Spectrum #1 Analysis #1  
:  
Sample Collection Date:  
Comment:

Batch Name: UNAT\_00011

Description:

Tracer Name: U-232\_00032  
Tracer Activity: 82.25 DPM / mL x (Vol.) 0.10 mL = 8.22 DPM  
Tracer Ref. Date: 8/25/2011 12:03:08PM

Detector: AV197 SN: 50-117Z5  
Acquisition Start Date: 5/5/2016 10:51:35AM  
Live Time: 960.00 min.  
Real Time: 960.01 min.  
Background Date: 4/25/2016 9:56:18AM  
Bkgd Info: Sample: ICB;AV197; Det: AV197; Spectrum #1; 4/25/2016 9:56:18 AM

### Sample

Sample Volume : 0.10  
First Stage Dilution: N/A  
Aliquot: N/A Aliquot Fraction: N/A  
Dilution 2: N/A  
Lab Preparation:

### Batch

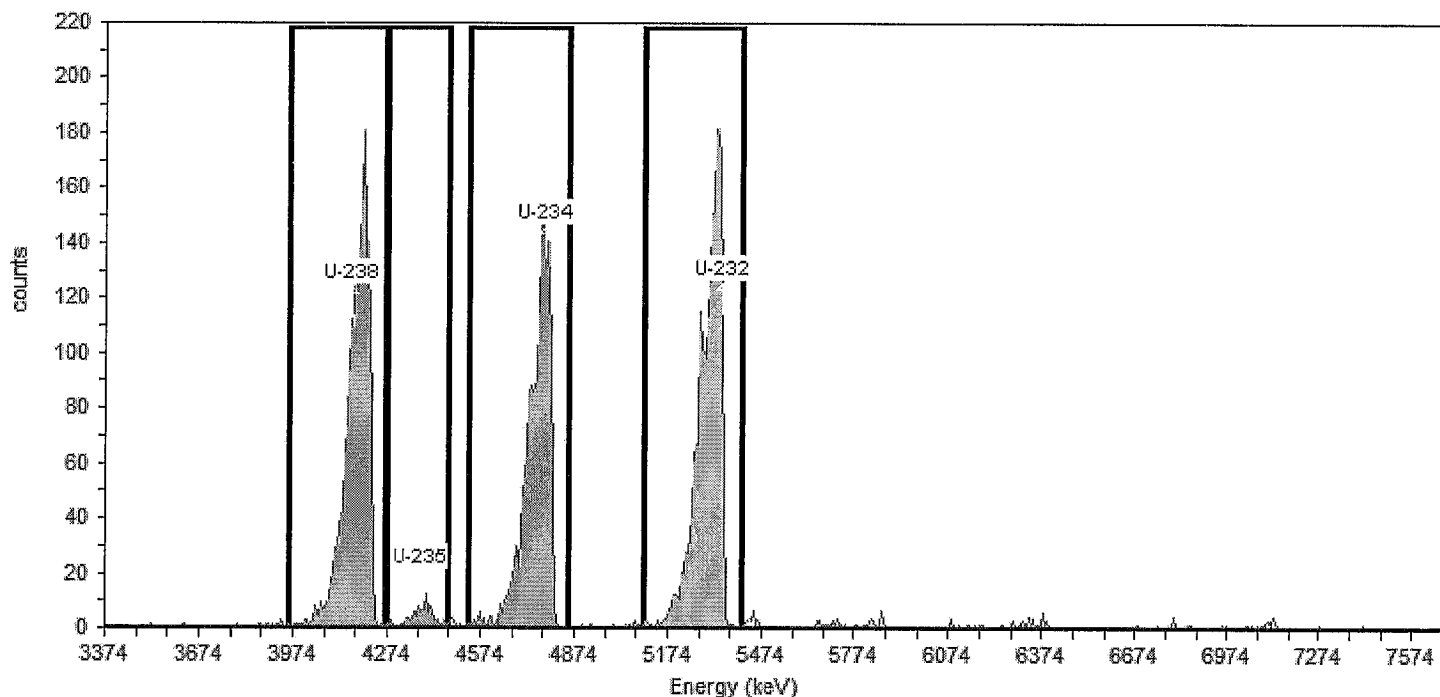
Client Name: Undefined  
Client Contact:  
Analyst: 60040

### Tracer

Tracer Nuclide: U-232  
Tracer Recovery: 95.37%

### Acquisition

Energy Calibration: IC-9794;AV197-20151017  
Efficiency Calibration:IC-9794;AV197-20151017  
Calibration Date: 10/18/2015 3:55:22PM  
Energy Cal: Gain = 7.4575 keV / Ch  
Offset = 3,366.95 keV  
Quadratic = 0.0000 keV / Ch<sup>2</sup>  
Efficiency: 24.48% +/- 0.31% TPU(2 sigma)



### General Analysis

Analysis Method: ROI Analysis, Set Name = UROI  
Decay Correction:5/5/2016 10:49:41AM  
MDA Constants:  $K_{\alpha} = 1.64$ ,  $K_{\beta} = 1.64$

Nuclide Library: Uranium  
MDA Source: Background

### Nuclide Summary (ROI)

| Nuclide | Peak Energy keV | Peak Expected keV | Peak Diff keV | ROI Start keV | ROI End keV | FWHM keV | B.R. % | Gross Counts | Bkgd Counts | Net Counts | Activity Units    |
|---------|-----------------|-------------------|---------------|---------------|-------------|----------|--------|--------------|-------------|------------|-------------------|
| U-234   | 4776.4          | 4,775.8           | 0.6           | 4530.3        | 4851.0      | 73.5     | 99.8   | 1519         | 3.0000      | 1516.00    | 6.779E+001 DPM/mL |
| U-232   | 5343.2          | 5,320.3           | 22.9          | 5097.1        | 5410.3      | 78.8     | 100.1  | 1769         | 6.0000      | 1763.00    | 7.844E+001 DPM/mL |
| U-238   | 4157.5          | 4,196.0           | -38.5         | 3956.1        | 4261.9      | 72.8     | 100.0  | 1655         | 0.0000      | 1655.00    | 7.385E+001 DPM/mL |
| U-235   | 4381.2          | 4,396.0           | -14.8         | 4269.3        | 4470.7      | 62.5     | 80.2   | 77           | 0.0000      | 77.00      | 4.284E+000 DPM/mL |

UNWAT Verification  
Aliquot Only

Batch No. :

Balance ID :

Note: If a section below is not used, marked the N/A box and initial & date next to the N/A.  
i.e. Mark the N/A box if a tracer is not added to the sample(s) then initial and date next to the N/A.

| No | Sample Number  | Aliquot (g / mL) | Crucible ID | Dilution |
|----|----------------|------------------|-------------|----------|
| 15 | Verification-1 | 0.1              | 194         | 9C:199   |
| 16 | 2              | 1                | 195         | 9C:200   |
| 17 | 3              | 1                | 197         | 9C:201   |
| 4  |                |                  |             |          |
| 5  |                |                  |             |          |
| 6  |                |                  |             |          |
| 7  |                |                  |             |          |
| 8  |                |                  |             |          |
| 9  |                |                  |             |          |
| 10 |                |                  |             |          |
| 11 |                |                  |             |          |
| 12 |                |                  |             |          |
| 13 |                |                  |             |          |
| 14 |                |                  |             |          |
| 15 |                |                  |             |          |
| 16 |                |                  |             |          |
| 17 |                |                  |             |          |
| 18 |                |                  |             |          |
| 19 |                |                  |             |          |
| 20 |                |                  |             |          |
| 21 |                |                  |             |          |
| 22 |                |                  |             |          |
| 23 |                |                  |             |          |
| 24 |                |                  |             |          |

Samples Spiked and Traced By: SUB / 5/21/16  
Initials / Date

Verification Signature & Date: JML / 5/21/16  
Initials / Date

Tracer ☐ N/A

Isotope: U-232

Std Sol'n No.: U-232-00032

Vol (mL): 0.1

Ref Activity (dpm/mL):

Act Ref Date:

LCS Standard ☐ N/A

Isotope: UNWAT

Std Sol'n ID.: UNWAT-00011

Vol (mL): 0.1

Ref Activity (dpm/mL): 234-12.409 238-72.2649

Act Ref Date: 03-30-08

SOP's applied in preparing these samples. Mark box to left for all that apply:

|                                          |                                                     |                                                     |
|------------------------------------------|-----------------------------------------------------|-----------------------------------------------------|
| <input type="checkbox"/> ST-RC-0003 Rev. | <input type="checkbox"/> ST-RC-0040 Rev.            | <input type="checkbox"/> ST-RC-0110 Rev.            |
| <input type="checkbox"/> ST-RC-0004 Rev. | <input type="checkbox"/> ST-RC-0041 Rev.            | <input type="checkbox"/> ST-RC-0120 Rev.            |
| <input type="checkbox"/> ST-RC-0014 Rev. | <input type="checkbox"/> ST-RC-0050 Rev.            | <input type="checkbox"/> ST-RC-0232 Rev.            |
| <input type="checkbox"/> ST-RC-0020 Rev. | <input type="checkbox"/> ST-RC-0090 Rev.            | <input checked="" type="checkbox"/> ST-RC-0238 Rev. |
| <input type="checkbox"/> ST-RC-0021 Rev. | <input checked="" type="checkbox"/> ST-RC-0100 Rev. | <input type="checkbox"/> ST-RC-0240 Rev.            |
|                                          |                                                     | <input type="checkbox"/> ST-RC-0241 Rev.            |
|                                          |                                                     | <input type="checkbox"/> ST-RC-0242 Rev.            |
|                                          |                                                     | <input type="checkbox"/> ST-RC-5016 Rev.            |
|                                          |                                                     | <input type="checkbox"/>                            |
|                                          |                                                     | <input type="checkbox"/>                            |

| Count Time                                     | Matrix                                    |
|------------------------------------------------|-------------------------------------------|
| Long Count <input checked="" type="checkbox"/> | Soil <input type="checkbox"/>             |
| Short Count <input type="checkbox"/>           | H <sub>2</sub> O <input type="checkbox"/> |

Isotope(s)

|                                 |                                 |                                           |                                 |
|---------------------------------|---------------------------------|-------------------------------------------|---------------------------------|
| <input type="checkbox"/> αβ     | <input type="checkbox"/> Iso Pu | <input type="checkbox"/> Tc-99            | <input type="checkbox"/> Iso Cm |
| <input type="checkbox"/> Iso Am | <input type="checkbox"/> Ra     | <input type="checkbox"/> Iso Th           | <input type="checkbox"/> Pu-241 |
| <input type="checkbox"/> KPA    | <input type="checkbox"/> Sr     | <input checked="" type="checkbox"/> Iso U | <input type="checkbox"/> Th-229 |
| <input type="checkbox"/> Np     | <input type="checkbox"/> TAR    | <input type="checkbox"/> C-14             | <input type="checkbox"/> Cl-36  |

Prepared By: SUB

Date:

Reviewed by:

Date:

Page 1



**Reagent ID: UNAT\_00011**

Description: UNAT spike  
No. of Bottles: 1  
Storage Location: RAD Actinide STDs  
Reagent Volume: 200.000 mL  
Creation Date: 04/28/2015  
Open Date:  
Container(s): 622074  
Comment:

Expiration Date: 05/20/2016  
Laboratory: TestAmerica St. Louis  
Prepared By: Bernsen, Sarah C  
Solvent: 1M HNO3  
Solvent Lot: n/a

### Reagent Analyte Information

| Analyte | Source ID         | Source Exp. Date | Source Conc. | Source Conc. Units | Final Conc. | Final Conc. Units |
|---------|-------------------|------------------|--------------|--------------------|-------------|-------------------|
| U-234   | UNAT Parent_00001 | 05/20/2016       | 706.91200    | dpm/mL             | 70.69123    | dpm/mL            |
| U-235   | UNAT Parent_00001 | 05/20/2016       | 33.70600     | dpm/mL             | 3.37064     | dpm/mL            |
| U-238   | UNAT Parent_00001 | 05/20/2016       | 722.65000    | dpm/mL             | 72.26499    | dpm/mL            |

### Source Reagents

| Reagent           | Description | Type | Expiration | Vendor | Vendor Lot # | Vendor Cat Lot # | Volume Used | Volume Units |
|-------------------|-------------|------|------------|--------|--------------|------------------|-------------|--------------|
| UNAT Parent_00001 | UNAT Parent |      | 05/20/16   |        |              |                  | 20.00000    | mL           |

# Uranium only via UTEVA

ST-RC-0238

Batch: \_\_\_\_\_

\*All rinses should flow at 1 mL/minute (only 3M HNO<sub>3</sub> may be done at 3 mL/minute)

UTEVA lot: UTSR156

11.4.4

~~UTEVA cartridge~~

11.4.5

~~5mL 3M HNO<sub>3</sub>~~

COMPLETED ☐

11.4.6

~~Load sample~~

11.4.7

25mL 3M HNO<sub>3</sub>

COMPLETED ☒

11.4.8

5mL 9M HCl

COMPLETED ☒

11.4.9

20mL  
5M HCl / 0.05M oxalic

COMPLETED ☒

11.4.10-  
11.4.11

Elute into clean tube  
with 15mL 1M HCl

COMPLETED ☒

# **ALPHA SPECTROSCOPY**

# Method A-01-R U

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Isotopic Uranium (Alpha  
Spectrometry) by Method A-01-R

# Prep Batch: 254505

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Preparation, Extraction  
Chromatography Resin Actinide  
Separation

# Alpha Spectroscopy Analysis Detail Report

## Prep Batch: 254505

Lab ID: MB 160-254505/1-A  
 Client ID:  
 Sigma: 2

Analyzed: 06/08/16 14:16  
 Detector: AV192  
 Dil Fac: 1

Decay Corrected: No  
 Yield Truncated: Yes  
 Ts: 400

| Analyte         | MB Result | Count Unc | Total Unc | Qualifier | Unit  | RL     | MDC         | Anly Batch |              |
|-----------------|-----------|-----------|-----------|-----------|-------|--------|-------------|------------|--------------|
| Uranium 238     | 0.04469   | 0.0616    | 0.0618    | U         | pCi/L | 0.100  | 0.0956      | 255590     |              |
| Uranium 234     | 0.07512   | 0.0897    | 0.0899    | U G       | pCi/L | 0.100  | 0.140       | 255590     |              |
| Uranium-235/236 | 0.02157   | 0.0431    | 0.0432    | U         | pCi/L | 0.100  | 0.0647      | 255590     |              |
| Tracer          | MB Result | Count Unc | Total Unc | Qualifier | Unit  | MDC    | Spike Added | % Rec      | % Rec Limits |
| Uranium 232     | 3.727     | 0.370     | 0.484     |           | pCi/L | 0.0734 | 7.41        | 52.7       | 30 - 110     |

Lab ID: LCS 160-254505/2-A  
 Client ID:  
 Sigma: 2

Analyzed: 06/08/16 14:16  
 Detector: AV193  
 Dil Fac: 1

Decay Corrected: No  
 Yield Truncated: Yes  
 Ts: 400

| Analyte     | LCS Result | Count Unc | Total Unc | Qualifier | Unit  | RL     | MDC         | Anly Batch |              |
|-------------|------------|-----------|-----------|-----------|-------|--------|-------------|------------|--------------|
| Uranium 238 | 6.408      | 0.546     | 0.767     |           | pCi/L | 0.100  | 0.0350      | 255591     |              |
| Uranium 234 | 6.492      | 0.551     | 0.775     |           | pCi/L | 0.100  | 0.0767      | 255591     |              |
| Tracer      | LCS Result | Count Unc | Total Unc | Qualifier | Unit  | MDC    | Spike Added | % Rec      | % Rec Limits |
| Uranium 232 | 5.380      | 0.439     | 0.630     |           | pCi/L | 0.0973 | 7.41        | 76.0       | 30 - 110     |

Lab ID: LCSD 160-254505/3-A  
 Client ID:  
 Sigma: 2

Analyzed: 06/08/16 14:16  
 Detector: AV195  
 Dil Fac: 1

Decay Corrected: No  
 Yield Truncated: Yes  
 Ts: 400

| Analyte     | LCSD Result | Count Unc | Total Unc | Qualifier | Unit  | RL     | MDC         | Anly Batch |              |
|-------------|-------------|-----------|-----------|-----------|-------|--------|-------------|------------|--------------|
| Uranium 238 | 6.782       | 0.567     | 0.803     |           | pCi/L | 0.100  | 0.0355      | 255592     |              |
| Uranium 234 | 6.638       | 0.562     | 0.792     |           | pCi/L | 0.100  | 0.0875      | 255592     |              |
| Tracer      | LCSD Result | Count Unc | Total Unc | Qualifier | Unit  | MDC    | Spike Added | % Rec      | % Rec Limits |
| Uranium 232 | 5.210       | 0.427     | 0.611     |           | pCi/L | 0.0701 | 7.41        | 73.6       | 30 - 110     |

Lab ID: 160-17563-1  
 Client ID: GW-GWW-052616  
 Sigma: 2

Analyzed: 06/08/16 14:16  
 Detector: AV197  
 Dil Fac: 1

Decay Corrected: No  
 Yield Truncated: Yes  
 Ts: 400

| Analyte         | Result | Count Unc | Total Unc | Qualifier | Unit  | RL    | MDC    | Anly Batch |
|-----------------|--------|-----------|-----------|-----------|-------|-------|--------|------------|
| Uranium 238     | 0.0138 | 0.0276    | 0.0276    | U         | pCi/L | 0.100 | 0.0414 | 255594     |
| Uranium 234     | 0.0691 | 0.0618    | 0.0620    |           | pCi/L | 0.100 | 0.0414 | 255594     |
| Uranium-235/236 | 0.000  | 0.0143    | 0.0143    | U         | pCi/L | 0.100 | 0.0516 | 255594     |

# Alpha Spectroscopy Analysis Detail Report

Prep Batch: 254505

| Tracer      | Result | Count Unc | Total Unc | Qualifier | Unit  | MDC    | Spike Added | % Rec | % Rec Limits |
|-------------|--------|-----------|-----------|-----------|-------|--------|-------------|-------|--------------|
| Uranium 232 | 4.71   | 0.418     | 0.576     |           | pCi/L | 0.0972 | 7.40        | 66.7  | 30 - 110     |

Lab ID: 160-17563-2  
Client ID: GW-NB34-052616  
Sigma: 2

Analyzed: 06/08/16 14:17  
Detector: AV198  
Dil Fac: 1

Decay Corrected: No  
Yield Truncated: Yes  
Ts: 400

| Analyte         | Result | Count Unc | Total Unc | Qualifier | Unit  | RL    | MDC         | Any Batch |              |
|-----------------|--------|-----------|-----------|-----------|-------|-------|-------------|-----------|--------------|
| Uranium 238     | 0.0334 | 0.0564    | 0.0565    | U G       | pCi/L | 0.100 | 0.101       | 255595    |              |
| Uranium 234     | 0.0580 | 0.110     | 0.110     | U G       | pCi/L | 0.100 | 0.198       | 255595    |              |
| Uranium-235/236 | 0.0176 | 0.0757    | 0.0757    | U G       | pCi/L | 0.100 | 0.166       | 255595    |              |
| Tracer          | Result | Count Unc | Total Unc | Qualifier | Unit  | MDC   | Spike Added | % Rec     | % Rec Limits |
| Uranium 232     | 3.98   | 0.375     | 0.502     |           | pCi/L | 0.105 | 7.40        | 56.3      | 30 - 110     |

Lab ID: 160-17563-3  
Client ID: GW-GWY-052616  
Sigma: 2

Analyzed: 06/08/16 14:17  
Detector: AV199  
Dil Fac: 1

Decay Corrected: No  
Yield Truncated: Yes  
Ts: 400

| Analyte         | Result | Count Unc | Total Unc | Qualifier | Unit  | RL     | MDC         | Anly Batch |              |
|-----------------|--------|-----------|-----------|-----------|-------|--------|-------------|------------|--------------|
| Uranium 238     | 0.277  | 0.127     | 0.129     |           | pCi/L | 0.100  | 0.0437      | 255733     |              |
| Uranium 234     | 0.330  | 0.141     | 0.143     |           | pCi/L | 0.100  | 0.0807      | 255733     |              |
| Uranium-235/236 | 0.000  | 0.0151    | 0.0151    | U         | pCi/L | 0.100  | 0.0545      | 255733     |              |
| Tracer          | Result | Count Unc | Total Unc | Qualifier | Unit  | MDC    | Spike Added | % Rec      | % Rec Limits |
| Uranium 232     | 4.42   | 0.402     | 0.547     |           | pCi/L | 0.0836 | 7.40        | 62.5       | 30 - 110     |

Lab ID: 160-17563-4  
Client ID: GW-PZ02-052616  
Sigma: 2

Analyzed: 06/08/16 14:17  
Detector: AV200  
Dil Fac: 1

Decay Corrected: No  
Yield Truncated: Yes  
Ts: 400

| Analyte         | Result | Count Unc | Total Unc | Qualifier | Unit  | RL    | MDC         | Anly Batch |              |
|-----------------|--------|-----------|-----------|-----------|-------|-------|-------------|------------|--------------|
| Uranium 238     | 0.0286 | 0.0613    | 0.0614    | U G       | pCi/L | 0.100 | 0.121       | 255596     |              |
| Uranium 234     | 0.0382 | 0.0710    | 0.0710    | U G       | pCi/L | 0.100 | 0.132       | 255596     |              |
| Uranium-235/236 | 0.0204 | 0.0408    | 0.0408    | U         | pCi/L | 0.100 | 0.0611      | 255596     |              |
| Tracer          | Result | Count Unc | Total Unc | Qualifier | Unit  | MDC   | Spike Added | % Rec      | % Rec Limits |
| Uranium 232     | 3.99   | 0.387     | 0.512     |           | pCi/L | 0.108 | 7.40        | 56.4       | 30 - 110     |

# Alpha Spectroscopy Analysis Detail Report

## Prep Batch: 254505

### Quality Control Summary

| Method Blank ID:             | Analyte         | Parent Result | Spike Added | MB Result   | Qualifier | Unit  | % Rec | % Rec Limits | RPD | RER  | DER  | RER Limit | Z Factor     |
|------------------------------|-----------------|---------------|-------------|-------------|-----------|-------|-------|--------------|-----|------|------|-----------|--------------|
| MB 160-254505/1-A            | Uranium 238     |               |             | 0.04469     | U         | pCi/L |       |              |     |      |      |           | 1.44743675   |
| MB 160-254505/1-A            | Uranium 234     |               |             | 0.07512     | U G       | pCi/L |       |              |     |      |      |           | 1.6706791    |
| MB 160-254505/1-A            | Uranium-235/236 |               |             | 0.02157     | U         | pCi/L |       |              |     |      |      |           | .99911917    |
| Lab Control Sample ID:       | Analyte         | Parent Result | Spike Added | LCS Result  | Qualifier | Unit  | % Rec | % Rec Limits | RPD | RER  | DER  | RER Limit | Z Factor     |
| LCS 160-254505/2-A           | Uranium 238     |               | 6.51        | 6.408       |           | pCi/L | 98    | 83 - 121     | 6   |      |      |           | -.1879636108 |
| LCS 160-254505/2-A           | Uranium 234     |               | 6.37        | 6.492       |           | pCi/L | 102   | 84 - 120     | 2   |      |      |           | .2283152775  |
| Lab Control Sample Duplicate | Analyte         | Parent Result | Spike Added | LCSD Result | Qualifier | Unit  | % Rec | % Rec Limits | RPD | RER  | DER  | RER Limit | Z Factor     |
| LCSD 160-254505/3-A          | Uranium 238     |               | 6.51        | 6.782       |           | pCi/L | 104   | 83 - 121     | 6   | 0.24 | 0.67 | 1         | .4869596254  |
| LCSD 160-254505/3-A          | Uranium 234     |               | 6.37        | 6.638       |           | pCi/L | 104   | 84 - 120     | 2   | 0.09 | 0.26 | 1         | .4914081157  |

Glossary:

Ts = Count Duration, Sample

## ALPHA SPECTROSCOPY BATCH WORKSHEET

Lab Name: TestAmerica St. Louis Job No.: 160-17563-1

SDG No.: \_\_\_\_\_

Batch Number: 254505 Batch Start Date: 06/02/16 14:38 Batch Analyst: Kennedy, Shannon EBatch Method: ExtChrom Batch End Date: 06/06/16 09:45

| Lab Sample ID        | Client Sample ID | Method Chain        | Basis | InitialAmount | U-232 00032 | UNAT 00012 |  |  |  |
|----------------------|------------------|---------------------|-------|---------------|-------------|------------|--|--|--|
| MB 160-254505/1      |                  | ExtChrom,<br>A-01-R |       | 500 mL        | 0.1 mL      |            |  |  |  |
| LCS<br>160-254505/2  |                  | ExtChrom,<br>A-01-R |       | 500 mL        | 0.1 mL      | 0.1 mL     |  |  |  |
| LCSD<br>160-254505/3 |                  | ExtChrom,<br>A-01-R |       | 500 mL        | 0.1 mL      | 0.1 mL     |  |  |  |
| 160-17563-A-1        | GW-GWW-052616    | ExtChrom,<br>A-01-R | T     | 500.47 mL     | 0.1 mL      |            |  |  |  |
| 160-17563-A-2        | GW-NB34-052616   | ExtChrom,<br>A-01-R | T     | 500.48 mL     | 0.1 mL      |            |  |  |  |
| 160-17563-B-3        | GW-GWY-052616    | ExtChrom,<br>A-01-R | T     | 500.54 mL     | 0.1 mL      |            |  |  |  |
| 160-17563-B-4        | GW-PZ02-052616   | ExtChrom,<br>A-01-R | T     | 500.37 mL     | 0.1 mL      |            |  |  |  |

| Batch Notes                       |                        |
|-----------------------------------|------------------------|
| Balance ID                        | 1125353055             |
| Analyst ID - Column               | sek                    |
| Column Date                       | 6/3/16                 |
| Analyst ID - CoPrecipitation      | nmn                    |
| CoPrecipitation Date              | 6/6/16                 |
| Pipette ID                        | RAD 097                |
| Analyst ID - Reagent Drop Witness | rjs per sek            |
| Analyst ID - Reagent Drop         | sek                    |
| SOP Number                        | ST-RC-0100, ST-RC-0232 |

| Basis | Basis Description |
|-------|-------------------|
| T     | Total/NA          |

The pound sign (#) in the amount added field denotes that the reagent was used undiluted. All calculations are performed using the stated concentration for this reagent.

A-01-R

Page 1 of 1

Sample Name: MB 160-254505/1-A Type: Blank  
Spectrum #2 Analysis #1  
: MB 160-254505/1-A  
Sample Collection Date: 6/6/2016 9:46:00AM  
Comment:

## Sample

Sample Volume : 0.50 Sample Units: L  
First Stage Dilution: N/A  
Aliquot: N/A Aliquot Fraction: N/A  
Dilution 2: N/A  
Lab Preparation:

Batch Name: 254505

## Batch

Client Name: Undefined  
Client Contact:  
Analyst: 60040

Description:

## Tracer

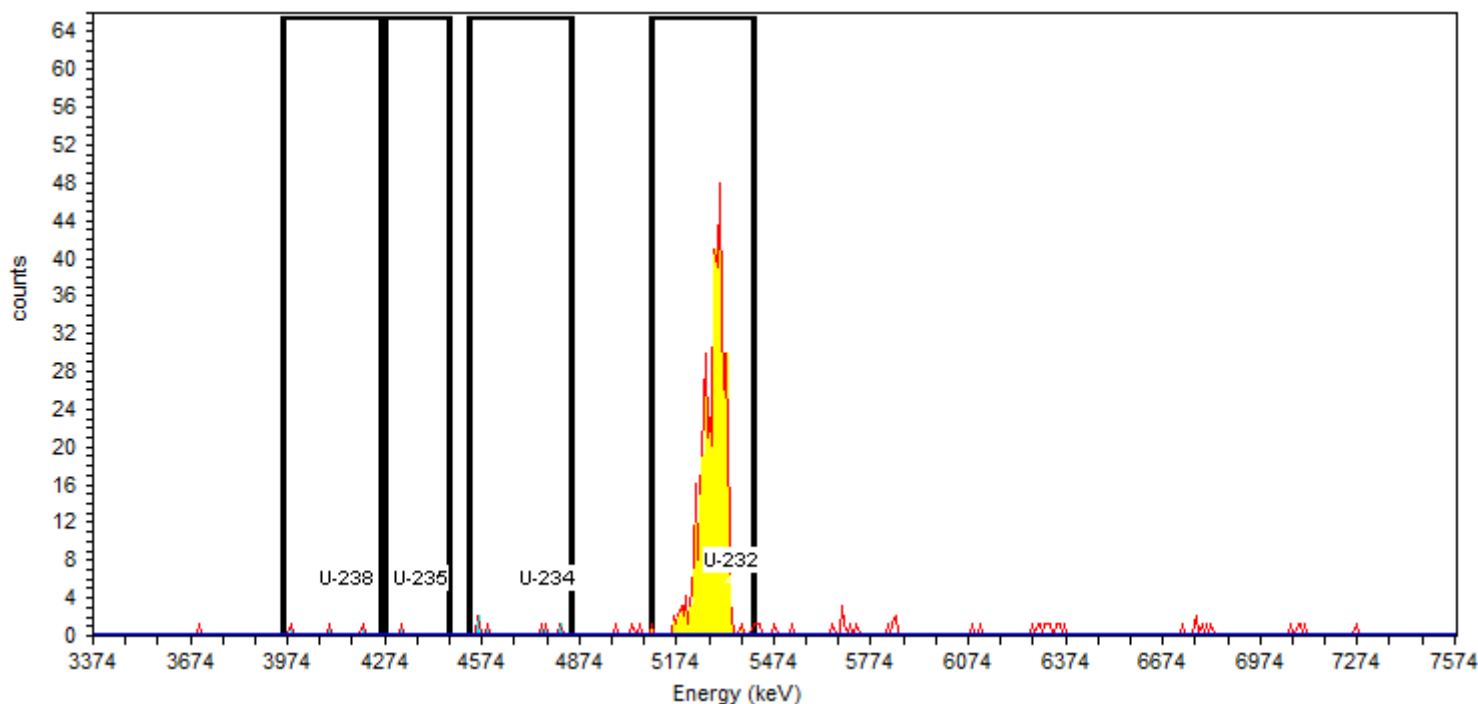
Tracer Name: U-232\_00032  
Tracer Activity: 82.25 DPM / mL x (Vol.) 0.10 mL = 8.22 DPM  
Tracer Ref. Date: 8/25/2011 12:03:08PM

Tracer Nuclide: U-232  
Tracer Recovery: 52.68%

Detector: AV192 SN: 50-119J7  
Acquisition Start Date: 6/8/2016 2:16:58PM  
Live Time: 400.00 min.  
Real Time: 400.01 min.  
Background Date: 5/19/2016 1:01:37PM  
Bkgd Info: Sample: ICB;AV192; Det: AV192; Spectrum #1; 5/19/2016  
1:01:37 PM

## Acquisition

Energy Calibration: IC-8876;AV192-20151017  
Efficiency Calibration:IC-8876;AV192-20151017  
Calibration Date: 10/18/2015 3:55:07PM  
Energy Cal: Gain = 7.4575 keV / Ch  
Offset = 3,366.95 keV  
Quadratic = 0.0000 keV / Ch<sup>2</sup>  
Efficiency: 24.71% +/- 0.29% TPU(2 sigma)



## General Analysis

Analysis Method: ROI Analysis, Set Name = UROI  
Decay Correction:6/7/2016 5:16:08PM  
MDA Constants:  $K\alpha = 1.64$ ,  $K\beta = 1.64$

Nuclide Library: Uranium  
MDA Source: Background

## Nuclide Summary (ROI)

| Nuclide | Peak Energy keV | Peak Expected keV | Peak Diff keV | ROI Start keV | ROI End keV | FWHM keV | B.R. % | Gross Counts | Bkgd Counts | Net Counts | Activity   | Units |
|---------|-----------------|-------------------|---------------|---------------|-------------|----------|--------|--------------|-------------|------------|------------|-------|
| U-238   | 4157.5          | 4,196.0           | -38.5         | 3956.1        | 4261.9      | 28.5     | 100.0  | 3            | 0.4167      | 2.58       | 4.469E-002 | pCi/L |
| U-235   | 4381.2          | 4,396.0           | -14.8         | 4269.3        | 4470.7      | 18.3     | 80.2   | 1            | 0.0000      | 1.00       | 2.157E-002 | pCi/L |
| U-234   | 4776.4          | 4,775.8           | 0.6           | 4530.3        | 4851.0      | 9.4      | 99.8   | 6            | 1.6667      | 4.33       | 7.512E-002 | pCi/L |
| U-232   | 5343.2          | 5,320.3           | 22.9          | 5097.1        | 5410.3      | 72.0     | 100.1  | 411          | 1.6667      | 409.33     | 3.903E+000 | pCi/L |

Sample Name: **LCS 160-254505/2-A** Type: **Control**  
Spectrum #2 Analysis #1  
: **LCS 160-254505/2-A**  
Sample Collection Date: **6/6/2016 9:46:00AM**  
Comment:

### Sample

Sample Volume : **0.50** Sample Units: **L**  
First Stage Dilution: **N/A**  
Aliquot: **N/A** Aliquot Fraction: **N/A**  
Dilution 2: **N/A**  
Lab Preparation:

Batch Name: **254505**

### Batch

Client Name: **Undefined**  
Client Contact:  
Analyst: **60040**

Description:

### Tracer

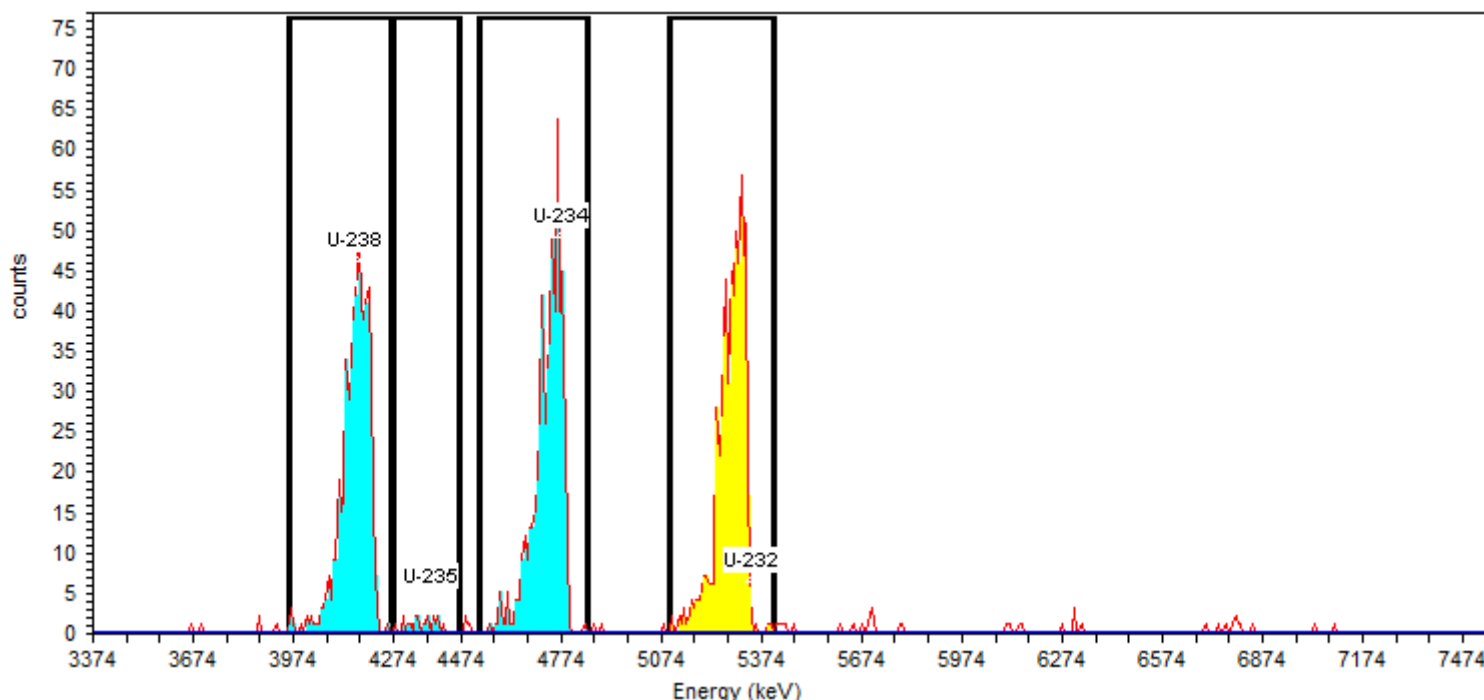
Tracer Name: **U-232\_00032**  
Tracer Activity: **82.25 DPM / mL x (Vol.) 0.10 mL = 8.22 DPM**  
Tracer Ref. Date: **8/25/2011 12:03:08PM**

Tracer Nuclide: **U-232**  
Tracer Recovery: **76.04%**

Detector: **AV193** SN: **50-11915**  
Acquisition Start Date: **6/8/2016 2:16:59PM**  
Live Time: **400.00 min.**  
Real Time: **400.00 min.**  
Background Date: **5/19/2016 1:01:37PM**  
Bkgd Info: **Sample: ICB;AV193; Det: AV193; Spectrum #1; 5/19/2016 1:01:37 PM**

### Acquisition

Energy Calibration: **IC-8877;AV193-20151017**  
Efficiency Calibration: **IC-8877;AV193-20151017**  
Calibration Date: **10/18/2015 3:55:11PM**  
Energy Cal: Gain = **7.4575 keV / Ch**  
Offset = **3,366.95 keV**  
Quadratic = **0.0000 keV / Ch<sup>2</sup>**  
Efficiency: **25.42% +/- 0.31% TPU(2 sigma)**



### General Analysis

Analysis Method: **ROI Analysis, Set Name = UROI**  
Decay Correction: **6/7/2016 5:16:06PM**  
MDA Constants: **K $\alpha$  = 1.64 , K $\beta$  = 1.64**

Nuclide Library: **Uranium**  
MDA Source: **Background**

### Nuclide Summary (ROI)

| Nuclide | Peak Energy keV | Peak Expected keV | Peak Diff keV | ROI Start keV | ROI End keV | FWHM keV | B.R. % | Gross Counts | Bkgd Counts | Net Counts | Activity   | Units |
|---------|-----------------|-------------------|---------------|---------------|-------------|----------|--------|--------------|-------------|------------|------------|-------|
| U-238   | 4157.5          | 4,196.0           | -38.5         | 3956.1        | 4261.9      | 85.4     | 100.0  | 550          | 0.0000      | 550.00     | 6.408E+000 | pCi/L |
| U-235   | 4381.2          | 4,396.0           | -14.8         | 4269.3        | 4470.7      | 110.1    | 80.2   | 19           | 0.0000      | 19.00      | 2.760E-001 | pCi/L |
| U-234   | 4776.4          | 4,775.8           | 0.6           | 4530.3        | 4851.0      | 76.4     | 99.8   | 557          | 0.8333      | 556.17     | 6.492E+000 | pCi/L |
| U-232   | 5343.2          | 5,320.3           | 22.9          | 5097.1        | 5410.3      | 85.4     | 100.1  | 612          | 4.1667      | 607.83     | 5.634E+000 | pCi/L |

Sample Name: **LCSD 160-254505/3-A** Type: **Control**  
 Spectrum #2 Analysis #1  
 : **LCSD 160-254505/3-A**  
 Sample Collection Date: **6/6/2016 9:46:00AM**  
 Comment:

## Sample

Sample Volume : **0.50** Sample Units: **L**  
 First Stage Dilution: **N/A**  
 Aliquot: **N/A** Aliquot Fraction: **N/A**  
 Dilution 2: **N/A**  
 Lab Preparation:

Batch Name: **254505**

## Batch

Client Name: **Undefined**  
 Client Contact:  
 Analyst: **60040**

Description:

## Tracer

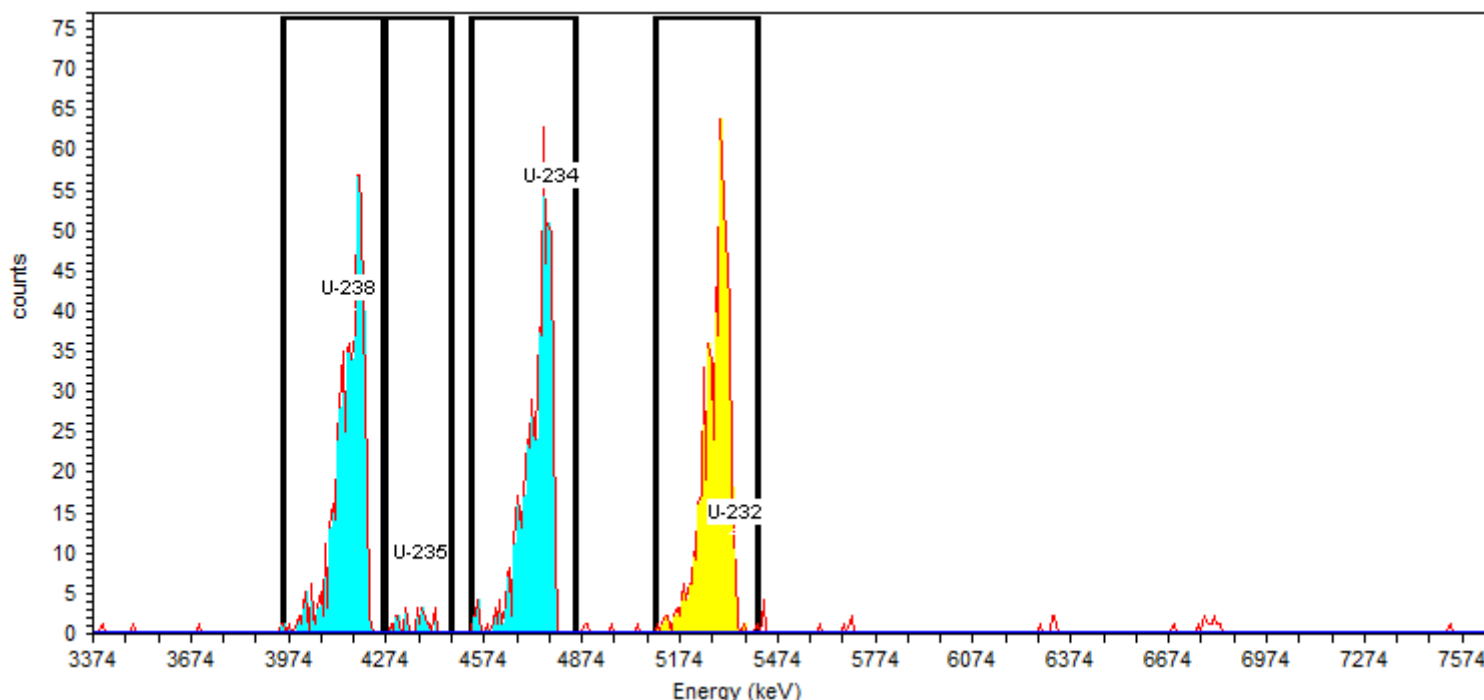
Tracer Name: **U-232\_00032**  
 Tracer Activity: **82.25 DPM / mL x (Vol.) 0.10 mL = 8.22 DPM**  
 Tracer Ref. Date: **8/25/2011 12:03:08PM**

Tracer Nuclide: **U-232**  
 Tracer Recovery: **73.63%**

Detector: **AV195** SN: **50-117AA2**  
 Acquisition Start Date: **6/8/2016 2:16:59PM**  
 Live Time: **400.00 min.**  
 Real Time: **400.00 min.**  
 Background Date: **5/19/2016 1:01:38PM**  
 Bkgd Info: **Sample: ICB;AV195; Det: AV195; Spectrum #1; 5/19/2016 1:01:38 PM**

## Acquisition

Energy Calibration: **IC-9792;AV195-20151017a**  
 Efficiency Calibration: **IC-9792;AV195-20151017a**  
 Calibration Date: **10/18/2015 3:55:41PM**  
 Energy Cal: Gain = **7.4575 keV / Ch**  
 Offset = **3,366.95 keV**  
 Quadratic = **0.0000 keV / Ch<sup>2</sup>**  
 Efficiency: **25.85% +/- 0.30% TPU(2 sigma)**



## General Analysis

Analysis Method: **ROI Analysis, Set Name = UROI**  
 Decay Correction: **6/7/2016 5:16:07PM**  
 MDA Constants: **K $\alpha$  = 1.64, K $\beta$  = 1.64**

Nuclide Library: **Uranium**  
 MDA Source: **Background**

## Nuclide Summary (ROI)

| Nuclide | Peak Energy keV | Peak Expected keV | Peak Diff keV | ROI Start keV | ROI End keV | FWHM keV | B.R. % | Gross Counts | Bkgd Counts | Net Counts | Activity   | Units |
|---------|-----------------|-------------------|---------------|---------------|-------------|----------|--------|--------------|-------------|------------|------------|-------|
| U-238   | 4157.5          | 4,196.0           | -38.5         | 3956.1        | 4261.9      | 83.8     | 100.0  | 573          | 0.0000      | 573.00     | 6.782E+000 | pCi/L |
| U-235   | 4381.2          | 4,396.0           | -14.8         | 4269.3        | 4470.7      | 101.4    | 80.2   | 24           | 0.0000      | 24.00      | 3.542E-001 | pCi/L |
| U-234   | 4776.4          | 4,775.8           | 0.6           | 4530.3        | 4851.0      | 65.2     | 99.8   | 561          | 1.2500      | 559.75     | 6.638E+000 | pCi/L |
| U-232   | 5343.2          | 5,320.3           | 22.9          | 5097.1        | 5410.3      | 80.3     | 100.1  | 600          | 1.6667      | 598.33     | 5.456E+000 | pCi/L |

Sample Name: 160-17563-A-1-B Type: Sample  
Spectrum #2 Analysis #1  
: 160-17563-A-1-B  
Sample Collection Date: 5/26/2016 10:50:00AM  
Comment:

## Sample

Sample Volume : 0.50 Sample Units: L  
First Stage Dilution: N/A  
Aliquot: N/A Aliquot Fraction: N/A  
Dilution 2: N/A  
Lab Preparation:

Batch Name: 254505

## Batch

Client Name: Undefined  
Client Contact:  
Analyst: 60040

Description:

## Tracer

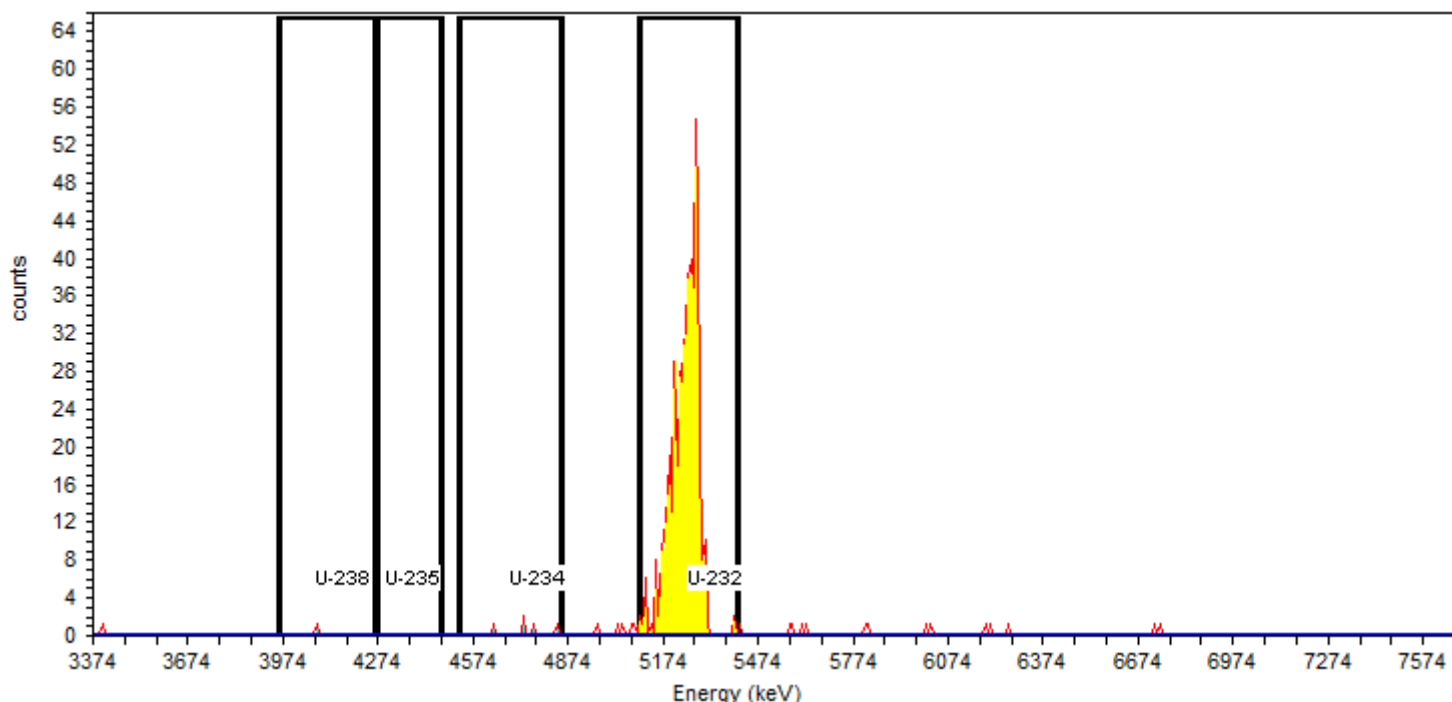
Tracer Name: U-232\_00032  
Tracer Activity: 82.25 DPM / mL x (Vol.) 0.10 mL = 8.22 DPM  
Tracer Ref. Date: 8/25/2011 12:03:08PM

Tracer Nuclide: U-232  
Tracer Recovery: 66.70%

Detector: AV197 SN: 50-117Z5  
Acquisition Start Date: 6/8/2016 2:16:59PM  
Live Time: 400.00 min.  
Real Time: 400.00 min.  
Background Date: 5/19/2016 1:01:38PM  
Bkgd Info: Sample: ICB;AV197; Det: AV197; Spectrum #1; 5/19/2016 1:01:38 PM

## Acquisition

Energy Calibration: IC-9794;AV197-20151017  
Efficiency Calibration:IC-9794;AV197-20151017  
Calibration Date: 10/18/2015 3:55:22PM  
Energy Cal: Gain = 7.4575 keV / Ch  
Offset = 3,366.95 keV  
Quadratic = 0.0000 keV / Ch<sup>2</sup>  
Efficiency: 24.48% +/- 0.31% TPU(2 sigma)



## General Analysis

Analysis Method: ROI Analysis, Set Name = UROI  
Decay Correction:6/7/2016 5:16:06PM  
MDA Constants:  $K\alpha = 1.64$ ,  $K\beta = 1.64$

Nuclide Library: Uranium  
MDA Source: Background

## Nuclide Summary (ROI)

| Nuclide | Peak Energy keV | Peak Expected keV | Peak Diff keV | ROI Start keV | ROI End keV | FWHM keV | B.R. % | Gross Counts | Bkgd Counts | Net Counts | Activity   | Units |
|---------|-----------------|-------------------|---------------|---------------|-------------|----------|--------|--------------|-------------|------------|------------|-------|
| U-238   | 4157.5          | 4,196.0           | -38.5         | 3956.1        | 4261.9      | 44.5     | 100.0  | 1            | 0.0000      | 1.00       | 1.378E-002 | pCi/L |
| U-235   | 4381.2          | 4,396.0           | -14.8         | 4269.3        | 4470.7      | .0       | 80.2   | 0            | 0.0000      | 0.00       | 0.000E+000 | pCi/L |
| U-234   | 4776.4          | 4,775.8           | 0.6           | 4530.3        | 4851.0      | 10.7     | 99.8   | 5            | 0.0000      | 5.00       | 6.906E-002 | pCi/L |
| U-232   | 5343.2          | 5,320.3           | 22.9          | 5097.1        | 5410.3      | 86.1     | 100.1  | 517          | 3.7500      | 513.25     | 4.937E+000 | pCi/L |

Sample Name: 160-17563-A-2-A Type: Sample  
Spectrum #2 Analysis #1  
: 160-17563-A-2-A  
Sample Collection Date: 5/26/2016 2:00:00PM  
Comment:

## Sample

Sample Volume : 0.50 Sample Units: L  
First Stage Dilution: N/A  
Aliquot: N/A Aliquot Fraction: N/A  
Dilution 2: N/A  
Lab Preparation:

Batch Name: 254505

## Batch

Client Name: Undefined  
Client Contact:  
Analyst: 60040

Description:

## Tracer

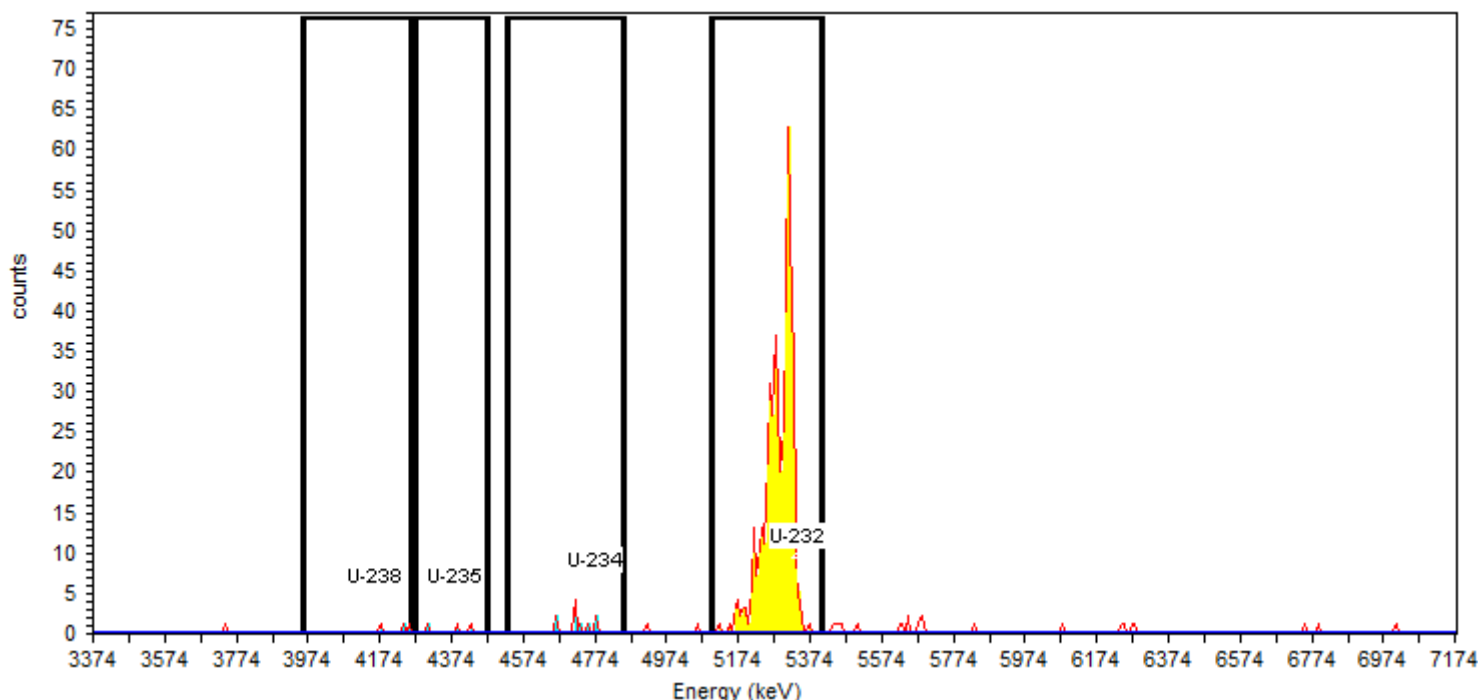
Tracer Name: U-232\_00032  
Tracer Activity: 82.25 DPM / mL x (Vol.) 0.10 mL = 8.22 DPM  
Tracer Ref. Date: 8/25/2011 12:03:08PM

Tracer Nuclide: U-232  
Tracer Recovery: 56.31%

Detector: AV198 SN: 50-117AA7  
Acquisition Start Date: 6/8/2016 2:17:00PM  
Live Time: 400.00 min.  
Real Time: 400.00 min.  
Background Date: 5/19/2016 1:01:38PM  
Bkgd Info: Sample: ICB;AV198; Det: AV198; Spectrum #1; 5/19/2016  
1:01:38 PM

## Acquisition

Energy Calibration: CCV-9795;AV198-20151122  
Efficiency Calibration:CCV-9795;AV198-20151122  
Calibration Date: 11/22/2015 4:27:37PM  
Energy Cal: Gain = 7.4575 keV / Ch  
Offset = 3,366.95 keV  
Quadratic = 0.0000 keV / Ch<sup>2</sup>  
Efficiency: 25.90% +/- 0.46% TPU(2 sigma)



## General Analysis

Analysis Method: ROI Analysis, Set Name = UROI  
Decay Correction: 6/7/2016 5:16:06PM  
MDA Constants:  $K\alpha = 1.64$ ,  $K\beta = 1.64$

Nuclide Library: Uranium  
MDA Source: Background

## Nuclide Summary (ROI)

| Nuclide | Peak Energy keV | Peak Expected keV | Peak Diff keV | ROI Start keV | ROI End keV | FWHM keV | B.R. % | Gross Counts | Bkgd Counts | Net Counts | Activity   | Units |
|---------|-----------------|-------------------|---------------|---------------|-------------|----------|--------|--------------|-------------|------------|------------|-------|
| U-238   | 4157.5          | 4,196.0           | -38.5         | 3956.1        | 4261.9      | 24.9     | 100.0  | 3            | 0.8333      | 2.17       | 3.343E-002 | pCi/L |
| U-235   | 4381.2          | 4,396.0           | -14.8         | 4269.3        | 4470.7      | 18.3     | 80.2   | 3            | 2.0833      | 0.92       | 1.763E-002 | pCi/L |
| U-234   | 4776.4          | 4,775.8           | 0.6           | 4530.3        | 4851.0      | 43.3     | 99.8   | 10           | 6.2500      | 3.75       | 5.797E-002 | pCi/L |
| U-232   | 5343.2          | 5,320.3           | 22.9          | 5097.1        | 5410.3      | 86.3     | 100.1  | 464          | 5.4167      | 458.58     | 4.168E+000 | pCi/L |

Sample Name: 160-17563-B-3-A Type: Sample  
Spectrum #2 Analysis #1  
: 160-17563-B-3-A  
Sample Collection Date: 5/26/2016 3:15:00PM  
Comment:

## Sample

Sample Volume : 0.50 Sample Units: L  
First Stage Dilution: N/A  
Aliquot: N/A Aliquot Fraction: N/A  
Dilution 2: N/A  
Lab Preparation:

Batch Name: 254505

## Batch

Client Name: Undefined  
Client Contact:  
Analyst: 60040

Description:

## Tracer

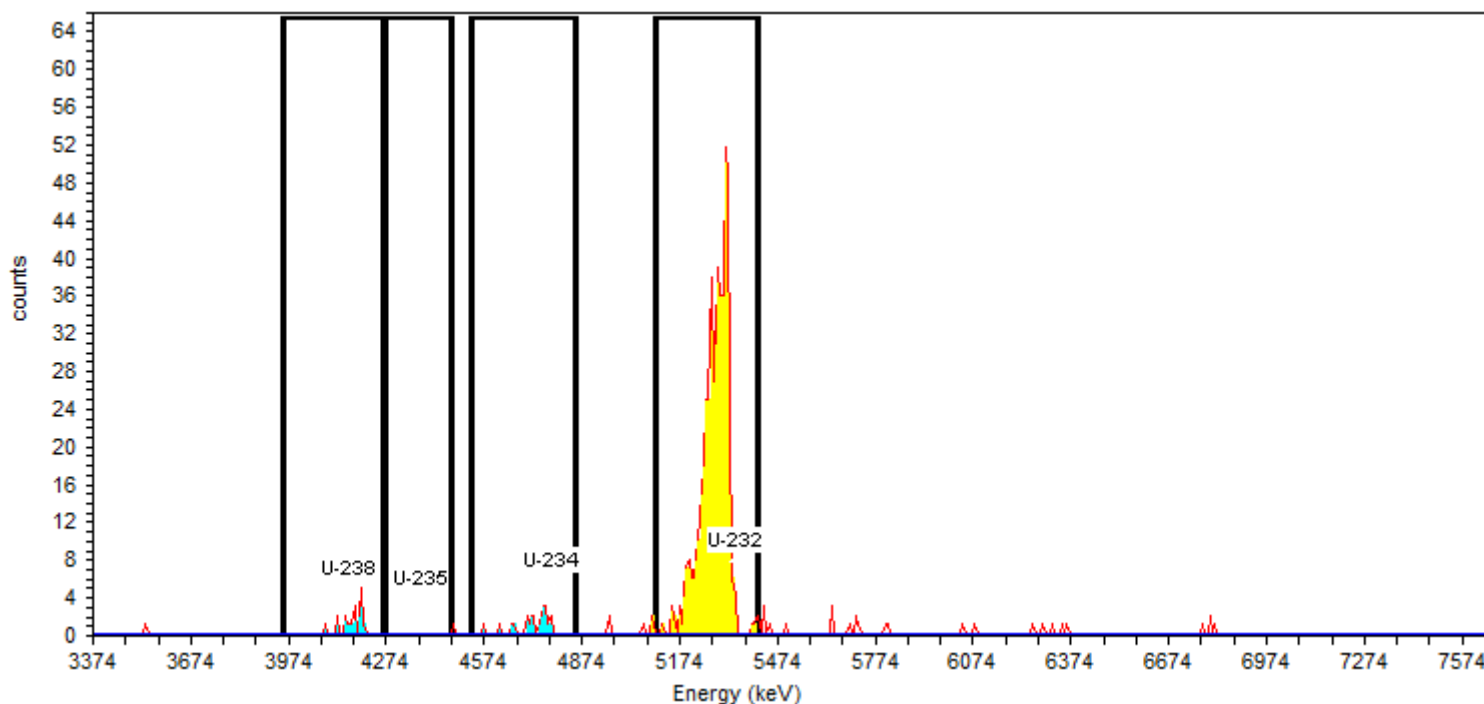
Tracer Name: U-232\_00032  
Tracer Activity: 82.25 DPM / mL x (Vol.) 0.10 mL = 8.22 DPM  
Tracer Ref. Date: 8/25/2011 12:03:08PM

Tracer Nuclide: U-232  
Tracer Recovery: 62.49%

Detector: AV199 SN: 50-117Z3  
Acquisition Start Date: 6/8/2016 2:17:00PM  
Live Time: 400.00 min.  
Real Time: 400.01 min.  
Background Date: 5/19/2016 1:01:39PM  
Bkgd Info: Sample: ICB;AV199; Det: AV199; Spectrum #1; 5/19/2016 1:01:39 PM

## Acquisition

Energy Calibration: IC-9817;AV199-20151017  
Efficiency Calibration:IC-9817;AV199-20151017  
Calibration Date: 10/18/2015 3:55:29PM  
Energy Cal: Gain = 7.4575 keV / Ch  
Offset = 3,366.95 keV  
Quadratic = 0.0000 keV / Ch<sup>2</sup>  
Efficiency: 24.71% +/- 0.30% TPU(2 sigma)



## General Analysis

Analysis Method: ROI Analysis, Set Name = UROI  
Decay Correction:6/7/2016 5:16:06PM  
MDA Constants:  $K\alpha = 1.64$ ,  $K\beta = 1.64$

Nuclide Library: Uranium  
MDA Source: Background

## Nuclide Summary (ROI)

| Nuclide | Peak Energy keV | Peak Expected keV | Peak Diff keV | ROI Start keV | ROI End keV | FWHM keV | B.R. % | Gross Counts | Bkgd Counts | Net Counts | Activity   | Units |
|---------|-----------------|-------------------|---------------|---------------|-------------|----------|--------|--------------|-------------|------------|------------|-------|
| U-238   | 4157.5          | 4,196.0           | -38.5         | 3956.1        | 4261.9      | 67.5     | 100.0  | 19           | 0.0000      | 19.00      | 2.768E-001 | pCi/L |
| U-235   | 4381.2          | 4,396.0           | -14.8         | 4269.3        | 4470.7      | .0       | 80.2   | 0            | 0.0000      | 0.00       | 0.000E+000 | pCi/L |
| U-234   | 4776.4          | 4,775.8           | 0.6           | 4530.3        | 4851.0      | 77.0     | 99.8   | 23           | 0.4167      | 22.58      | 3.297E-001 | pCi/L |
| U-232   | 5343.2          | 5,320.3           | 22.9          | 5097.1        | 5410.3      | 83.0     | 100.1  | 488          | 2.5000      | 485.50     | 4.625E+000 | pCi/L |

Sample Name: 160-17563-B-4-A Type: Sample  
Spectrum #2 Analysis #1  
: 160-17563-B-4-A  
Sample Collection Date: 5/26/2016 2:35:00PM  
Comment:

## Sample

Sample Volume : 0.50 Sample Units: L  
First Stage Dilution: N/A  
Aliquot: N/A Aliquot Fraction: N/A  
Dilution 2: N/A  
Lab Preparation:

Batch Name: 254505

## Batch

Client Name: Undefined  
Client Contact:  
Analyst: 60040

Description:

## Tracer

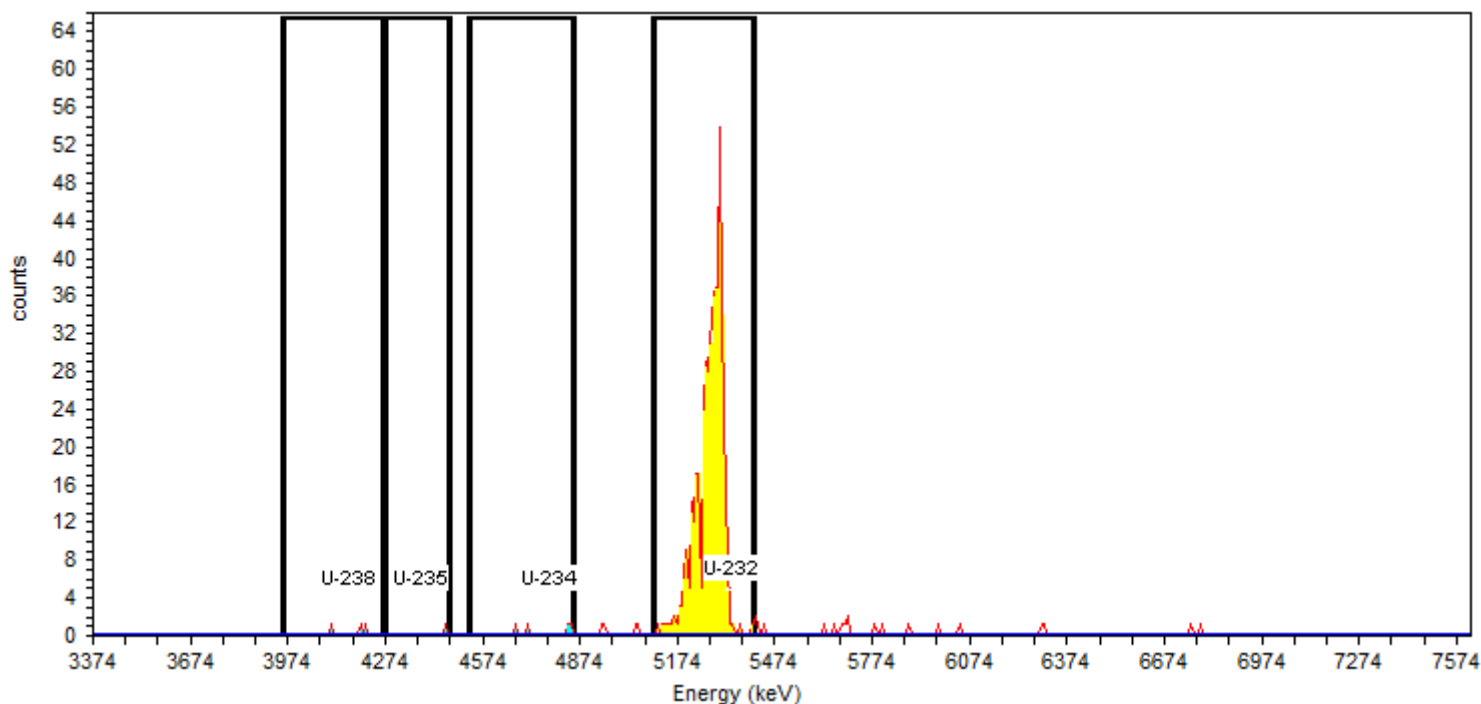
Tracer Name: U-232\_00032  
Tracer Activity: 82.25 DPM / mL x (Vol.) 0.10 mL = 8.22 DPM  
Tracer Ref. Date: 8/25/2011 12:03:08PM

Tracer Nuclide: U-232  
Tracer Recovery: 56.43%

Detector: AV200 SN: 50-117J6  
Acquisition Start Date: 6/8/2016 2:17:00PM  
Live Time: 400.00 min.  
Real Time: 400.00 min.  
Background Date: 5/20/2016 3:00:07PM  
Bkgd Info: Sample: ICB;AV200; Det: AV200; Spectrum #1; 5/20/2016  
3:00:07 PM

## Acquisition

Energy Calibration: IC-9884;AV200-20151017  
Efficiency Calibration:IC-9884;AV200-20151017  
Calibration Date: 10/18/2015 3:55:33PM  
Energy Cal: Gain = 7.4575 keV / Ch  
Offset = 3,366.95 keV  
Quadratic = 0.0000 keV / Ch<sup>2</sup>  
Efficiency: 24.41% +/- 0.35% TPU(2 sigma)



## General Analysis

Analysis Method: ROI Analysis, Set Name = UROI  
Decay Correction: 6/7/2016 5:16:06PM  
MDA Constants:  $K\alpha = 1.64$ ,  $K\beta = 1.64$

Nuclide Library: Uranium  
MDA Source: Background

## Nuclide Summary (ROI)

| Nuclide | Peak Energy keV | Peak Expected keV | Peak Diff keV | ROI Start keV | ROI End keV | FWHM keV | B.R. % | Gross Counts | Bkgd Counts | Net Counts | Activity   | Units |
|---------|-----------------|-------------------|---------------|---------------|-------------|----------|--------|--------------|-------------|------------|------------|-------|
| U-238   | 4157.5          | 4,196.0           | -38.5         | 3956.1        | 4261.9      | 126.0    | 100.0  | 3            | 1.2500      | 1.75       | 2.860E-002 | pCi/L |
| U-235   | 4381.2          | 4,396.0           | -14.8         | 4269.3        | 4470.7      | 11.0     | 80.2   | 1            | 0.0000      | 1.00       | 2.038E-002 | pCi/L |
| U-234   | 4776.4          | 4,775.8           | 0.6           | 4530.3        | 4851.0      | 15.5     | 99.8   | 4            | 1.6667      | 2.33       | 3.821E-002 | pCi/L |
| U-232   | 5343.2          | 5,320.3           | 22.9          | 5097.1        | 5410.3      | 69.6     | 100.1  | 438          | 5.0000      | 433.00     | 4.178E+000 | pCi/L |

# Daily Checks

## Alpha Spectroscopy Daily Pulser Check

Analysis Date: 06/08/16

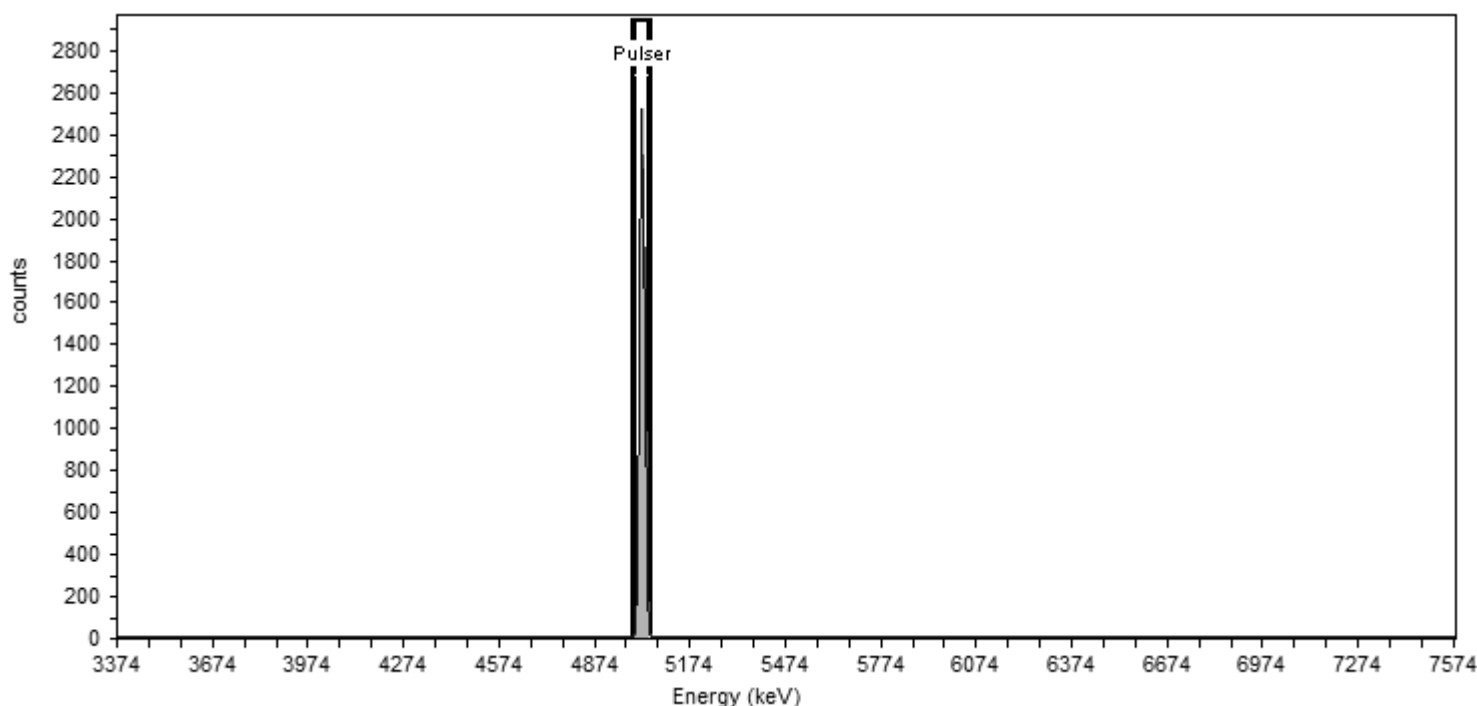
| Detector | Analysis Date  | Gross Counts |               |      | FWHM (keV) |          |      | Pulser Center |             |      | Energy (keV) |               |      |
|----------|----------------|--------------|---------------|------|------------|----------|------|---------------|-------------|------|--------------|---------------|------|
|          |                | Result       | Criteria      | P/F  | Result     | Criteria | P/F  | Result        | Criteria    | P/F  | Result       | Criteria      | P/F  |
| AV192    | 06/08/16 10:01 | 5979         | 5701.2-6301.3 | Pass | 16.4       | 10-20    | Pass | 222.0         | 217.0-227.0 | Pass | 5022         | 4982.6-5062.6 | Pass |
| AV193    | 06/08/16 10:01 | 5747         | 5571.4-6157.9 | Pass | 13.1       | 10-20    | Pass | 223.0         | 217.1-227.1 | Pass | 5030         | 4983.4-5063.4 | Pass |
| AV195    | 06/08/16 10:01 | 5867         | 5665.0-6261.3 | Pass | 12.6       | 10-20    | Pass | 224.0         | 219.1-229.1 | Pass | 5037         | 4998.0-5078.0 | Pass |
| AV197    | 06/08/16 10:01 | 5966         | 5714.2-6315.7 | Pass | 16.6       | 10-20    | Pass | 217.1         | 211.9-221.9 | Pass | 4986         | 4944.8-5024.8 | Pass |
| AV198    | 06/08/16 10:01 | 6009         | 5708.4-6309.3 | Pass | 15.7       | 10-20    | Pass | 225.1         | 219.2-229.2 | Pass | 5046         | 4998.7-5078.7 | Pass |
| AV199    | 06/08/16 10:01 | 5767         | 5584.5-6172.3 | Pass | 12.8       | 10-20    | Pass | 218.9         | 214.0-224.0 | Pass | 4999         | 4959.9-5039.9 | Pass |
| AV200    | 06/08/16 10:01 | 6007         | 5688.6-6287.4 | Pass | 14.9       | 10-20    | Pass | 222.0         | 216.9-226.9 | Pass | 5022         | 4981.7-5061.7 | Pass |

**Sample**  
Sample Name: Pulser;AV192  
Comment: Spectrum #12 Analysis #1

**Batch**  
Batch Name: May2016b  
Description:

**Acquisition**  
Detector: AV192 , SN: 50-119J7  
Acquisition Start Date: 6/8/2016 10:01:53AM  
Live Time: 1.00 min.  
Real Time: 1.00 min.  
Calibration Name: IC-8876;AV192-20151017  
Calibration Date: 10/18/2015 3:55:07PM

Energy Calibration Equation:  
Gain = 7.4575 keV / Ch  
Offset = 3,366.95 keV  
Quadratic = 0.0000 keV / Ch<sup>2</sup>



**General Analysis**  
Analysis Method: Peak Fit Analysis

| Nuclide Summary (Peak Search) |                 |                  |                |          |          |              |
|-------------------------------|-----------------|------------------|----------------|----------|----------|--------------|
| Nuclide                       | Peak Energy keV | Start Energy keV | End Energy keV | FWHM keV | Fit Area | Gross Counts |
| Pulser                        | 5022.344        | 4994.411         | 5050.276       | 16.41    | 5,925.66 | 5,979.46     |

Sample Name: Pulser;AV193

Comment:

Sample

Spectrum #12 Analysis #1

Batch

Batch Name: May2016b

Description:

Acquisition

Detector: AV193 , SN: 50-119I5

Acquisition Start Date: 6/8/2016 10:01:53AM

Live Time: 1.00 min.

Real Time: 1.00 min.

Calibration Name: IC-8877;AV193-20151017

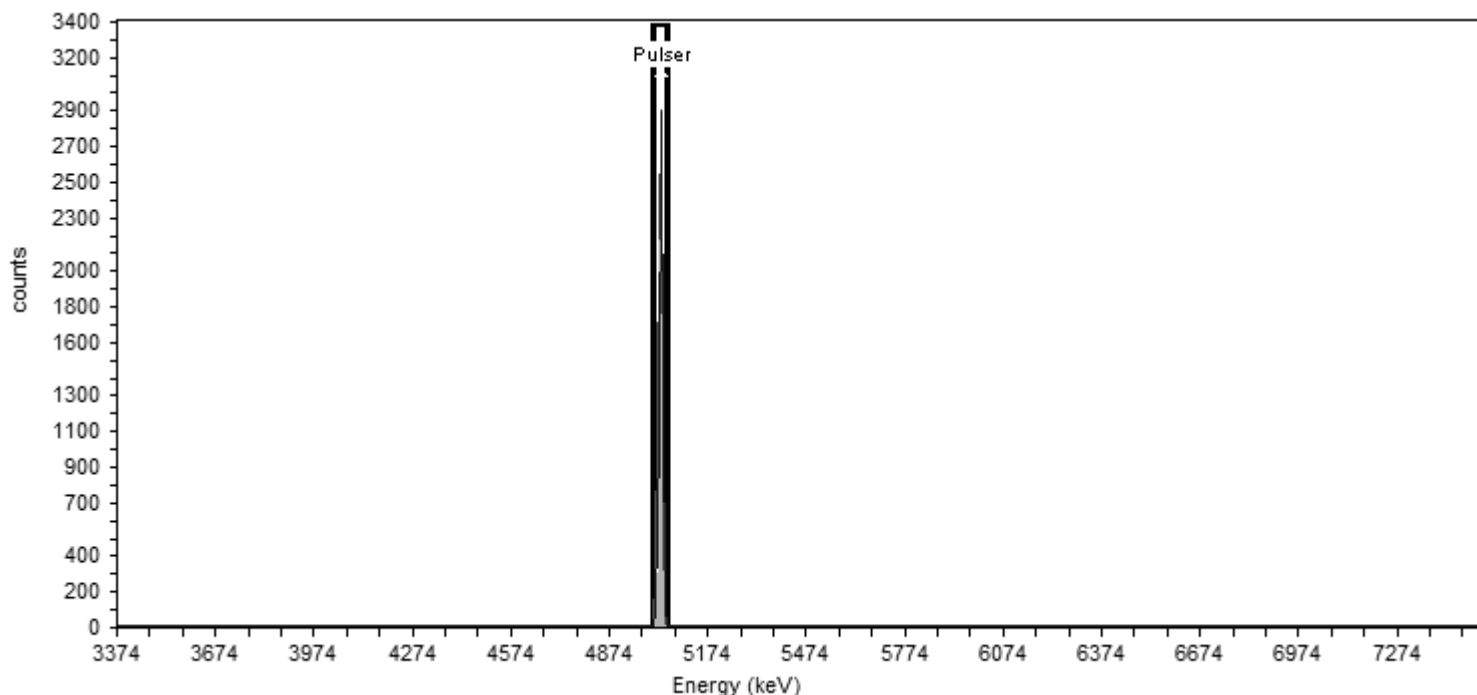
Calibration Date: 10/18/2015 3:55:11PM

Energy Calibration Equation:

Gain = 7.4575 keV / Ch

Offset = 3,366.95 keV

Quadratic = 0.0000 keV / Ch<sup>2</sup>



### General Analysis

Analysis Method: Peak Fit Analysis

### Nuclide Summary (Peak Search)

| Nuclide | Peak Energy keV | Start Energy keV | End Energy keV | FWHM keV | Fit Area | Gross Counts |
|---------|-----------------|------------------|----------------|----------|----------|--------------|
| Pulser  | 5030.355        | 5008.013         | 5052.698       | 13.13    | 5,458.71 | 5,747.37     |

Sample Name: Pulser;AV195

Comment:

### Sample

Spectrum #12 Analysis #1

### Batch

Batch Name: May2016b

Description:

### Acquisition

Detector: AV195 , SN: 50-117AA2

Acquisition Start Date: 6/8/2016 10:01:53AM

Live Time: 1.00 min.

Real Time: 1.01 min.

Calibration Name: IC-9792;AV195-20151017a

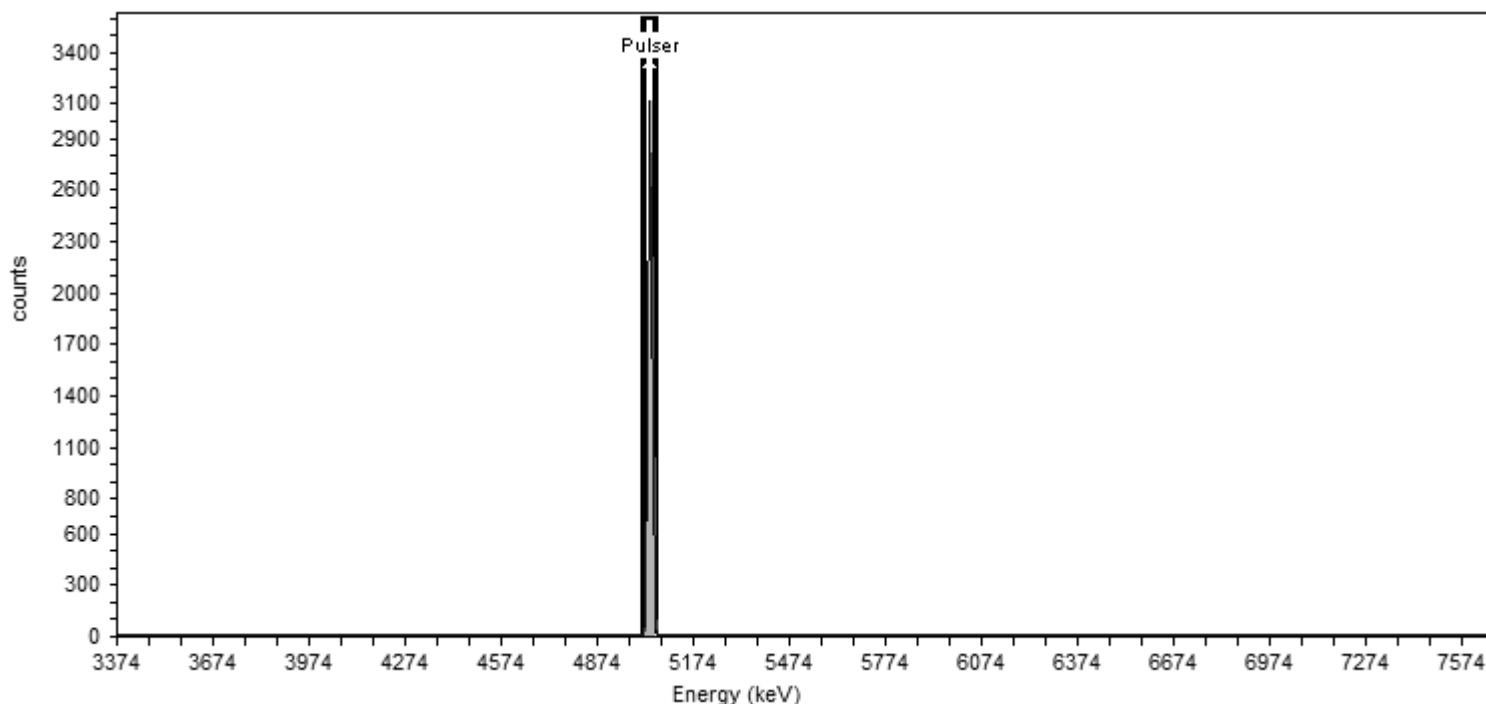
Calibration Date: 10/18/2015 3:55:41PM

Energy Calibration Equation:

Gain = 7.4575 keV / Ch

Offset = 3,366.95 keV

Quadratic = 0.0000 keV / Ch<sup>2</sup>



### General Analysis

Analysis Method: Peak Fit Analysis

### Nuclide Summary (Peak Search)

| Nuclide | Peak Energy keV | Start Energy keV | End Energy keV | FWHM keV | Fit Area | Gross Counts |
|---------|-----------------|------------------|----------------|----------|----------|--------------|
| Pulser  | 5037.222        | 5015.799         | 5058.645       | 12.59    | 5,622.80 | 5,867.23     |

Sample Name: Pulser;AV197

Comment:

**Sample**

Spectrum #12 Analysis #1

**Batch**

Batch Name: May2016b

Description:

**Acquisition**

Detector: AV197 , SN: 50-117Z5

Acquisition Start Date: 6/8/2016 10:01:54AM

Live Time: 1.00 min.

Real Time: 1.00 min.

Calibration Name: IC-9794;AV197-20151017

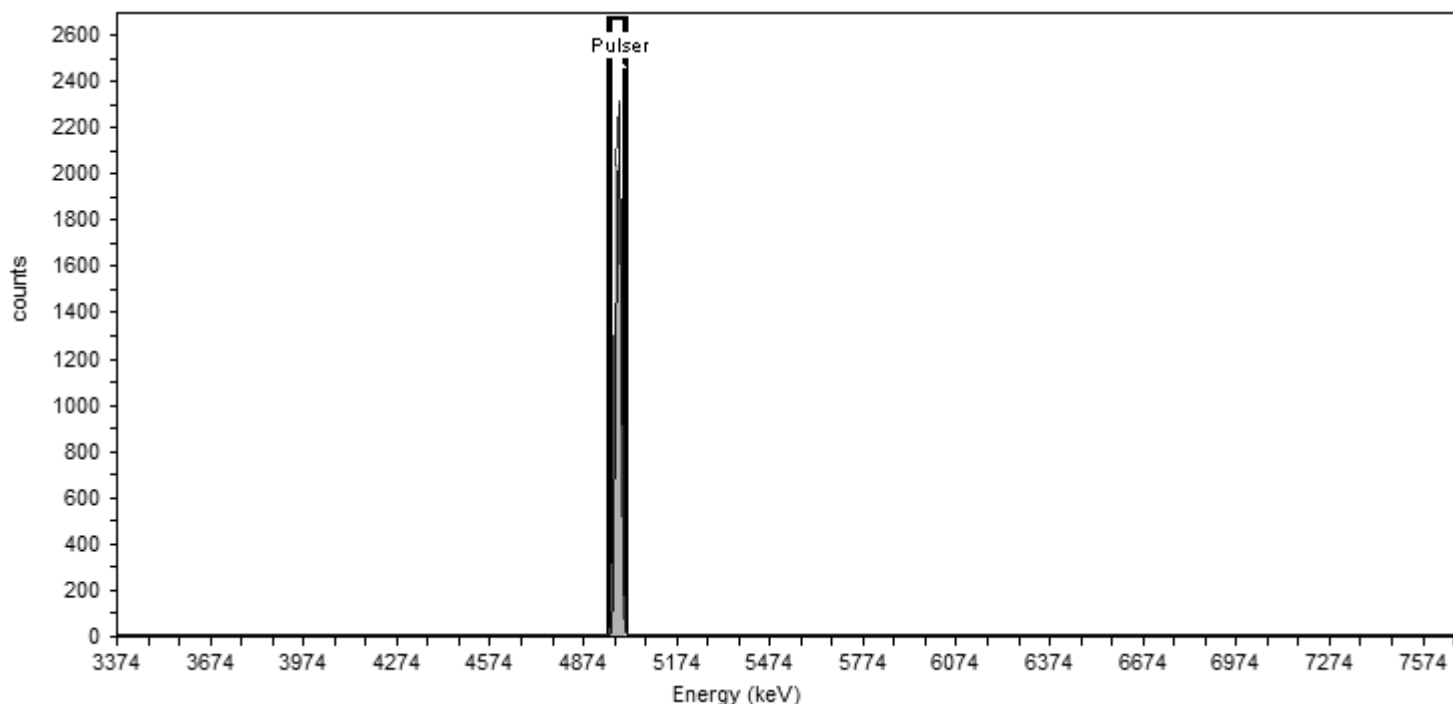
Calibration Date: 10/18/2015 3:55:22PM

Energy Calibration Equation:

Gain = 7.4575 keV / Ch

Offset = 3,366.95 keV

Quadratic = 0.0000 keV / Ch<sup>2</sup>



### General Analysis

Analysis Method: Peak Fit Analysis

### Nuclide Summary (Peak Search)

| Nuclide | Peak Energy keV | Start Energy keV | End Energy keV | FWHM keV | Fit Area | Gross Counts |
|---------|-----------------|------------------|----------------|----------|----------|--------------|
| Pulser  | 4986.102        | 4957.863         | 5014.340       | 16.59    | 5,497.12 | 5,965.58     |

Sample Name: Pulser;AV198

Comment:

### Sample

Spectrum #12 Analysis #1

### Batch

Batch Name: May2016b

Description:

### Acquisition

Detector: AV198 , SN: 50-117AA7

Acquisition Start Date: 6/8/2016 10:01:54AM

Live Time: 1.00 min.

Real Time: 1.00 min.

Calibration Name: CCV-9795;AV198-20151122

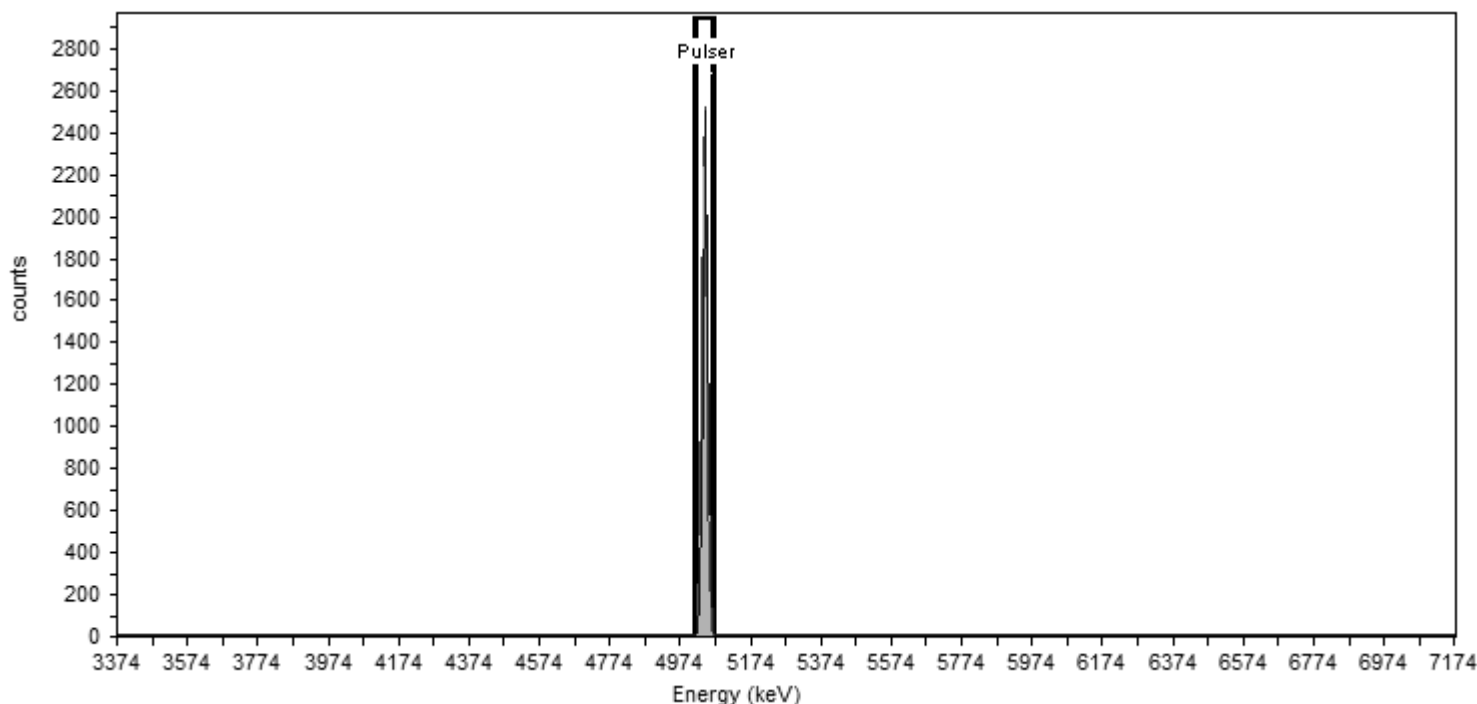
Calibration Date: 11/22/2015 4:27:37PM

Energy Calibration Equation:

Gain = 7.4575 keV / Ch

Offset = 3,366.95 keV

Quadratic = 0.0000 keV / Ch<sup>2</sup>



### General Analysis

Analysis Method: Peak Fit Analysis

### Nuclide Summary (Peak Search)

| Nuclide | Peak Energy keV | Start Energy keV | End Energy keV | FWHM keV | Fit Area | Gross Counts |
|---------|-----------------|------------------|----------------|----------|----------|--------------|
| Pulser  | 5045.620        | 5018.962         | 5072.277       | 15.66    | 5,659.62 | 6,009.22     |

Sample Name: Pulser;AV199

Comment:

**Sample**

Spectrum #12 Analysis #1

**Batch**

Batch Name: May2016b

Description:

**Acquisition**

Detector: AV199 , SN: 50-117Z3

Acquisition Start Date: 6/8/2016 10:01:54AM

Live Time: 1.00 min.

Real Time: 1.00 min.

Calibration Name: IC-9817;AV199-20151017

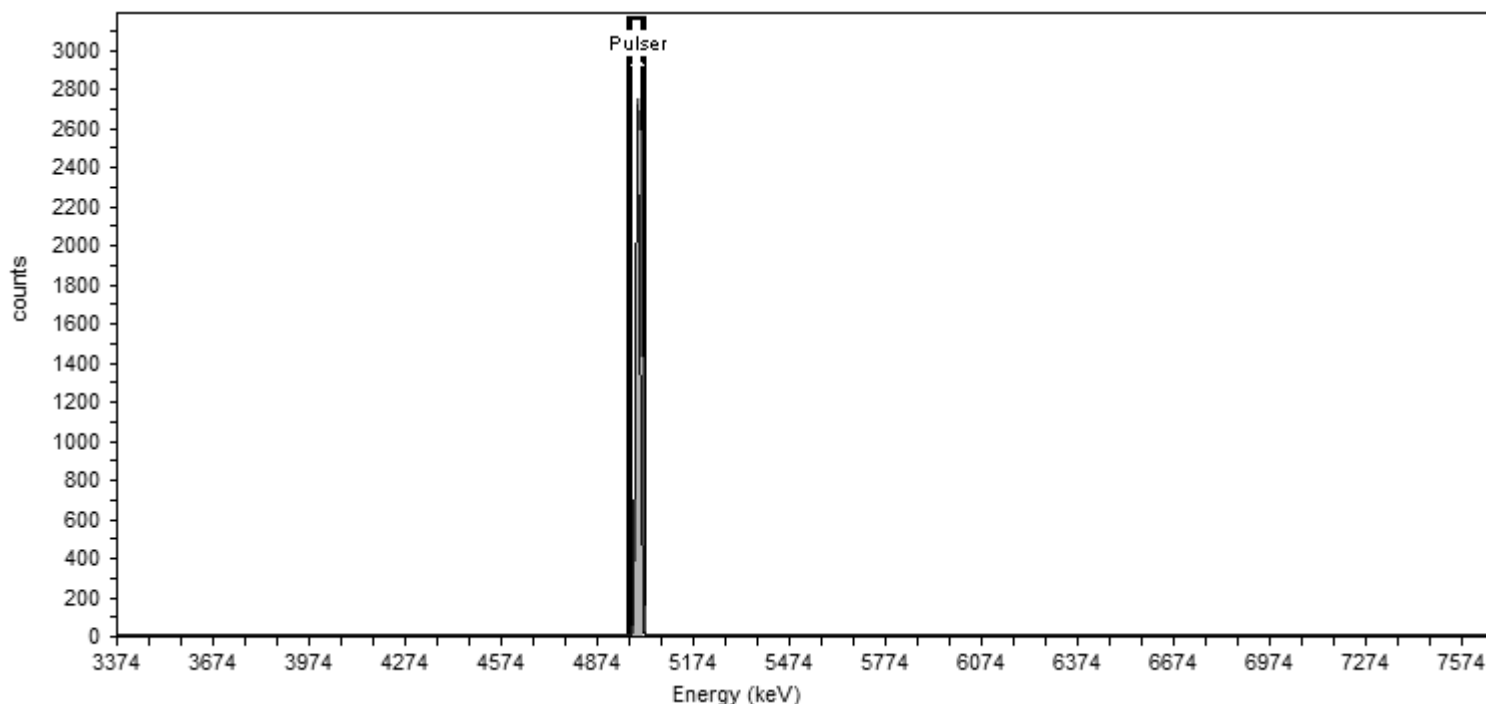
Calibration Date: 10/18/2015 3:55:29PM

Energy Calibration Equation:

Gain = 7.4575 keV / Ch

Offset = 3,366.95 keV

Quadratic = 0.0000 keV / Ch<sup>2</sup>



### General Analysis

Analysis Method: Peak Fit Analysis

### Nuclide Summary (Peak Search)

| Nuclide | Peak Energy keV | Start Energy keV | End Energy keV | FWHM keV | Fit Area | Gross Counts |
|---------|-----------------|------------------|----------------|----------|----------|--------------|
| Pulser  | 4999.373        | 4977.605         | 5021.140       | 12.79    | 5,036.62 | 5,767.22     |

Sample Name: Pulser;AV200

Comment:

### Sample

Spectrum #12 Analysis #1

### Batch

Batch Name: May2016b

Description:

### Acquisition

Detector: AV200 , SN: 50-117J6

Acquisition Start Date: 6/8/2016 10:01:54AM

Live Time: 1.00 min.

Real Time: 1.00 min.

Calibration Name: IC-9884;AV200-20151017

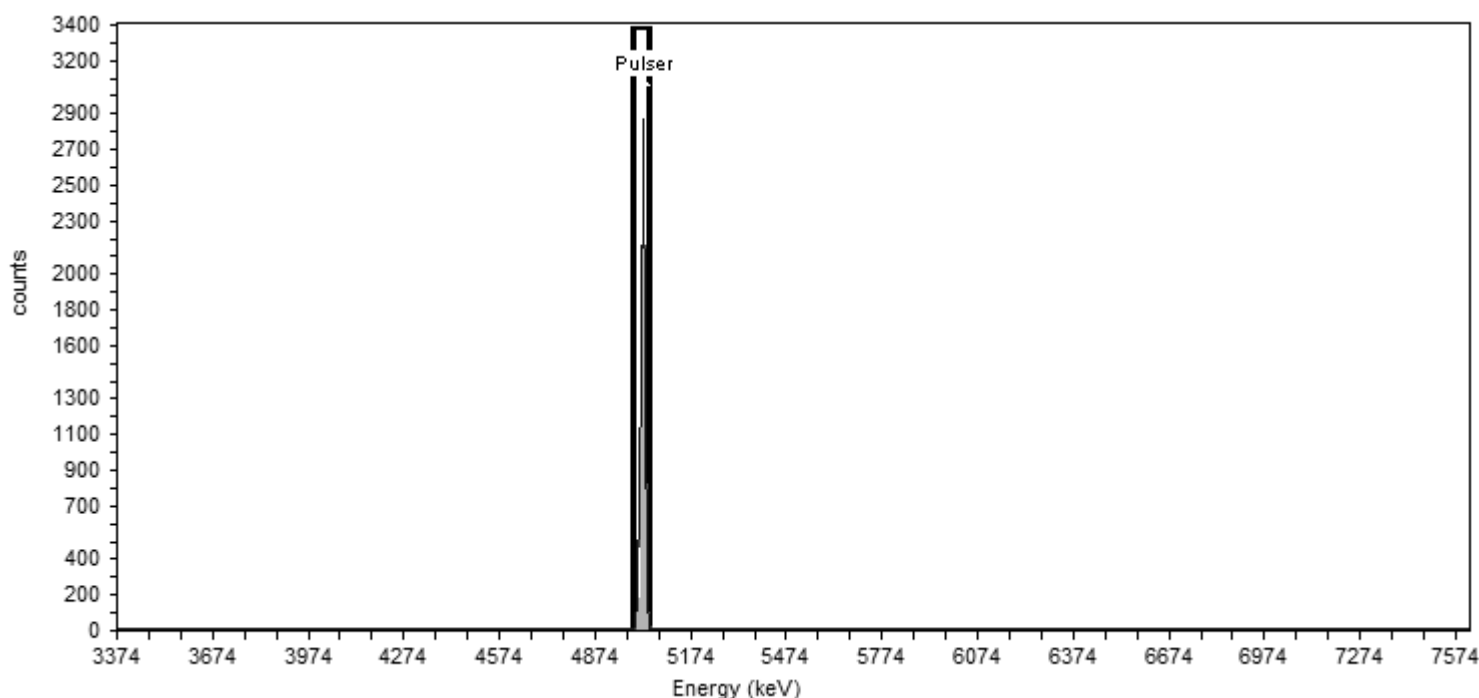
Calibration Date: 10/18/2015 3:55:33PM

Energy Calibration Equation:

Gain = 7.4575 keV / Ch

Offset = 3,366.95 keV

Quadratic = 0.0000 keV / Ch<sup>2</sup>



### General Analysis

Analysis Method: Peak Fit Analysis

### Nuclide Summary (Peak Search)

| Nuclide | Peak Energy keV | Start Energy keV | End Energy keV | FWHM keV | Fit Area | Gross Counts |
|---------|-----------------|------------------|----------------|----------|----------|--------------|
| Pulser  | 5022.459        | 4997.134         | 5047.785       | 14.88    | 6,123.69 | 6,006.65     |

# Initial Calibrations

Sample Name: IC-8876;AV192-20151017

Description:

Detector: AV192

### Calibration

Analyst: 60040

Analysis Date: 10/18/2015 3:55:07PM

Calibration Type: Energy And Efficiency

Certificate ID: 82235-334

Prepared by: Analytics

Description:

### Source Info

Certification Date: 6/4/2010 12:00:00PM

### Acquisition

Detector: AV192 , SN: 50-119J7

Acquisition Start Date: 10/17/2015 6:13:38PM

Live Time: 140.00 min.

Real Time: 140.01 min.

Energy Calibration Equation:

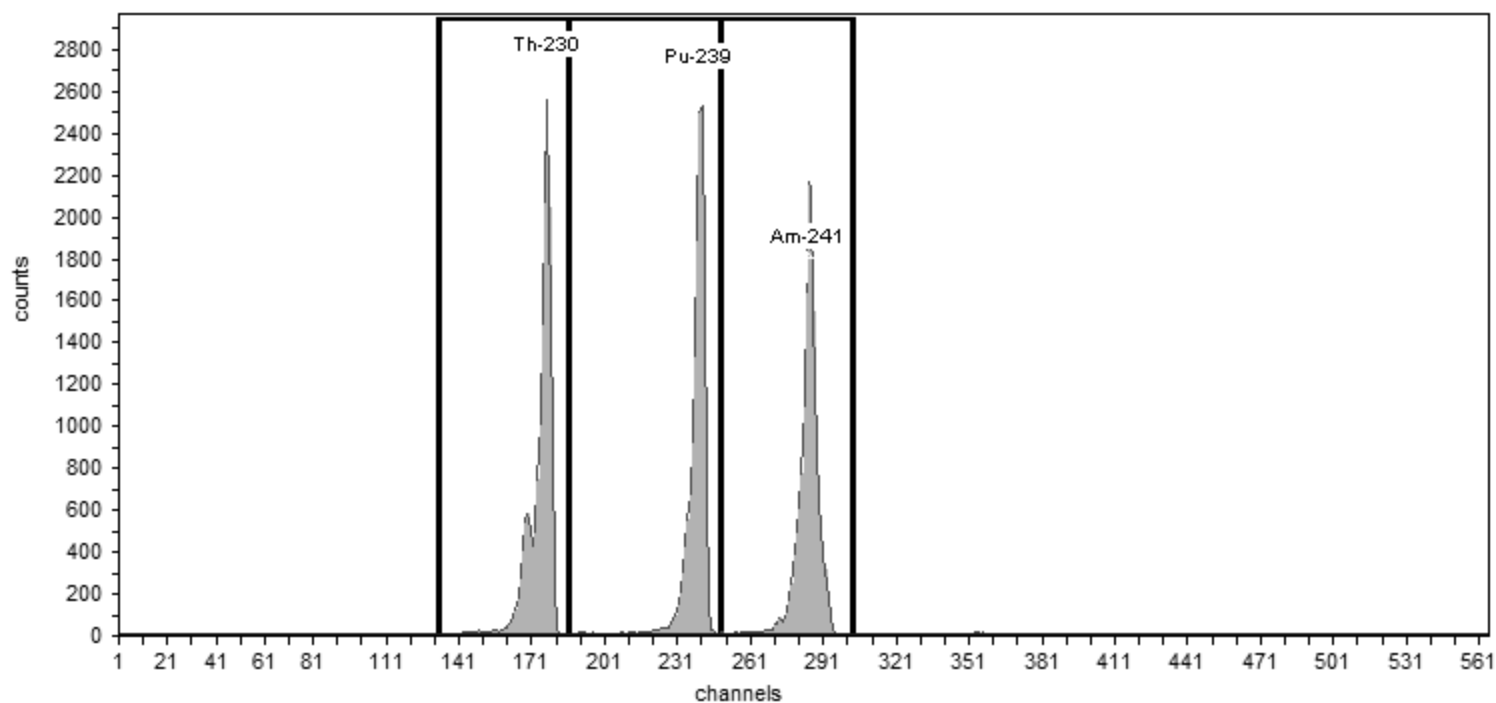
Gain = 7.4575 keV / Ch

Offset = 3,366.95 keV

Quadratic = 0.0000 keV / Ch<sup>2</sup>

Efficiency Calibration Name: IC-8876;AV192-20151017

Efficiency: 24.71% +/- 0.29% TPU(2 sigma)



### General Analysis

Method: Manual (ROI)

Algorithm: Linear

Initial Calibration: Yes

Shelf: 0

### Nuclide Activity Summary

| Nuclide | Peak Channel | Peak Energy keV | ROI Start Channel | ROI End Channel | Peak FWHM keV | Gross Counts | Net Count Rate (cpm) |
|---------|--------------|-----------------|-------------------|-----------------|---------------|--------------|----------------------|
| Th-230  | 177          | 4,687.50        | 132               | 186             | 30.81         | 15,129.00    | 108.06               |
| Pu-239  | 240          | 5,155.40        | 186               | 249             | 34.26         | 14,583.00    | 104.16               |
| Am-241  | 284          | 5,485.70        | 249               | 303             | 35.26         | 14,907.00    | 106.48               |

Sample Name: IC-8877;AV193-20151017  
Description:  
Detector: AV193

### Calibration

Analyst: 60040  
Analysis Date: 10/18/2015 3:55:11PM  
Calibration Type: Energy And Efficiency

Certificate ID: 82236-334  
Prepared by: Analytics  
Description:

### Source Info

Certification Date: 6/2/2010 12:00:00PM

### Acquisition

Detector: AV193 , SN: 50-11915  
Acquisition Start Date: 10/17/2015 6:13:48PM

Live Time: 140.00 min.  
Real Time: 140.01 min.

Energy Calibration Equation:

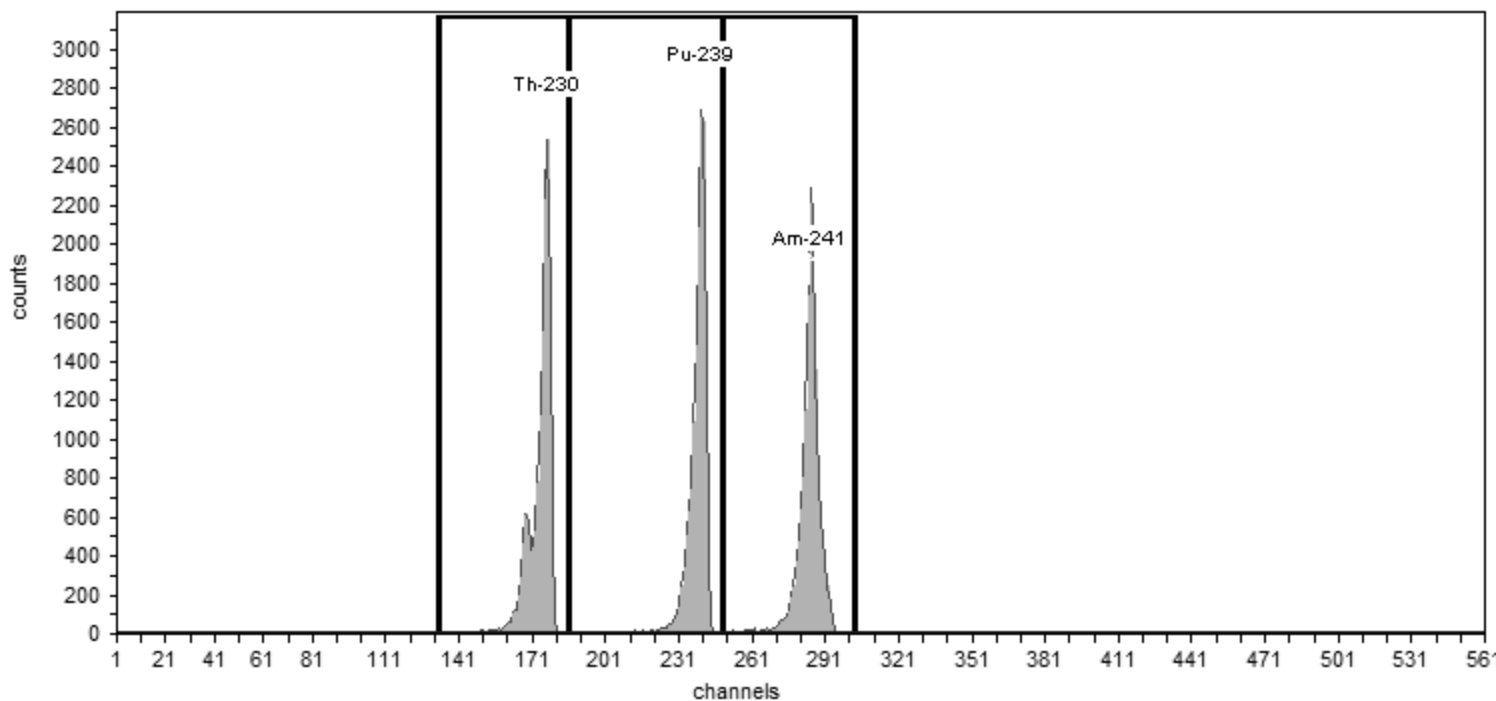
Gain = 7.4575 keV / Ch

Offset = 3,366.95 keV

Quadratic = 0.0000 keV / Ch<sup>2</sup>

Efficiency Calibration Name: IC-8877;AV193-20151017

Efficiency: 25.42% +/- 0.31% TPU(2 sigma)



### General Analysis

Method: Manual (ROI)  
Algorithm: Linear

Initial Calibration: Yes  
Shelf: 0

### Nuclide Activity Summary

| Nuclide | Peak Channel | Peak Energy keV | ROI Start Channel | ROI End Channel | Peak FWHM keV | Gross Counts | Net Count Rate (cpm) |
|---------|--------------|-----------------|-------------------|-----------------|---------------|--------------|----------------------|
| Th-230  | 177          | 4,687.50        | 132               | 186             | 30.15         | 14,591.00    | 104.22               |
| Pu-239  | 240          | 5,155.40        | 186               | 249             | 33.33         | 14,933.00    | 106.66               |
| Am-241  | 284          | 5,485.70        | 249               | 303             | 32.55         | 14,605.00    | 104.32               |

Sample Name: IC-9792;AV195-20151017a  
Description:  
Detector: AV195

### Calibration

Analyst: 60040  
Analysis Date: 10/18/2015 3:55:41PM  
Calibration Type: Energy And Efficiency

Certificate ID: 82240-334  
Prepared by: Analytics  
Description:

### Source Info

Certification Date: 6/8/2010 12:00:00PM

### Acquisition

Detector: AV195 , SN: 50-117AA2  
Acquisition Start Date: 10/17/2015 6:19:39PM

Live Time: 140.00 min.  
Real Time: 140.03 min.

Energy Calibration Equation:

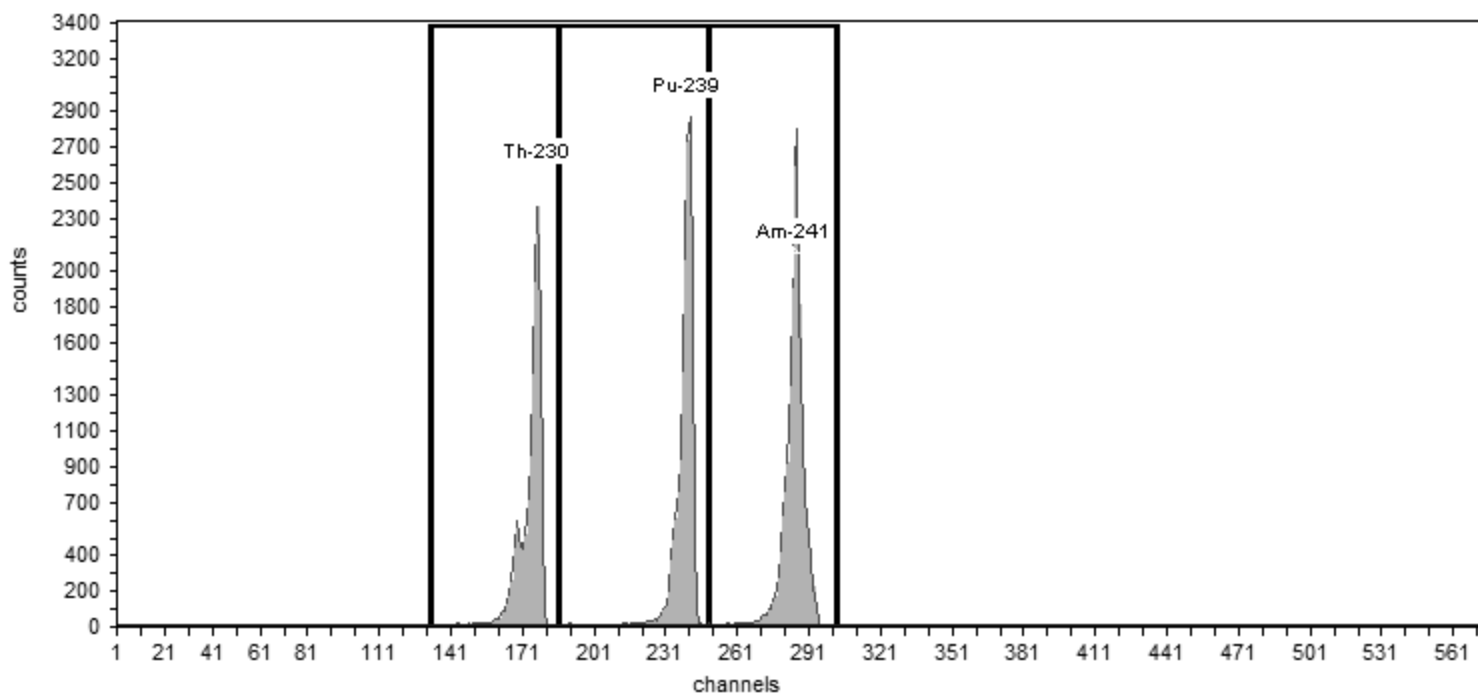
Gain = 7.4575 keV / Ch

Offset = 3,366.95 keV

Quadratic = 0.0000 keV / Ch<sup>2</sup>

Efficiency Calibration Name: IC-9792;AV195-20151017a

Efficiency: 25.85% +/- 0.30% TPU(2 sigma)



### General Analysis

Method: Manual (ROI)  
Algorithm: Linear

Initial Calibration: Yes  
Shelf: 0

### Nuclide Activity Summary

| Nuclide | Peak Channel | Peak Energy keV | ROI Start Channel | ROI End Channel | Peak FWHM keV | Gross Counts | Net Count Rate (cpm) |
|---------|--------------|-----------------|-------------------|-----------------|---------------|--------------|----------------------|
| Th-230  | 177          | 4,687.50        | 132               | 186             | 29.97         | 13,714.00    | 97.96                |
| Pu-239  | 240          | 5,155.40        | 186               | 249             | 31.72         | 15,476.00    | 110.54               |
| Am-241  | 284          | 5,485.70        | 249               | 303             | 33.21         | 17,919.00    | 127.99               |

Sample Name: IC-9794;AV197-20151017  
Description:  
Detector: AV197

### Calibration

Analyst: 60040  
Analysis Date: 10/18/2015 3:55:22PM  
Calibration Type: Energy And Efficiency

Certificate ID: 82242-334  
Prepared by: Analytics  
Description:

### Source Info

Certification Date: 6/8/2010 12:00:00PM

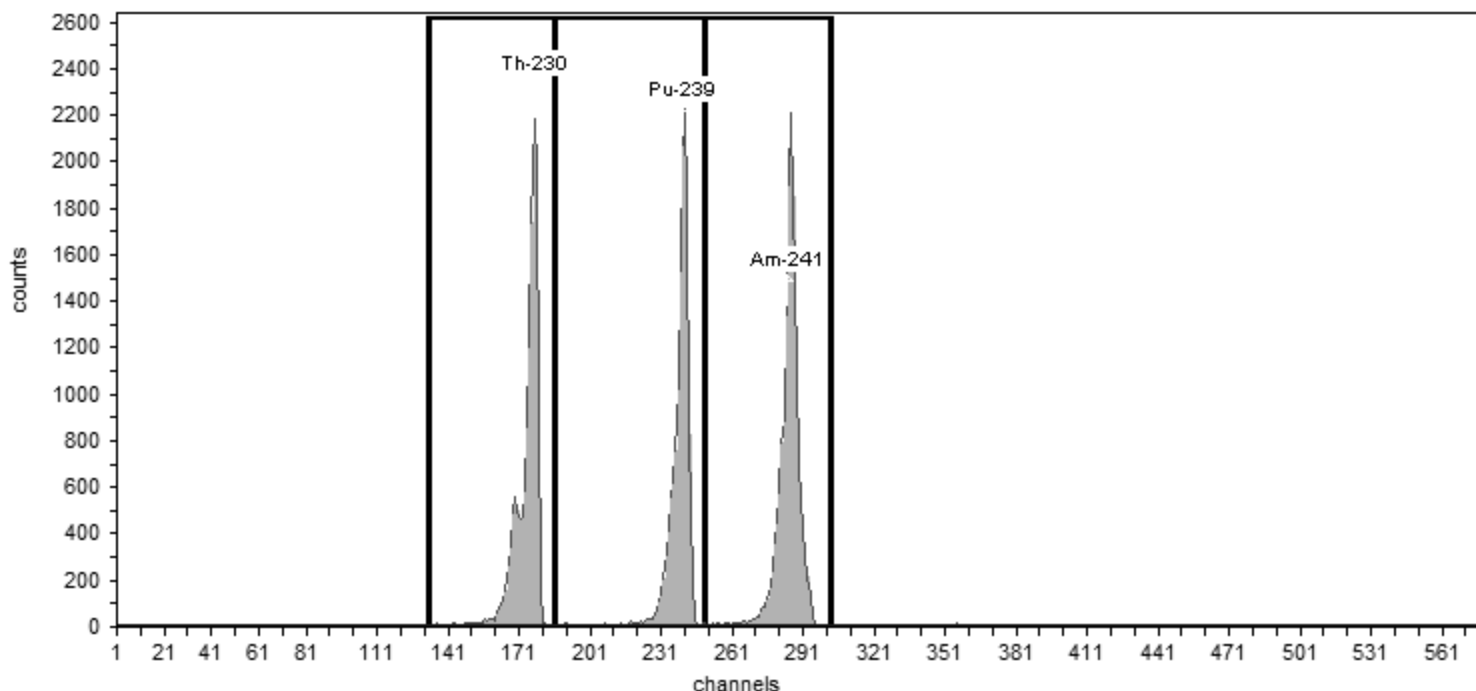
### Acquisition

Detector: AV197 , SN: 50-117Z5  
Acquisition Start Date: 10/17/2015 6:14:35PM

Live Time: 140.00 min.  
Real Time: 140.01 min.

Energy Calibration Equation:  
Gain = 7.4575 keV / Ch  
Offset = 3,366.95 keV  
Quadratic = 0.0000 keV / Ch<sup>2</sup>  
Efficiency: 24.48% +/- 0.31% TPU(2 sigma)

Efficiency Calibration Name: IC-9794;AV197-20151017



### General Analysis

Method: Manual (ROI)  
Algorithm: Linear

Initial Calibration: Yes  
Shelf: 0

### Nuclide Activity Summary

| Nuclide | Peak Channel | Peak Energy keV | ROI Start Channel | ROI End Channel | Peak FWHM keV | Gross Counts | Net Count Rate (cpm) |
|---------|--------------|-----------------|-------------------|-----------------|---------------|--------------|----------------------|
| Th-230  | 177          | 4,687.50        | 132               | 186             | 31.00         | 13,395.00    | 95.68                |
| Pu-239  | 240          | 5,155.40        | 186               | 249             | 33.69         | 13,158.00    | 93.99                |
| Am-241  | 284          | 5,485.70        | 249               | 303             | 33.63         | 14,743.00    | 105.31               |

Sample Name: IC-9795;AV198-20151017

Description:

Detector: AV198

### Calibration

Analyst: 60040

Analysis Date: 10/18/2015 3:55:25PM

Calibration Type: Energy And Efficiency

Certificate ID: 82243-334

Prepared by: Analytics

Description:

### Source Info

Certification Date: 6/9/2010 12:00:00PM

### Acquisition

Detector: AV198 , SN: 50-117AA7

Acquisition Start Date: 10/17/2015 6:15:03PM

Live Time: 140.00 min.

Real Time: 140.01 min.

Energy Calibration Equation:

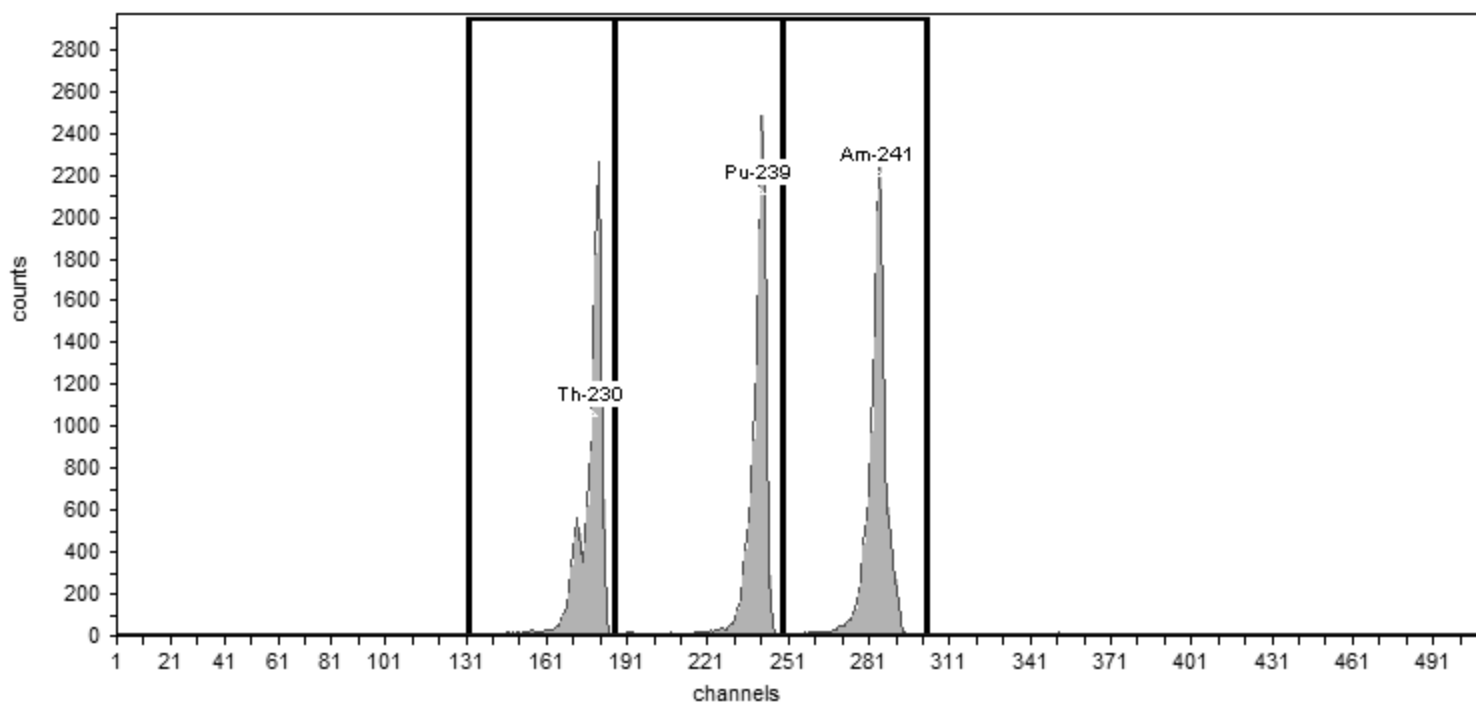
Gain = 7.4575 keV / Ch

Offset = 3,366.95 keV

Quadratic = 0.0000 keV / Ch<sup>2</sup>

Efficiency Calibration Name: IC-9795;AV198-20151017

Efficiency: 26.02% +/- 0.34% TPU(2 sigma)



### General Analysis

Method: Manual (ROI)

Algorithm: Linear

Initial Calibration: Yes

Shelf: 0

### Nuclide Activity Summary

| Nuclide | Peak Channel | Peak Energy keV | ROI Start Channel | ROI End Channel | Peak FWHM keV | Gross Counts | Net Count Rate (cpm) |
|---------|--------------|-----------------|-------------------|-----------------|---------------|--------------|----------------------|
| Th-230  | 177          | 4,687.50        | 132               | 186             | 29.73         | 12,790.00    | 91.36                |
| Pu-239  | 240          | 5,155.40        | 186               | 249             | 30.64         | 13,076.00    | 93.40                |
| Am-241  | 284          | 5,485.70        | 249               | 303             | 31.11         | 13,863.00    | 99.02                |

Sample Name: IC-9817;AV199-20151017

Description:

Detector: AV199

### Calibration

Analyst: 60040

Analysis Date: 10/18/2015 3:55:29PM

Calibration Type: Energy And Efficiency

Certificate ID: 82244-334

Prepared by: Analytics

Description:

### Source Info

Certification Date: 6/9/2010 12:00:00PM

### Acquisition

Detector: AV199 , SN: 50-117Z3

Acquisition Start Date: 10/17/2015 6:15:17PM

Live Time: 140.00 min.

Real Time: 140.01 min.

Energy Calibration Equation:

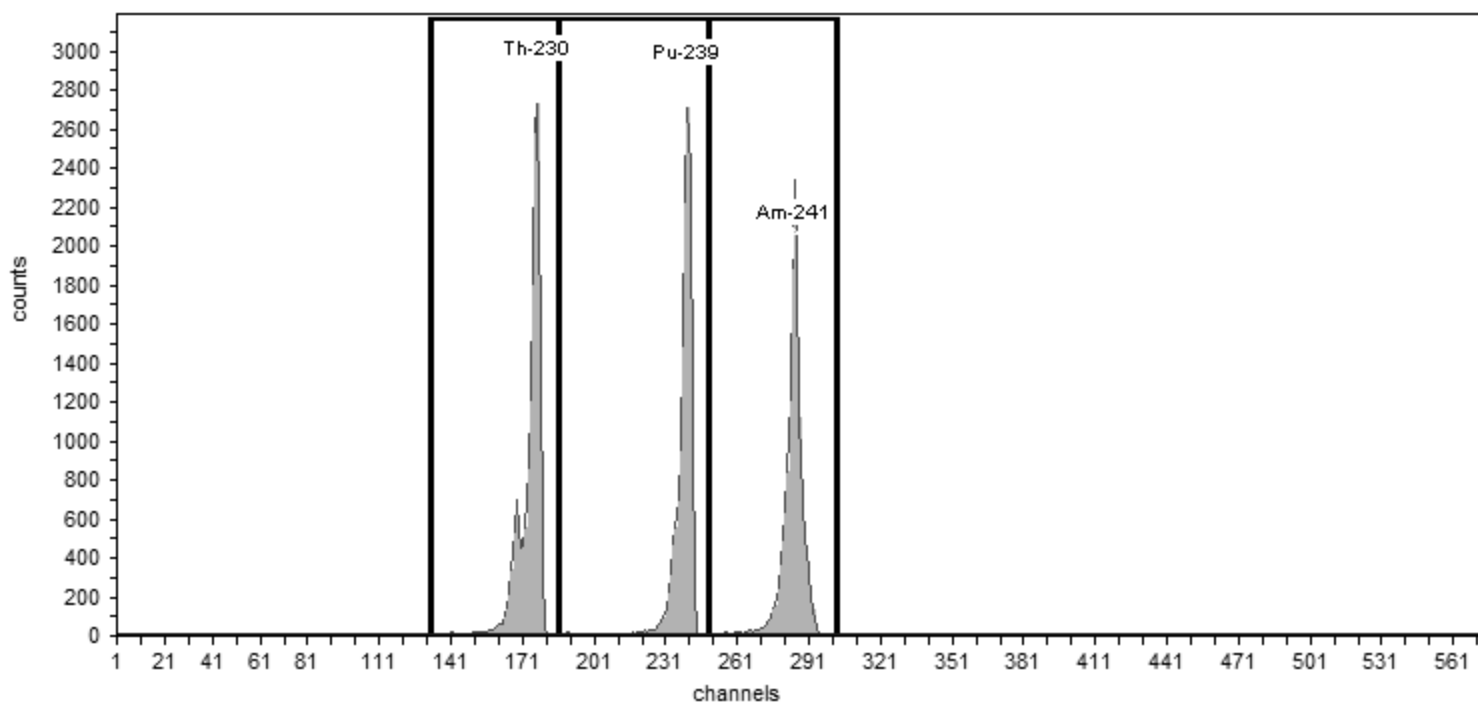
Gain = 7.4575 keV / Ch

Offset = 3,366.95 keV

Quadratic = 0.0000 keV / Ch<sup>2</sup>

Efficiency Calibration Name: IC-9817;AV199-20151017

Efficiency: 24.71% +/- 0.30% TPU(2 sigma)



### General Analysis

Method: Manual (ROI)

Algorithm: Linear

Initial Calibration: Yes

Shelf: 0

### Nuclide Activity Summary

| Nuclide | Peak Channel | Peak Energy keV | ROI Start Channel | ROI End Channel | Peak FWHM keV | Gross Counts | Net Count Rate (cpm) |
|---------|--------------|-----------------|-------------------|-----------------|---------------|--------------|----------------------|
| Th-230  | 177          | 4,687.50        | 132               | 186             | 28.96         | 15,446.00    | 110.33               |
| Pu-239  | 240          | 5,155.40        | 186               | 249             | 29.88         | 13,902.00    | 99.30                |
| Am-241  | 284          | 5,485.70        | 249               | 303             | 29.92         | 14,059.00    | 100.42               |

Sample Name: IC-9884;AV200-20151017  
Description:  
Detector: AV200

### Calibration

Analyst: 60040  
Analysis Date: 10/18/2015 3:55:33PM  
Calibration Type: Energy And Efficiency

Certificate ID: 82245-334  
Prepared by: Analytics  
Description:

### Source Info

Certification Date: 6/9/2010 12:00:00PM

### Acquisition

Detector: AV200 , SN: 50-117J6  
Acquisition Start Date: 10/17/2015 6:15:29PM

Live Time: 140.00 min.  
Real Time: 140.01 min.

Energy Calibration Equation:

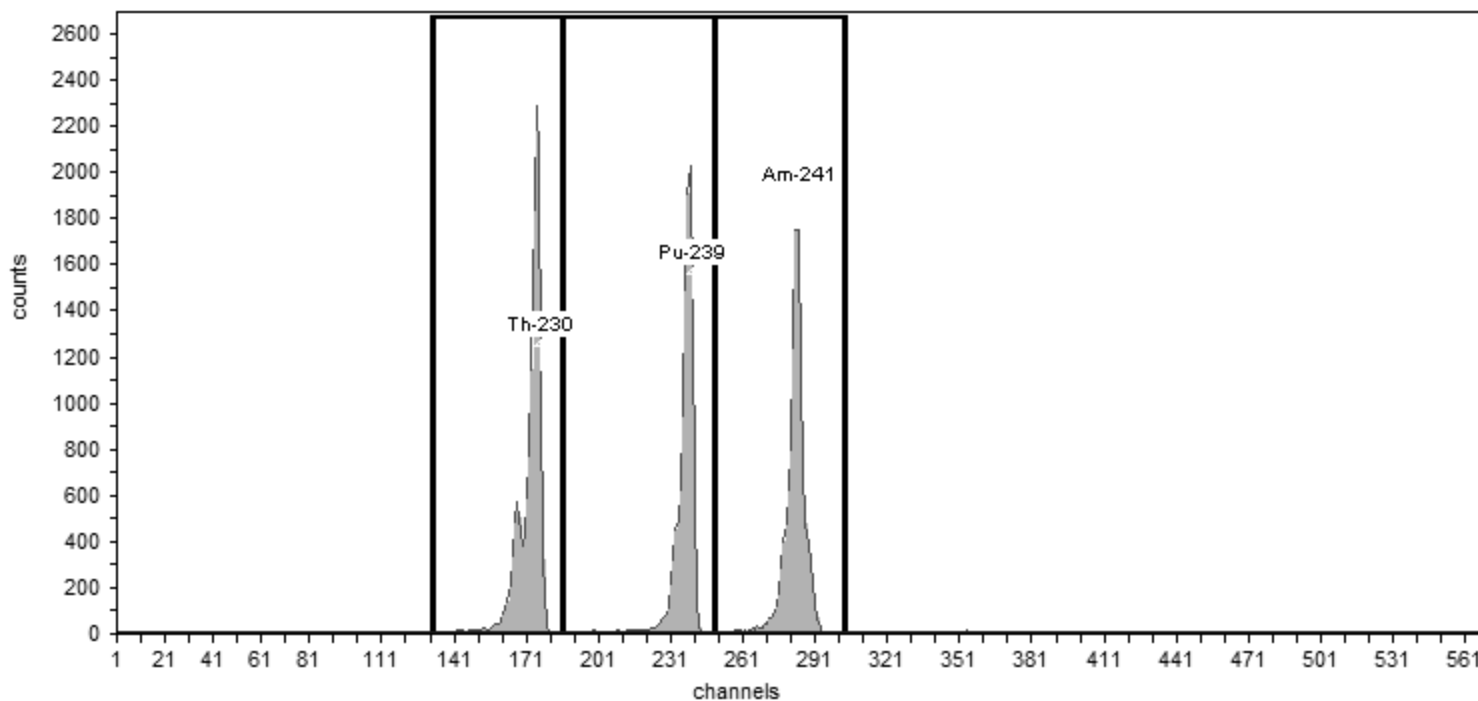
Gain = 7.4575 keV / Ch

Offset = 3,366.95 keV

Quadratic = 0.0000 keV / Ch<sup>2</sup>

Efficiency Calibration Name: IC-9884;AV200-20151017

Efficiency: 24.41% +/- 0.35% TPU(2 sigma)



### General Analysis

Method: Manual (ROI)  
Algorithm: Linear

Initial Calibration: Yes  
Shelf: 0

### Nuclide Activity Summary

| Nuclide | Peak Channel | Peak Energy keV | ROI Start Channel | ROI End Channel | Peak FWHM keV | Gross Counts | Net Count Rate (cpm) |
|---------|--------------|-----------------|-------------------|-----------------|---------------|--------------|----------------------|
| Th-230  | 177          | 4,687.50        | 132               | 186             | 29.48         | 13,618.00    | 97.27                |
| Pu-239  | 240          | 5,155.40        | 186               | 249             | 32.34         | 11,160.00    | 79.71                |
| Am-241  | 284          | 5,485.70        | 249               | 303             | 33.15         | 11,444.00    | 81.74                |

# **Initial Calibration Verifications**

## Alpha Spectroscopy Calibration Summary

### Detector: AV192

| Lab Sample ID    | Analysis Date  | Reagent ID      | Efficiency | Efficiency Limits | Efficiency Recovery | Recovery Limits |
|------------------|----------------|-----------------|------------|-------------------|---------------------|-----------------|
| IC 160-223489/1  | 10/17/15 18:13 | 82235-334_00001 | 0.2471     | 0.20-0.32         |                     |                 |
| ICV 160-223607/1 | 11/01/15 14:23 | 82247-334_00001 | 0.2472     | 0.20-0.32         | 100.0               | 95-105          |
| CCV 160-252658/1 | 05/23/16 15:18 | 82235-334_00001 | 0.2372     | 0.20-0.32         | 96.0                | 95-105          |

### Detector: AV193

| Lab Sample ID    | Analysis Date  | Reagent ID      | Efficiency | Efficiency Limits | Efficiency Recovery | Recovery Limits |
|------------------|----------------|-----------------|------------|-------------------|---------------------|-----------------|
| IC 160-223490/1  | 10/17/15 18:13 | 82236-334_00001 | 0.2542     | 0.20-0.32         |                     |                 |
| ICV 160-223608/1 | 11/01/15 14:24 | 82246-334_00001 | 0.2559     | 0.20-0.32         | 100.6               | 95-105          |
| CCV 160-252659/1 | 05/23/16 13:50 | 82236-334_00001 | 0.2506     | 0.20-0.32         | 98.6                | 95-105          |

### Detector: AV195

| Lab Sample ID    | Analysis Date  | Reagent ID      | Efficiency | Efficiency Limits | Efficiency Recovery | Recovery Limits |
|------------------|----------------|-----------------|------------|-------------------|---------------------|-----------------|
| IC 160-223492/1  | 10/17/15 18:19 | 82240-334_00001 | 0.2585     | 0.20-0.32         |                     |                 |
| ICV 160-223610/1 | 11/01/15 14:28 | 82243-334_00001 | 0.2594     | 0.20-0.32         | 100.4               | 95-105          |
| CCV 160-252660/1 | 05/23/16 12:23 | 82240-334_00001 | 0.2500     | 0.20-0.32         | 96.7                | 95-105          |

### Detector: AV197

| Lab Sample ID    | Analysis Date  | Reagent ID      | Efficiency | Efficiency Limits | Efficiency Recovery | Recovery Limits |
|------------------|----------------|-----------------|------------|-------------------|---------------------|-----------------|
| IC 160-223494/1  | 10/17/15 18:14 | 82242-334_00001 | 0.2448     | 0.20-0.32         |                     |                 |
| ICV 160-223612/1 | 11/01/15 14:25 | 82237-334_00003 | 0.2464     | 0.20-0.32         | 100.7               | 95-105          |
| CCV 160-252662/1 | 05/23/16 12:28 | 82242-334_00001 | 0.2366     | 0.20-0.32         | 96.7                | 95-105          |

### Detector: AV198

| Lab Sample ID    | Analysis Date  | Reagent ID      | Efficiency | Efficiency Limits | Efficiency Recovery | Recovery Limits |
|------------------|----------------|-----------------|------------|-------------------|---------------------|-----------------|
| IC 160-223495/1  | 10/17/15 18:15 | 82243-334_00001 | 0.2602     | 0.20-0.32         |                     |                 |
| ICV 160-223613/1 | 11/01/15 14:25 | 82240-334_00001 | 0.2541     | 0.20-0.32         | 97.6                | 95-105          |
| CCV 160-252663/1 | 05/23/16 12:38 | 82243-334_00001 | 0.2575     | 0.20-0.32         | 98.9                | 95-105          |

### Detector: AV199

| Lab Sample ID    | Analysis Date  | Reagent ID      | Efficiency | Efficiency Limits | Efficiency Recovery | Recovery Limits |
|------------------|----------------|-----------------|------------|-------------------|---------------------|-----------------|
| IC 160-223496/1  | 10/17/15 18:15 | 82244-334_00001 | 0.2471     | 0.20-0.32         |                     |                 |
| ICV 160-223614/1 | 11/01/15 14:25 | 82241-334_00001 | 0.2515     | 0.20-0.32         | 101.8               | 95-105          |
| CCV 160-252664/1 | 05/23/16 12:27 | 82244-334_00001 | 0.2409     | 0.20-0.32         | 97.5                | 95-105          |

### Detector: AV200

| Lab Sample ID    | Analysis Date  | Reagent ID      | Efficiency | Efficiency Limits | Efficiency Recovery | Recovery Limits |
|------------------|----------------|-----------------|------------|-------------------|---------------------|-----------------|
| IC 160-223497/1  | 10/17/15 18:15 | 82245-334_00001 | 0.2441     | 0.20-0.32         |                     |                 |
| ICV 160-223615/1 | 11/01/15 14:26 | 82234-334_00001 | 0.2409     | 0.20-0.32         | 98.7                | 95-105          |
| CCV 160-252665/1 | 05/23/16 12:37 | 82245-334_00001 | 0.2340     | 0.20-0.32         | 95.9                | 95-105          |

Sample Name: ICV-9886;AV192-20151101  
Description:  
Detector: AV192

### Calibration

Analyst: 60040  
Analysis Date: 11/1/2015 3:55:50PM  
Calibration Type: Energy And Efficiency

Certificate ID: 82247-334  
Prepared by: Analytics  
Description:

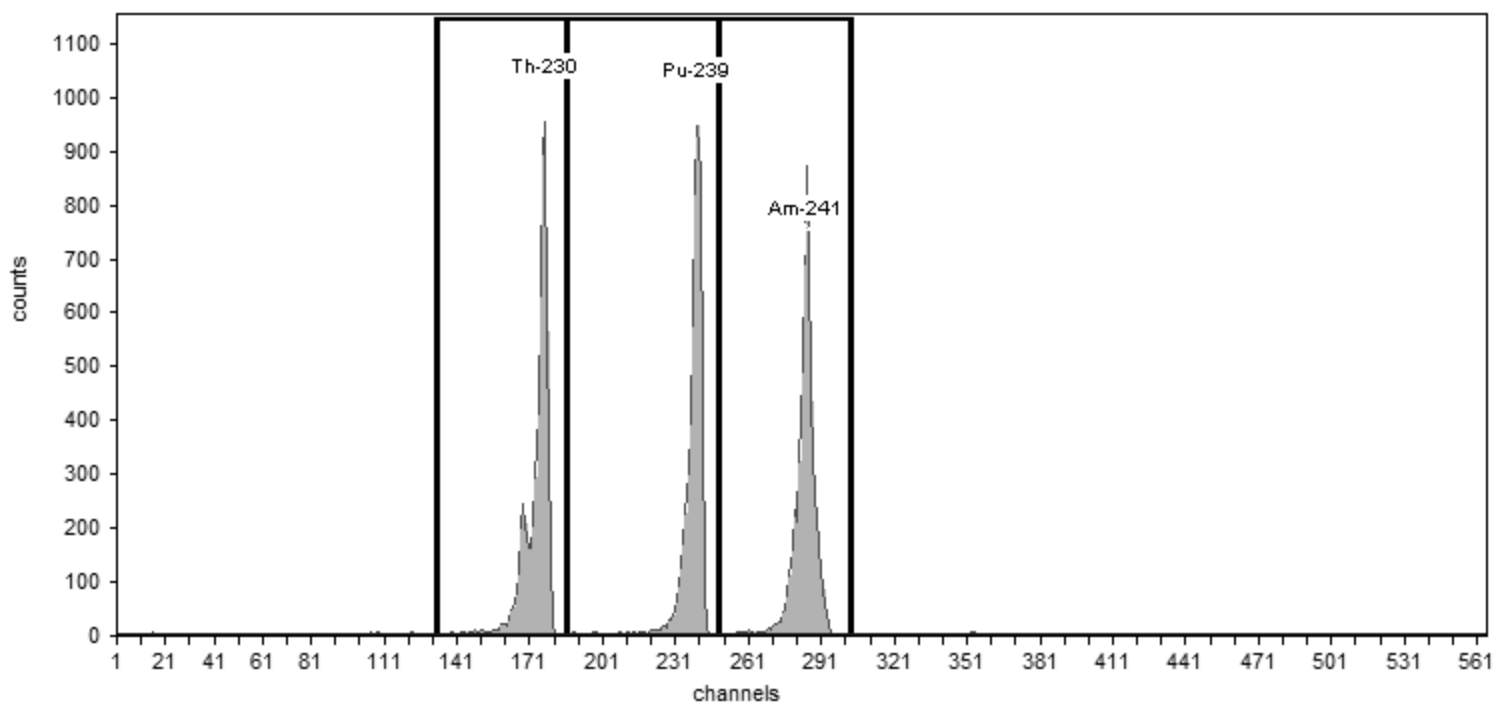
### Source Info

Certification Date: 6/10/2010 12:00:00PM

### Acquisition

Detector: AV192 , SN: 50-119J7  
Acquisition Start Date: 11/1/2015 2:23:52PM  
Live Time: 60.00 min.  
Real Time: 60.00 min.

Energy Calibration Equation:  
Gain = 7.4575 keV / Ch  
Offset = 3,366.95 keV  
Quadratic = 0.0000 keV / Ch<sup>2</sup>  
Efficiency Calibration Name: ICV-9886;AV192-20151101  
Efficiency: 24.72% +/- 0.45% TPU(2 sigma)



### General Analysis

Method: Manual (ROI)  
Algorithm: Linear

Initial Calibration: No  
Shelf: 0

### Nuclide Activity Summary

| Nuclide | Peak Channel | Peak Energy keV | ROI Start Channel | ROI End Channel | Peak FWHM keV | Gross Counts | Net Count Rate (cpm) |
|---------|--------------|-----------------|-------------------|-----------------|---------------|--------------|----------------------|
| Th-230  | 177          | 4,687.50        | 132               | 186             | 29.06         | 5,515.00     | 91.92                |
| Pu-239  | 240          | 5,155.40        | 186               | 249             | 33.05         | 5,275.00     | 87.92                |
| Am-241  | 284          | 5,485.70        | 249               | 303             | 32.16         | 5,456.00     | 90.93                |

Sample Name: ICV-9885;AV193-20151101  
Description:  
Detector: AV193

### Calibration

Analyst: 60040  
Analysis Date: 11/1/2015 3:55:53PM  
Calibration Type: Energy And Efficiency

Certificate ID: 82246-334  
Prepared by: Analytics  
Description:

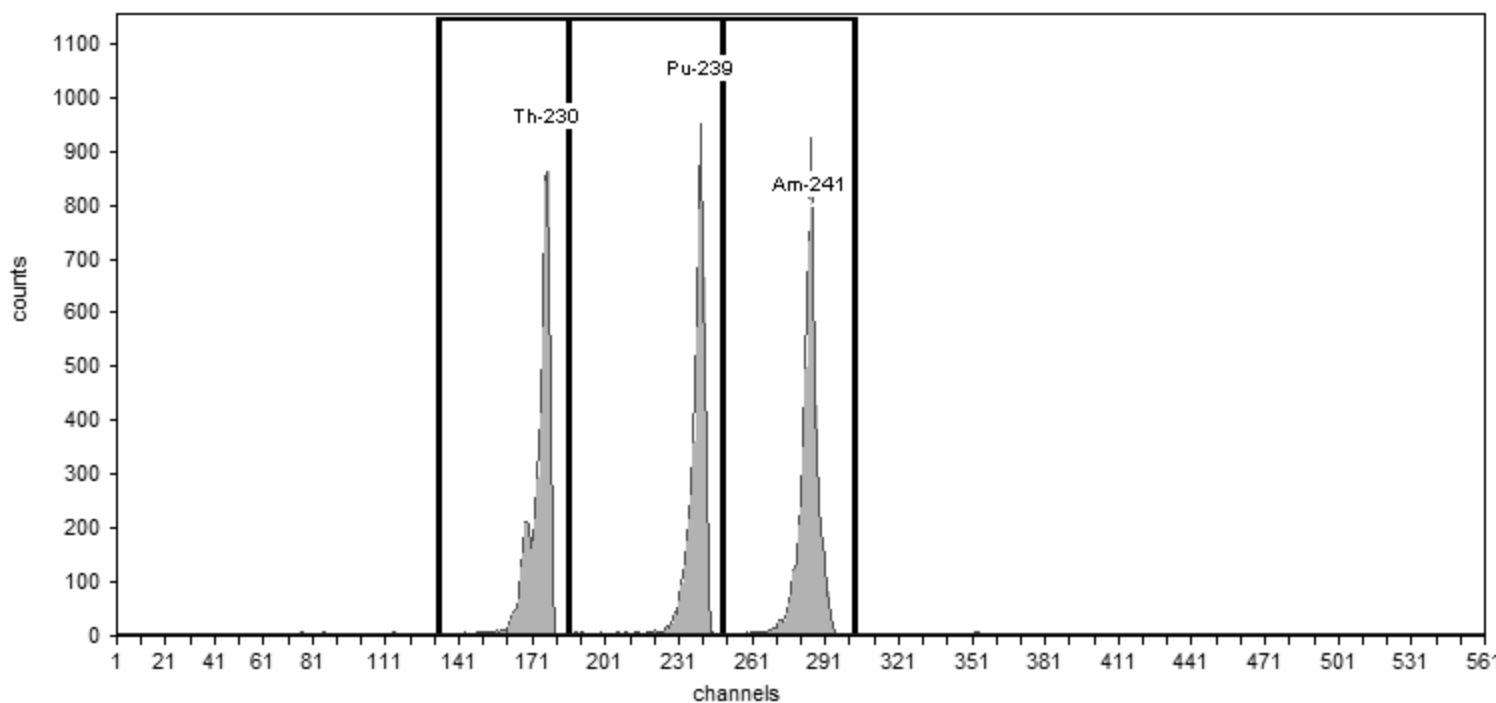
### Source Info

Certification Date: 6/9/2010 12:00:00PM

### Acquisition

Detector: AV193 , SN: 50-11915  
Acquisition Start Date: 11/1/2015 2:24:16PM  
Live Time: 60.00 min.  
Real Time: 60.00 min.

Energy Calibration Equation:  
Gain = 7.4575 keV / Ch  
Offset = 3,366.95 keV  
Quadratic = 0.0000 keV / Ch<sup>2</sup>  
Efficiency Calibration Name: ICV-9885;AV193-20151101  
Efficiency: 25.59% +/- 0.49% TPU(2 sigma)



### General Analysis

Method: Manual (ROI)  
Algorithm: Linear

Initial Calibration: No  
Shelf: 0

### Nuclide Activity Summary

| Nuclide | Peak Channel | Peak Energy keV | ROI Start Channel | ROI End Channel | Peak FWHM keV | Gross Counts | Net Count Rate (cpm) |
|---------|--------------|-----------------|-------------------|-----------------|---------------|--------------|----------------------|
| Th-230  | 177          | 4,687.50        | 132               | 186             | 29.65         | 5,075.00     | 84.58                |
| Pu-239  | 240          | 5,155.40        | 186               | 249             | 29.99         | 4,901.00     | 81.68                |
| Am-241  | 284          | 5,485.70        | 249               | 303             | 30.60         | 5,573.00     | 92.88                |

Sample Name: ICV-9795;AV195-20151101a  
Description:  
Detector: AV195

### Calibration

Analyst: 60040  
Analysis Date: 11/1/2015 3:56:19PM  
Calibration Type: Energy And Efficiency

Certificate ID: 82243-334  
Prepared by: Analytics  
Description:

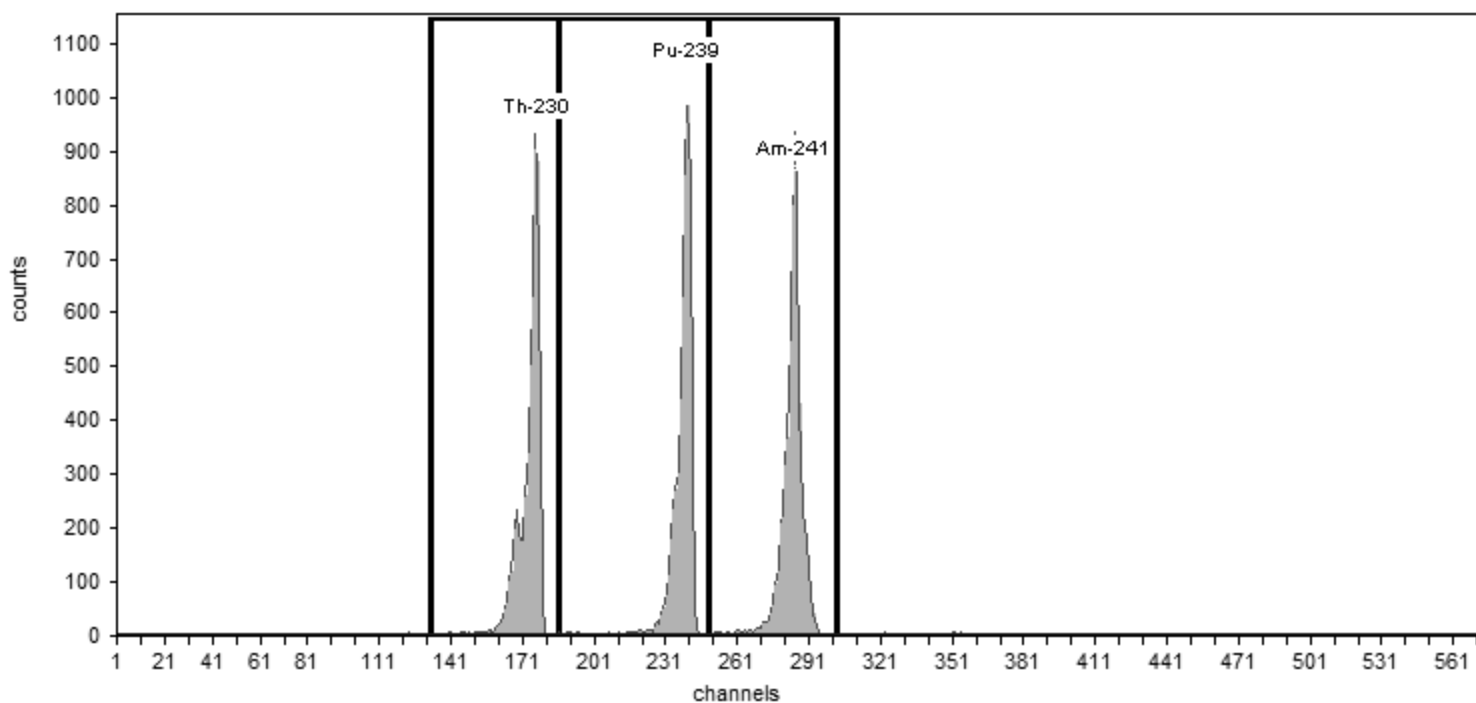
### Source Info

Certification Date: 6/9/2010 12:00:00PM

### Acquisition

Detector: AV195 , SN: 50-117AA2  
Acquisition Start Date: 11/1/2015 2:28:52PM  
Live Time: 60.00 min.  
Real Time: 60.00 min.

Energy Calibration Equation:  
Gain = 7.4575 keV / Ch  
Offset = 3,366.95 keV  
Quadratic = 0.0000 keV / Ch<sup>2</sup>  
Efficiency Calibration Name: ICV-9795;AV195-2015110  
Efficiency: 25.94% +/- 0.46% TPU(2 sigma)



### General Analysis

Method: Manual (ROI)  
Algorithm: Linear

Initial Calibration: No  
Shelf: 0

### Nuclide Activity Summary

| Nuclide | Peak Channel | Peak Energy keV | ROI Start Channel | ROI End Channel | Peak FWHM keV | Gross Counts | Net Count Rate (cpm) |
|---------|--------------|-----------------|-------------------|-----------------|---------------|--------------|----------------------|
| Th-230  | 177          | 4,687.50        | 132               | 186             | 30.62         | 5,443.00     | 90.72                |
| Pu-239  | 240          | 5,155.40        | 186               | 249             | 32.96         | 5,557.00     | 92.62                |
| Am-241  | 284          | 5,485.70        | 249               | 303             | 32.40         | 5,972.00     | 99.53                |

Sample Name: ICV-9520;AV197-20151101  
Description:  
Detector: AV197

### Calibration

Analyst: 60040  
Analysis Date: 11/1/2015 3:56:02PM  
Calibration Type: Energy And Efficiency

Certificate ID: 82237-334  
Prepared by: Analytics  
Description:

### Source Info

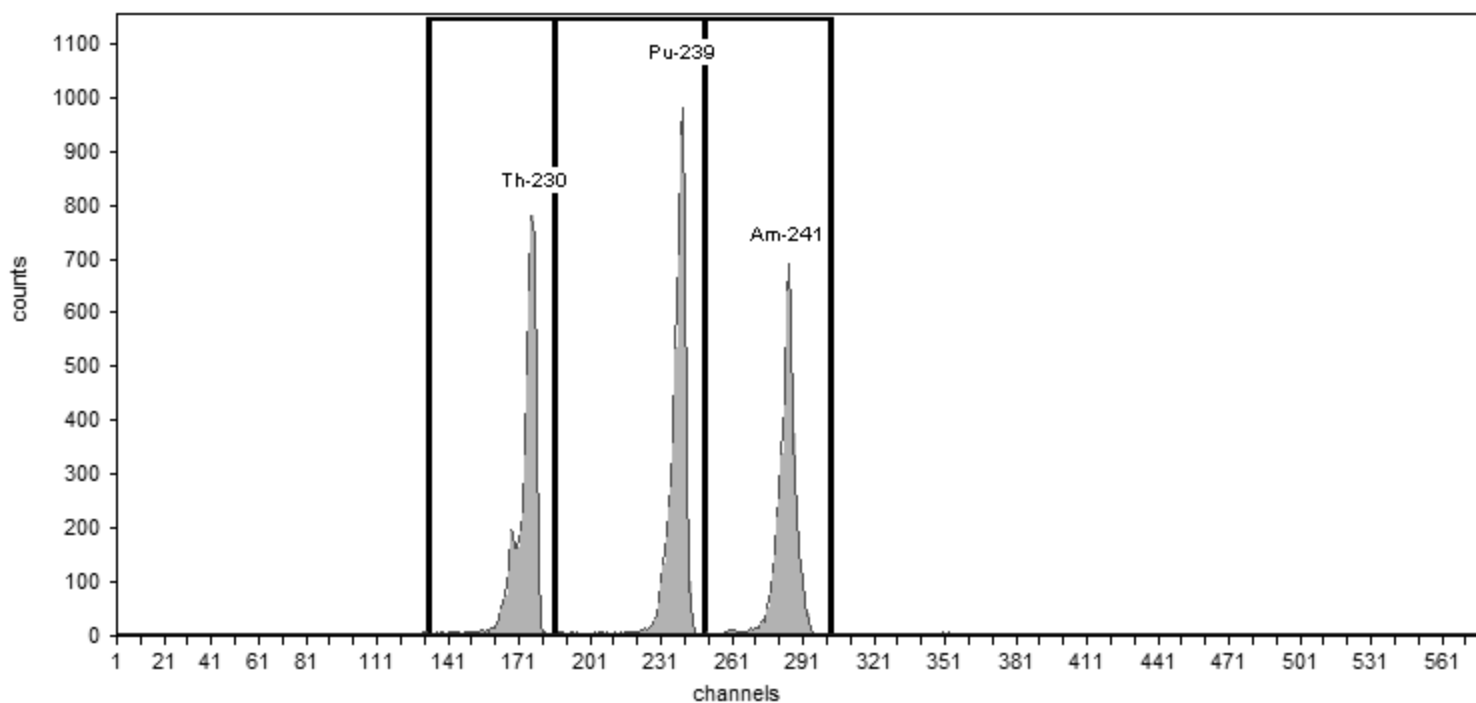
Certification Date: 6/1/2010 12:00:00PM

### Acquisition

Detector: AV197 , SN: 50-117Z5  
Acquisition Start Date: 11/1/2015 2:25:26PM  
Live Time: 60.00 min.  
Real Time: 60.00 min.

Energy Calibration Equation:  
Gain = 7.4575 keV / Ch  
Offset = 3,366.95 keV  
Quadratic = 0.0000 keV / Ch<sup>2</sup>  
Efficiency: 24.64% +/- 0.46% TPU(2 sigma)

Efficiency Calibration Name: ICV-9520;AV197-20151101



### General Analysis

Method: Manual (ROI)  
Algorithm: Linear

Initial Calibration: No  
Shelf: 0

### Nuclide Activity Summary

| Nuclide | Peak Channel | Peak Energy keV | ROI Start Channel | ROI End Channel | Peak FWHM keV | Gross Counts | Net Count Rate (cpm) |
|---------|--------------|-----------------|-------------------|-----------------|---------------|--------------|----------------------|
| Th-230  | 177          | 4,687.50        | 132               | 186             | 34.77         | 5,112.00     | 85.20                |
| Pu-239  | 240          | 5,155.40        | 186               | 249             | 36.23         | 5,886.00     | 98.10                |
| Am-241  | 284          | 5,485.70        | 249               | 303             | 37.94         | 4,830.00     | 80.50                |

Sample Name: ICV-9792;AV198-20151101  
Description:  
Detector: AV198

### Calibration

Analyst: 60040  
Analysis Date: 11/1/2015 3:56:05PM  
Calibration Type: Energy And Efficiency

Certificate ID: 82240-334  
Prepared by: Analytics  
Description:

### Source Info

Certification Date: 6/8/2010 12:00:00PM

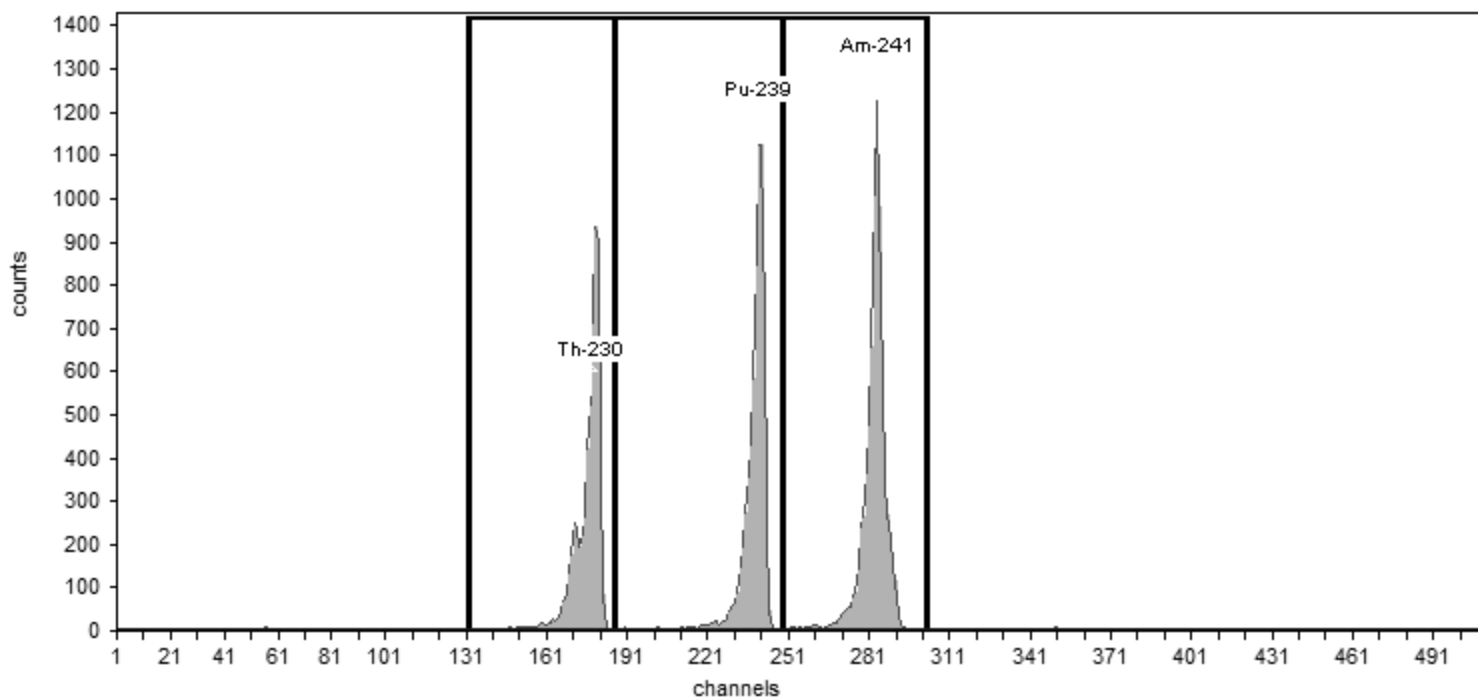
Detector: AV198 , SN: 50-117AA7  
Acquisition Start Date: 11/1/2015 2:25:40PM

Live Time: 60.00 min.  
Real Time: 60.00 min.

### Acquisition

Energy Calibration Equation:  
Gain = 7.4575 keV / Ch  
Offset = 3,366.95 keV  
Quadratic = 0.0000 keV / Ch<sup>2</sup>  
Efficiency: 25.41% +/- 0.40% TPU(2 sigma)

Efficiency Calibration Name: ICV-9792;AV198-20151101



### General Analysis

Method: Manual (ROI)  
Algorithm: Linear

Initial Calibration: No  
Shelf: 0

### Nuclide Activity Summary

| Nuclide | Peak Channel | Peak Energy keV | ROI Start Channel | ROI End Channel | Peak FWHM keV | Gross Counts | Net Count Rate (cpm) |
|---------|--------------|-----------------|-------------------|-----------------|---------------|--------------|----------------------|
| Th-230  | 177          | 4,687.50        | 132               | 186             | 32.43         | 5,791.00     | 96.52                |
| Pu-239  | 240          | 5,155.40        | 186               | 249             | 33.43         | 6,533.00     | 108.88               |
| Am-241  | 284          | 5,485.70        | 249               | 303             | 30.71         | 7,524.00     | 125.40               |

Sample Name: ICV-9793;AV199-20151101  
Description:  
Detector: AV199

### Calibration

Analyst: 60040  
Analysis Date: 11/1/2015 3:56:07PM  
Calibration Type: Energy And Efficiency

Certificate ID: 82241-334  
Prepared by: Analytics  
Description:

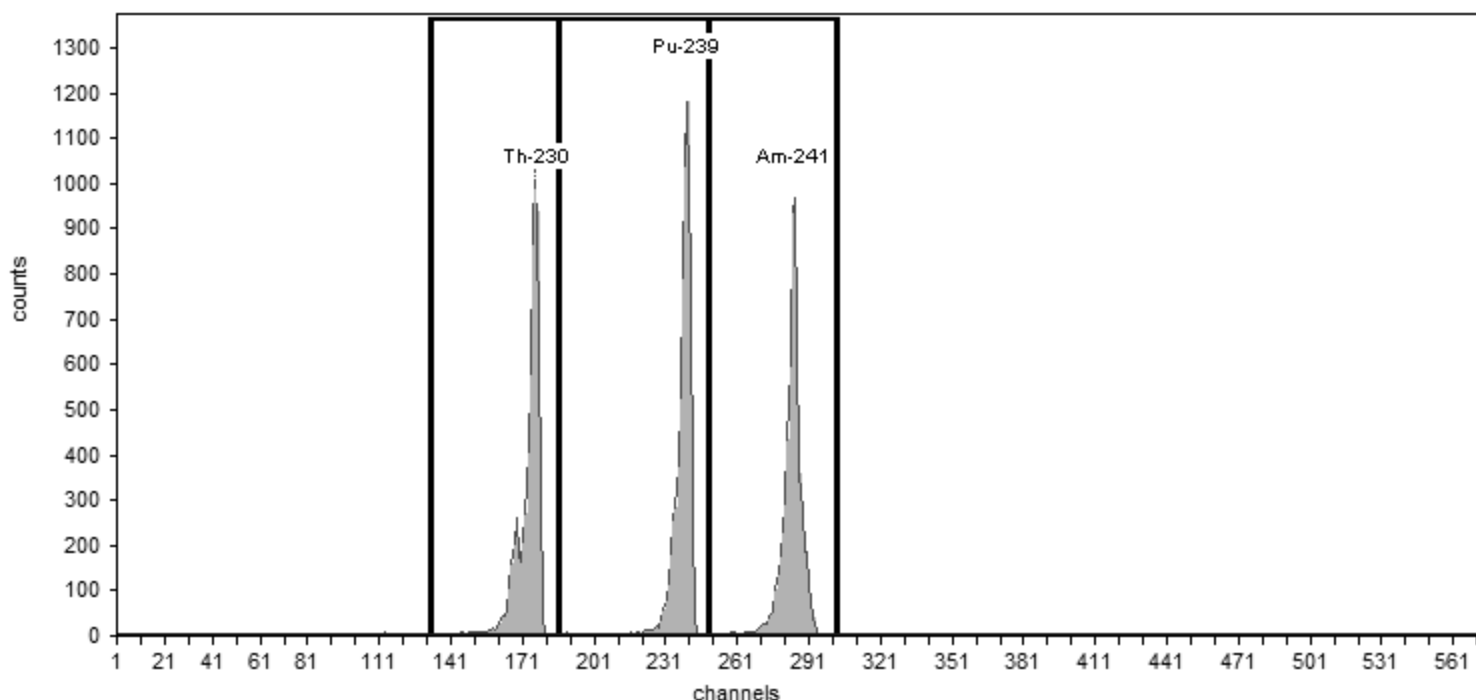
### Source Info

Certification Date: 6/8/2010 12:00:00PM

### Acquisition

Detector: AV199 , SN: 50-117Z3  
Acquisition Start Date: 11/1/2015 2:25:56PM  
Live Time: 60.00 min.  
Real Time: 60.00 min.

Energy Calibration Equation:  
Gain = 7.4575 keV / Ch  
Offset = 3,366.95 keV  
Quadratic = 0.0000 keV / Ch<sup>2</sup>  
Efficiency Calibration Name: ICV-9793;AV199-20151101  
Efficiency: 25.15% +/- 0.42% TPU(2 sigma)



### General Analysis

Method: Manual (ROI)  
Algorithm: Linear

Initial Calibration: No  
Shelf: 0

### Nuclide Activity Summary

| Nuclide | Peak Channel | Peak Energy keV | ROI Start Channel | ROI End Channel | Peak FWHM keV | Gross Counts | Net Count Rate (cpm) |
|---------|--------------|-----------------|-------------------|-----------------|---------------|--------------|----------------------|
| Th-230  | 177          | 4,687.50        | 132               | 186             | 29.93         | 5,988.00     | 99.80                |
| Pu-239  | 240          | 5,155.40        | 186               | 249             | 30.79         | 6,118.00     | 101.97               |
| Am-241  | 284          | 5,485.70        | 249               | 303             | 31.69         | 6,015.00     | 100.25               |

Sample Name: ICV-8875;AV200-20151101  
Description:  
Detector: AV200

### Calibration

Analyst: 60040  
Analysis Date: 11/1/2015 3:56:11PM  
Calibration Type: Energy And Efficiency

Certificate ID: 82234-334  
Prepared by: Analytics  
Description:

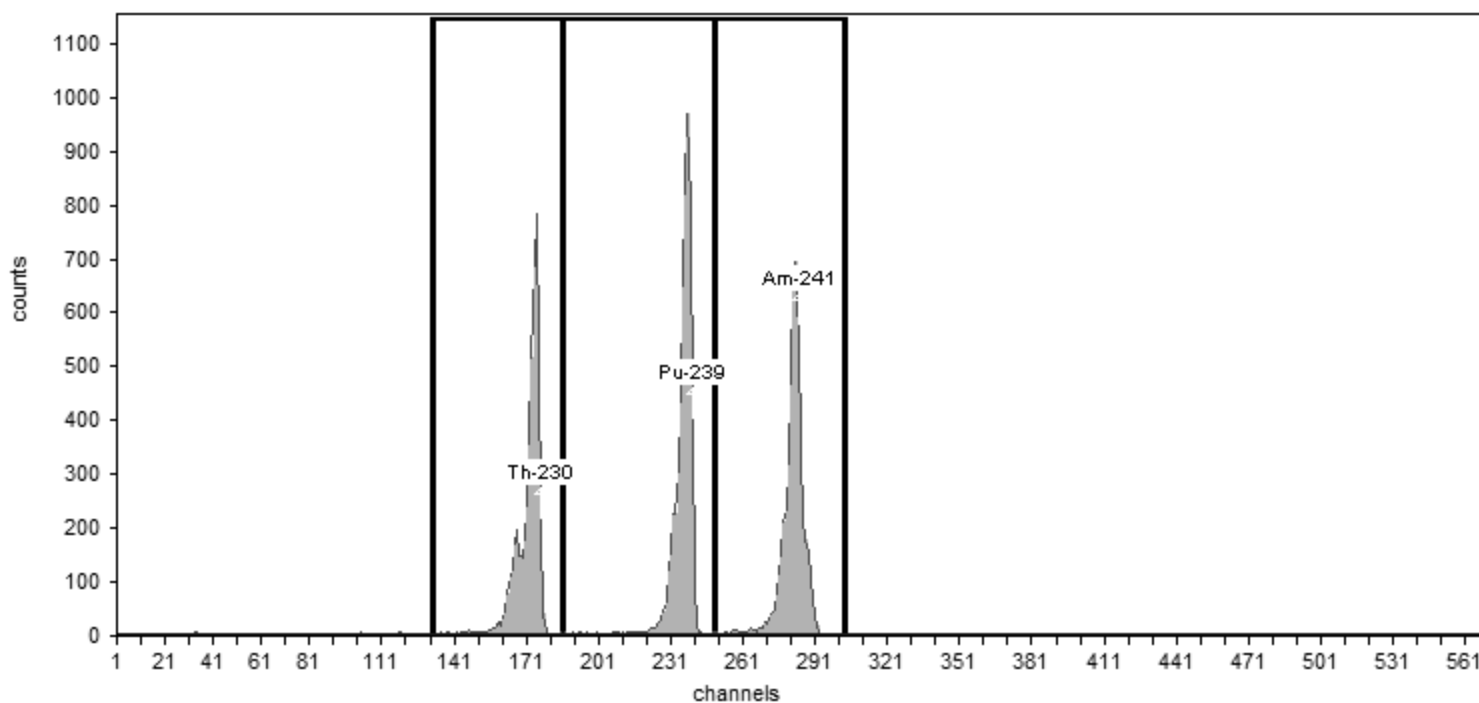
### Source Info

Certification Date: 6/2/2010 12:00:00PM

### Acquisition

Detector: AV200 , SN: 50-117J6  
Acquisition Start Date: 11/1/2015 2:26:11PM  
Live Time: 60.00 min.  
Real Time: 60.00 min.

Energy Calibration Equation:  
Gain = 7.4575 keV / Ch  
Offset = 3,366.95 keV  
Quadratic = 0.0000 keV / Ch<sup>2</sup>  
Efficiency Calibration Name: ICV-8875;AV200-20151101  
Efficiency: 24.09% +/- 0.45% TPU(2 sigma)



### General Analysis

Method: Manual (ROI)  
Algorithm: Linear

Initial Calibration: No  
Shelf: 0

### Nuclide Activity Summary

| Nuclide | Peak Channel | Peak Energy keV | ROI Start Channel | ROI End Channel | Peak FWHM keV | Gross Counts | Net Count Rate (cpm) |
|---------|--------------|-----------------|-------------------|-----------------|---------------|--------------|----------------------|
| Th-230  | 177          | 4,687.50        | 132               | 186             | 31.02         | 4,670.00     | 77.83                |
| Pu-239  | 240          | 5,155.40        | 186               | 249             | 33.77         | 5,472.00     | 91.20                |
| Am-241  | 284          | 5,485.70        | 249               | 303             | 35.49         | 4,837.00     | 80.62                |

# Monthly Calibration Verifications

Sample Name: CCV-8876;AV192-20160523  
Description:  
Detector: AV192

### Calibration

Analyst: 60040  
Analysis Date: 5/23/2016 4:19:16PM  
Calibration Type: Energy And Efficiency

Certificate ID: 82235-334  
Prepared by: Analytics  
Description:

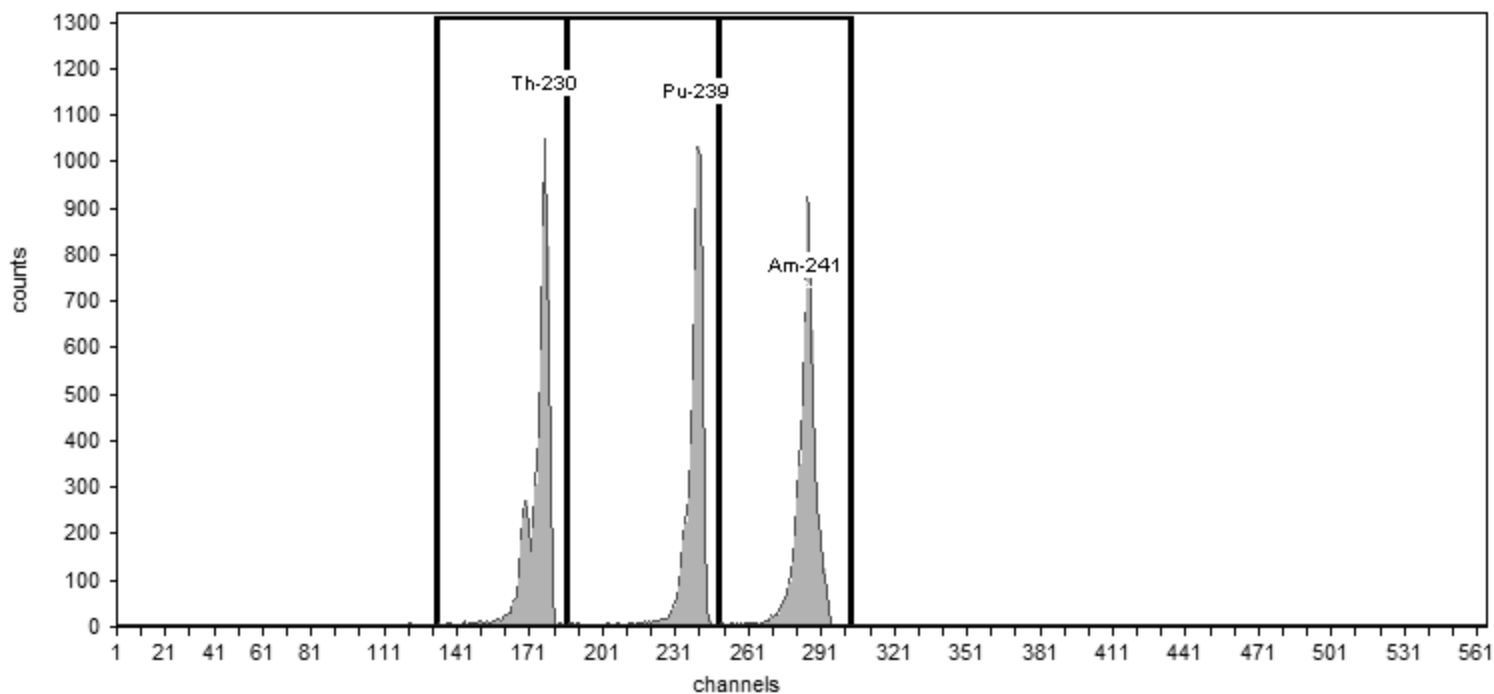
### Source Info

Certification Date: 6/4/2010 12:00:00PM

### Acquisition

Detector: AV192 , SN: 50-119J7  
Acquisition Start Date: 5/23/2016 3:18:15PM  
Live Time: 60.00 min.  
Real Time: 60.00 min.  
Efficiency Calibration Name: CCV-8876;AV192-20160523

Energy Calibration Equation:  
Gain = 7.4575 keV / Ch  
Offset = 3,366.95 keV  
Quadratic = 0.0000 keV / Ch<sup>2</sup>  
Efficiency: 23.72% +/- 0.39% TPU(2 sigma)



### General Analysis

Method: Manual (ROI)  
Algorithm: Linear

Initial Calibration: No  
Shelf: 1

### Nuclide Activity Summary

| Nuclide | Peak Channel | Peak Energy keV | ROI Start Channel | ROI End Channel | Peak FWHM keV | Gross Counts | Net Count Rate (cpm) |
|---------|--------------|-----------------|-------------------|-----------------|---------------|--------------|----------------------|
| Th-230  | 177          | 4,687.50        | 132               | 186             | 29.99         | 6,211.00     | 103.52               |
| Pu-239  | 240          | 5,155.40        | 186               | 249             | 32.77         | 5,832.00     | 97.20                |
| Am-241  | 284          | 5,485.70        | 249               | 303             | 35.31         | 6,291.00     | 104.85               |

Sample Name: CCV-8877;AV193-20160523  
Description:  
Detector: AV193

### Calibration

Analyst: 60040  
Analysis Date: 5/23/2016 3:01:40PM  
Calibration Type: Energy And Efficiency

Certificate ID: 82236-334  
Prepared by: Analytics  
Description:

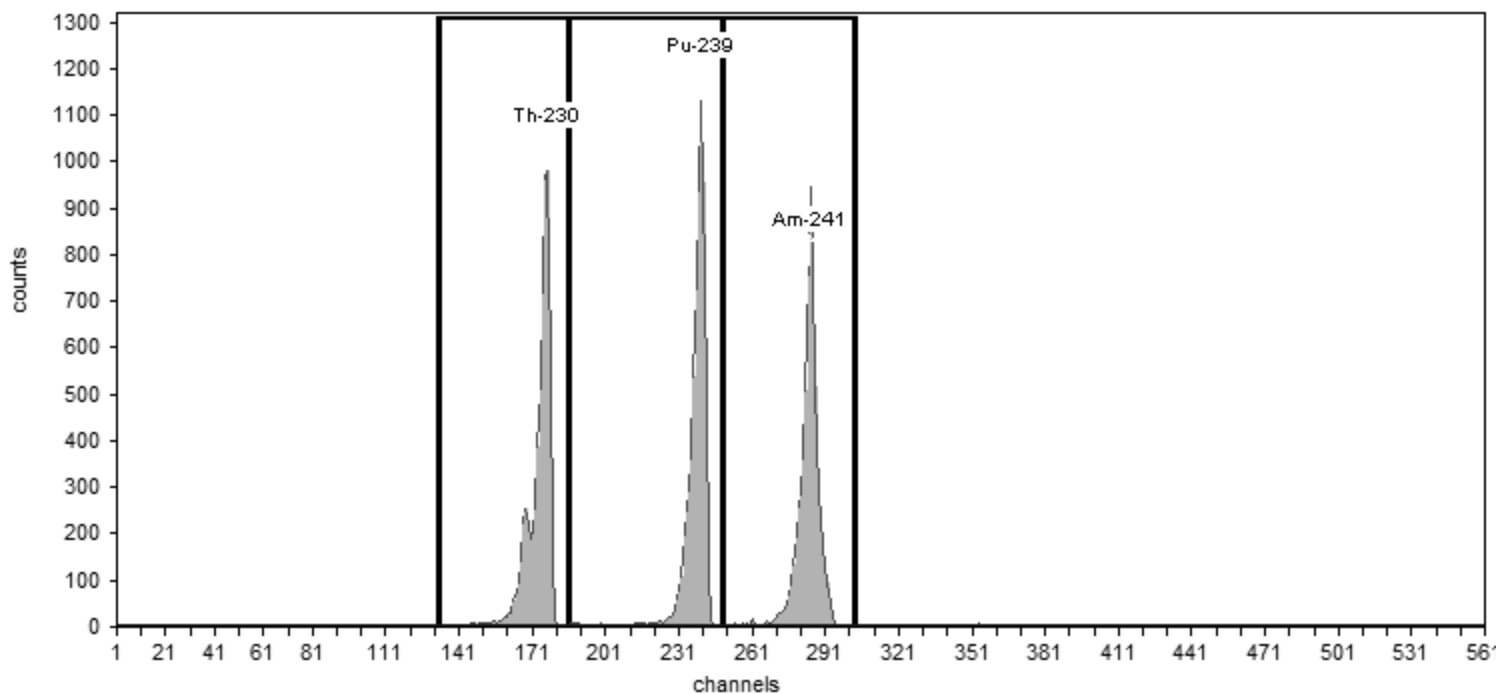
### Source Info

Certification Date: 6/2/2010 12:00:00PM

### Acquisition

Detector: AV193 , SN: 50-11915  
Acquisition Start Date: 5/23/2016 1:50:02PM  
Live Time: 60.00 min.  
Real Time: 60.00 min.  
Efficiency Calibration Name: CCV-8877;AV193-20160523

Energy Calibration Equation:  
Gain = 7.4575 keV / Ch  
Offset = 3,366.95 keV  
Quadratic = 0.0000 keV / Ch<sup>2</sup>  
Efficiency: 25.06% +/- 0.41% TPU(2 sigma)



### General Analysis

Method: Manual (ROI)  
Algorithm: Linear

Initial Calibration: No  
Shelf: 1

### Nuclide Activity Summary

| Nuclide | Peak Channel | Peak Energy keV | ROI Start Channel | ROI End Channel | Peak FWHM keV | Gross Counts | Net Count Rate (cpm) |
|---------|--------------|-----------------|-------------------|-----------------|---------------|--------------|----------------------|
| Th-230  | 177          | 4,687.50        | 132               | 186             | 32.43         | 6,130.00     | 102.17               |
| Pu-239  | 240          | 5,155.40        | 186               | 249             | 35.11         | 6,434.00     | 107.23               |
| Am-241  | 284          | 5,485.70        | 249               | 303             | 32.97         | 6,086.00     | 101.43               |

Sample Name: CCV-9792;AV195-20160523  
Description:  
Detector: AV195

### Calibration

Analyst: 60040  
Analysis Date: 5/23/2016 1:38:18PM  
Calibration Type: Energy And Efficiency

Certificate ID: 82240-334  
Prepared by: Analytics  
Description:

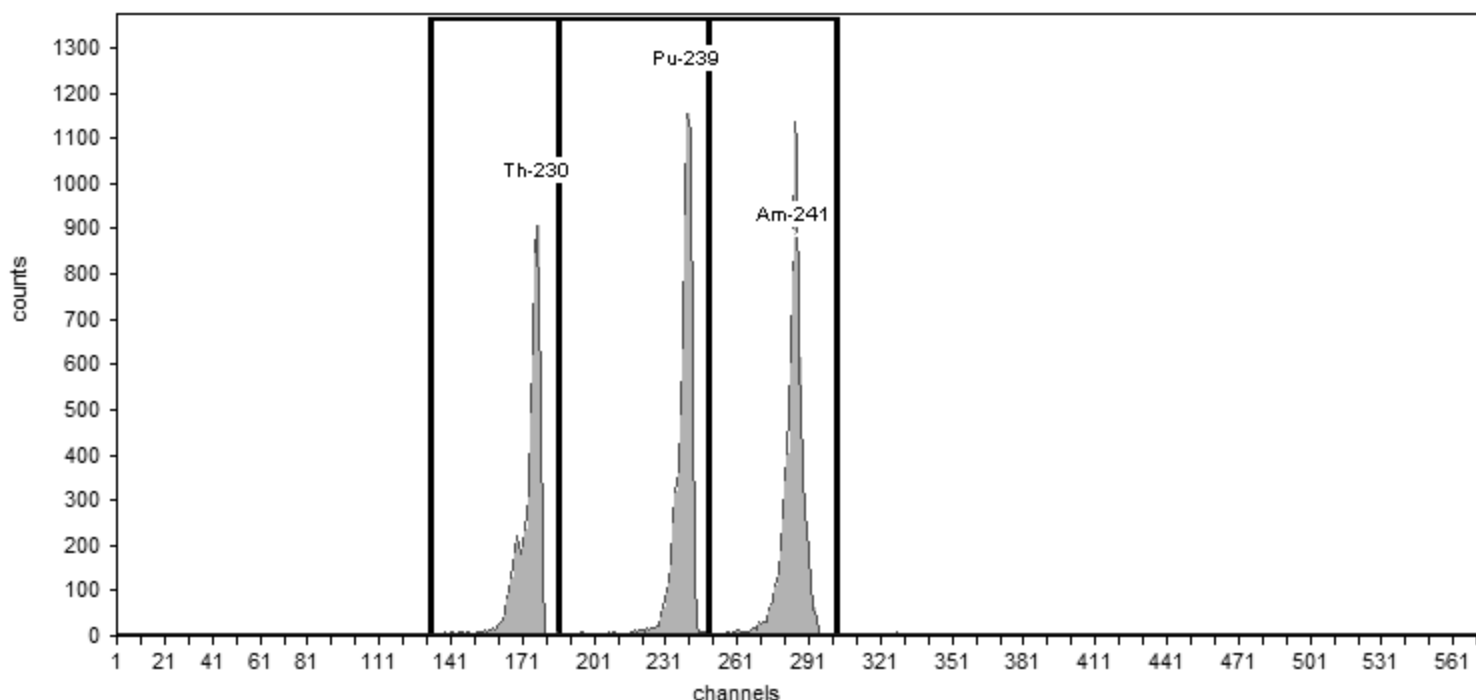
### Source Info

Certification Date: 6/8/2010 12:00:00PM

### Acquisition

Detector: AV195 , SN: 50-117AA2  
Acquisition Start Date: 5/23/2016 12:23:48PM  
Live Time: 60.00 min.  
Real Time: 60.00 min.

Energy Calibration Equation:  
Gain = 7.4575 keV / Ch  
Offset = 3,366.95 keV  
Quadratic = 0.0000 keV / Ch<sup>2</sup>  
Efficiency Calibration Name: CCV-9792;AV195-20160523  
Efficiency: 25.00% +/- 0.40% TPU(2 sigma)



### General Analysis

Method: Manual (ROI)  
Algorithm: Linear

Initial Calibration: No  
Shelf: 1

### Nuclide Activity Summary

| Nuclide | Peak Channel | Peak Energy keV | ROI Start Channel | ROI End Channel | Peak FWHM keV | Gross Counts | Net Count Rate (cpm) |
|---------|--------------|-----------------|-------------------|-----------------|---------------|--------------|----------------------|
| Th-230  | 177          | 4,687.50        | 132               | 186             | 33.00         | 5,586.00     | 93.10                |
| Pu-239  | 240          | 5,155.40        | 186               | 249             | 32.27         | 6,612.00     | 110.20               |
| Am-241  | 284          | 5,485.70        | 249               | 303             | 32.42         | 7,331.00     | 122.18               |

Sample Name: CCV-9794;AV197-20160523  
Description:  
Detector: AV197

### Calibration

Analyst: 60040  
Analysis Date: 5/23/2016 1:39:07PM  
Calibration Type: Energy And Efficiency

Certificate ID: 82242-334  
Prepared by: Analytics  
Description:

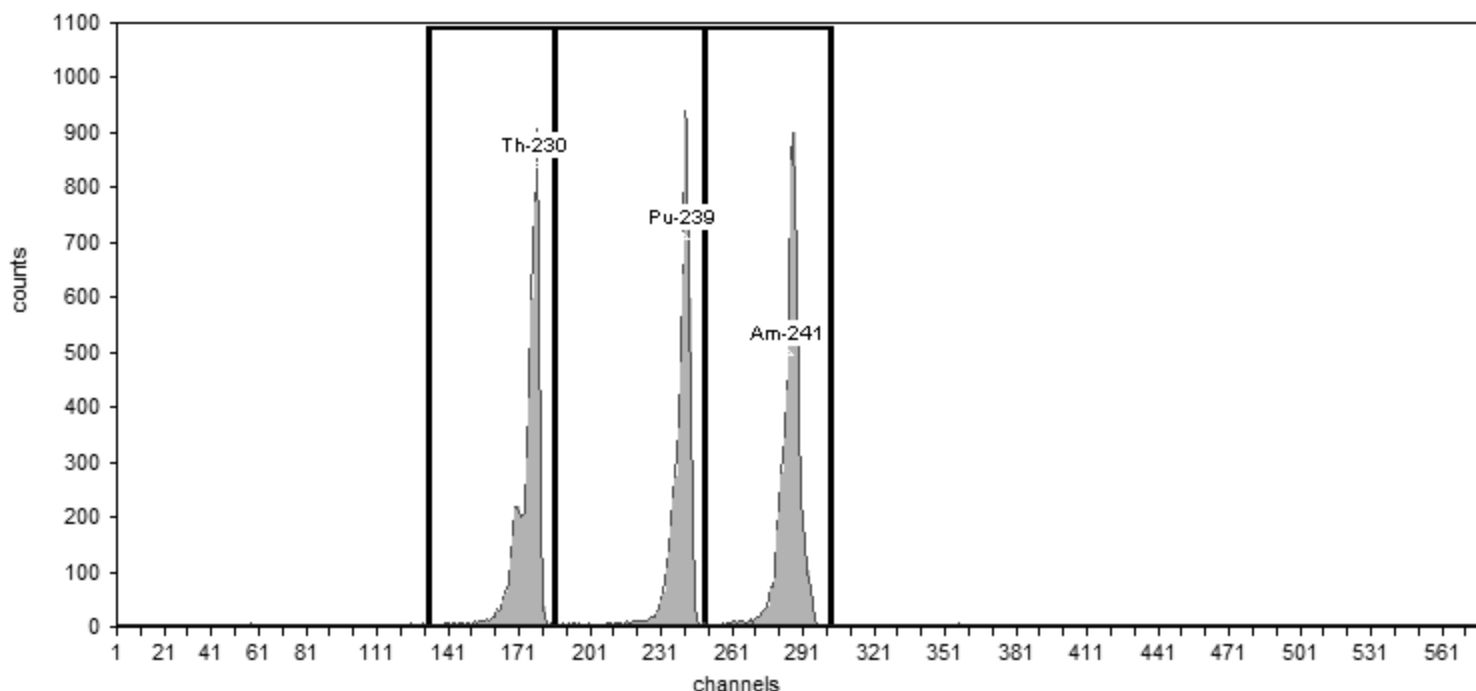
### Source Info

Certification Date: 6/8/2010 12:00:00PM

### Acquisition

Detector: AV197 , SN: 50-117Z5  
Acquisition Start Date: 5/23/2016 12:28:08PM  
Live Time: 60.00 min.  
Real Time: 60.00 min.

Energy Calibration Equation:  
Gain = 7.4575 keV / Ch  
Offset = 3,366.95 keV  
Quadratic = 0.0000 keV / Ch<sup>2</sup>  
Efficiency Calibration Name: CCV-9794;AV197-201605;  
Efficiency: 23.66% +/- 0.41% TPU(2 sigma)



### General Analysis

Method: Manual (ROI)  
Algorithm: Linear

Initial Calibration: No  
Shelf: 1

### Nuclide Activity Summary

| Nuclide | Peak Channel | Peak Energy keV | ROI Start Channel | ROI End Channel | Peak FWHM keV | Gross Counts | Net Count Rate (cpm) |
|---------|--------------|-----------------|-------------------|-----------------|---------------|--------------|----------------------|
| Th-230  | 177          | 4,687.50        | 132               | 186             | 31.70         | 5,609.00     | 93.48                |
| Pu-239  | 240          | 5,155.40        | 186               | 249             | 33.08         | 5,453.00     | 90.88                |
| Am-241  | 284          | 5,485.70        | 249               | 303             | 34.50         | 6,039.00     | 100.65               |

Sample Name: CCV-9795;AV198-20160523a  
Description:  
Detector: AV198

### Calibration

Analyst: 60040  
Analysis Date: 5/23/2016 1:39:30PM  
Calibration Type: Energy And Efficiency

Certificate ID: 82243-334  
Prepared by: Analytics  
Description:

### Source Info

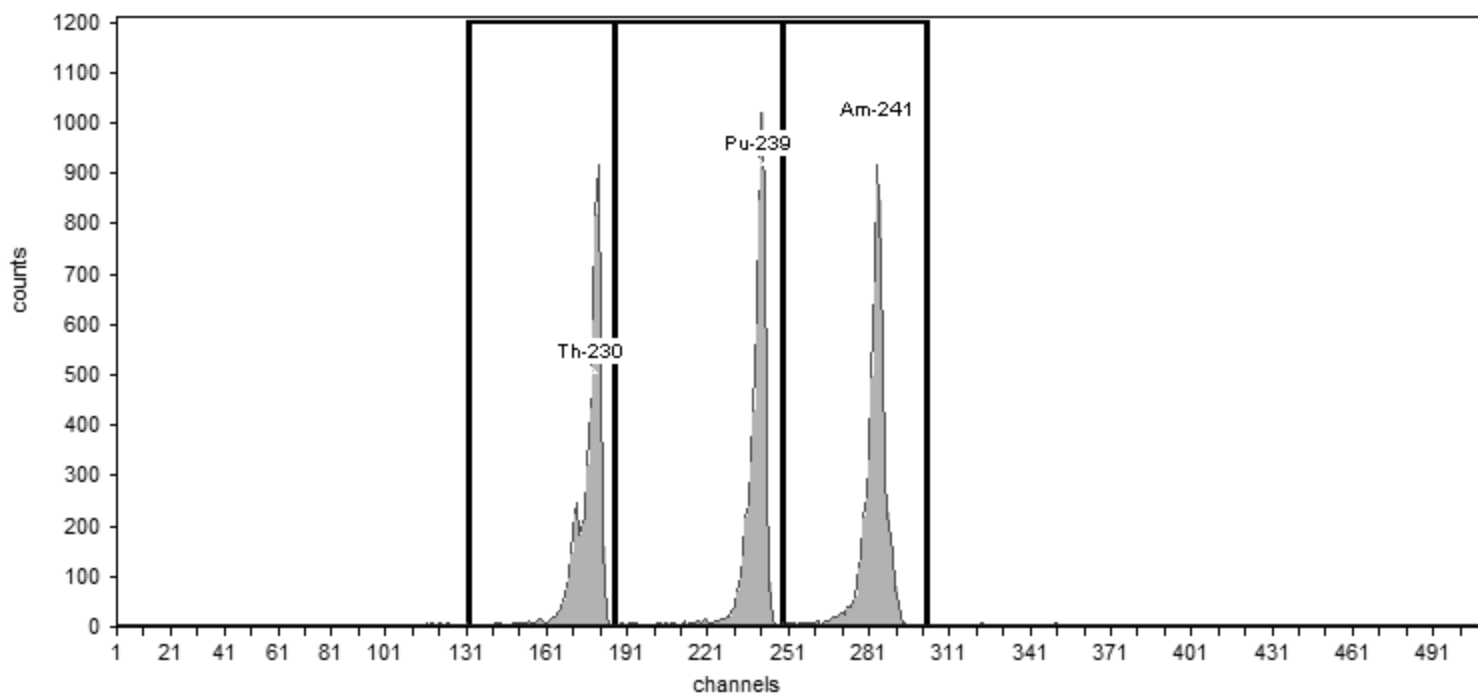
Certification Date: 6/9/2010 12:00:00PM

### Acquisition

Detector: AV198 , SN: 50-117AA7  
Acquisition Start Date: 5/23/2016 12:38:08PM  
Live Time: 60.00 min.  
Real Time: 60.00 min.

Energy Calibration Equation:  
Gain = 7.4575 keV / Ch  
Offset = 3,366.95 keV  
Quadratic = 0.0000 keV / Ch<sup>2</sup>  
Efficiency: 25.75% +/- 0.45% TPU(2 sigma)

Efficiency Calibration Name: CCV-9795;AV198-20160523a



### General Analysis

Method: Manual (ROI)  
Algorithm: Linear

Initial Calibration: No  
Shelf: 1

### Nuclide Activity Summary

| Nuclide | Peak Channel | Peak Energy keV | ROI Start Channel | ROI End Channel | Peak FWHM keV | Gross Counts | Net Count Rate (cpm) |
|---------|--------------|-----------------|-------------------|-----------------|---------------|--------------|----------------------|
| Th-230  | 177          | 4,687.50        | 132               | 186             | 30.82         | 5,463.00     | 91.05                |
| Pu-239  | 240          | 5,155.40        | 186               | 249             | 31.08         | 5,508.00     | 91.80                |
| Am-241  | 284          | 5,485.70        | 249               | 303             | 34.20         | 5,870.00     | 97.83                |

Sample Name: CCV-9817;AV199-20160523  
Description:  
Detector: AV199

### Calibration

Analyst: 60040  
Analysis Date: 5/23/2016 1:38:57PM  
Calibration Type: Energy And Efficiency

Certificate ID: 82244-334  
Prepared by: Analytics  
Description:

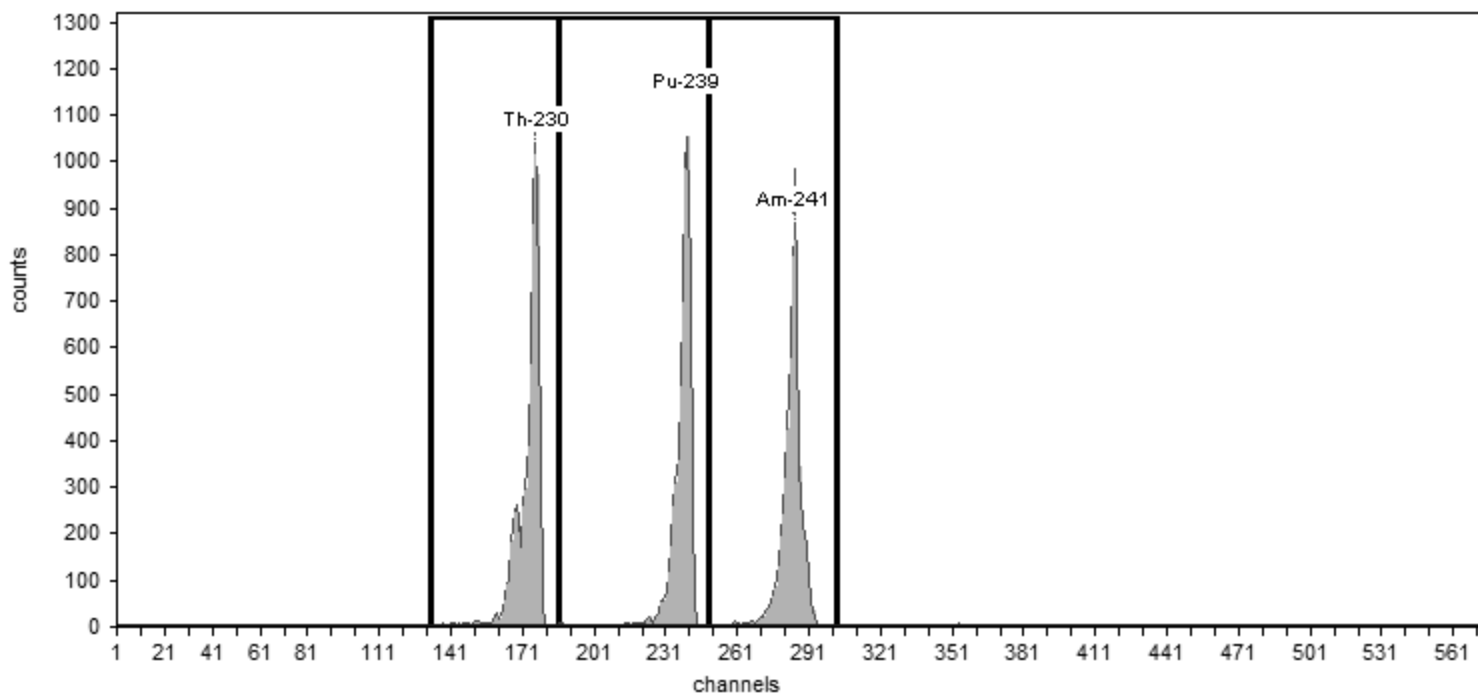
### Source Info

Certification Date: 6/9/2010 12:00:00PM

### Acquisition

Detector: AV199 , SN: 50-117Z3  
Acquisition Start Date: 5/23/2016 12:27:26PM  
Live Time: 60.00 min.  
Real Time: 60.00 min.

Energy Calibration Equation:  
Gain = 7.4575 keV / Ch  
Offset = 3,366.95 keV  
Quadratic = 0.0000 keV / Ch<sup>2</sup>  
Efficiency Calibration Name: CCV-9817;AV199-20160523  
Efficiency: 24.09% +/- 0.40% TPU(2 sigma)



### General Analysis

Method: Manual (ROI)  
Algorithm: Linear

Initial Calibration: No  
Shelf: 1

### Nuclide Activity Summary

| Nuclide | Peak Channel | Peak Energy keV | ROI Start Channel | ROI End Channel | Peak FWHM keV | Gross Counts | Net Count Rate (cpm) |
|---------|--------------|-----------------|-------------------|-----------------|---------------|--------------|----------------------|
| Th-230  | 177          | 4,687.50        | 132               | 186             | 29.24         | 6,362.00     | 106.03               |
| Pu-239  | 240          | 5,155.40        | 186               | 249             | 32.99         | 5,901.00     | 98.35                |
| Am-241  | 284          | 5,485.70        | 249               | 303             | 30.64         | 5,870.00     | 97.83                |

Sample Name: CCV-9884;AV200-20160523a  
Description:  
Detector: AV200

### Calibration

Analyst: 60040  
Analysis Date: 5/23/2016 1:39:24PM  
Calibration Type: Energy And Efficiency

Certificate ID: 82245-334  
Prepared by: Analytics  
Description:

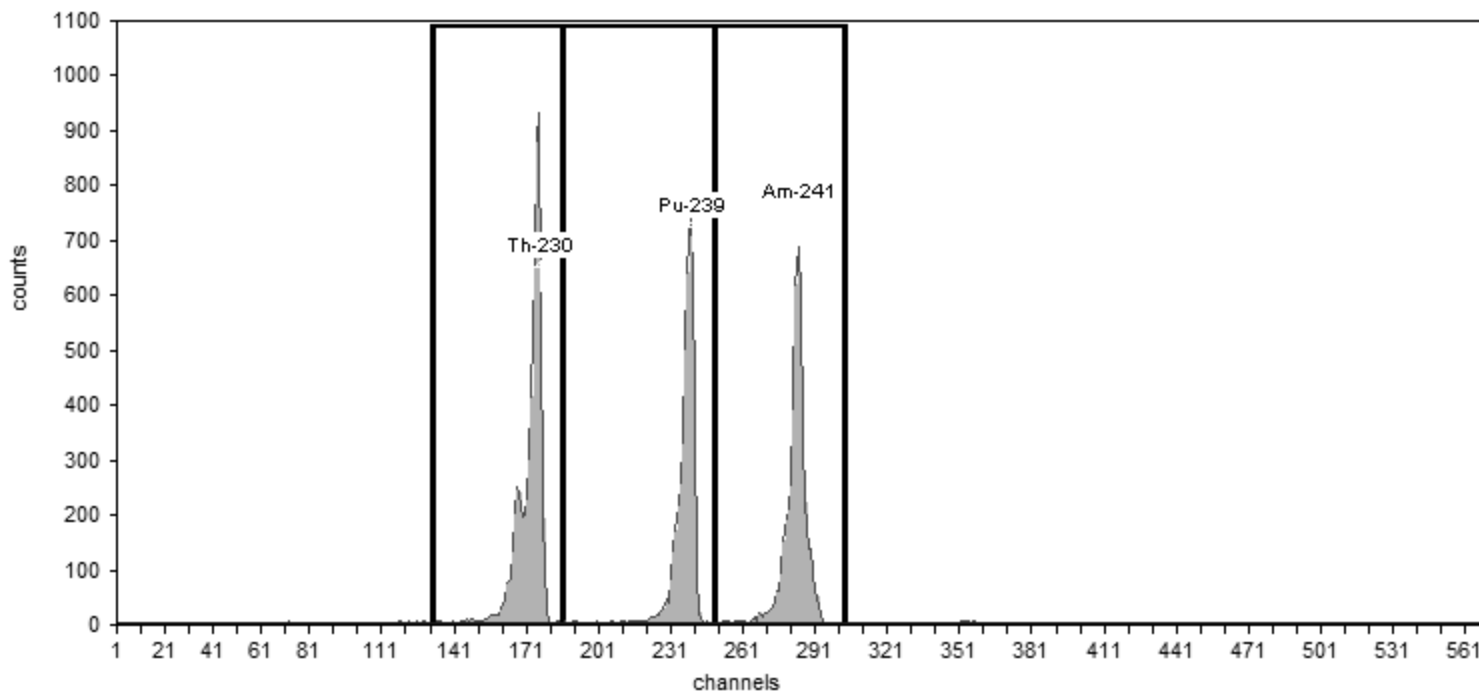
### Source Info

Certification Date: 6/9/2010 12:00:00PM

### Acquisition

Detector: AV200 , SN: 50-117J6  
Acquisition Start Date: 5/23/2016 12:37:41PM  
Live Time: 60.00 min.  
Real Time: 60.00 min.  
Efficiency Calibration Name: CCV-9884;AV200-20160523a

Energy Calibration Equation:  
Gain = 7.4575 keV / Ch  
Offset = 3,366.95 keV  
Quadratic = 0.0000 keV / Ch<sup>2</sup>  
Efficiency: 23.40% +/- 0.45% TPU(2 sigma)



### General Analysis

Method: Manual (ROI)  
Algorithm: Linear

Initial Calibration: No  
Shelf: 1

### Nuclide Activity Summary

| Nuclide | Peak Channel | Peak Energy keV | ROI Start Channel | ROI End Channel | Peak FWHM keV | Gross Counts | Net Count Rate (cpm) |
|---------|--------------|-----------------|-------------------|-----------------|---------------|--------------|----------------------|
| Th-230  | 177          | 4,687.50        | 132               | 186             | 30.47         | 5,815.00     | 96.92                |
| Pu-239  | 240          | 5,155.40        | 186               | 249             | 35.04         | 4,488.00     | 74.80                |
| Am-241  | 284          | 5,485.70        | 249               | 303             | 32.39         | 4,562.00     | 76.03                |

# Monthly Backgrounds

Sample Name: **ICB;AV192**

Comment:

### Sample

Spectrum #1 Analysis #1

Analyst: **60040**

Batch Name: **May2016**

Description:

### Batch

### Acquisition

Detector: **AV192**, SN: **50-119J7**

Acquisition Start Date: **5/19/2016 1:01:37PM**

Live Time: **960.00 min.**

Real Time: **960.01 min.**

Calibration Name: **IC-8876;AV192-20151017**

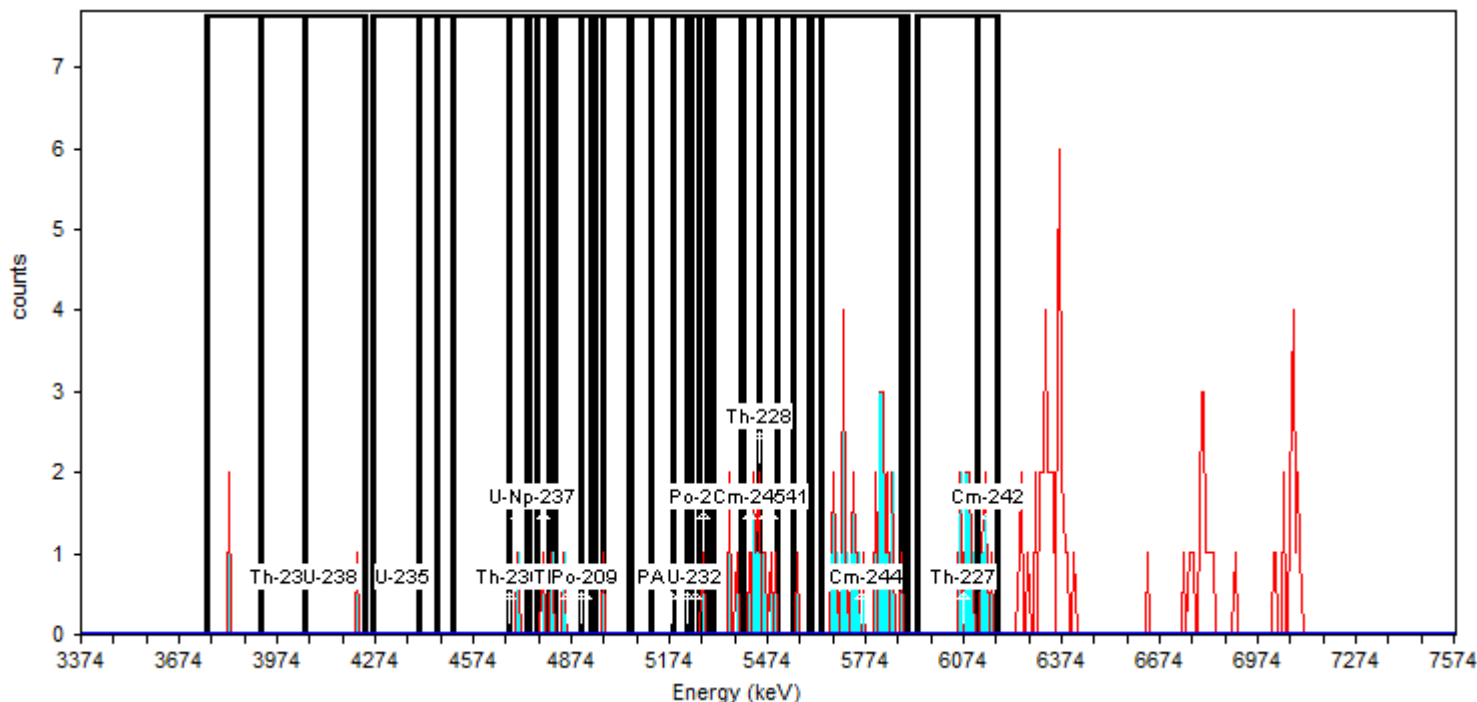
Calibration Date: **10/18/2015 3:55:07PM**

Energy Calibration Equation:

Gain = **7.4575 keV / Ch**

Offset = **3,366.95 keV**

Quadratic = **0.0000 keV / Ch<sup>2</sup>**



### General Analysis

Analysis Method: **Absolute ROI Analysis**, Set Name = **11/05\_BackgroundROI**, Nuclide Library: **Background ROI Library**

Total Background Counts: **133.00**

# Nuclide Summary (ROI)

| <u>RegionName</u> | <u>Peak Energy</u><br>(keV) | <u>Start Energy</u><br>(keV) | <u>End Energy</u><br>(keV) | <u>GrossCounts</u> | <u>Count Rate</u><br>(CPM) | <u>CR Uncertainty</u><br>(CPM) |
|-------------------|-----------------------------|------------------------------|----------------------------|--------------------|----------------------------|--------------------------------|
| Th-232            | 3,985.93                    | 3,754.75                     | 4,053.05                   | 2.00               | 2.083E-003                 | 1.804E-003                     |
| U-238             | 4,135.08                    | 3,918.81                     | 4,239.49                   | 1.00               | 1.042E-003                 | 1.473E-003                     |
| U-235             | 4,358.81                    | 4,261.86                     | 4,463.21                   | 0.00               | 0.000E+000                 | 1.473E-003                     |
| Th-230            | 4,679.48                    | 4,403.55                     | 4,746.60                   | 1.00               | 1.042E-003                 | 1.473E-003                     |
| U-234             | 4,709.31                    | 4,507.96                     | 4,821.17                   | 3.00               | 3.125E-003                 | 2.083E-003                     |
| Pu-242            | 4,903.21                    | 4,679.48                     | 4,947.95                   | 4.00               | 4.167E-003                 | 2.329E-003                     |
| Th-229            | 4,858.46                    | 4,739.14                     | 5,119.48                   | 4.00               | 4.167E-003                 | 2.329E-003                     |
| Np-237            | 4,783.89                    | 4,768.97                     | 4,806.26                   | 1.00               | 1.042E-003                 | 1.473E-003                     |
| Po-209            | 4,918.12                    | 4,903.21                     | 4,933.04                   | 0.00               | 0.000E+000                 | 1.473E-003                     |
| Pu-239            | 5,179.14                    | 4,970.33                     | 5,238.80                   | 1.00               | 1.042E-003                 | 1.473E-003                     |
| Am-243            | 5,231.34                    | 5,052.36                     | 5,305.92                   | 1.00               | 1.042E-003                 | 1.473E-003                     |
| U-232             | 5,253.71                    | 5,059.82                     | 5,402.86                   | 4.00               | 4.167E-003                 | 2.329E-003                     |
| Th-228            | 5,447.61                    | 5,186.59                     | 5,507.27                   | 14.00              | 1.458E-002                 | 4.034E-003                     |
| Po-210            | 5,276.09                    | 5,231.34                     | 5,291.00                   | 1.00               | 1.042E-003                 | 1.473E-003                     |
| Pu-238            | 5,469.98                    | 5,268.63                     | 5,552.01                   | 14.00              | 1.458E-002                 | 4.034E-003                     |
| Am-241            | 5,484.90                    | 5,298.46                     | 5,604.22                   | 14.00              | 1.458E-002                 | 4.034E-003                     |
| Cm-245            | 5,417.78                    | 5,395.41                     | 5,447.61                   | 6.00               | 6.250E-003                 | 2.756E-003                     |
| Pu-236            | 5,760.83                    | 5,611.67                     | 5,887.60                   | 30.00              | 3.125E-002                 | 5.800E-003                     |
| Cm-244            | 5,775.74                    | 5,641.51                     | 5,902.52                   | 30.00              | 3.125E-002                 | 5.800E-003                     |
| Th-227            | 6,074.04                    | 5,932.35                     | 6,178.45                   | 14.00              | 1.458E-002                 | 4.034E-003                     |
| Cm-242            | 6,148.62                    | 6,118.79                     | 6,178.45                   | 5.00               | 5.208E-003                 | 2.552E-003                     |

Sample Name: ICB;AV193

Comment:

## Sample

Spectrum #1      Analysis #1

Analyst: 60040

Batch Name: May2016

**Description:**

## Batch

## Acquisition

Detector: AV193 , SN: 50-11915

Acquisition Start Date: 5/19/2016 1:01:37PM

Live Time: 960.00 min.

Real Time: 960.00 min.

Calibration Name: IC-8877;AV193-20151017

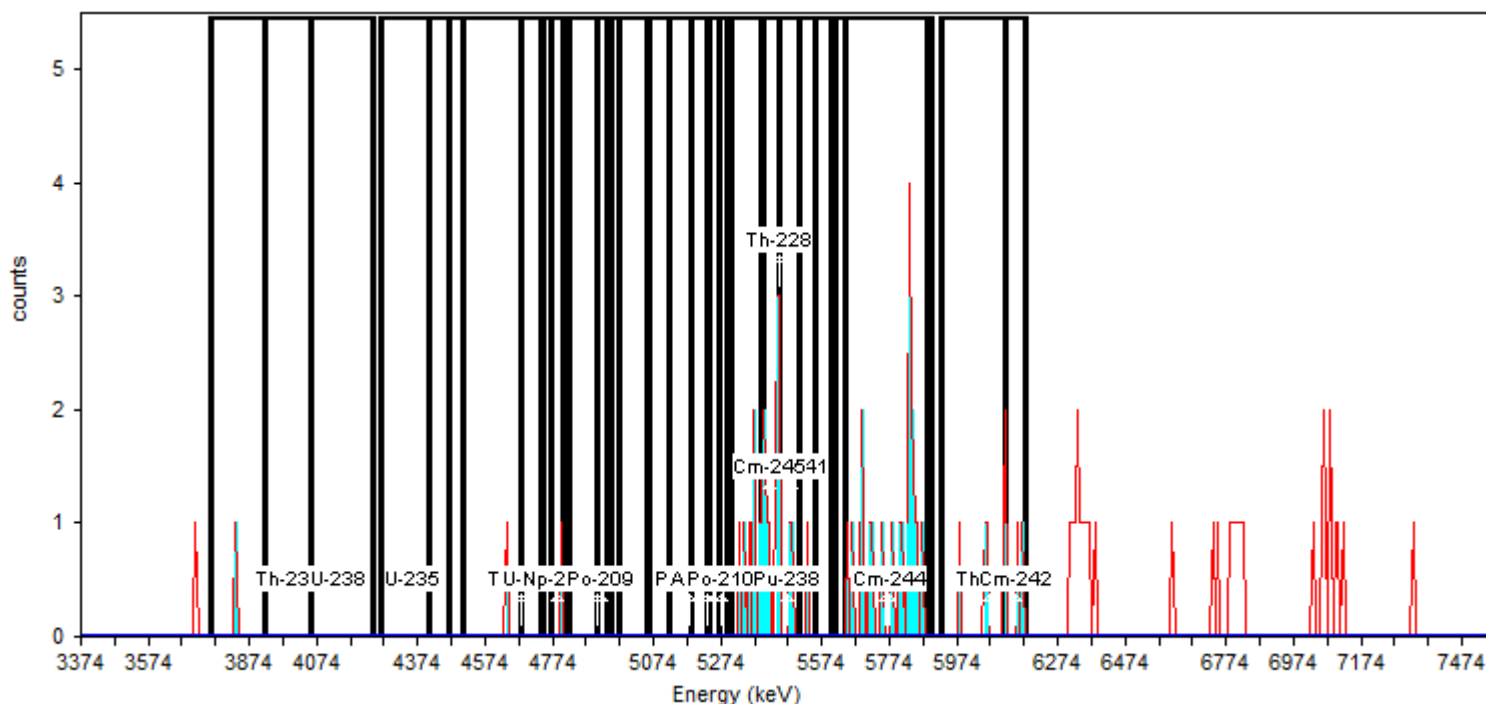
Calibration Date: 10/18/2015 3:55:11PM

Energy Calibration Equation:

Gain = 7.4575 keV / Ch

Offset = 3,366.95 keV

Quadratic = 0.0000 keV / Ch<sup>2</sup>



## General Analysis

Analysis Method: Absolute ROI Analysis, Set Name = 11/05\_BackgroundROI, Nuclide Library: Background ROI Library

Total Background Counts: 81.00

# Nuclide Summary (ROI)

| <u>RegionName</u> | <u>Peak Energy</u> | <u>Start Energy</u> | <u>End Energy</u> | <u>GrossCounts</u> | <u>Count Rate</u> | <u>CR Uncertainty</u> |
|-------------------|--------------------|---------------------|-------------------|--------------------|-------------------|-----------------------|
|                   | (keV)              | (keV)               | (keV)             |                    | (CPM)             | (CPM)                 |
| Th-232            | 3,985.93           | 3,754.75            | 4,053.05          | 1.00               | 1.042E-003        | 1.473E-003            |
| U-238             | 4,135.08           | 3,918.81            | 4,239.49          | 0.00               | 0.000E+000        | 1.473E-003            |
| U-235             | 4,358.81           | 4,261.86            | 4,463.21          | 0.00               | 0.000E+000        | 1.473E-003            |
| Th-230            | 4,679.48           | 4,403.55            | 4,746.60          | 1.00               | 1.042E-003        | 1.473E-003            |
| U-234             | 4,709.31           | 4,507.96            | 4,821.17          | 2.00               | 2.083E-003        | 1.804E-003            |
| Pu-242            | 4,903.21           | 4,679.48            | 4,947.95          | 1.00               | 1.042E-003        | 1.473E-003            |
| Th-229            | 4,858.46           | 4,739.14            | 5,119.48          | 1.00               | 1.042E-003        | 1.473E-003            |
| Np-237            | 4,783.89           | 4,768.97            | 4,806.26          | 1.00               | 1.042E-003        | 1.473E-003            |
| Po-209            | 4,918.12           | 4,903.21            | 4,933.04          | 0.00               | 0.000E+000        | 1.473E-003            |
| Pu-239            | 5,179.14           | 4,970.33            | 5,238.80          | 0.00               | 0.000E+000        | 1.473E-003            |
| Am-243            | 5,231.34           | 5,052.36            | 5,305.92          | 0.00               | 0.000E+000        | 1.473E-003            |
| U-232             | 5,253.71           | 5,059.82            | 5,402.86          | 9.00               | 9.375E-003        | 3.294E-003            |
| Th-228            | 5,447.61           | 5,186.59            | 5,507.27          | 19.00              | 1.979E-002        | 4.658E-003            |
| Po-210            | 5,276.09           | 5,231.34            | 5,291.00          | 0.00               | 0.000E+000        | 1.473E-003            |
| Pu-238            | 5,469.98           | 5,268.63            | 5,552.01          | 20.00              | 2.083E-002        | 4.774E-003            |
| Am-241            | 5,484.90           | 5,298.46            | 5,604.22          | 20.00              | 2.083E-002        | 4.774E-003            |
| Cm-245            | 5,417.78           | 5,395.41            | 5,447.61          | 11.00              | 1.146E-002        | 3.608E-003            |
| Pu-236            | 5,760.83           | 5,611.67            | 5,887.60          | 20.00              | 2.083E-002        | 4.774E-003            |
| Cm-244            | 5,775.74           | 5,641.51            | 5,902.52          | 20.00              | 2.083E-002        | 4.774E-003            |
| Th-227            | 6,074.04           | 5,932.35            | 6,178.45          | 7.00               | 7.292E-003        | 2.946E-003            |
| Cm-242            | 6,148.62           | 6,118.79            | 6,178.45          | 4.00               | 4.167E-003        | 2.329E-003            |

Comment:

## Sample

Analyst: 60040

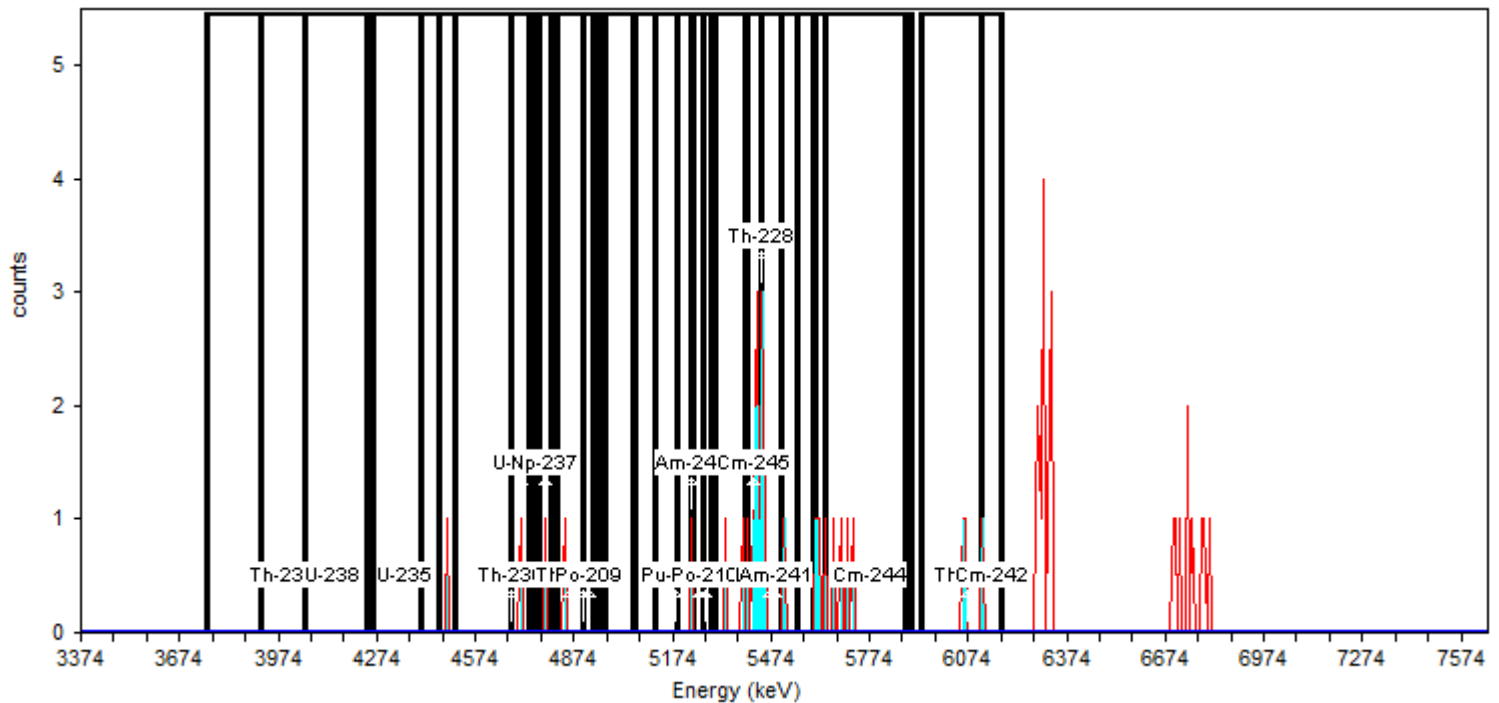
Description:

## Batch

## Acquisition

Energy Calibration Equation:

Gain = 7.4575 keV / Ch  
Offset = 3,366.95 keV  
Quadratic = 0.0000 keV / Ch<sup>2</sup>



## General Analysis

Analysis Method: Absolute ROI Analysis, Set Name = 11/05\_BackgroundROI, Nuclide Library: Background ROI Library  
Total Background Counts: 51.00

# Nuclide Summary (ROI)

| <u>RegionName</u> | <u>Peak Energy</u><br>(keV) | <u>Start Energy</u><br>(keV) | <u>End Energy</u><br>(keV) | <u>GrossCounts</u> | <u>Count Rate</u><br>(CPM) | <u>CR Uncertainty</u><br>(CPM) |
|-------------------|-----------------------------|------------------------------|----------------------------|--------------------|----------------------------|--------------------------------|
| Th-232            | 3,985.93                    | 3,754.75                     | 4,053.05                   | 0.00               | 0.000E+000                 | 1.473E-003                     |
| U-238             | 4,135.08                    | 3,918.81                     | 4,239.49                   | 0.00               | 0.000E+000                 | 1.473E-003                     |
| U-235             | 4,358.81                    | 4,261.86                     | 4,463.21                   | 0.00               | 0.000E+000                 | 1.473E-003                     |
| Th-230            | 4,679.48                    | 4,403.55                     | 4,746.60                   | 2.00               | 2.083E-003                 | 1.804E-003                     |
| U-234             | 4,709.31                    | 4,507.96                     | 4,821.17                   | 2.00               | 2.083E-003                 | 1.804E-003                     |
| Pu-242            | 4,903.21                    | 4,679.48                     | 4,947.95                   | 3.00               | 3.125E-003                 | 2.083E-003                     |
| Th-229            | 4,858.46                    | 4,739.14                     | 5,119.48                   | 2.00               | 2.083E-003                 | 1.804E-003                     |
| Np-237            | 4,783.89                    | 4,768.97                     | 4,806.26                   | 1.00               | 1.042E-003                 | 1.473E-003                     |
| Po-209            | 4,918.12                    | 4,903.21                     | 4,933.04                   | 0.00               | 0.000E+000                 | 1.473E-003                     |
| Pu-239            | 5,179.14                    | 4,970.33                     | 5,238.80                   | 1.00               | 1.042E-003                 | 1.473E-003                     |
| Am-243            | 5,231.34                    | 5,052.36                     | 5,305.92                   | 1.00               | 1.042E-003                 | 1.473E-003                     |
| U-232             | 5,253.71                    | 5,059.82                     | 5,402.86                   | 4.00               | 4.167E-003                 | 2.329E-003                     |
| Th-228            | 5,447.61                    | 5,186.59                     | 5,507.27                   | 15.00              | 1.563E-002                 | 4.167E-003                     |
| Po-210            | 5,276.09                    | 5,231.34                     | 5,291.00                   | 1.00               | 1.042E-003                 | 1.473E-003                     |
| Pu-238            | 5,469.98                    | 5,268.63                     | 5,552.01                   | 15.00              | 1.563E-002                 | 4.167E-003                     |
| Am-241            | 5,484.90                    | 5,298.46                     | 5,604.22                   | 15.00              | 1.563E-002                 | 4.167E-003                     |
| Cm-245            | 5,417.78                    | 5,395.41                     | 5,447.61                   | 11.00              | 1.146E-002                 | 3.608E-003                     |
| Pu-236            | 5,760.83                    | 5,611.67                     | 5,887.60                   | 7.00               | 7.292E-003                 | 2.946E-003                     |
| Cm-244            | 5,775.74                    | 5,641.51                     | 5,902.52                   | 5.00               | 5.208E-003                 | 2.552E-003                     |
| Th-227            | 6,074.04                    | 5,932.35                     | 6,178.45                   | 3.00               | 3.125E-003                 | 2.083E-003                     |
| Cm-242            | 6,148.62                    | 6,118.79                     | 6,178.45                   | 1.00               | 1.042E-003                 | 1.473E-003                     |

Sample Name: **ICB;AV197**

Comment:

### Sample

Spectrum #1 Analysis #1

Analyst: **60040**

Batch Name: **May2016**

Description:

### Batch

### Acquisition

Detector: **AV197**, SN: **50-117Z5**

Acquisition Start Date: **5/19/2016 1:01:38PM**

Live Time: **960.00 min.**

Real Time: **960.01 min.**

Calibration Name: **IC-9794;AV197-20151017**

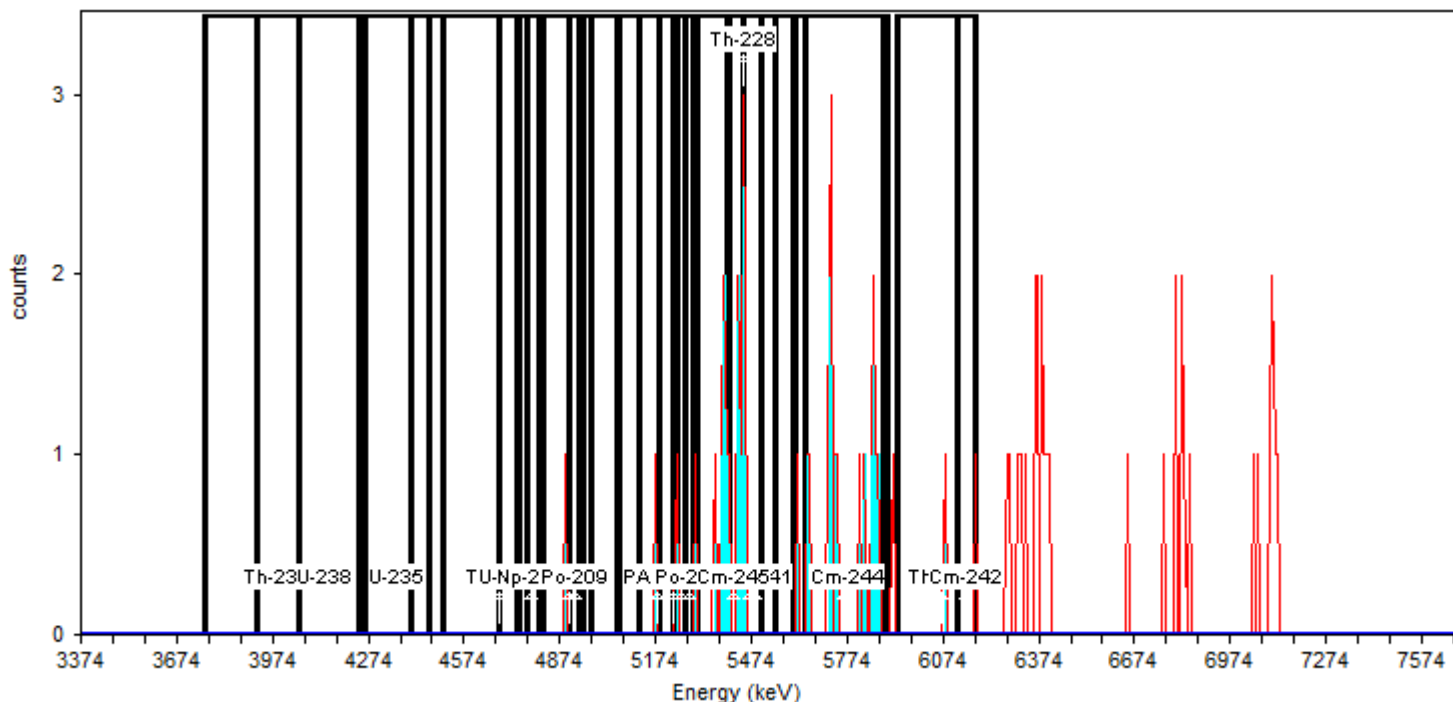
Calibration Date: **10/18/2015 3:55:22PM**

Energy Calibration Equation:

Gain = **7.4575 keV / Ch**

Offset = **3,366.95 keV**

Quadratic = **0.0000 keV / Ch<sup>2</sup>**



### General Analysis

Analysis Method: **Absolute ROI Analysis**, Set Name = **11/05\_BackgroundROI**, Nuclide Library: **Background ROI Library**

Total Background Counts: **67.00**

# **Nuclide Summary (ROI)**

| <b><u>RegionName</u></b> | <b><u>Peak Energy</u></b> | <b><u>Start Energy</u></b> | <b><u>End Energy</u></b> | <b><u>GrossCounts</u></b> | <b><u>Count Rate</u></b> | <b><u>CR Uncertainty</u></b> |
|--------------------------|---------------------------|----------------------------|--------------------------|---------------------------|--------------------------|------------------------------|
|                          | <b>(keV)</b>              | <b>(keV)</b>               | <b>(keV)</b>             |                           | <b>(CPM)</b>             | <b>(CPM)</b>                 |
| Th-232                   | 3,985.93                  | 3,754.75                   | 4,053.05                 | 0.00                      | 0.000E+000               | 1.473E-003                   |
| U-238                    | 4,135.08                  | 3,918.81                   | 4,239.49                 | 0.00                      | 0.000E+000               | 1.473E-003                   |
| U-235                    | 4,358.81                  | 4,261.86                   | 4,463.21                 | 0.00                      | 0.000E+000               | 1.473E-003                   |
| Th-230                   | 4,679.48                  | 4,403.55                   | 4,746.60                 | 0.00                      | 0.000E+000               | 1.473E-003                   |
| U-234                    | 4,709.31                  | 4,507.96                   | 4,821.17                 | 0.00                      | 0.000E+000               | 1.473E-003                   |
| Pu-242                   | 4,903.21                  | 4,679.48                   | 4,947.95                 | 1.00                      | 1.042E-003               | 1.473E-003                   |
| Th-229                   | 4,858.46                  | 4,739.14                   | 5,119.48                 | 1.00                      | 1.042E-003               | 1.473E-003                   |
| Np-237                   | 4,783.89                  | 4,768.97                   | 4,806.26                 | 0.00                      | 0.000E+000               | 1.473E-003                   |
| Po-209                   | 4,918.12                  | 4,903.21                   | 4,933.04                 | 0.00                      | 0.000E+000               | 1.473E-003                   |
| Pu-239                   | 5,179.14                  | 4,970.33                   | 5,238.80                 | 2.00                      | 2.083E-003               | 1.804E-003                   |
| Am-243                   | 5,231.34                  | 5,052.36                   | 5,305.92                 | 3.00                      | 3.125E-003               | 2.083E-003                   |
| U-232                    | 5,253.71                  | 5,059.82                   | 5,402.86                 | 9.00                      | 9.375E-003               | 3.294E-003                   |
| Th-228                   | 5,447.61                  | 5,186.59                   | 5,507.27                 | 16.00                     | 1.667E-002               | 4.295E-003                   |
| Po-210                   | 5,276.09                  | 5,231.34                   | 5,291.00                 | 1.00                      | 1.042E-003               | 1.473E-003                   |
| Pu-238                   | 5,469.98                  | 5,268.63                   | 5,552.01                 | 15.00                     | 1.563E-002               | 4.167E-003                   |
| Am-241                   | 5,484.90                  | 5,298.46                   | 5,604.22                 | 15.00                     | 1.563E-002               | 4.167E-003                   |
| Cm-245                   | 5,417.78                  | 5,395.41                   | 5,447.61                 | 8.00                      | 8.333E-003               | 3.125E-003                   |
| Pu-236                   | 5,760.83                  | 5,611.67                   | 5,887.60                 | 17.00                     | 1.771E-002               | 4.419E-003                   |
| Cm-244                   | 5,775.74                  | 5,641.51                   | 5,902.52                 | 16.00                     | 1.667E-002               | 4.295E-003                   |
| Th-227                   | 6,074.04                  | 5,932.35                   | 6,178.45                 | 2.00                      | 2.083E-003               | 1.804E-003                   |
| Cm-242                   | 6,148.62                  | 6,118.79                   | 6,178.45                 | 1.00                      | 1.042E-003               | 1.473E-003                   |

Sample Name: **ICB;AV198**

Comment:

### Sample

Spectrum #1 Analysis #1

Analyst: **60040**

### Batch

Batch Name: **May2016**

Description:

### Acquisition

Detector: **AV198**, SN: **50-117AA7**

Acquisition Start Date: **5/19/2016 1:01:38PM**

Live Time: **960.00 min.**

Real Time: **960.29 min.**

Calibration Name: **CCV-9795;AV198-20151122**

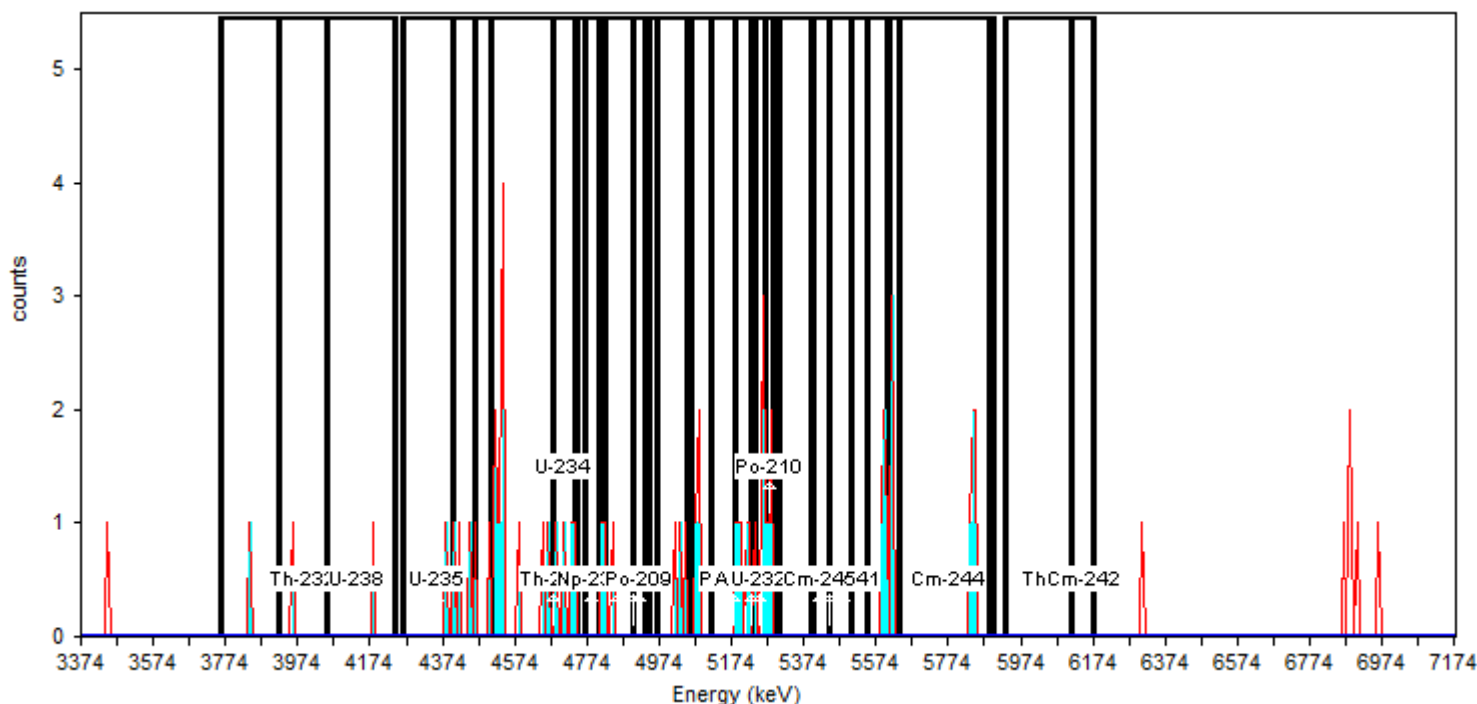
Calibration Date: **11/22/2015 4:27:37PM**

Energy Calibration Equation:

Gain = **7.4575 keV / Ch**

Offset = **3,366.95 keV**

Quadratic = **0.0000 keV / Ch<sup>2</sup>**



### General Analysis

Analysis Method: **Absolute ROI Analysis**, Set Name = **11/05\_BackgroundROI**, Nuclide Library: **Background ROI Library**

Total Background Counts: **66.00**

# **Nuclide Summary (ROI)**

| <b><u>RegionName</u></b> | <b><u>Peak Energy</u></b> | <b><u>Start Energy</u></b> | <b><u>End Energy</u></b> | <b><u>GrossCounts</u></b> | <b><u>Count Rate</u></b> | <b><u>CR Uncertainty</u></b> |
|--------------------------|---------------------------|----------------------------|--------------------------|---------------------------|--------------------------|------------------------------|
|                          | <b>(keV)</b>              | <b>(keV)</b>               | <b>(keV)</b>             |                           | <b>(CPM)</b>             | <b>(CPM)</b>                 |
| Th-232                   | 3,985.93                  | 3,754.75                   | 4,053.05                 | 2.00                      | 2.083E-003               | 1.804E-003                   |
| U-238                    | 4,135.08                  | 3,918.81                   | 4,239.49                 | 2.00                      | 2.083E-003               | 1.804E-003                   |
| U-235                    | 4,358.81                  | 4,261.86                   | 4,463.21                 | 5.00                      | 5.208E-003               | 2.552E-003                   |
| Th-230                   | 4,679.48                  | 4,403.55                   | 4,746.60                 | 20.00                     | 2.083E-002               | 4.774E-003                   |
| U-234                    | 4,709.31                  | 4,507.96                   | 4,821.17                 | 17.00                     | 1.771E-002               | 4.419E-003                   |
| Pu-242                   | 4,903.21                  | 4,679.48                   | 4,947.95                 | 7.00                      | 7.292E-003               | 2.946E-003                   |
| Th-229                   | 4,858.46                  | 4,739.14                   | 5,119.48                 | 10.00                     | 1.042E-002               | 3.455E-003                   |
| Np-237                   | 4,783.89                  | 4,768.97                   | 4,806.26                 | 0.00                      | 0.000E+000               | 1.473E-003                   |
| Po-209                   | 4,918.12                  | 4,903.21                   | 4,933.04                 | 0.00                      | 0.000E+000               | 1.473E-003                   |
| Pu-239                   | 5,179.14                  | 4,970.33                   | 5,238.80                 | 12.00                     | 1.250E-002               | 3.756E-003                   |
| Am-243                   | 5,231.34                  | 5,052.36                   | 5,305.92                 | 16.00                     | 1.667E-002               | 4.295E-003                   |
| U-232                    | 5,253.71                  | 5,059.82                   | 5,402.86                 | 16.00                     | 1.667E-002               | 4.295E-003                   |
| Th-228                   | 5,447.61                  | 5,186.59                   | 5,507.27                 | 13.00                     | 1.354E-002               | 3.898E-003                   |
| Po-210                   | 5,276.09                  | 5,231.34                   | 5,291.00                 | 8.00                      | 8.333E-003               | 3.125E-003                   |
| Pu-238                   | 5,469.98                  | 5,268.63                   | 5,552.01                 | 4.00                      | 4.167E-003               | 2.329E-003                   |
| Am-241                   | 5,484.90                  | 5,298.46                   | 5,604.22                 | 4.00                      | 4.167E-003               | 2.329E-003                   |
| Cm-245                   | 5,417.78                  | 5,395.41                   | 5,447.61                 | 0.00                      | 0.000E+000               | 1.473E-003                   |
| Pu-236                   | 5,760.83                  | 5,611.67                   | 5,887.60                 | 8.00                      | 8.333E-003               | 3.125E-003                   |
| Cm-244                   | 5,775.74                  | 5,641.51                   | 5,902.52                 | 5.00                      | 5.208E-003               | 2.552E-003                   |
| Th-227                   | 6,074.04                  | 5,932.35                   | 6,178.45                 | 0.00                      | 0.000E+000               | 1.473E-003                   |
| Cm-242                   | 6,148.62                  | 6,118.79                   | 6,178.45                 | 0.00                      | 0.000E+000               | 1.473E-003                   |

Sample Name: **ICB;AV199**

Comment:

### Sample

Spectrum #1 Analysis #1

Analyst: **60040**

Batch Name: **May2016**

Description:

### Batch

### Acquisition

Detector: **AV199**, SN: **50-117Z3**

Acquisition Start Date: **5/19/2016 1:01:39PM**

Live Time: **960.00 min.**

Real Time: **960.01 min.**

Calibration Name: **IC-9817;AV199-20151017**

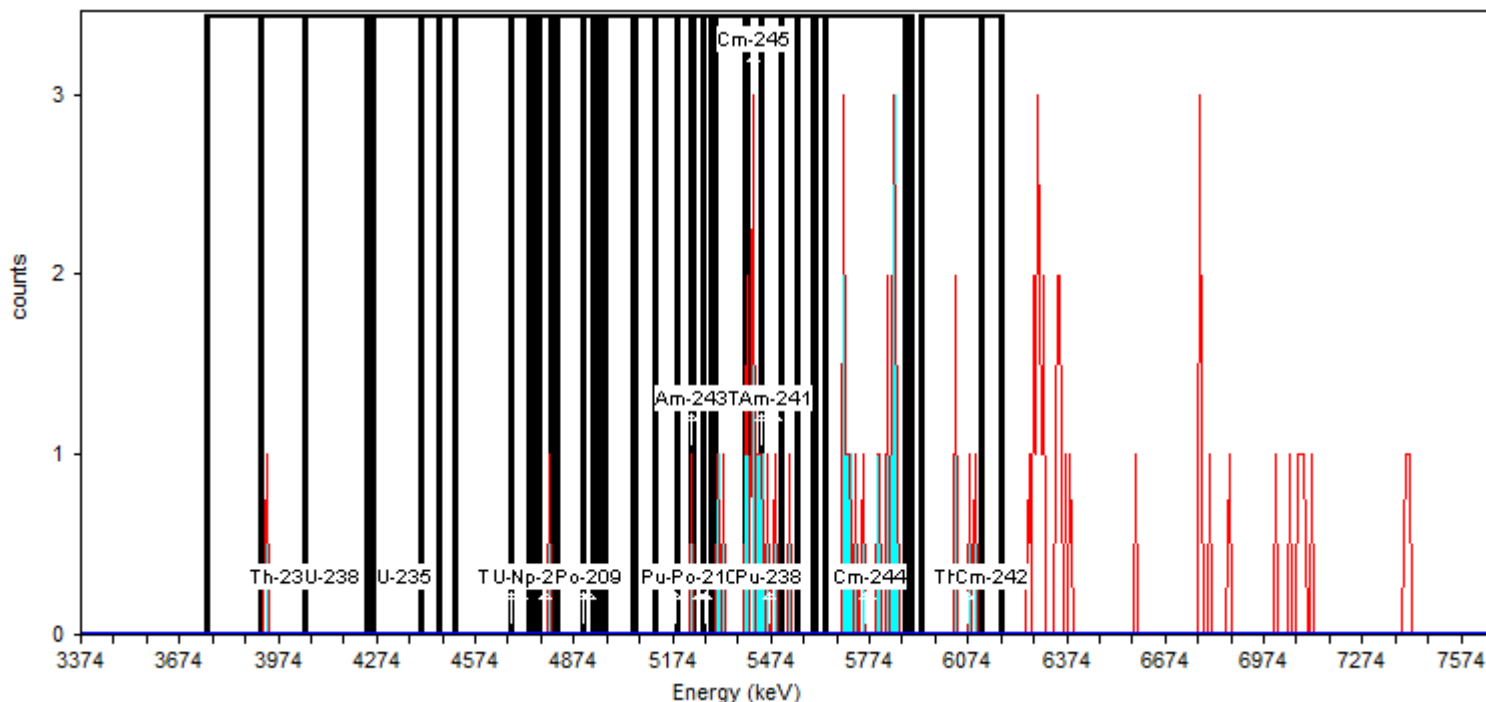
Calibration Date: **10/18/2015 3:55:29PM**

Energy Calibration Equation:

Gain = **7.4575 keV / Ch**

Offset = **3,366.95 keV**

Quadratic = **0.0000 keV / Ch<sup>2</sup>**



### General Analysis

Analysis Method: **Absolute ROI Analysis**, Set Name = **11/05\_BackgroundROI**, Nuclide Library: **Background ROI Library**

Total Background Counts: **72.00**

# Nuclide Summary (ROI)

| <u>RegionName</u> | <u>Peak Energy</u> | <u>Start Energy</u> | <u>End Energy</u> | <u>GrossCounts</u> | <u>Count Rate</u> | <u>CR Uncertainty</u> |
|-------------------|--------------------|---------------------|-------------------|--------------------|-------------------|-----------------------|
|                   | (keV)              | (keV)               | (keV)             |                    | (CPM)             | (CPM)                 |
| Th-232            | 3,985.93           | 3,754.75            | 4,053.05          | 1.00               | 1.042E-003        | 1.473E-003            |
| U-238             | 4,135.08           | 3,918.81            | 4,239.49          | 1.00               | 1.042E-003        | 1.473E-003            |
| U-235             | 4,358.81           | 4,261.86            | 4,463.21          | 0.00               | 0.000E+000        | 1.473E-003            |
| Th-230            | 4,679.48           | 4,403.55            | 4,746.60          | 0.00               | 0.000E+000        | 1.473E-003            |
| U-234             | 4,709.31           | 4,507.96            | 4,821.17          | 1.00               | 1.042E-003        | 1.473E-003            |
| Pu-242            | 4,903.21           | 4,679.48            | 4,947.95          | 1.00               | 1.042E-003        | 1.473E-003            |
| Th-229            | 4,858.46           | 4,739.14            | 5,119.48          | 1.00               | 1.042E-003        | 1.473E-003            |
| Np-237            | 4,783.89           | 4,768.97            | 4,806.26          | 1.00               | 1.042E-003        | 1.473E-003            |
| Po-209            | 4,918.12           | 4,903.21            | 4,933.04          | 0.00               | 0.000E+000        | 1.473E-003            |
| Pu-239            | 5,179.14           | 4,970.33            | 5,238.80          | 1.00               | 1.042E-003        | 1.473E-003            |
| Am-243            | 5,231.34           | 5,052.36            | 5,305.92          | 1.00               | 1.042E-003        | 1.473E-003            |
| U-232             | 5,253.71           | 5,059.82            | 5,402.86          | 6.00               | 6.250E-003        | 2.756E-003            |
| Th-228            | 5,447.61           | 5,186.59            | 5,507.27          | 14.00              | 1.458E-002        | 4.034E-003            |
| Po-210            | 5,276.09           | 5,231.34            | 5,291.00          | 1.00               | 1.042E-003        | 1.473E-003            |
| Pu-238            | 5,469.98           | 5,268.63            | 5,552.01          | 14.00              | 1.458E-002        | 4.034E-003            |
| Am-241            | 5,484.90           | 5,298.46            | 5,604.22          | 14.00              | 1.458E-002        | 4.034E-003            |
| Cm-245            | 5,417.78           | 5,395.41            | 5,447.61          | 9.00               | 9.375E-003        | 3.294E-003            |
| Pu-236            | 5,760.83           | 5,611.67            | 5,887.60          | 17.00              | 1.771E-002        | 4.419E-003            |
| Cm-244            | 5,775.74           | 5,641.51            | 5,902.52          | 17.00              | 1.771E-002        | 4.419E-003            |
| Th-227            | 6,074.04           | 5,932.35            | 6,178.45          | 4.00               | 4.167E-003        | 2.329E-003            |
| Cm-242            | 6,148.62           | 6,118.79            | 6,178.45          | 0.00               | 0.000E+000        | 1.473E-003            |

Comment:

## Sample

Analyst: 60040

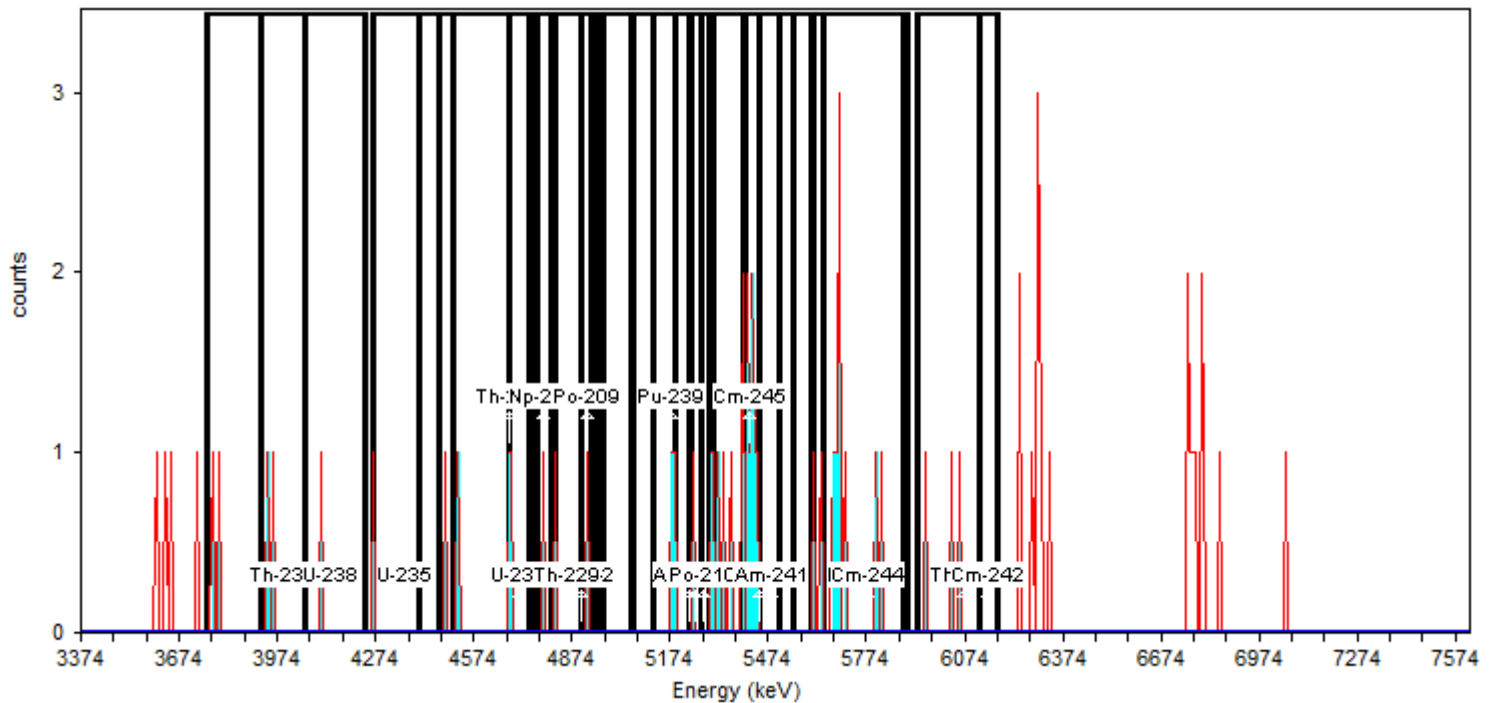
Description:

## Batch

## Acquisition

Energy Calibration Equation:

Gain = 7.4575 keV / Ch  
Offset = 3,366.95 keV  
Quadratic = 0.0000 keV / Ch<sup>2</sup>



## General Analysis

Analysis Method: Absolute ROI Analysis, Set Name = 11/05\_BackgroundROI, Nuclide Library: Background ROI Library  
Total Background Counts: 67.00

# Nuclide Summary (ROI)

| <u>RegionName</u> | <u>Peak Energy</u><br>(keV) | <u>Start Energy</u><br>(keV) | <u>End Energy</u><br>(keV) | <u>GrossCounts</u> | <u>Count Rate</u><br>(CPM) | <u>CR Uncertainty</u><br>(CPM) |
|-------------------|-----------------------------|------------------------------|----------------------------|--------------------|----------------------------|--------------------------------|
| Th-232            | 3,985.93                    | 3,754.75                     | 4,053.05                   | 4.00               | 4.167E-003                 | 2.329E-003                     |
| U-238             | 4,135.08                    | 3,918.81                     | 4,239.49                   | 3.00               | 3.125E-003                 | 2.083E-003                     |
| U-235             | 4,358.81                    | 4,261.86                     | 4,463.21                   | 1.00               | 1.042E-003                 | 1.473E-003                     |
| Th-230            | 4,679.48                    | 4,403.55                     | 4,746.60                   | 4.00               | 4.167E-003                 | 2.329E-003                     |
| U-234             | 4,709.31                    | 4,507.96                     | 4,821.17                   | 5.00               | 5.208E-003                 | 2.552E-003                     |
| Pu-242            | 4,903.21                    | 4,679.48                     | 4,947.95                   | 5.00               | 5.208E-003                 | 2.552E-003                     |
| Th-229            | 4,858.46                    | 4,739.14                     | 5,119.48                   | 3.00               | 3.125E-003                 | 2.083E-003                     |
| Np-237            | 4,783.89                    | 4,768.97                     | 4,806.26                   | 1.00               | 1.042E-003                 | 1.473E-003                     |
| Po-209            | 4,918.12                    | 4,903.21                     | 4,933.04                   | 1.00               | 1.042E-003                 | 1.473E-003                     |
| Pu-239            | 5,179.14                    | 4,970.33                     | 5,238.80                   | 2.00               | 2.083E-003                 | 1.804E-003                     |
| Am-243            | 5,231.34                    | 5,052.36                     | 5,305.92                   | 5.00               | 5.208E-003                 | 2.552E-003                     |
| U-232             | 5,253.71                    | 5,059.82                     | 5,402.86                   | 10.00              | 1.042E-002                 | 3.455E-003                     |
| Th-228            | 5,447.61                    | 5,186.59                     | 5,507.27                   | 16.00              | 1.667E-002                 | 4.295E-003                     |
| Po-210            | 5,276.09                    | 5,231.34                     | 5,291.00                   | 1.00               | 1.042E-003                 | 1.473E-003                     |
| Pu-238            | 5,469.98                    | 5,268.63                     | 5,552.01                   | 14.00              | 1.458E-002                 | 4.034E-003                     |
| Am-241            | 5,484.90                    | 5,298.46                     | 5,604.22                   | 14.00              | 1.458E-002                 | 4.034E-003                     |
| Cm-245            | 5,417.78                    | 5,395.41                     | 5,447.61                   | 9.00               | 9.375E-003                 | 3.294E-003                     |
| Pu-236            | 5,760.83                    | 5,611.67                     | 5,887.60                   | 11.00              | 1.146E-002                 | 3.608E-003                     |
| Cm-244            | 5,775.74                    | 5,641.51                     | 5,902.52                   | 9.00               | 9.375E-003                 | 3.294E-003                     |
| Th-227            | 6,074.04                    | 5,932.35                     | 6,178.45                   | 3.00               | 3.125E-003                 | 2.083E-003                     |
| Cm-242            | 6,148.62                    | 6,118.79                     | 6,178.45                   | 0.00               | 0.000E+000                 | 1.473E-003                     |

# Run Logs

# Alpha Spectroscopy Run Log

## Detector: AV192

| Analysis Date  | Count<br>Minutes | Lab Sample ID       | Client Sample ID | Analysis<br>Batch | Prep<br>Batch | Method | Analyst<br>Initials |
|----------------|------------------|---------------------|------------------|-------------------|---------------|--------|---------------------|
| 10/17/15 18:13 | 140              | IC 160-223489/1     |                  | 223489            |               |        | PS                  |
| 11/01/15 14:23 | 60               | ICV 160-223607/1    |                  | 223607            |               |        | PS                  |
| 05/19/16 13:01 | 960              | ICB 160-252344/1    |                  | 252344            |               |        | PS                  |
| 05/23/16 15:18 | 60               | CCV 160-252658/1    |                  | 252658            |               |        | PS                  |
| 06/08/16 10:01 | 1                | PULSER 160-255590/1 |                  | 255590            |               |        | ALD                 |
| 06/08/16 14:16 | 400              | MB 160-254505/1-A   |                  | 255590            | 254505        | A-01-R | ALD                 |

## Detector: AV193

| Analysis Date  | Count<br>Minutes | Lab Sample ID       | Client Sample ID | Analysis<br>Batch | Prep<br>Batch | Method | Analyst<br>Initials |
|----------------|------------------|---------------------|------------------|-------------------|---------------|--------|---------------------|
| 10/17/15 18:13 | 140              | IC 160-223490/1     |                  | 223490            |               |        | PS                  |
| 11/01/15 14:24 | 60               | ICV 160-223608/1    |                  | 223608            |               |        | PS                  |
| 05/19/16 13:01 | 960              | ICB 160-252345/1    |                  | 252345            |               |        | PS                  |
| 05/23/16 13:50 | 60               | CCV 160-252659/1    |                  | 252659            |               |        | PS                  |
| 06/08/16 10:01 | 1                | PULSER 160-255591/1 |                  | 255591            |               |        | ALD                 |
| 06/08/16 14:16 | 400              | LCS 160-254505/2-A  |                  | 255591            | 254505        | A-01-R | ALD                 |

## Detector: AV195

| Analysis Date  | Count<br>Minutes | Lab Sample ID       | Client Sample ID | Analysis<br>Batch | Prep<br>Batch | Method | Analyst<br>Initials |
|----------------|------------------|---------------------|------------------|-------------------|---------------|--------|---------------------|
| 10/17/15 18:19 | 140              | IC 160-223492/1     |                  | 223492            |               |        | PS                  |
| 11/01/15 14:28 | 60               | ICV 160-223610/1    |                  | 223610            |               |        | PS                  |
| 05/19/16 13:01 | 960              | ICB 160-252347/1    |                  | 252347            |               |        | PS                  |
| 05/23/16 12:23 | 60               | CCV 160-252660/1    |                  | 252660            |               |        | PS                  |
| 06/08/16 10:01 | 1                | PULSER 160-255592/1 |                  | 255592            |               |        | ALD                 |
| 06/08/16 14:16 | 400              | LCSD 160-254505/3-A |                  | 255592            | 254505        | A-01-R | ALD                 |

## Detector: AV197

| Analysis Date  | Count<br>Minutes | Lab Sample ID       | Client Sample ID | Analysis<br>Batch | Prep<br>Batch | Method | Analyst<br>Initials |
|----------------|------------------|---------------------|------------------|-------------------|---------------|--------|---------------------|
| 10/17/15 18:14 | 140              | IC 160-223494/1     |                  | 223494            |               |        | PS                  |
| 11/01/15 14:25 | 60               | ICV 160-223612/1    |                  | 223612            |               |        | PS                  |
| 05/19/16 13:01 | 960              | ICB 160-252349/1    |                  | 252349            |               |        | PS                  |
| 05/23/16 12:28 | 60               | CCV 160-252662/1    |                  | 252662            |               |        | PS                  |
| 06/08/16 10:01 | 1                | PULSER 160-255594/1 |                  | 255594            |               |        | ALD                 |
| 06/08/16 14:16 | 400              | 160-17563-1         | GW-GWW-052616    | 255594            | 254505        | A-01-R | ALD                 |

## Detector: AV198

| Analysis Date  | Count<br>Minutes | Lab Sample ID       | Client Sample ID | Analysis<br>Batch | Prep<br>Batch | Method | Analyst<br>Initials |
|----------------|------------------|---------------------|------------------|-------------------|---------------|--------|---------------------|
| 10/17/15 18:15 | 140              | IC 160-223495/1     |                  | 223495            |               |        | PS                  |
| 11/01/15 14:25 | 60               | ICV 160-223613/1    |                  | 223613            |               |        | PS                  |
| 05/19/16 13:01 | 960              | ICB 160-252350/1    |                  | 252350            |               |        | PS                  |
| 05/23/16 12:38 | 60               | CCV 160-252663/1    |                  | 252663            |               |        | PS                  |
| 06/08/16 10:01 | 1                | PULSER 160-255595/1 |                  | 255595            |               |        | ALD                 |
| 06/08/16 14:17 | 400              | 160-17563-2         | GW-NB34-052616   | 255595            | 254505        | A-01-R | ALD                 |

## Detector: AV199

| Analysis Date  | Count<br>Minutes | Lab Sample ID    | Client Sample ID | Analysis<br>Batch | Prep<br>Batch | Method | Analyst<br>Initials |
|----------------|------------------|------------------|------------------|-------------------|---------------|--------|---------------------|
| 10/17/15 18:15 | 140              | IC 160-223496/1  |                  | 223496            |               |        | PS                  |
| 11/01/15 14:25 | 60               | ICV 160-223614/1 |                  | 223614            |               |        | PS                  |

## Alpha Spectroscopy Run Log

### Detector: AV199 (Continued)

| Analysis Date  | Count<br>Minutes | Lab Sample ID       | Client Sample ID | Analysis<br>Batch | Prep<br>Batch | Method | Analyst<br>Initials |
|----------------|------------------|---------------------|------------------|-------------------|---------------|--------|---------------------|
| 05/19/16 13:01 | 960              | ICB 160-252351/1    |                  | 252351            |               |        | PS                  |
| 05/23/16 12:27 | 60               | CCV 160-252664/1    |                  | 252664            |               |        | PS                  |
| 06/08/16 10:01 | 1                | PULSER 160-255733/1 |                  | 255733            |               |        | ALD                 |
| 06/08/16 14:17 | 400              | 160-17563-3         | GW-GWY-052616    | 255733            | 254505        | A-01-R | ALD                 |

### Detector: AV200

| Analysis Date  | Count<br>Minutes | Lab Sample ID       | Client Sample ID | Analysis<br>Batch | Prep<br>Batch | Method | Analyst<br>Initials |
|----------------|------------------|---------------------|------------------|-------------------|---------------|--------|---------------------|
| 10/17/15 18:15 | 140              | IC 160-223497/1     |                  | 223497            |               |        | PS                  |
| 11/01/15 14:26 | 60               | ICV 160-223615/1    |                  | 223615            |               |        | PS                  |
| 05/20/16 15:00 | 960              | ICB 160-252421/1    |                  | 252421            |               |        | PS                  |
| 05/23/16 12:37 | 60               | CCV 160-252665/1    |                  | 252665            |               |        | PS                  |
| 06/08/16 10:01 | 1                | PULSER 160-255596/1 |                  | 255596            |               |        | ALD                 |
| 06/08/16 14:17 | 400              | 160-17563-4         | GW-PZ02-052616   | 255596            | 254505        | A-01-R | ALD                 |

# **GAMMA SPECTROSCOPY**

# Method TC-02-RC

## Tracers

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Technetium-99 Tracers

# Prep Batch: 254137

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Technetium-99 Tracers Prep

-----  
Sample Description: 254137\_Gamma\_TCCLBA 160-254137~1-A

Detector: Detector # 5

Batch ID: 254137

Work Order Number: Gamma

Lot Number: TCCLBA 160-254137~1-A  
-----

Decay to Time: 6/1/2016 12:00

Live Time: 600 sec

Acquisition Time: 6/1/2016 15:26:50

Real Time: 603 sec

Analysis Time: 6/1/2016 15:37

Dead Time: 0.41 %

Analysis Quantity: 1.000E+00 Sample  
-----

Efficiency Cal File: 5\_Soil\_TunaCan.Clb

Efficiency Cal Desc: 5\_Soil\_TunaCan\_90099\_032612

Efficiency Cal Date: 3/27/2012 17:20

Energy Cal Date: 2/28/2012 19:35

Library: Client\_Tc-99m.lib

Bkgd Correction File: 5\_2016-05-07\_0551.PBC  
-----

| Nuclide | Activity<br>pCi/Sample | 1-Sigma<br>Counting<br>Uncert<br>% | 1-Sigma<br>Counting<br>Uncert<br>pCi/Sample | 1-Sigma<br>Total<br>Uncert<br>pCi/Sample | Minimum<br>Detectable<br>Activity<br>pCi/Sample |
|---------|------------------------|------------------------------------|---------------------------------------------|------------------------------------------|-------------------------------------------------|
| TC-99M  | 4.524E+02              | 7.2                                | 3.258E+01                                   | 3.990E+01                                | 2.350E+01                                       |
| Total   | 4.524E+02              |                                    |                                             |                                          |                                                 |

-----

Analyst: Mike Aldridge

Sample description

254137\_Gamma\_TCCLBA 160-254137~1-A

Spectrum Filename: C:\User\SPC\Det5\5\_Gamma\_20160963.An1

Acquisition information

Start time: 6/1/2016 3:26:50 PM  
Live time: 600  
Real time: 603  
Dead time: 0.41 %  
Detector ID: 5

Detector system

Ge 5 SN/157

Calibration

Filename: 5\_Soil\_TunaCan.Clb  
5\_Soil\_TunaCan\_90099\_032612

Energy Calibration

Created: 2/28/2012 7:35:48 PM  
Zero offset: 0.158 keV  
Gain: 0.250 keV/channel  
Quadratic: 3.911E-08 keV/channel^2

Efficiency Calibration

Created: 3/27/2012 5:20:37 PM  
Knee Energy: 165.85 keV  
Above the Knee: Quadratic Uncertainty = 0.87 %  
Log(Eff):  $6.466115E-01 + (-7.830454E-01 * \text{Log}(E)) + (-4.117504E-03 * \text{Log}(E)^2)$   
Below the Knee: Quadratic Uncertainty = 1.43 %  
Log(Eff):  $-2.462251E+01 + (9.075211E+00 * \text{Log}(E)) + (-9.664422E-01 * \text{Log}(E)^2)$

Library Files

Main analysis library: Client\_Tc-99m.lib  
Library Match Width: 0.500  
Peak stripping: Library based

Analysis parameters

Analysis engine: Env32 G800W064  
Start channel: 150 ( 37.62keV )  
Stop channel: 8000 ( 2000.81keV )  
Peak rejection level: 1000.000%  
Peak search sensitivity: 3  
Sample Size: 1.0000E+00 +/- 0.000E+00%  
Activity scaling factor:  $1.0000E+00 / (3.7000E-02 * 1.0000E+00) = 2.7027E+01$   
Detection limit method: Reg. Guide 4.16 Method

(Page 2 of 5)

Random error: 4.0000000E+00  
 Systematic error: 4.0000000E+00  
 Fraction Limit: 0.000%  
 Background width: 3  
 Half lives decay limit: 12.000  
 Activity range factor: 2.000  
 Min. step backg. energy 0.000  
 Multiplet shift channel 2.000

| Corrections                   | Status | Comments                                     |
|-------------------------------|--------|----------------------------------------------|
| Decay correct to date:        | YES    | 6/1/2016 12:00:00 PM                         |
| Decay during acquisition:     | YES    |                                              |
| Decay during collection:      | NO     |                                              |
| True coincidence correction:  | NO     |                                              |
| Peaked background correction: | YES    | 5_2016-05-07_0551.PBC<br>5/7/2016 5:51:59 AM |
| Absorption (Internal):        | NO     |                                              |
| Geometry correction:          | NO     |                                              |
| Random summing:               | NO     |                                              |

total peaks alloc. 1 cutoff: 5.00E+01 %  
 Energy Calibration  
 Normalized diff: 0.0525

\*\*\*\*\* S U M M A R Y O F P E A K S I N R A N G E \*\*\*\*\*

| Peak<br>Energy | Area | Uncert | FWHM | Corrctn<br>Factor | Nuclide<br>Energy | Brnch.<br>Ratio | Act.<br>pCi/Samp | Nuc   |
|----------------|------|--------|------|-------------------|-------------------|-----------------|------------------|-------|
| 140.46         | 203. | 7.20   | 0.71 | 3.412E-02         | 140.51            | 89.060          | 4.524E+02        | TC99M |

No unknown peaks passed sensitivity test.

-----  
 This section based on library: Client\_Tc-99m.lib

\*\*\*\*\* I D E N T I F I E D P E A K S U M M A R Y \*\*\*\*\*

| Nuclide | Peak<br>Channel | Centroid<br>Energy | Background<br>Counts | Net Area<br>Counts | Intensity<br>Cts/Sec | Uncert<br>1 Sigma | FWHM<br>% | FWHM<br>keV |
|---------|-----------------|--------------------|----------------------|--------------------|----------------------|-------------------|-----------|-------------|
| TC-99M  | 561.88          | 140.51             | 3.                   | 203.               | 0.339                | 7.20              | 0.705D    |             |

s - Peak fails shape tests.  
 D - Peak area deconvoluted.  
 A Derived peak area.

| ***** S U M M A R Y O F L I B R A R Y P E A K U S A G E *****                                                |      |            |                      |            |             |                       |
|--------------------------------------------------------------------------------------------------------------|------|------------|----------------------|------------|-------------|-----------------------|
| - Nuclide -                                                                                                  |      | Average    | ----- Peak -----     |            |             |                       |
| Name                                                                                                         | Code | Activity   | Energy               | Activity   | Code        | MDA Value             |
|                                                                                                              |      | pCi/Sample | keV                  | pCi/Sample |             | pCi/Sample            |
| COMMENTS                                                                                                     |      |            |                      |            |             |                       |
| <hr/>                                                                                                        |      |            |                      |            |             |                       |
| TC-99M                                                                                                       | I    | 4.5239E+02 |                      |            |             | 2.51E-01              |
|                                                                                                              |      |            |                      |            |             | Energy duplication    |
|                                                                                                              |      |            | 140.51               | 4.524E+02  | ( 2.350E+01 | 7.20E+00 8.91E+01 G K |
| ( - This peak used in the nuclide activity average.                                                          |      |            |                      |            |             |                       |
| * - Peak is too wide, but only one peak in library.                                                          |      |            |                      |            |             |                       |
| ! - Peak is part of a multiplet and this area went negative during deconvolution.                            |      |            |                      |            |             |                       |
| ? - Peak is too narrow.                                                                                      |      |            |                      |            |             |                       |
| @ - Peak is too wide at FW25M, but ok at FWHM.                                                               |      |            |                      |            |             |                       |
| % - Peak fails sensitivity test.                                                                             |      |            |                      |            |             |                       |
| \$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.                 |      |            |                      |            |             |                       |
| + - Peak activity higher than counting uncertainty range.                                                    |      |            |                      |            |             |                       |
| - - Peak activity lower than counting uncertainty range.                                                     |      |            |                      |            |             |                       |
| = - Peak outside analysis energy range.                                                                      |      |            |                      |            |             |                       |
| & - Calculated peak centroid is not close enough to the library energy centroid for positive identification. |      |            |                      |            |             |                       |
| P - Peakbackground subtraction                                                                               |      |            |                      |            |             |                       |
| } - Peak is too close to another for the activity to be found directly.                                      |      |            |                      |            |             |                       |
|                                                                                                              |      |            |                      |            |             |                       |
| Nuclide Codes:                                                                                               |      |            | Peak Codes:          |            |             |                       |
| T - Thermal Neutron Activation                                                                               |      |            | G - Gamma Ray        |            |             |                       |
| F - Fast Neutron Activation                                                                                  |      |            | X - X-Ray            |            |             |                       |
| I - Fission Product                                                                                          |      |            | P - Positron Decay   |            |             |                       |
| N - Naturally Occurring Isotope                                                                              |      |            | S - Single-Escape    |            |             |                       |
| P - Photon Reaction                                                                                          |      |            | D - Double-Escape    |            |             |                       |
| C - Charged Particle Reaction                                                                                |      |            | K - Key Line         |            |             |                       |
| M - No MDA Calculation                                                                                       |      |            | A - Not in Average   |            |             |                       |
| R - Coincidence Corrected                                                                                    |      |            | C - Coincidence Peak |            |             |                       |
| H - Halflife limit exceeded                                                                                  |      |            |                      |            |             |                       |

\*\*\*\*\* D I S C A R D E D I S O T O P E P E A K S \*\*\*\*\*

| Nuclide | Centroid | Background | Net Area | Intensity | Uncert    | Activity |
|---------|----------|------------|----------|-----------|-----------|----------|
|         | Energy   | Counts     | Counts   | Cts/Sec   | 1 Sigma % |          |

P - Peakbackground subtraction

\*\*\*\*\* S U M M A R Y O F N U C L I D E S I N S A M P L E \*\*\*\*\*  
 Time of Count Time Corrected Uncertainty 1 Sigma  
 Nuclide Activity Activity Counting MDA  
 pCi/Sample pCi/Sample pCi/Sample

|                                           |            |            |            |          |
|-------------------------------------------|------------|------------|------------|----------|
| TC-99M                                    | 3.0417E+02 | 4.5239E+02 | 7.201E+00% | 2.35E+01 |
| < - MDA value printed.                    |            |            |            |          |
| A - Activity printed, but activity < MDA. |            |            |            |          |
| B - Activity < MDA and failed test.       |            |            |            |          |
| C - Area < Critical level.                |            |            |            |          |
| F - Failed fraction or key line test.     |            |            |            |          |
| H - Halflife limit exceeded               |            |            |            |          |

----- S U M M A R Y -----  
 Total Activity ( 37.6 to 2000.8 keV) 3.042E+02 pCi/Sample  
 Total Decayed Activity ( 37.6 to 2000.8 keV) 4.5238528E+02 pCi/Sample

The library has energies which are not separable.



-----  
Sample Description: 254137\_Gamma\_TCCLBA 160-254137~1-A

Detector: Detector # 7

Batch ID: 254137

Work Order Number: Gamma

Lot Number: TCCLBA 160-254137~1-A  
-----

Decay to Time: 6/1/2016 12:00

Live Time: 600 sec

Acquisition Time: 6/1/2016 15:44:26

Real Time: 607 sec

Analysis Time: 6/1/2016 15:55

Dead Time: 1.20 %

Analysis Quantity: 1.000E+00 Sample  
-----

Efficiency Cal File: 7\_Soil\_TunaCan.Clb

Efficiency Cal Desc: 7\_TunaCan\_90099\_032712

Efficiency Cal Date: 3/16/2012 11:45

Energy Cal Date: 2/23/2012 08:40

Library: Client\_Tc-99m.lib

Bkgd Correction File: 7\_2016-05-07\_0559.PBC  
-----

| Nuclide | Activity<br>pCi/Sample | 1-Sigma<br>Counting<br>Uncert<br>% | 1-Sigma<br>Counting<br>Uncert<br>pCi/Sample | 1-Sigma<br>Total<br>Uncert<br>pCi/Sample | Minimum<br>Detectable<br>Activity<br>pCi/Sample |
|---------|------------------------|------------------------------------|---------------------------------------------|------------------------------------------|-------------------------------------------------|
| TC-99M  | 4.685E+02              | 5.7                                | 2.671E+01                                   | 3.582E+01                                | 1.554E+01                                       |
| Total   | 4.685E+02              |                                    |                                             |                                          |                                                 |

-----

Analyst: Mike Aldridge

Sample description

254137\_Gamma\_TCCLBA 160-254137~1-A

Spectrum Filename: C:\User\SPC\Det7\7\_Gamma\_20161280.An1

Acquisition information

Start time: 6/1/2016 3:44:26 PM  
Live time: 600  
Real time: 607  
Dead time: 1.20 %  
Detector ID: 7

Detector system

Ge 7 SN/154

Calibration

Filename: 7\_Soil\_TunaCan.Clb  
7\_TunaCan\_90099\_032712

Energy Calibration

Created: 2/23/2012 8:40:56 AM  
Zero offset: 0.117 keV  
Gain: 0.250 keV/channel  
Quadratic: 3.508E-09 keV/channel^2

Efficiency Calibration

Created: 3/16/2012 11:45:14 AM  
Knee Energy: 165.85 keV  
Above the Knee: Quadratic Uncertainty = 0.87 %  
Log(Eff):  $6.716580E-01 + (-6.166540E-01 * \text{Log}(E)) + (-2.065917E-02 * \text{Log}(E)^2)$   
Below the Knee: Quadratic Uncertainty = 1.48 %  
Log(Eff):  $-2.689695E+01 + (1.019544E+01 * \text{Log}(E)) + (-1.081671E+00 * \text{Log}(E)^2)$

Library Files

Main analysis library: Client\_Tc-99m.lib  
Library Match Width: 0.500  
Peak stripping: Library based

Analysis parameters

Analysis engine: Env32 G800W064  
Start channel: 150 ( 37.61keV )  
Stop channel: 8000 ( 2000.13keV )  
Peak rejection level: 1000.000%  
Peak search sensitivity: 3  
Sample Size: 1.0000E+00 +/- 0.000E+00%  
Activity scaling factor:  $1.0000E+00 / (3.7000E-02 * 1.0000E+00) = 2.7027E+01$   
Detection limit method: Reg. Guide 4.16 Method

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Random error: 4.0000000E+00  
 Systematic error: 4.0000000E+00  
 Fraction Limit: 0.000%  
 Background width: 3  
 Half lives decay limit: 12.000  
 Activity range factor: 2.000  
 Min. step backg. energy 0.000  
 Multiplet shift channel 2.000

| Corrections                   | Status | Comments                                     |
|-------------------------------|--------|----------------------------------------------|
| Decay correct to date:        | YES    | 6/1/2016 12:00:00 PM                         |
| Decay during acquisition:     | YES    |                                              |
| Decay during collection:      | NO     |                                              |
| True coincidence correction:  | NO     |                                              |
| Peaked background correction: | YES    | 7_2016-05-07_0559.PBC<br>5/7/2016 5:59:56 AM |
| Absorption (Internal):        | NO     |                                              |
| Geometry correction:          | NO     |                                              |
| Random summing:               | NO     |                                              |

total peaks alloc. 1 cutoff: 5.00E+01 %  
 Energy Calibration  
 Normalized diff: 0.1314

\*\*\*\*\* S U M M A R Y O F P E A K S I N R A N G E \*\*\*\*\*

| Peak<br>Energy | Area | Uncert | FWHM | Corrctn<br>Factor | Nuclide<br>Energy | Brnch.<br>Ratio | Act.<br>pCi/Samp | Nuc   |
|----------------|------|--------|------|-------------------|-------------------|-----------------|------------------|-------|
| 140.39         | 318. | 5.70   | 0.92 | 5.338E-02         | 140.51            | 89.060          | 4.685E+02        | TC99M |

No unknown peaks passed sensitivity test.

-----  
 This section based on library: Client\_Tc-99m.lib

\*\*\*\*\* I D E N T I F I E D P E A K S U M M A R Y \*\*\*\*\*

| Nuclide | Peak<br>Channel | Centroid<br>Energy | Background<br>Counts | Net Area<br>Counts | Intensity<br>Cts/Sec | Uncert<br>1 Sigma | FWHM<br>% | FWHM<br>keV |
|---------|-----------------|--------------------|----------------------|--------------------|----------------------|-------------------|-----------|-------------|
| TC-99M  | 561.63          | 140.51             | 3.                   | 318.               | 0.530                | 5.70              | 0.924D    |             |

s - Peak fails shape tests.  
 D - Peak area deconvoluted.  
 A Derived peak area.

| ***** S U M M A R Y O F L I B R A R Y P E A K U S A G E *****                                                |      |            |                      |            |                                   |                    |
|--------------------------------------------------------------------------------------------------------------|------|------------|----------------------|------------|-----------------------------------|--------------------|
| - Nuclide -                                                                                                  |      | Average    | ----- Peak -----     |            |                                   |                    |
| Name                                                                                                         | Code | Activity   | Energy               | Activity   | Code                              | MDA Value          |
|                                                                                                              |      | pCi/Sample | keV                  | pCi/Sample |                                   | pCi/Sample         |
|                                                                                                              |      |            |                      |            |                                   | COMMENTS           |
| TC-99M                                                                                                       | I    | 4.6849E+02 |                      |            |                                   | 2.51E-01           |
|                                                                                                              |      |            |                      |            |                                   | Energy duplication |
|                                                                                                              |      |            | 140.51               | 4.685E+02  | ( 1.554E+01 5.70E+00 8.91E+01 G K |                    |
| ( - This peak used in the nuclide activity average.                                                          |      |            |                      |            |                                   |                    |
| * - Peak is too wide, but only one peak in library.                                                          |      |            |                      |            |                                   |                    |
| ! - Peak is part of a multiplet and this area went negative during deconvolution.                            |      |            |                      |            |                                   |                    |
| ? - Peak is too narrow.                                                                                      |      |            |                      |            |                                   |                    |
| @ - Peak is too wide at FW25M, but ok at FWHM.                                                               |      |            |                      |            |                                   |                    |
| % - Peak fails sensitivity test.                                                                             |      |            |                      |            |                                   |                    |
| \$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.                 |      |            |                      |            |                                   |                    |
| + - Peak activity higher than counting uncertainty range.                                                    |      |            |                      |            |                                   |                    |
| - - Peak activity lower than counting uncertainty range.                                                     |      |            |                      |            |                                   |                    |
| = - Peak outside analysis energy range.                                                                      |      |            |                      |            |                                   |                    |
| & - Calculated peak centroid is not close enough to the library energy centroid for positive identification. |      |            |                      |            |                                   |                    |
| P - Peakbackground subtraction                                                                               |      |            |                      |            |                                   |                    |
| } - Peak is too close to another for the activity to be found directly.                                      |      |            |                      |            |                                   |                    |
| Nuclide Codes:                                                                                               |      |            | Peak Codes:          |            |                                   |                    |
| T - Thermal Neutron Activation                                                                               |      |            | G - Gamma Ray        |            |                                   |                    |
| F - Fast Neutron Activation                                                                                  |      |            | X - X-Ray            |            |                                   |                    |
| I - Fission Product                                                                                          |      |            | P - Positron Decay   |            |                                   |                    |
| N - Naturally Occurring Isotope                                                                              |      |            | S - Single-Escape    |            |                                   |                    |
| P - Photon Reaction                                                                                          |      |            | D - Double-Escape    |            |                                   |                    |
| C - Charged Particle Reaction                                                                                |      |            | K - Key Line         |            |                                   |                    |
| M - No MDA Calculation                                                                                       |      |            | A - Not in Average   |            |                                   |                    |
| R - Coincidence Corrected                                                                                    |      |            | C - Coincidence Peak |            |                                   |                    |
| H - Halflife limit exceeded                                                                                  |      |            |                      |            |                                   |                    |

\*\*\*\*\* D I S C A R D E D I S O T O P E P E A K S \*\*\*\*\*

| Nuclide | Centroid | Background | Net Area | Intensity | Uncert    | Activity |
|---------|----------|------------|----------|-----------|-----------|----------|
|         | Energy   | Counts     | Counts   | Cts/Sec   | 1 Sigma % |          |

P - Peakbackground subtraction

|         |                                                           |                |             |         |            |
|---------|-----------------------------------------------------------|----------------|-------------|---------|------------|
| *****   | S U M M A R Y   O F   N U C L I D E S   I N   S A M P L E |                |             |         | *****      |
|         | Time of Count                                             | Time Corrected | Uncertainty | 1 Sigma |            |
| Nuclide | Activity                                                  | Activity       | Counting    |         | MDA        |
|         | pCi/Sample                                                | pCi/Sample     |             |         | pCi/Sample |

|        |            |            |            |  |          |
|--------|------------|------------|------------|--|----------|
| TC-99M | 3.0454E+02 | 4.6849E+02 | 5.701E+00% |  | 1.55E+01 |
|--------|------------|------------|------------|--|----------|

< - MDA value printed.  
 A - Activity printed, but activity < MDA.  
 B - Activity < MDA and failed test.  
 C - Area < Critical level.  
 F - Failed fraction or key line test.  
 H - Halflife limit exceeded

----- S U M M A R Y -----

|                          |         |             |               |            |
|--------------------------|---------|-------------|---------------|------------|
| Total Activity (         | 37.6 to | 2000.1 keV) | 3.045E+02     | pCi/Sample |
| Total Decayed Activity ( | 37.6 to | 2000.1 keV) | 4.6849094E+02 | pCi/Sample |

The library has energies which are not separable.



-----  
Sample Description: 254137\_Gamma\_TCCLBA 160-254137~1-A

Detector: Detector # 8

Batch ID: 254137

Work Order Number: Gamma

Lot Number: TCCLBA 160-254137~1-A  
-----

Decay to Time: 6/1/2016 12:00

Live Time: 600 sec

Acquisition Time: 6/1/2016 16:21:03

Real Time: 617 sec

Analysis Time: 6/1/2016 16:31

Dead Time: 2.83 %

Analysis Quantity: 1.000E+00 Sample  
-----

Efficiency Cal File: 8\_Soil\_TunaCan.Clb

Efficiency Cal Desc: 8\_Soil\_TunaCan\_90099\_032712

Efficiency Cal Date: 3/28/2012 10:35

Energy Cal Date: 2/28/2012 10:34

Library: Client\_Tc-99m.lib

Bkgd Correction File: 8\_2016-05-07\_1503.PBC  
-----

| Nuclide | Activity<br>pCi/Sample | 1-Sigma<br>Counting<br>Uncert<br>% | 1-Sigma<br>Counting<br>Uncert<br>pCi/Sample | 1-Sigma<br>Total<br>Uncert<br>pCi/Sample | Minimum<br>Detectable<br>Activity<br>pCi/Sample |
|---------|------------------------|------------------------------------|---------------------------------------------|------------------------------------------|-------------------------------------------------|
| TC-99M  | 3.932E+02              | 7.4                                | 2.898E+01                                   | 3.523E+01                                | 1.575E+01                                       |
| Total   | 3.932E+02              |                                    |                                             |                                          |                                                 |

-----

Analyst: Mike Aldridge

Sample description

254137\_Gamma\_TCCLBA 160-254137~1-A

Spectrum Filename: C:\User\SPC\Det8\8\_Gamma\_20160677.An1

Acquisition information

Start time: 6/1/2016 4:21:03 PM  
Live time: 600  
Real time: 617  
Dead time: 2.83 %  
Detector ID: 8

Detector system

Ge 8 SN/174

Calibration

Filename: 8\_Soil\_TunaCan.Clb  
8\_Soil\_TunaCan\_90099\_032712

Energy Calibration

Created: 2/28/2012 10:34:41 AM  
Zero offset: 0.052 keV  
Gain: 0.250 keV/channel  
Quadratic: 5.282E-10 keV/channel^2

Efficiency Calibration

Created: 3/28/2012 10:35:20 AM  
Knee Energy: 165.85 keV  
Above the Knee: Quadratic Uncertainty = 1.39 %  
Log(Eff):  $-1.098764E-01 + (-4.958544E-01 * \text{Log}(E)) + (-2.572270E-02 * \text{Log}(E)^2)$   
Below the Knee: Quadratic Uncertainty = 1.71 %  
Log(Eff):  $-2.525301E+01 + (9.398253E+00 * \text{Log}(E)) + (-1.000034E+00 * \text{Log}(E)^2)$

Library Files

Main analysis library: Client\_Tc-99m.lib  
Library Match Width: 0.500  
Peak stripping: Library based

Analysis parameters

Analysis engine: Env32 G800W064  
Start channel: 150 ( 37.55keV )  
Stop channel: 8000 ( 1999.97keV )  
Peak rejection level: 1000.000%  
Peak search sensitivity: 3  
Sample Size: 1.0000E+00 +/- 0.000E+00%  
Activity scaling factor:  $1.0000E+00 / (3.7000E-02 * 1.0000E+00) = 2.7027E+01$   
Detection limit method: Reg. Guide 4.16 Method

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Random error: 4.0000000E+00  
 Systematic error: 4.0000000E+00  
 Fraction Limit: 0.000%  
 Background width: 3  
 Half lives decay limit: 12.000  
 Activity range factor: 2.000  
 Min. step backg. energy 0.000  
 Multiplet shift channel 2.000

| Corrections                   | Status | Comments                                     |
|-------------------------------|--------|----------------------------------------------|
| Decay correct to date:        | YES    | 6/1/2016 12:00:00 PM                         |
| Decay during acquisition:     | YES    |                                              |
| Decay during collection:      | NO     |                                              |
| True coincidence correction:  | NO     |                                              |
| Peaked background correction: | YES    | 8_2016-05-07_1503.PBC<br>5/7/2016 3:03:11 PM |
| Absorption (Internal):        | NO     |                                              |
| Geometry correction:          | NO     |                                              |
| Random summing:               | NO     |                                              |

total peaks alloc. 1 cutoff: 5.00E+01 %  
 Energy Calibration  
 Normalized diff: 0.0439

\*\*\*\*\* S U M M A R Y O F P E A K S I N R A N G E \*\*\*\*\*

| Peak<br>Energy | Area | Uncert | FWHM | Corrctn<br>Factor | Nuclide<br>Energy | Brnch.<br>Ratio | Act.<br>pCi/Samp | Nuc   |
|----------------|------|--------|------|-------------------|-------------------|-----------------|------------------|-------|
| 140.56         | 184. | 7.37   | 0.85 | 3.945E-02         | 140.51            | 89.060          | 3.932E+02        | TC99M |

No unknown peaks passed sensitivity test.

-----  
 This section based on library: Client\_Tc-99m.lib

\*\*\*\*\* I D E N T I F I E D P E A K S U M M A R Y \*\*\*\*\*

| Nuclide | Peak<br>Channel | Centroid<br>Energy | Background<br>Counts | Net Area<br>Counts | Intensity<br>Cts/Sec | Uncert<br>1 Sigma | FWHM<br>% | FWHM<br>keV |
|---------|-----------------|--------------------|----------------------|--------------------|----------------------|-------------------|-----------|-------------|
| TC-99M  | 561.86          | 140.51             | 0.                   | 184.               | 0.307                | 7.37              | 0.849D    |             |

s - Peak fails shape tests.  
 D - Peak area deconvoluted.  
 A Derived peak area.

| ***** S U M M A R Y O F L I B R A R Y P E A K U S A G E *****                                                |      |            |                      |            |                                   |                    |
|--------------------------------------------------------------------------------------------------------------|------|------------|----------------------|------------|-----------------------------------|--------------------|
| - Nuclide -                                                                                                  |      | Average    | ----- Peak -----     |            |                                   |                    |
| Name                                                                                                         | Code | Activity   | Energy               | Activity   | Code                              | MDA Value          |
|                                                                                                              |      | pCi/Sample | keV                  | pCi/Sample |                                   | pCi/Sample         |
|                                                                                                              |      |            |                      |            |                                   | COMMENTS           |
| <hr/>                                                                                                        |      |            |                      |            |                                   |                    |
| TC-99M                                                                                                       | I    | 3.9316E+02 |                      |            |                                   | 2.51E-01           |
|                                                                                                              |      |            |                      |            |                                   | Energy duplication |
|                                                                                                              |      |            | 140.51               | 3.932E+02  | ( 1.575E+01 7.37E+00 8.91E+01 G K |                    |
| ( - This peak used in the nuclide activity average.                                                          |      |            |                      |            |                                   |                    |
| * - Peak is too wide, but only one peak in library.                                                          |      |            |                      |            |                                   |                    |
| ! - Peak is part of a multiplet and this area went negative during deconvolution.                            |      |            |                      |            |                                   |                    |
| ? - Peak is too narrow.                                                                                      |      |            |                      |            |                                   |                    |
| @ - Peak is too wide at FW25M, but ok at FWHM.                                                               |      |            |                      |            |                                   |                    |
| % - Peak fails sensitivity test.                                                                             |      |            |                      |            |                                   |                    |
| \$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.                 |      |            |                      |            |                                   |                    |
| + - Peak activity higher than counting uncertainty range.                                                    |      |            |                      |            |                                   |                    |
| - - Peak activity lower than counting uncertainty range.                                                     |      |            |                      |            |                                   |                    |
| = - Peak outside analysis energy range.                                                                      |      |            |                      |            |                                   |                    |
| & - Calculated peak centroid is not close enough to the library energy centroid for positive identification. |      |            |                      |            |                                   |                    |
| P - Peakbackground subtraction                                                                               |      |            |                      |            |                                   |                    |
| } - Peak is too close to another for the activity to be found directly.                                      |      |            |                      |            |                                   |                    |
|                                                                                                              |      |            |                      |            |                                   |                    |
| Nuclide Codes:                                                                                               |      |            | Peak Codes:          |            |                                   |                    |
| T - Thermal Neutron Activation                                                                               |      |            | G - Gamma Ray        |            |                                   |                    |
| F - Fast Neutron Activation                                                                                  |      |            | X - X-Ray            |            |                                   |                    |
| I - Fission Product                                                                                          |      |            | P - Positron Decay   |            |                                   |                    |
| N - Naturally Occurring Isotope                                                                              |      |            | S - Single-Escape    |            |                                   |                    |
| P - Photon Reaction                                                                                          |      |            | D - Double-Escape    |            |                                   |                    |
| C - Charged Particle Reaction                                                                                |      |            | K - Key Line         |            |                                   |                    |
| M - No MDA Calculation                                                                                       |      |            | A - Not in Average   |            |                                   |                    |
| R - Coincidence Corrected                                                                                    |      |            | C - Coincidence Peak |            |                                   |                    |
| H - Halflife limit exceeded                                                                                  |      |            |                      |            |                                   |                    |

\*\*\*\*\* D I S C A R D E D I S O T O P E P E A K S \*\*\*\*\*

| Nuclide | Centroid | Background | Net Area | Intensity | Uncert    | Activity |
|---------|----------|------------|----------|-----------|-----------|----------|
|         | Energy   | Counts     | Counts   | Cts/Sec   | 1 Sigma % |          |

P - Peakbackground subtraction

\*\*\*\*\* S U M M A R Y O F N U C L I D E S I N S A M P L E \*\*\*\*\*  
 Time of Count Time Corrected Uncertainty 1 Sigma  
 Nuclide Activity Activity Counting MDA  
 pCi/Sample pCi/Sample pCi/Sample

| Nuclide | Activity<br>pCi/Sample | Activity<br>pCi/Sample | Counting<br>Uncertainty | MDA<br>pCi/Sample |
|---------|------------------------|------------------------|-------------------------|-------------------|
| TC-99M  | 2.3822E+02             | 3.9316E+02             | 7.372E+00%              | 1.57E+01          |

- < - MDA value printed.
- A - Activity printed, but activity < MDA.
- B - Activity < MDA and failed test.
- C - Area < Critical level.
- F - Failed fraction or key line test.
- H - Halflife limit exceeded

----- S U M M A R Y -----  
 Total Activity ( 37.5 to 2000.0 keV) 2.382E+02 pCi/Sample  
 Total Decayed Activity ( 37.5 to 2000.0 keV) 3.9315674E+02 pCi/Sample

The library has energies which are not separable.



-----  
Sample Description: 254137\_Gamma\_TCCLBB 160-254137~2-A

Detector: Detector # 7

Batch ID: 254137

Work Order Number: Gamma

Lot Number: TCCLBB 160-254137~2-A  
-----

Decay to Time: 6/1/2016 12:00

Live Time: 600 sec

Acquisition Time: 6/1/2016 15:27:49

Real Time: 607 sec

Analysis Time: 6/1/2016 15:38

Dead Time: 1.21 %

Analysis Quantity: 1.000E+00 Sample  
-----

Efficiency Cal File: 7\_Soil\_TunaCan.Clb

Efficiency Cal Desc: 7\_TunaCan\_90099\_032712

Efficiency Cal Date: 3/16/2012 11:45

Energy Cal Date: 2/23/2012 08:40

Library: Client\_Tc-99m.lib

Bkgd Correction File: 7\_2016-05-07\_0559.PBC  
-----

| Nuclide | Activity<br>pCi/Sample | 1-Sigma<br>Counting<br>Uncert<br>% | 1-Sigma<br>Counting<br>Uncert<br>pCi/Sample | 1-Sigma<br>Total<br>Uncert<br>pCi/Sample | Minimum<br>Detectable<br>Activity<br>pCi/Sample |
|---------|------------------------|------------------------------------|---------------------------------------------|------------------------------------------|-------------------------------------------------|
| TC-99M  | 4.695E+02              | 5.6                                | 2.630E+01                                   | 3.555E+01                                | 1.505E+01                                       |
| Total   | 4.695E+02              |                                    |                                             |                                          |                                                 |

-----

Analyst: Mike Aldridge

Sample description

254137\_Gamma\_TCCLBB 160-254137~2-A

Spectrum Filename: C:\User\SPC\Det7\7\_Gamma\_20161279.An1

Acquisition information

Start time: 6/1/2016 3:27:49 PM  
Live time: 600  
Real time: 607  
Dead time: 1.21 %  
Detector ID: 7

Detector system

Ge 7 SN/154

Calibration

Filename: 7\_Soil\_TunaCan.Clb  
7\_TunaCan\_90099\_032712

Energy Calibration

Created: 2/23/2012 8:40:56 AM  
Zero offset: 0.117 keV  
Gain: 0.250 keV/channel  
Quadratic: 3.508E-09 keV/channel^2

Efficiency Calibration

Created: 3/16/2012 11:45:14 AM  
Knee Energy: 165.85 keV  
Above the Knee: Quadratic Uncertainty = 0.87 %  
Log(Eff):  $6.716580E-01 + (-6.166540E-01 * \text{Log}(E)) + (-2.065917E-02 * \text{Log}(E)^2)$   
Below the Knee: Quadratic Uncertainty = 1.48 %  
Log(Eff):  $-2.689695E+01 + (1.019544E+01 * \text{Log}(E)) + (-1.081671E+00 * \text{Log}(E)^2)$

Library Files

Main analysis library: Client\_Tc-99m.lib  
Library Match Width: 0.500  
Peak stripping: Library based

Analysis parameters

Analysis engine: Env32 G800W064  
Start channel: 150 ( 37.61keV )  
Stop channel: 8000 ( 2000.13keV )  
Peak rejection level: 1000.000%  
Peak search sensitivity: 3  
Sample Size: 1.0000E+00 +/- 0.000E+00%  
Activity scaling factor:  $1.0000E+00 / (3.7000E-02 * 1.0000E+00) = 2.7027E+01$   
Detection limit method: Reg. Guide 4.16 Method

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Random error: 4.0000000E+00  
 Systematic error: 4.0000000E+00  
 Fraction Limit: 0.000%  
 Background width: 3  
 Half lives decay limit: 12.000  
 Activity range factor: 2.000  
 Min. step backg. energy 0.000  
 Multiplet shift channel 2.000

| Corrections                   | Status | Comments                                     |
|-------------------------------|--------|----------------------------------------------|
| Decay correct to date:        | YES    | 6/1/2016 12:00:00 PM                         |
| Decay during acquisition:     | YES    |                                              |
| Decay during collection:      | NO     |                                              |
| True coincidence correction:  | NO     |                                              |
| Peaked background correction: | YES    | 7_2016-05-07_0559.PBC<br>5/7/2016 5:59:56 AM |
| Absorption (Internal):        | NO     |                                              |
| Geometry correction:          | NO     |                                              |
| Random summing:               | NO     |                                              |

total peaks alloc. 1 cutoff: 5.00E+01 %  
 Energy Calibration  
 Normalized diff: 0.0728

\*\*\*\*\* S U M M A R Y O F P E A K S I N R A N G E \*\*\*\*\*

| Peak<br>Energy | Area | Uncert | FWHM | Corrctn<br>Factor | Nuclide<br>Energy | Brnch.<br>Ratio | Act.<br>pCi/Samp | Nuc   |
|----------------|------|--------|------|-------------------|-------------------|-----------------|------------------|-------|
| 140.44         | 329. | 5.60   | 0.78 | 5.337E-02         | 140.51            | 89.060          | 4.695E+02        | TC99M |

No unknown peaks passed sensitivity test.

-----  
 This section based on library: Client\_Tc-99m.lib

\*\*\*\*\* I D E N T I F I E D P E A K S U M M A R Y \*\*\*\*\*

| Nuclide | Peak<br>Channel | Centroid<br>Energy | Background<br>Counts | Net Area<br>Counts | Intensity<br>Cts/Sec | Uncert<br>1 Sigma | FWHM<br>% | FWHM<br>keV |
|---------|-----------------|--------------------|----------------------|--------------------|----------------------|-------------------|-----------|-------------|
| TC-99M  | 561.63          | 140.51             | 3.                   | 329.               | 0.549                | 5.60              | 0.783D    |             |

s - Peak fails shape tests.  
 D - Peak area deconvoluted.  
 A Derived peak area.

| ***** S U M M A R Y O F L I B R A R Y P E A K U S A G E *****                                                |      |            |                      |            |             |                       |
|--------------------------------------------------------------------------------------------------------------|------|------------|----------------------|------------|-------------|-----------------------|
| - Nuclide -                                                                                                  |      | Average    | ----- Peak -----     |            |             |                       |
| Name                                                                                                         | Code | Activity   | Energy               | Activity   | Code        | MDA Value             |
|                                                                                                              |      | pCi/Sample | keV                  | pCi/Sample |             | pCi/Sample            |
|                                                                                                              |      |            |                      |            |             | COMMENTS              |
| TC-99M                                                                                                       | I    | 4.6948E+02 |                      |            |             | 2.51E-01              |
|                                                                                                              |      |            |                      |            |             | Energy duplication    |
|                                                                                                              |      |            | 140.51               | 4.695E+02  | ( 1.505E+01 | 5.60E+00 8.91E+01 G K |
| ( - This peak used in the nuclide activity average.                                                          |      |            |                      |            |             |                       |
| * - Peak is too wide, but only one peak in library.                                                          |      |            |                      |            |             |                       |
| ! - Peak is part of a multiplet and this area went negative during deconvolution.                            |      |            |                      |            |             |                       |
| ? - Peak is too narrow.                                                                                      |      |            |                      |            |             |                       |
| @ - Peak is too wide at FW25M, but ok at FWHM.                                                               |      |            |                      |            |             |                       |
| % - Peak fails sensitivity test.                                                                             |      |            |                      |            |             |                       |
| \$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.                 |      |            |                      |            |             |                       |
| + - Peak activity higher than counting uncertainty range.                                                    |      |            |                      |            |             |                       |
| - - Peak activity lower than counting uncertainty range.                                                     |      |            |                      |            |             |                       |
| = - Peak outside analysis energy range.                                                                      |      |            |                      |            |             |                       |
| & - Calculated peak centroid is not close enough to the library energy centroid for positive identification. |      |            |                      |            |             |                       |
| P - Peakbackground subtraction                                                                               |      |            |                      |            |             |                       |
| } - Peak is too close to another for the activity to be found directly.                                      |      |            |                      |            |             |                       |
| Nuclide Codes:                                                                                               |      |            | Peak Codes:          |            |             |                       |
| T - Thermal Neutron Activation                                                                               |      |            | G - Gamma Ray        |            |             |                       |
| F - Fast Neutron Activation                                                                                  |      |            | X - X-Ray            |            |             |                       |
| I - Fission Product                                                                                          |      |            | P - Positron Decay   |            |             |                       |
| N - Naturally Occurring Isotope                                                                              |      |            | S - Single-Escape    |            |             |                       |
| P - Photon Reaction                                                                                          |      |            | D - Double-Escape    |            |             |                       |
| C - Charged Particle Reaction                                                                                |      |            | K - Key Line         |            |             |                       |
| M - No MDA Calculation                                                                                       |      |            | A - Not in Average   |            |             |                       |
| R - Coincidence Corrected                                                                                    |      |            | C - Coincidence Peak |            |             |                       |
| H - Halflife limit exceeded                                                                                  |      |            |                      |            |             |                       |

\*\*\*\*\* D I S C A R D E D I S O T O P E P E A K S \*\*\*\*\*

| Nuclide | Centroid | Background | Net Area | Intensity | Uncert    | Activity |
|---------|----------|------------|----------|-----------|-----------|----------|
|         | Energy   | Counts     | Counts   | Cts/Sec   | 1 Sigma % |          |

P - Peakbackground subtraction

\*\*\*\*\* S U M M A R Y O F N U C L I D E S I N S A M P L E \*\*\*\*\*  
 Time of Count Time Corrected Uncertainty 1 Sigma  
 Nuclide Activity Activity Counting MDA  
 pCi/Sample pCi/Sample pCi/Sample

|                                           |            |            |            |          |
|-------------------------------------------|------------|------------|------------|----------|
| TC-99M                                    | 3.1506E+02 | 4.6948E+02 | 5.602E+00% | 1.51E+01 |
| < - MDA value printed.                    |            |            |            |          |
| A - Activity printed, but activity < MDA. |            |            |            |          |
| B - Activity < MDA and failed test.       |            |            |            |          |
| C - Area < Critical level.                |            |            |            |          |
| F - Failed fraction or key line test.     |            |            |            |          |
| H - Halflife limit exceeded               |            |            |            |          |

----- S U M M A R Y -----  
 Total Activity ( 37.6 to 2000.1 keV) 3.151E+02 pCi/Sample  
 Total Decayed Activity ( 37.6 to 2000.1 keV) 4.6947565E+02 pCi/Sample

The library has energies which are not separable.



---

Sample Description: 254137\_Gamma\_TCCLBB 160-254137~2-A

Detector: Detector # 8

Batch ID: 254137

Work Order Number: Gamma

Lot Number: TCCLBB 160-254137~2-A

---

Decay to Time: 6/1/2016 12:00

Live Time: 600 sec

Acquisition Time: 6/1/2016 15:43:26

Real Time: 617 sec

Analysis Time: 6/1/2016 15:54

Dead Time: 2.83 %

Analysis Quantity: 1.000E+00 Sample

---

Efficiency Cal File: 8\_Soil\_TunaCan.Clb

Efficiency Cal Desc: 8\_Soil\_TunaCan\_90099\_032712

Efficiency Cal Date: 3/28/2012 10:35

Energy Cal Date: 2/28/2012 10:34

Library: Client\_Tc-99m.lib

Bkgd Correction File: 8\_2016-05-07\_1503.PBC

---

| Nuclide | Activity<br>pCi/Sample | 1-Sigma<br>Counting<br>Uncert<br>% | 1-Sigma<br>Counting<br>Uncert<br>pCi/Sample | 1-Sigma<br>Total<br>Uncert<br>pCi/Sample | Minimum<br>Detectable<br>Activity<br>pCi/Sample |
|---------|------------------------|------------------------------------|---------------------------------------------|------------------------------------------|-------------------------------------------------|
| TC-99M  | 4.781E+02              | 6.7                                | 3.182E+01                                   | 4.007E+01                                | 2.272E+01                                       |
| Total   | 4.781E+02              |                                    |                                             |                                          |                                                 |

---

Analyst: Mike Aldridge

Sample description

254137\_Gamma\_TCCLBB 160-254137~2-A

Spectrum Filename: C:\User\SPC\Det8\8\_Gamma\_20160676.An1

Acquisition information

Start time: 6/1/2016 3:43:26 PM  
Live time: 600  
Real time: 617  
Dead time: 2.83 %  
Detector ID: 8

Detector system

Ge 8 SN/174

Calibration

Filename: 8\_Soil\_TunaCan.Clb  
8\_Soil\_TunaCan\_90099\_032712

Energy Calibration

Created: 2/28/2012 10:34:41 AM  
Zero offset: 0.052 keV  
Gain: 0.250 keV/channel  
Quadratic: 5.282E-10 keV/channel^2

Efficiency Calibration

Created: 3/28/2012 10:35:20 AM  
Knee Energy: 165.85 keV  
Above the Knee: Quadratic Uncertainty = 1.39 %  
Log(Eff):  $-1.098764E-01 + (-4.958544E-01 * \text{Log}(E)) + (-2.572270E-02 * \text{Log}(E)^2)$   
Below the Knee: Quadratic Uncertainty = 1.71 %  
Log(Eff):  $-2.525301E+01 + (9.398253E+00 * \text{Log}(E)) + (-1.000034E+00 * \text{Log}(E)^2)$

Library Files

Main analysis library: Client\_Tc-99m.lib  
Library Match Width: 0.500  
Peak stripping: Library based

Analysis parameters

Analysis engine: Env32 G800W064  
Start channel: 150 ( 37.55keV )  
Stop channel: 8000 ( 1999.97keV )  
Peak rejection level: 1000.000%  
Peak search sensitivity: 3  
Sample Size: 1.0000E+00 +/- 0.000E+00%  
Activity scaling factor:  $1.0000E+00 / (3.7000E-02 * 1.0000E+00) = 2.7027E+01$   
Detection limit method: Reg. Guide 4.16 Method

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Random error: 4.0000000E+00  
 Systematic error: 4.0000000E+00  
 Fraction Limit: 0.000%  
 Background width: 3  
 Half lives decay limit: 12.000  
 Activity range factor: 2.000  
 Min. step backg. energy 0.000  
 Multiplet shift channel 2.000

| Corrections                   | Status | Comments                                     |
|-------------------------------|--------|----------------------------------------------|
| Decay correct to date:        | YES    | 6/1/2016 12:00:00 PM                         |
| Decay during acquisition:     | YES    |                                              |
| Decay during collection:      | NO     |                                              |
| True coincidence correction:  | NO     |                                              |
| Peaked background correction: | YES    | 8_2016-05-07_1503.PBC<br>5/7/2016 3:03:11 PM |
| Absorption (Internal):        | NO     |                                              |
| Geometry correction:          | NO     |                                              |
| Random summing:               | NO     |                                              |

total peaks alloc. 1 cutoff: 5.00E+01 %  
 Energy Calibration  
 Normalized diff: 0.0018

\*\*\*\*\* S U M M A R Y O F P E A K S I N R A N G E \*\*\*\*\*

| Peak<br>Energy | Area | Uncert | FWHM | Corrctn<br>Factor | Nuclide<br>Energy | Brnch.<br>Ratio | Act.<br>pCi/Samp | Nuc   |
|----------------|------|--------|------|-------------------|-------------------|-----------------|------------------|-------|
| 140.51         | 240. | 6.66   | 1.00 | 3.945E-02         | 140.51            | 89.060          | 4.781E+02        | TC99M |

No unknown peaks passed sensitivity test.

-----  
 This section based on library: Client\_Tc-99m.lib

\*\*\*\*\* I D E N T I F I E D P E A K S U M M A R Y \*\*\*\*\*

| Nuclide | Peak<br>Channel | Centroid<br>Energy | Background<br>Counts | Net Area<br>Counts | Intensity<br>Cts/Sec | Uncert<br>1 Sigma | FWHM<br>% | FWHM<br>keV |
|---------|-----------------|--------------------|----------------------|--------------------|----------------------|-------------------|-----------|-------------|
| TC-99M  | 561.86          | 140.51             | 4.                   | 240.               | 0.401                | 6.66              | 0.999D    |             |

s - Peak fails shape tests.  
 D - Peak area deconvoluted.  
 A Derived peak area.

| ***** S U M M A R Y O F L I B R A R Y P E A K U S A G E *****                                                |      |            |                      |            |             |                       |
|--------------------------------------------------------------------------------------------------------------|------|------------|----------------------|------------|-------------|-----------------------|
| - Nuclide -                                                                                                  |      | Average    | ----- Peak -----     |            |             |                       |
| Name                                                                                                         | Code | Activity   | Energy               | Activity   | Code        | MDA Value             |
|                                                                                                              |      | pCi/Sample | keV                  | pCi/Sample |             | pCi/Sample            |
| COMMENTS                                                                                                     |      |            |                      |            |             |                       |
| <hr/>                                                                                                        |      |            |                      |            |             |                       |
| TC-99M                                                                                                       | I    | 4.7809E+02 |                      |            |             | 2.51E-01              |
|                                                                                                              |      |            |                      |            |             | Energy duplication    |
|                                                                                                              |      |            | 140.51               | 4.781E+02  | ( 2.272E+01 | 6.66E+00 8.91E+01 G K |
| ( - This peak used in the nuclide activity average.                                                          |      |            |                      |            |             |                       |
| * - Peak is too wide, but only one peak in library.                                                          |      |            |                      |            |             |                       |
| ! - Peak is part of a multiplet and this area went negative during deconvolution.                            |      |            |                      |            |             |                       |
| ? - Peak is too narrow.                                                                                      |      |            |                      |            |             |                       |
| @ - Peak is too wide at FW25M, but ok at FWHM.                                                               |      |            |                      |            |             |                       |
| % - Peak fails sensitivity test.                                                                             |      |            |                      |            |             |                       |
| \$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.                 |      |            |                      |            |             |                       |
| + - Peak activity higher than counting uncertainty range.                                                    |      |            |                      |            |             |                       |
| - - Peak activity lower than counting uncertainty range.                                                     |      |            |                      |            |             |                       |
| = - Peak outside analysis energy range.                                                                      |      |            |                      |            |             |                       |
| & - Calculated peak centroid is not close enough to the library energy centroid for positive identification. |      |            |                      |            |             |                       |
| P - Peakbackground subtraction                                                                               |      |            |                      |            |             |                       |
| } - Peak is too close to another for the activity to be found directly.                                      |      |            |                      |            |             |                       |
|                                                                                                              |      |            |                      |            |             |                       |
| Nuclide Codes:                                                                                               |      |            | Peak Codes:          |            |             |                       |
| T - Thermal Neutron Activation                                                                               |      |            | G - Gamma Ray        |            |             |                       |
| F - Fast Neutron Activation                                                                                  |      |            | X - X-Ray            |            |             |                       |
| I - Fission Product                                                                                          |      |            | P - Positron Decay   |            |             |                       |
| N - Naturally Occurring Isotope                                                                              |      |            | S - Single-Escape    |            |             |                       |
| P - Photon Reaction                                                                                          |      |            | D - Double-Escape    |            |             |                       |
| C - Charged Particle Reaction                                                                                |      |            | K - Key Line         |            |             |                       |
| M - No MDA Calculation                                                                                       |      |            | A - Not in Average   |            |             |                       |
| R - Coincidence Corrected                                                                                    |      |            | C - Coincidence Peak |            |             |                       |
| H - Halflife limit exceeded                                                                                  |      |            |                      |            |             |                       |

\*\*\*\*\* D I S C A R D E D I S O T O P E P E A K S \*\*\*\*\*

| Nuclide | Centroid | Background | Net Area | Intensity | Uncert    | Activity |
|---------|----------|------------|----------|-----------|-----------|----------|
|         | Energy   | Counts     | Counts   | Cts/Sec   | 1 Sigma % |          |

P - Peakbackground subtraction

\*\*\*\*\* S U M M A R Y O F N U C L I D E S I N S A M P L E \*\*\*\*\*  
 Time of Count Time Corrected Uncertainty 1 Sigma  
 Nuclide Activity Activity Counting MDA  
 pCi/Sample pCi/Sample pCi/Sample

|        |            |            |            |          |
|--------|------------|------------|------------|----------|
| TC-99M | 3.1137E+02 | 4.7809E+02 | 6.656E+00% | 2.27E+01 |
|--------|------------|------------|------------|----------|

< - MDA value printed.  
 A - Activity printed, but activity < MDA.  
 B - Activity < MDA and failed test.  
 C - Area < Critical level.  
 F - Failed fraction or key line test.  
 H - Halflife limit exceeded

----- S U M M A R Y -----  
 Total Activity ( 37.5 to 2000.0 keV) 3.114E+02 pCi/Sample  
 Total Decayed Activity ( 37.5 to 2000.0 keV) 4.7808997E+02 pCi/Sample

The library has energies which are not separable.



-----  
Sample Description: 254137\_Gamma\_TCCLBB 160-254137~2-A

Detector: Detector # 5

Batch ID: 254137

Work Order Number: Gamma

Lot Number: TCCLBB 160-254137~2-A  
-----

Decay to Time: 6/1/2016 12:00

Live Time: 600 sec

Acquisition Time: 6/1/2016 16:18:24

Real Time: 603 sec

Analysis Time: 6/1/2016 16:29

Dead Time: 0.44 %

Analysis Quantity: 1.000E+00 Sample  
-----

Efficiency Cal File: 5\_Soil\_TunaCan.Clb

Efficiency Cal Desc: 5\_Soil\_TunaCan\_90099\_032612

Efficiency Cal Date: 3/27/2012 17:20

Energy Cal Date: 2/28/2012 19:35

Library: Client\_Tc-99m.lib

Bkgd Correction File: 5\_2016-05-07\_0551.PBC  
-----

| Nuclide | Activity<br>pCi/Sample | 1-Sigma<br>Counting<br>Uncert<br>% | 1-Sigma<br>Counting<br>Uncert<br>pCi/Sample | 1-Sigma<br>Total<br>Uncert<br>pCi/Sample | Minimum<br>Detectable<br>Activity<br>pCi/Sample |
|---------|------------------------|------------------------------------|---------------------------------------------|------------------------------------------|-------------------------------------------------|
| TC-99M  | 3.872E+02              | 8.2                                | 3.170E+01                                   | 3.733E+01                                | 2.478E+01                                       |
| Total   | 3.872E+02              |                                    |                                             |                                          |                                                 |

-----

Analyst: Mike Aldridge

Sample description

254137\_Gamma\_TCCLBB 160-254137~2-A

Spectrum Filename: C:\User\SPC\Det5\5\_Gamma\_20160965.An1

Acquisition information

Start time: 6/1/2016 4:18:24 PM  
Live time: 600  
Real time: 603  
Dead time: 0.44 %  
Detector ID: 5

Detector system

Ge 5 SN/157

Calibration

Filename: 5\_Soil\_TunaCan.Clb  
5\_Soil\_TunaCan\_90099\_032612

Energy Calibration

Created: 2/28/2012 7:35:48 PM  
Zero offset: 0.158 keV  
Gain: 0.250 keV/channel  
Quadratic: 3.911E-08 keV/channel^2

Efficiency Calibration

Created: 3/27/2012 5:20:37 PM  
Knee Energy: 165.85 keV  
Above the Knee: Quadratic Uncertainty = 0.87 %  
Log(Eff):  $6.466115E-01 + (-7.830454E-01 * \text{Log}(E)) + (-4.117504E-03 * \text{Log}(E)^2)$   
Below the Knee: Quadratic Uncertainty = 1.43 %  
Log(Eff):  $-2.462251E+01 + (9.075211E+00 * \text{Log}(E)) + (-9.664422E-01 * \text{Log}(E)^2)$

Library Files

Main analysis library: Client\_Tc-99m.lib  
Library Match Width: 0.500  
Peak stripping: Library based

Analysis parameters

Analysis engine: Env32 G800W064  
Start channel: 150 ( 37.62keV )  
Stop channel: 8000 ( 2000.81keV )  
Peak rejection level: 1000.000%  
Peak search sensitivity: 3  
Sample Size: 1.0000E+00 +/- 0.000E+00%  
Activity scaling factor:  $1.0000E+00 / (3.7000E-02 * 1.0000E+00) = 2.7027E+01$   
Detection limit method: Reg. Guide 4.16 Method

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Random error: 4.0000000E+00  
 Systematic error: 4.0000000E+00  
 Fraction Limit: 0.000%  
 Background width: 3  
 Half lives decay limit: 12.000  
 Activity range factor: 2.000  
 Min. step backg. energy 0.000  
 Multiplet shift channel 2.000

| Corrections                   | Status | Comments                                     |
|-------------------------------|--------|----------------------------------------------|
| Decay correct to date:        | YES    | 6/1/2016 12:00:00 PM                         |
| Decay during acquisition:     | YES    |                                              |
| Decay during collection:      | NO     |                                              |
| True coincidence correction:  | NO     |                                              |
| Peaked background correction: | YES    | 5_2016-05-07_0551.PBC<br>5/7/2016 5:51:59 AM |
| Absorption (Internal):        | NO     |                                              |
| Geometry correction:          | NO     |                                              |
| Random summing:               | NO     |                                              |

total peaks alloc. 1 cutoff: 5.00E+01 %  
 Energy Calibration  
 Normalized diff: 0.0042

\*\*\*\*\* S U M M A R Y O F P E A K S I N R A N G E \*\*\*\*\*

| Peak<br>Energy | Area | Uncert | FWHM | Corrctn<br>Factor | Nuclide<br>Energy | Brnch.<br>Ratio | Act.<br>pCi/Samp | Nuc   |
|----------------|------|--------|------|-------------------|-------------------|-----------------|------------------|-------|
| 140.51         | 158. | 8.19   | 0.57 | 3.411E-02         | 140.51            | 89.060          | 3.872E+02        | TC99M |

No unknown peaks passed sensitivity test.

-----  
 This section based on library: Client\_Tc-99m.lib

\*\*\*\*\* I D E N T I F I E D P E A K S U M M A R Y \*\*\*\*\*

| Nuclide | Peak<br>Channel | Centroid<br>Energy | Background<br>Counts | Net Area<br>Counts | Intensity<br>Cts/Sec | Uncert<br>1 Sigma | FWHM<br>% | FWHM<br>keV |
|---------|-----------------|--------------------|----------------------|--------------------|----------------------|-------------------|-----------|-------------|
| TC-99M  | 561.88          | 140.51             | 2.                   | 158.               | 0.262                | 8.19              | 0.572D    |             |

s - Peak fails shape tests.  
 D - Peak area deconvoluted.  
 A Derived peak area.

| ***** S U M M A R Y O F L I B R A R Y P E A K U S A G E *****                                                |      |            |                      |            |             |                       |
|--------------------------------------------------------------------------------------------------------------|------|------------|----------------------|------------|-------------|-----------------------|
| - Nuclide -                                                                                                  |      | Average    | ----- Peak -----     |            |             |                       |
| Name                                                                                                         | Code | Activity   | Energy               | Activity   | Code        | MDA Value             |
|                                                                                                              |      | pCi/Sample | keV                  | pCi/Sample |             | pCi/Sample            |
| COMMENTS                                                                                                     |      |            |                      |            |             |                       |
| <hr/>                                                                                                        |      |            |                      |            |             |                       |
| TC-99M                                                                                                       | I    | 3.8718E+02 |                      |            |             | 2.51E-01              |
|                                                                                                              |      |            |                      |            |             | Energy duplication    |
|                                                                                                              |      |            | 140.51               | 3.872E+02  | ( 2.478E+01 | 8.19E+00 8.91E+01 G K |
| ( - This peak used in the nuclide activity average.                                                          |      |            |                      |            |             |                       |
| * - Peak is too wide, but only one peak in library.                                                          |      |            |                      |            |             |                       |
| ! - Peak is part of a multiplet and this area went negative during deconvolution.                            |      |            |                      |            |             |                       |
| ? - Peak is too narrow.                                                                                      |      |            |                      |            |             |                       |
| @ - Peak is too wide at FW25M, but ok at FWHM.                                                               |      |            |                      |            |             |                       |
| % - Peak fails sensitivity test.                                                                             |      |            |                      |            |             |                       |
| \$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.                 |      |            |                      |            |             |                       |
| + - Peak activity higher than counting uncertainty range.                                                    |      |            |                      |            |             |                       |
| - - Peak activity lower than counting uncertainty range.                                                     |      |            |                      |            |             |                       |
| = - Peak outside analysis energy range.                                                                      |      |            |                      |            |             |                       |
| & - Calculated peak centroid is not close enough to the library energy centroid for positive identification. |      |            |                      |            |             |                       |
| P - Peakbackground subtraction                                                                               |      |            |                      |            |             |                       |
| } - Peak is too close to another for the activity to be found directly.                                      |      |            |                      |            |             |                       |
|                                                                                                              |      |            |                      |            |             |                       |
| Nuclide Codes:                                                                                               |      |            | Peak Codes:          |            |             |                       |
| T - Thermal Neutron Activation                                                                               |      |            | G - Gamma Ray        |            |             |                       |
| F - Fast Neutron Activation                                                                                  |      |            | X - X-Ray            |            |             |                       |
| I - Fission Product                                                                                          |      |            | P - Positron Decay   |            |             |                       |
| N - Naturally Occurring Isotope                                                                              |      |            | S - Single-Escape    |            |             |                       |
| P - Photon Reaction                                                                                          |      |            | D - Double-Escape    |            |             |                       |
| C - Charged Particle Reaction                                                                                |      |            | K - Key Line         |            |             |                       |
| M - No MDA Calculation                                                                                       |      |            | A - Not in Average   |            |             |                       |
| R - Coincidence Corrected                                                                                    |      |            | C - Coincidence Peak |            |             |                       |
| H - Halflife limit exceeded                                                                                  |      |            |                      |            |             |                       |

\*\*\*\*\* D I S C A R D E D I S O T O P E P E A K S \*\*\*\*\*

| Nuclide | Centroid | Background | Net Area | Intensity | Uncert    | Activity |
|---------|----------|------------|----------|-----------|-----------|----------|
|         | Energy   | Counts     | Counts   | Cts/Sec   | 1 Sigma % |          |

P - Peakbackground subtraction

\*\*\*\*\* S U M M A R Y O F N U C L I D E S I N S A M P L E \*\*\*\*\*  
 Time of Count Time Corrected Uncertainty 1 Sigma  
 Nuclide Activity Activity Counting MDA  
 pCi/Sample pCi/Sample pCi/Sample

|                                           |            |            |            |          |
|-------------------------------------------|------------|------------|------------|----------|
| TC-99M                                    | 2.3580E+02 | 3.8718E+02 | 8.187E+00% | 2.48E+01 |
| < - MDA value printed.                    |            |            |            |          |
| A - Activity printed, but activity < MDA. |            |            |            |          |
| B - Activity < MDA and failed test.       |            |            |            |          |
| C - Area < Critical level.                |            |            |            |          |
| F - Failed fraction or key line test.     |            |            |            |          |
| H - Halflife limit exceeded               |            |            |            |          |

----- S U M M A R Y -----  
 Total Activity ( 37.6 to 2000.8 keV) 2.358E+02 pCi/Sample  
 Total Decayed Activity ( 37.6 to 2000.8 keV) 3.8718463E+02 pCi/Sample

The library has energies which are not separable.



---

Sample Description: 254137\_Gamma\_TCCLBC 160-254137~3-A

Detector: Detector # 8

Batch ID: 254137

Work Order Number: Gamma

Lot Number: TCCLBC 160-254137~3-A

---

Decay to Time: 6/1/2016 12:00

Live Time: 600 sec

Acquisition Time: 6/1/2016 15:29:14

Real Time: 617 sec

Analysis Time: 6/1/2016 15:39

Dead Time: 2.82 %

Analysis Quantity: 1.000E+00 Sample

---

Efficiency Cal File: 8\_Soil\_TunaCan.Clb

Efficiency Cal Desc: 8\_Soil\_TunaCan\_90099\_032712

Efficiency Cal Date: 3/28/2012 10:35

Energy Cal Date: 2/28/2012 10:34

Library: Client\_Tc-99m.lib

Bkgd Correction File: 8\_2016-05-07\_1503.PBC

---

| Nuclide | Activity<br>pCi/Sample | 1-Sigma<br>Counting<br>Uncert<br>% | 1-Sigma<br>Counting<br>Uncert<br>pCi/Sample | 1-Sigma<br>Total<br>Uncert<br>pCi/Sample | Minimum<br>Detectable<br>Activity<br>pCi/Sample |
|---------|------------------------|------------------------------------|---------------------------------------------|------------------------------------------|-------------------------------------------------|
| TC-99M  | 4.739E+02              | 6.4                                | 3.028E+01                                   | 3.872E+01                                | 1.426E+01                                       |
| Total   | 4.739E+02              |                                    |                                             |                                          |                                                 |

---

Analyst: Mike Aldridge

Sample description

254137\_Gamma\_TCCLBC 160-254137~3-A

Spectrum Filename: C:\User\SPC\Det8\8\_Gamma\_20160675.An1

Acquisition information

Start time: 6/1/2016 3:29:14 PM  
Live time: 600  
Real time: 617  
Dead time: 2.82 %  
Detector ID: 8

Detector system

Ge 8 SN/174

Calibration

Filename: 8\_Soil\_TunaCan.Clb  
8\_Soil\_TunaCan\_90099\_032712

Energy Calibration

Created: 2/28/2012 10:34:41 AM  
Zero offset: 0.052 keV  
Gain: 0.250 keV/channel  
Quadratic: 5.282E-10 keV/channel^2

Efficiency Calibration

Created: 3/28/2012 10:35:20 AM  
Knee Energy: 165.85 keV  
Above the Knee: Quadratic Uncertainty = 1.39 %  
Log(Eff):  $-1.098764E-01 + (-4.958544E-01 * \text{Log}(E)) + (-2.572270E-02 * \text{Log}(E)^2)$   
Below the Knee: Quadratic Uncertainty = 1.71 %  
Log(Eff):  $-2.525301E+01 + (9.398253E+00 * \text{Log}(E)) + (-1.000034E+00 * \text{Log}(E)^2)$

Library Files

Main analysis library: Client\_Tc-99m.lib  
Library Match Width: 0.500  
Peak stripping: Library based

Analysis parameters

Analysis engine: Env32 G800W064  
Start channel: 150 ( 37.55keV )  
Stop channel: 8000 ( 1999.97keV )  
Peak rejection level: 1000.000%  
Peak search sensitivity: 3  
Sample Size: 1.0000E+00 +/- 0.000E+00%  
Activity scaling factor:  $1.0000E+00 / (3.7000E-02 * 1.0000E+00) = 2.7027E+01$   
Detection limit method: Reg. Guide 4.16 Method

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Random error: 4.0000000E+00  
 Systematic error: 4.0000000E+00  
 Fraction Limit: 0.000%  
 Background width: 3  
 Half lives decay limit: 12.000  
 Activity range factor: 2.000  
 Min. step backg. energy 0.000  
 Multiplet shift channel 2.000

| Corrections                   | Status | Comments                                     |
|-------------------------------|--------|----------------------------------------------|
| Decay correct to date:        | YES    | 6/1/2016 12:00:00 PM                         |
| Decay during acquisition:     | YES    |                                              |
| Decay during collection:      | NO     |                                              |
| True coincidence correction:  | NO     |                                              |
| Peaked background correction: | YES    | 8_2016-05-07_1503.PBC<br>5/7/2016 3:03:11 PM |
| Absorption (Internal):        | NO     |                                              |
| Geometry correction:          | NO     |                                              |
| Random summing:               | NO     |                                              |

total peaks alloc. 1 cutoff: 5.00E+01 %  
 Energy Calibration  
 Normalized diff: 0.0177

\*\*\*\*\* S U M M A R Y O F P E A K S I N R A N G E \*\*\*\*\*

| Peak<br>Energy | Area | Uncert | FWHM | Corrctn<br>Factor | Nuclide<br>Energy | Brnch.<br>Ratio | Act.<br>pCi/Samp | Nuc   |
|----------------|------|--------|------|-------------------|-------------------|-----------------|------------------|-------|
| 140.49         | 245. | 6.39   | 0.94 | 3.946E-02         | 140.51            | 89.060          | 4.739E+02        | TC99M |

No unknown peaks passed sensitivity test.

-----  
 This section based on library: Client\_Tc-99m.lib

\*\*\*\*\* I D E N T I F I E D P E A K S U M M A R Y \*\*\*\*\*

| Nuclide | Peak<br>Channel | Centroid<br>Energy | Background<br>Counts | Net Area<br>Counts | Intensity<br>Cts/Sec | Uncert<br>1 Sigma | FWHM<br>% | FWHM<br>keV |
|---------|-----------------|--------------------|----------------------|--------------------|----------------------|-------------------|-----------|-------------|
| TC-99M  | 561.86          | 140.51             | 0.                   | 245.               | 0.408                | 6.39              | 0.940D    |             |

s - Peak fails shape tests.  
 D - Peak area deconvoluted.  
 A Derived peak area.

| ***** S U M M A R Y O F L I B R A R Y P E A K U S A G E *****                                                |      |            |                      |            |                                   |                    |
|--------------------------------------------------------------------------------------------------------------|------|------------|----------------------|------------|-----------------------------------|--------------------|
| - Nuclide -                                                                                                  |      | Average    | ----- Peak -----     |            |                                   |                    |
| Name                                                                                                         | Code | Activity   | Energy               | Activity   | Code                              | MDA Value          |
|                                                                                                              |      | pCi/Sample | keV                  | pCi/Sample |                                   | pCi/Sample         |
| COMMENTS                                                                                                     |      |            |                      |            |                                   |                    |
| <hr/>                                                                                                        |      |            |                      |            |                                   |                    |
| TC-99M                                                                                                       | I    | 4.7394E+02 |                      |            |                                   | 2.51E-01           |
|                                                                                                              |      |            |                      |            |                                   | Energy duplication |
|                                                                                                              |      |            | 140.51               | 4.739E+02  | ( 1.426E+01 6.39E+00 8.91E+01 G K |                    |
| ( - This peak used in the nuclide activity average.                                                          |      |            |                      |            |                                   |                    |
| * - Peak is too wide, but only one peak in library.                                                          |      |            |                      |            |                                   |                    |
| ! - Peak is part of a multiplet and this area went negative during deconvolution.                            |      |            |                      |            |                                   |                    |
| ? - Peak is too narrow.                                                                                      |      |            |                      |            |                                   |                    |
| @ - Peak is too wide at FW25M, but ok at FWHM.                                                               |      |            |                      |            |                                   |                    |
| % - Peak fails sensitivity test.                                                                             |      |            |                      |            |                                   |                    |
| \$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.                 |      |            |                      |            |                                   |                    |
| + - Peak activity higher than counting uncertainty range.                                                    |      |            |                      |            |                                   |                    |
| - - Peak activity lower than counting uncertainty range.                                                     |      |            |                      |            |                                   |                    |
| = - Peak outside analysis energy range.                                                                      |      |            |                      |            |                                   |                    |
| & - Calculated peak centroid is not close enough to the library energy centroid for positive identification. |      |            |                      |            |                                   |                    |
| P - Peakbackground subtraction                                                                               |      |            |                      |            |                                   |                    |
| } - Peak is too close to another for the activity to be found directly.                                      |      |            |                      |            |                                   |                    |
|                                                                                                              |      |            |                      |            |                                   |                    |
| Nuclide Codes:                                                                                               |      |            | Peak Codes:          |            |                                   |                    |
| T - Thermal Neutron Activation                                                                               |      |            | G - Gamma Ray        |            |                                   |                    |
| F - Fast Neutron Activation                                                                                  |      |            | X - X-Ray            |            |                                   |                    |
| I - Fission Product                                                                                          |      |            | P - Positron Decay   |            |                                   |                    |
| N - Naturally Occurring Isotope                                                                              |      |            | S - Single-Escape    |            |                                   |                    |
| P - Photon Reaction                                                                                          |      |            | D - Double-Escape    |            |                                   |                    |
| C - Charged Particle Reaction                                                                                |      |            | K - Key Line         |            |                                   |                    |
| M - No MDA Calculation                                                                                       |      |            | A - Not in Average   |            |                                   |                    |
| R - Coincidence Corrected                                                                                    |      |            | C - Coincidence Peak |            |                                   |                    |
| H - Halflife limit exceeded                                                                                  |      |            |                      |            |                                   |                    |

\*\*\*\*\* D I S C A R D E D I S O T O P E P E A K S \*\*\*\*\*

| Nuclide | Centroid | Background | Net Area | Intensity | Uncert    | Activity |
|---------|----------|------------|----------|-----------|-----------|----------|
|         | Energy   | Counts     | Counts   | Cts/Sec   | 1 Sigma % |          |

P - Peakbackground subtraction

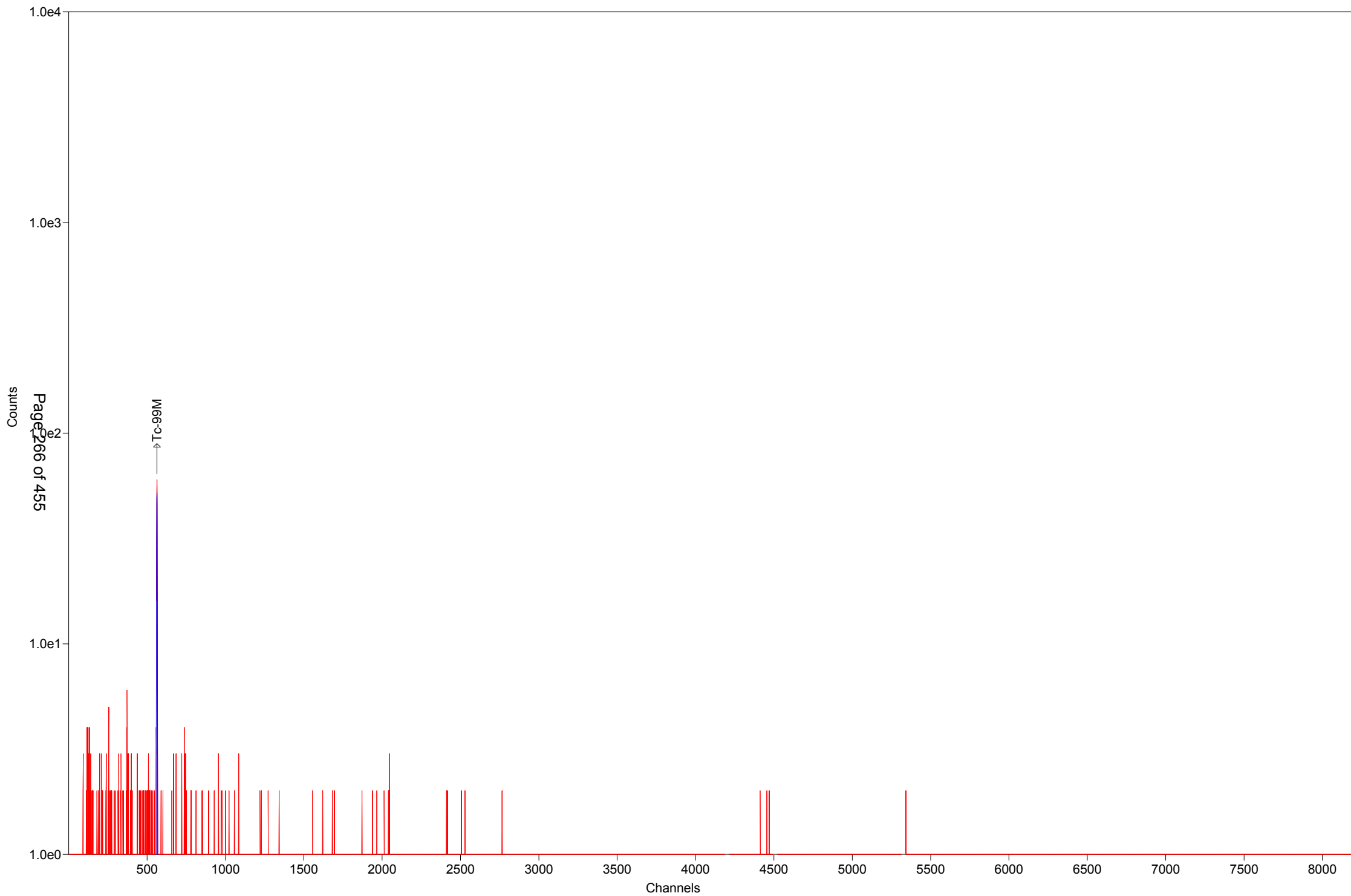
\*\*\*\*\* S U M M A R Y O F N U C L I D E S I N S A M P L E \*\*\*\*\*  
 Time of Count Time Corrected Uncertainty 1 Sigma  
 Nuclide Activity Activity Counting MDA  
 pCi/Sample pCi/Sample pCi/Sample

|        |            |            |            |          |
|--------|------------|------------|------------|----------|
| TC-99M | 3.1720E+02 | 4.7394E+02 | 6.389E+00% | 1.43E+01 |
|--------|------------|------------|------------|----------|

< - MDA value printed.  
 A - Activity printed, but activity < MDA.  
 B - Activity < MDA and failed test.  
 C - Area < Critical level.  
 F - Failed fraction or key line test.  
 H - Halflife limit exceeded

----- S U M M A R Y -----  
 Total Activity ( 37.5 to 2000.0 keV) 3.172E+02 pCi/Sample  
 Total Decayed Activity ( 37.5 to 2000.0 keV) 4.7394147E+02 pCi/Sample

The library has energies which are not separable.



-----  
Sample Description: 254137\_Gamma\_TCCLBC 160-254137~3-A

Detector: Detector # 5

Batch ID: 254137

Work Order Number: Gamma

Lot Number: TCCLBC 160-254137~3-A  
-----

Decay to Time: 6/1/2016 12:00

Live Time: 600 sec

Acquisition Time: 6/1/2016 15:45:48

Real Time: 602 sec

Analysis Time: 6/1/2016 15:56

Dead Time: 0.38 %

Analysis Quantity: 1.000E+00 Sample  
-----

Efficiency Cal File: 5\_Soil\_TunaCan.Clb

Efficiency Cal Desc: 5\_Soil\_TunaCan\_90099\_032612

Efficiency Cal Date: 3/27/2012 17:20

Energy Cal Date: 2/28/2012 19:35

Library: Client\_Tc-99m.lib

Bkgd Correction File: 5\_2016-05-07\_0551.PBC  
-----

| Nuclide | Activity<br>pCi/Sample | 1-Sigma<br>Counting<br>Uncert<br>% | 1-Sigma<br>Counting<br>Uncert<br>pCi/Sample | 1-Sigma<br>Total<br>Uncert<br>pCi/Sample | Minimum<br>Detectable<br>Activity<br>pCi/Sample |
|---------|------------------------|------------------------------------|---------------------------------------------|------------------------------------------|-------------------------------------------------|
| TC-99M  | 4.087E+02              | 7.9                                | 3.225E+01                                   | 3.838E+01                                | 3.262E+01                                       |
| Total   | 4.087E+02              |                                    |                                             |                                          |                                                 |

-----

Analyst: Mike Aldridge

Sample description

254137\_Gamma\_TCCLBC 160-254137~3-A

Spectrum Filename: C:\User\SPC\Det5\5\_Gamma\_20160964.An1

Acquisition information

Start time: 6/1/2016 3:45:48 PM  
Live time: 600  
Real time: 602  
Dead time: 0.38 %  
Detector ID: 5

Detector system

Ge 5 SN/157

Calibration

Filename: 5\_Soil\_TunaCan.Clb  
5\_Soil\_TunaCan\_90099\_032612

Energy Calibration

Created: 2/28/2012 7:35:48 PM  
Zero offset: 0.158 keV  
Gain: 0.250 keV/channel  
Quadratic: 3.911E-08 keV/channel^2

Efficiency Calibration

Created: 3/27/2012 5:20:37 PM  
Knee Energy: 165.85 keV  
Above the Knee: Quadratic Uncertainty = 0.87 %  
Log(Eff):  $6.466115E-01 + (-7.830454E-01 * \text{Log}(E)) + (-4.117504E-03 * \text{Log}(E)^2)$   
Below the Knee: Quadratic Uncertainty = 1.43 %  
Log(Eff):  $-2.462251E+01 + (9.075211E+00 * \text{Log}(E)) + (-9.664422E-01 * \text{Log}(E)^2)$

Library Files

Main analysis library: Client\_Tc-99m.lib  
Library Match Width: 0.500  
Peak stripping: Library based

Analysis parameters

Analysis engine: Env32 G800W064  
Start channel: 150 ( 37.62keV )  
Stop channel: 8000 ( 2000.81keV )  
Peak rejection level: 1000.000%  
Peak search sensitivity: 3  
Sample Size: 1.0000E+00 +/- 0.000E+00%  
Activity scaling factor:  $1.0000E+00 / (3.7000E-02 * 1.0000E+00) = 2.7027E+01$   
Detection limit method: Reg. Guide 4.16 Method

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Random error: 4.0000000E+00  
 Systematic error: 4.0000000E+00  
 Fraction Limit: 0.000%  
 Background width: 3  
 Half lives decay limit: 12.000  
 Activity range factor: 2.000  
 Min. step backg. energy 0.000  
 Multiplet shift channel 2.000

| Corrections                   | Status | Comments                                     |
|-------------------------------|--------|----------------------------------------------|
| Decay correct to date:        | YES    | 6/1/2016 12:00:00 PM                         |
| Decay during acquisition:     | YES    |                                              |
| Decay during collection:      | NO     |                                              |
| True coincidence correction:  | NO     |                                              |
| Peaked background correction: | YES    | 5_2016-05-07_0551.PBC<br>5/7/2016 5:51:59 AM |
| Absorption (Internal):        | NO     |                                              |
| Geometry correction:          | NO     |                                              |
| Random summing:               | NO     |                                              |

total peaks alloc. 1 cutoff: 5.00E+01 %  
 Energy Calibration  
 Normalized diff: 0.0342

\*\*\*\*\* S U M M A R Y O F P E A K S I N R A N G E \*\*\*\*\*

| Peak<br>Energy | Area | Uncert | FWHM | Corrctn<br>Factor | Nuclide<br>Energy | Brnch.<br>Ratio | Act.<br>pCi/Samp | Nuc   |
|----------------|------|--------|------|-------------------|-------------------|-----------------|------------------|-------|
| 140.48         | 177. | 7.89   | 0.84 | 3.411E-02         | 140.51            | 89.060          | 4.087E+02        | TC99M |

No unknown peaks passed sensitivity test.

-----  
 This section based on library: Client\_Tc-99m.lib

\*\*\*\*\* I D E N T I F I E D P E A K S U M M A R Y \*\*\*\*\*

| Nuclide | Peak<br>Channel | Centroid<br>Energy | Background<br>Counts | Net Area<br>Counts | Intensity<br>Cts/Sec | Uncert<br>1 Sigma | FWHM<br>% | FWHM<br>keV |
|---------|-----------------|--------------------|----------------------|--------------------|----------------------|-------------------|-----------|-------------|
| TC-99M  | 561.88          | 140.51             | 6.                   | 177.               | 0.295                | 7.89              | 0.838D    |             |

s - Peak fails shape tests.  
 D - Peak area deconvoluted.  
 A Derived peak area.

| ***** S U M M A R Y O F L I B R A R Y P E A K U S A G E *****                                                |      |            |                      |            |                                   |                    |
|--------------------------------------------------------------------------------------------------------------|------|------------|----------------------|------------|-----------------------------------|--------------------|
| - Nuclide -                                                                                                  |      | Average    | ----- Peak -----     |            |                                   |                    |
| Name                                                                                                         | Code | Activity   | Energy               | Activity   | Code                              | MDA Value          |
|                                                                                                              |      | pCi/Sample | keV                  | pCi/Sample |                                   | pCi/Sample         |
|                                                                                                              |      |            |                      |            |                                   | COMMENTS           |
| TC-99M                                                                                                       | I    | 4.0873E+02 |                      |            |                                   | 2.51E-01           |
|                                                                                                              |      |            |                      |            |                                   | Energy duplication |
|                                                                                                              |      |            | 140.51               | 4.087E+02  | ( 3.262E+01 7.89E+00 8.91E+01 G K |                    |
| ( - This peak used in the nuclide activity average.                                                          |      |            |                      |            |                                   |                    |
| * - Peak is too wide, but only one peak in library.                                                          |      |            |                      |            |                                   |                    |
| ! - Peak is part of a multiplet and this area went negative during deconvolution.                            |      |            |                      |            |                                   |                    |
| ? - Peak is too narrow.                                                                                      |      |            |                      |            |                                   |                    |
| @ - Peak is too wide at FW25M, but ok at FWHM.                                                               |      |            |                      |            |                                   |                    |
| % - Peak fails sensitivity test.                                                                             |      |            |                      |            |                                   |                    |
| \$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.                 |      |            |                      |            |                                   |                    |
| + - Peak activity higher than counting uncertainty range.                                                    |      |            |                      |            |                                   |                    |
| - - Peak activity lower than counting uncertainty range.                                                     |      |            |                      |            |                                   |                    |
| = - Peak outside analysis energy range.                                                                      |      |            |                      |            |                                   |                    |
| & - Calculated peak centroid is not close enough to the library energy centroid for positive identification. |      |            |                      |            |                                   |                    |
| P - Peakbackground subtraction                                                                               |      |            |                      |            |                                   |                    |
| } - Peak is too close to another for the activity to be found directly.                                      |      |            |                      |            |                                   |                    |
| Nuclide Codes:                                                                                               |      |            | Peak Codes:          |            |                                   |                    |
| T - Thermal Neutron Activation                                                                               |      |            | G - Gamma Ray        |            |                                   |                    |
| F - Fast Neutron Activation                                                                                  |      |            | X - X-Ray            |            |                                   |                    |
| I - Fission Product                                                                                          |      |            | P - Positron Decay   |            |                                   |                    |
| N - Naturally Occurring Isotope                                                                              |      |            | S - Single-Escape    |            |                                   |                    |
| P - Photon Reaction                                                                                          |      |            | D - Double-Escape    |            |                                   |                    |
| C - Charged Particle Reaction                                                                                |      |            | K - Key Line         |            |                                   |                    |
| M - No MDA Calculation                                                                                       |      |            | A - Not in Average   |            |                                   |                    |
| R - Coincidence Corrected                                                                                    |      |            | C - Coincidence Peak |            |                                   |                    |
| H - Halflife limit exceeded                                                                                  |      |            |                      |            |                                   |                    |

\*\*\*\*\* D I S C A R D E D I S O T O P E P E A K S \*\*\*\*\*

| Nuclide | Centroid | Background | Net Area | Intensity | Uncert    | Activity |
|---------|----------|------------|----------|-----------|-----------|----------|
|         | Energy   | Counts     | Counts   | Cts/Sec   | 1 Sigma % |          |

P - Peakbackground subtraction

|         |                                                           |                |             |         |            |
|---------|-----------------------------------------------------------|----------------|-------------|---------|------------|
| *****   | S U M M A R Y   O F   N U C L I D E S   I N   S A M P L E |                |             |         | *****      |
|         | Time of Count                                             | Time Corrected | Uncertainty | 1 Sigma |            |
| Nuclide | Activity                                                  | Activity       | Counting    |         | MDA        |
|         | pCi/Sample                                                | pCi/Sample     |             |         | pCi/Sample |

|        |            |            |            |  |          |
|--------|------------|------------|------------|--|----------|
| TC-99M | 2.6499E+02 | 4.0873E+02 | 7.889E+00% |  | 3.26E+01 |
|--------|------------|------------|------------|--|----------|

< - MDA value printed.  
 A - Activity printed, but activity < MDA.  
 B - Activity < MDA and failed test.  
 C - Area < Critical level.  
 F - Failed fraction or key line test.  
 H - Halflife limit exceeded

----- S U M M A R Y -----

|                          |         |             |               |            |
|--------------------------|---------|-------------|---------------|------------|
| Total Activity (         | 37.6 to | 2000.8 keV) | 2.650E+02     | pCi/Sample |
| Total Decayed Activity ( | 37.6 to | 2000.8 keV) | 4.0873001E+02 | pCi/Sample |

The library has energies which are not separable.



-----  
Sample Description: 254137\_Gamma\_TCCLBC 160-254137~3-A

Detector: Detector # 7

Batch ID: 254137

Work Order Number: Gamma

Lot Number: TCCLBC 160-254137~3-A  
-----

Decay to Time: 6/1/2016 12:00

Live Time: 600 sec

Acquisition Time: 6/1/2016 16:19:23

Real Time: 607 sec

Analysis Time: 6/1/2016 16:29

Dead Time: 1.19 %

Analysis Quantity: 1.000E+00 Sample  
-----

Efficiency Cal File: 7\_Soil\_TunaCan.Clb

Efficiency Cal Desc: 7\_TunaCan\_90099\_032712

Efficiency Cal Date: 3/16/2012 11:45

Energy Cal Date: 2/23/2012 08:40

Library: Client\_Tc-99m.lib

Bkgd Correction File: 7\_2016-05-07\_0559.PBC  
-----

| Nuclide | Activity<br>pCi/Sample | 1-Sigma<br>Counting<br>Uncert<br>% | 1-Sigma<br>Counting<br>Uncert<br>pCi/Sample | 1-Sigma<br>Total<br>Uncert<br>pCi/Sample | Minimum<br>Detectable<br>Activity<br>pCi/Sample |
|---------|------------------------|------------------------------------|---------------------------------------------|------------------------------------------|-------------------------------------------------|
| TC-99M  | 4.535E+02              | 6.1                                | 2.781E+01                                   | 3.615E+01                                | 2.224E+01                                       |
| Total   | 4.535E+02              |                                    |                                             |                                          |                                                 |

-----

Analyst: Mike Aldridge

Sample description

254137\_Gamma\_TCCLBC 160-254137~3-A

Spectrum Filename: C:\User\SPC\Det7\7\_Gamma\_20161281.An1

Acquisition information

Start time: 6/1/2016 4:19:23 PM  
Live time: 600  
Real time: 607  
Dead time: 1.19 %  
Detector ID: 7

Detector system

Ge 7 SN/154

Calibration

Filename: 7\_Soil\_TunaCan.Clb  
7\_TunaCan\_90099\_032712

Energy Calibration

Created: 2/23/2012 8:40:56 AM  
Zero offset: 0.117 keV  
Gain: 0.250 keV/channel  
Quadratic: 3.508E-09 keV/channel^2

Efficiency Calibration

Created: 3/16/2012 11:45:14 AM  
Knee Energy: 165.85 keV  
Above the Knee: Quadratic Uncertainty = 0.87 %  
Log(Eff):  $6.716580E-01 + (-6.166540E-01 * \text{Log}(E)) + (-2.065917E-02 * \text{Log}(E)^2)$   
Below the Knee: Quadratic Uncertainty = 1.48 %  
Log(Eff):  $-2.689695E+01 + (1.019544E+01 * \text{Log}(E)) + (-1.081671E+00 * \text{Log}(E)^2)$

Library Files

Main analysis library: Client\_Tc-99m.lib  
Library Match Width: 0.500  
Peak stripping: Library based

Analysis parameters

Analysis engine: Env32 G800W064  
Start channel: 150 ( 37.61keV )  
Stop channel: 8000 ( 2000.13keV )  
Peak rejection level: 1000.000%  
Peak search sensitivity: 3  
Sample Size: 1.0000E+00 +/- 0.000E+00%  
Activity scaling factor:  $1.0000E+00 / (3.7000E-02 * 1.0000E+00) = 2.7027E+01$   
Detection limit method: Reg. Guide 4.16 Method

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Random error: 4.0000000E+00  
 Systematic error: 4.0000000E+00  
 Fraction Limit: 0.000%  
 Background width: 3  
 Half lives decay limit: 12.000  
 Activity range factor: 2.000  
 Min. step backg. energy 0.000  
 Multiplet shift channel 2.000

| Corrections                   | Status | Comments                                     |
|-------------------------------|--------|----------------------------------------------|
| Decay correct to date:        | YES    | 6/1/2016 12:00:00 PM                         |
| Decay during acquisition:     | YES    |                                              |
| Decay during collection:      | NO     |                                              |
| True coincidence correction:  | NO     |                                              |
| Peaked background correction: | YES    | 7_2016-05-07_0559.PBC<br>5/7/2016 5:59:56 AM |
| Absorption (Internal):        | NO     |                                              |
| Geometry correction:          | NO     |                                              |
| Random summing:               | NO     |                                              |

total peaks alloc. 1 cutoff: 5.00E+01 %  
 Energy Calibration  
 Normalized diff: 0.0863

\*\*\*\*\* S U M M A R Y O F P E A K S I N R A N G E \*\*\*\*\*

| Peak<br>Energy | Area | Uncert | FWHM | Corrctn<br>Factor | Nuclide<br>Energy | Brnch.<br>Ratio | Act.<br>pCi/Samp | Nuc   |
|----------------|------|--------|------|-------------------|-------------------|-----------------|------------------|-------|
| 140.43         | 288. | 6.13   | 0.92 | 5.337E-02         | 140.51            | 89.060          | 4.535E+02        | TC99M |

No unknown peaks passed sensitivity test.

-----  
 This section based on library: Client\_Tc-99m.lib

\*\*\*\*\* I D E N T I F I E D P E A K S U M M A R Y \*\*\*\*\*

| Nuclide | Peak<br>Channel | Centroid<br>Energy | Background<br>Counts | Net Area<br>Counts | Intensity<br>Cts/Sec | Uncert<br>1 Sigma | FWHM<br>% | FWHM<br>keV |
|---------|-----------------|--------------------|----------------------|--------------------|----------------------|-------------------|-----------|-------------|
| TC-99M  | 561.63          | 140.51             | 6.                   | 288.               | 0.480                | 6.13              | 0.917D    |             |

s - Peak fails shape tests.  
 D - Peak area deconvoluted.  
 A Derived peak area.

| ***** S U M M A R Y O F L I B R A R Y P E A K U S A G E *****                                                |      |            |                      |            |                                   |                    |
|--------------------------------------------------------------------------------------------------------------|------|------------|----------------------|------------|-----------------------------------|--------------------|
| - Nuclide -                                                                                                  |      | Average    | ----- Peak -----     |            |                                   |                    |
| Name                                                                                                         | Code | Activity   | Energy               | Activity   | Code                              | MDA Value          |
|                                                                                                              |      | pCi/Sample | keV                  | pCi/Sample |                                   | pCi/Sample         |
| COMMENTS                                                                                                     |      |            |                      |            |                                   |                    |
| <hr/>                                                                                                        |      |            |                      |            |                                   |                    |
| TC-99M                                                                                                       | I    | 4.5349E+02 |                      |            |                                   | 2.51E-01           |
|                                                                                                              |      |            |                      |            |                                   | Energy duplication |
|                                                                                                              |      |            | 140.51               | 4.535E+02  | ( 2.224E+01 6.13E+00 8.91E+01 G K |                    |
| ( - This peak used in the nuclide activity average.                                                          |      |            |                      |            |                                   |                    |
| * - Peak is too wide, but only one peak in library.                                                          |      |            |                      |            |                                   |                    |
| ! - Peak is part of a multiplet and this area went negative during deconvolution.                            |      |            |                      |            |                                   |                    |
| ? - Peak is too narrow.                                                                                      |      |            |                      |            |                                   |                    |
| @ - Peak is too wide at FW25M, but ok at FWHM.                                                               |      |            |                      |            |                                   |                    |
| % - Peak fails sensitivity test.                                                                             |      |            |                      |            |                                   |                    |
| \$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.                 |      |            |                      |            |                                   |                    |
| + - Peak activity higher than counting uncertainty range.                                                    |      |            |                      |            |                                   |                    |
| - - Peak activity lower than counting uncertainty range.                                                     |      |            |                      |            |                                   |                    |
| = - Peak outside analysis energy range.                                                                      |      |            |                      |            |                                   |                    |
| & - Calculated peak centroid is not close enough to the library energy centroid for positive identification. |      |            |                      |            |                                   |                    |
| P - Peakbackground subtraction                                                                               |      |            |                      |            |                                   |                    |
| } - Peak is too close to another for the activity to be found directly.                                      |      |            |                      |            |                                   |                    |
|                                                                                                              |      |            |                      |            |                                   |                    |
| Nuclide Codes:                                                                                               |      |            | Peak Codes:          |            |                                   |                    |
| T - Thermal Neutron Activation                                                                               |      |            | G - Gamma Ray        |            |                                   |                    |
| F - Fast Neutron Activation                                                                                  |      |            | X - X-Ray            |            |                                   |                    |
| I - Fission Product                                                                                          |      |            | P - Positron Decay   |            |                                   |                    |
| N - Naturally Occurring Isotope                                                                              |      |            | S - Single-Escape    |            |                                   |                    |
| P - Photon Reaction                                                                                          |      |            | D - Double-Escape    |            |                                   |                    |
| C - Charged Particle Reaction                                                                                |      |            | K - Key Line         |            |                                   |                    |
| M - No MDA Calculation                                                                                       |      |            | A - Not in Average   |            |                                   |                    |
| R - Coincidence Corrected                                                                                    |      |            | C - Coincidence Peak |            |                                   |                    |
| H - Halflife limit exceeded                                                                                  |      |            |                      |            |                                   |                    |

\*\*\*\*\* D I S C A R D E D I S O T O P E P E A K S \*\*\*\*\*

| Nuclide | Centroid | Background | Net Area | Intensity | Uncert    | Activity |
|---------|----------|------------|----------|-----------|-----------|----------|
|         | Energy   | Counts     | Counts   | Cts/Sec   | 1 Sigma % |          |

P - Peakbackground subtraction

|         |                                                           |                |             |         |            |
|---------|-----------------------------------------------------------|----------------|-------------|---------|------------|
| *****   | S U M M A R Y   O F   N U C L I D E S   I N   S A M P L E |                |             |         | *****      |
|         | Time of Count                                             | Time Corrected | Uncertainty | 1 Sigma |            |
| Nuclide | Activity                                                  | Activity       | Counting    |         | MDA        |
|         | pCi/Sample                                                | pCi/Sample     |             |         | pCi/Sample |

|        |            |            |            |  |          |
|--------|------------|------------|------------|--|----------|
| TC-99M | 2.7566E+02 | 4.5349E+02 | 6.133E+00% |  | 2.22E+01 |
|--------|------------|------------|------------|--|----------|

< - MDA value printed.  
 A - Activity printed, but activity < MDA.  
 B - Activity < MDA and failed test.  
 C - Area < Critical level.  
 F - Failed fraction or key line test.  
 H - Halflife limit exceeded

----- S U M M A R Y -----

|                                              |                          |
|----------------------------------------------|--------------------------|
| Total Activity ( 37.6 to 2000.1 keV)         | 2.757E+02 pCi/Sample     |
| Total Decayed Activity ( 37.6 to 2000.1 keV) | 4.5349152E+02 pCi/Sample |

The library has energies which are not separable.



# Prep Batch: 254155

---

## Technetium-99 Tracers Prep

-----  
Sample Description: 254155\_Gamma\_MB 160-254155~1-A

Detector: Detector # 7

Batch ID: 254155

Work Order Number: Gamma

Lot Number: MB 160-254155~1-A  
-----

Decay to Time: 6/1/2016 12:00

Live Time: 600 sec

Acquisition Time: 6/1/2016 18:03:50

Real Time: 607 sec

Analysis Time: 6/1/2016 18:14

Dead Time: 1.17 %

Analysis Quantity: 1.000E+00 Sample  
-----

Efficiency Cal File: 7\_Soil\_TunaCan.Clb

Efficiency Cal Desc: 7\_TunaCan\_90099\_032712

Efficiency Cal Date: 3/16/2012 11:45

Energy Cal Date: 2/23/2012 08:40

Library: Client\_Tc-99m.lib

Bkgd Correction File: 7\_2016-05-07\_0559.PBC  
-----

| Nuclide | Activity<br>pCi/Sample | 1-Sigma<br>Counting<br>Uncert<br>% | 1-Sigma<br>Counting<br>Uncert<br>pCi/Sample | 1-Sigma<br>Total<br>Uncert<br>pCi/Sample | Minimum<br>Detectable<br>Activity<br>pCi/Sample |
|---------|------------------------|------------------------------------|---------------------------------------------|------------------------------------------|-------------------------------------------------|
| TC-99M  | 4.381E+02              | 6.8                                | 2.989E+01                                   | 3.730E+01                                | 2.388E+01                                       |
| Total   | 4.381E+02              |                                    |                                             |                                          |                                                 |

-----

Analyst: Mike Aldridge

Sample description

254155\_Gamma\_MB 160-254155~1-A

Spectrum Filename: C:\User\SPC\Det7\7\_Gamma\_20161283.An1

Acquisition information

Start time: 6/1/2016 6:03:50 PM  
Live time: 600  
Real time: 607  
Dead time: 1.17 %  
Detector ID: 7

Detector system

Ge 7 SN/154

Calibration

Filename: 7\_Soil\_TunaCan.Clb  
7\_TunaCan\_90099\_032712

Energy Calibration

Created: 2/23/2012 8:40:56 AM  
Zero offset: 0.117 keV  
Gain: 0.250 keV/channel  
Quadratic: 3.508E-09 keV/channel^2

Efficiency Calibration

Created: 3/16/2012 11:45:14 AM  
Knee Energy: 165.85 keV  
Above the Knee: Quadratic Uncertainty = 0.87 %  
Log(Eff):  $6.716580E-01 + (-6.166540E-01 * \text{Log}(E)) + (-2.065917E-02 * \text{Log}(E)^2)$   
Below the Knee: Quadratic Uncertainty = 1.48 %  
Log(Eff):  $-2.689695E+01 + (1.019544E+01 * \text{Log}(E)) + (-1.081671E+00 * \text{Log}(E)^2)$

Library Files

Main analysis library: Client\_Tc-99m.lib  
Library Match Width: 0.500  
Peak stripping: Library based

Analysis parameters

Analysis engine: Env32 G800W064  
Start channel: 150 ( 37.61keV )  
Stop channel: 8000 ( 2000.13keV )  
Peak rejection level: 1000.000%  
Peak search sensitivity: 3  
Sample Size: 1.0000E+00 +/- 0.000E+00%  
Activity scaling factor:  $1.0000E+00 / (3.7000E-02 * 1.0000E+00) = 2.7027E+01$   
Detection limit method: Reg. Guide 4.16 Method

(Page 2 of 5)

Random error: 4.0000000E+00  
 Systematic error: 4.0000000E+00  
 Fraction Limit: 0.000%  
 Background width: 3  
 Half lives decay limit: 12.000  
 Activity range factor: 2.000  
 Min. step backg. energy 0.000  
 Multiplet shift channel 2.000

| Corrections                   | Status | Comments                                     |
|-------------------------------|--------|----------------------------------------------|
| Decay correct to date:        | YES    | 6/1/2016 12:00:00 PM                         |
| Decay during acquisition:     | YES    |                                              |
| Decay during collection:      | NO     |                                              |
| True coincidence correction:  | NO     |                                              |
| Peaked background correction: | YES    | 7_2016-05-07_0559.PBC<br>5/7/2016 5:59:56 AM |
| Absorption (Internal):        | NO     |                                              |
| Geometry correction:          | NO     |                                              |
| Random summing:               | NO     |                                              |

total peaks alloc. 1 cutoff: 5.00E+01 %  
 Energy Calibration  
 Normalized diff: 0.0929

\*\*\*\*\* S U M M A R Y O F P E A K S I N R A N G E \*\*\*\*\*

| Peak<br>Energy | Area | Uncert | FWHM | Corrctn<br>Factor | Nuclide<br>Energy | Brnch.<br>Ratio | Act.<br>pCi/Samp | Nuc   |
|----------------|------|--------|------|-------------------|-------------------|-----------------|------------------|-------|
| 140.42         | 228. | 6.82   | 0.94 | 5.337E-02         | 140.51            | 89.060          | 4.381E+02        | TC99M |

No unknown peaks passed sensitivity test.

-----  
 This section based on library: Client\_Tc-99m.lib

\*\*\*\*\* I D E N T I F I E D P E A K S U M M A R Y \*\*\*\*\*

| Nuclide | Peak<br>Channel | Centroid<br>Energy | Background<br>Counts | Net Area<br>Counts | Intensity<br>Cts/Sec | Uncert<br>1 Sigma | FWHM<br>% | FWHM<br>keV |
|---------|-----------------|--------------------|----------------------|--------------------|----------------------|-------------------|-----------|-------------|
| TC-99M  | 561.63          | 140.51             | 4.                   | 228.               | 0.379                | 6.82              | 0.936D    |             |

s - Peak fails shape tests.  
 D - Peak area deconvoluted.  
 A Derived peak area.

| ***** S U M M A R Y O F L I B R A R Y P E A K U S A G E *****                                                |      |            |                      |            |                                   |                    |
|--------------------------------------------------------------------------------------------------------------|------|------------|----------------------|------------|-----------------------------------|--------------------|
| - Nuclide -                                                                                                  |      | Average    | ----- Peak -----     |            |                                   |                    |
| Name                                                                                                         | Code | Activity   | Energy               | Activity   | Code                              | MDA Value          |
|                                                                                                              |      | pCi/Sample | keV                  | pCi/Sample |                                   | pCi/Sample         |
| COMMENTS                                                                                                     |      |            |                      |            |                                   |                    |
| <hr/>                                                                                                        |      |            |                      |            |                                   |                    |
| TC-99M                                                                                                       | I    | 4.3806E+02 |                      |            |                                   | 2.51E-01           |
|                                                                                                              |      |            |                      |            |                                   | Energy duplication |
|                                                                                                              |      |            | 140.51               | 4.381E+02  | ( 2.388E+01 6.82E+00 8.91E+01 G K |                    |
| ( - This peak used in the nuclide activity average.                                                          |      |            |                      |            |                                   |                    |
| * - Peak is too wide, but only one peak in library.                                                          |      |            |                      |            |                                   |                    |
| ! - Peak is part of a multiplet and this area went negative during deconvolution.                            |      |            |                      |            |                                   |                    |
| ? - Peak is too narrow.                                                                                      |      |            |                      |            |                                   |                    |
| @ - Peak is too wide at FW25M, but ok at FWHM.                                                               |      |            |                      |            |                                   |                    |
| % - Peak fails sensitivity test.                                                                             |      |            |                      |            |                                   |                    |
| \$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.                 |      |            |                      |            |                                   |                    |
| + - Peak activity higher than counting uncertainty range.                                                    |      |            |                      |            |                                   |                    |
| - - Peak activity lower than counting uncertainty range.                                                     |      |            |                      |            |                                   |                    |
| = - Peak outside analysis energy range.                                                                      |      |            |                      |            |                                   |                    |
| & - Calculated peak centroid is not close enough to the library energy centroid for positive identification. |      |            |                      |            |                                   |                    |
| P - Peakbackground subtraction                                                                               |      |            |                      |            |                                   |                    |
| } - Peak is too close to another for the activity to be found directly.                                      |      |            |                      |            |                                   |                    |
|                                                                                                              |      |            |                      |            |                                   |                    |
| Nuclide Codes:                                                                                               |      |            | Peak Codes:          |            |                                   |                    |
| T - Thermal Neutron Activation                                                                               |      |            | G - Gamma Ray        |            |                                   |                    |
| F - Fast Neutron Activation                                                                                  |      |            | X - X-Ray            |            |                                   |                    |
| I - Fission Product                                                                                          |      |            | P - Positron Decay   |            |                                   |                    |
| N - Naturally Occurring Isotope                                                                              |      |            | S - Single-Escape    |            |                                   |                    |
| P - Photon Reaction                                                                                          |      |            | D - Double-Escape    |            |                                   |                    |
| C - Charged Particle Reaction                                                                                |      |            | K - Key Line         |            |                                   |                    |
| M - No MDA Calculation                                                                                       |      |            | A - Not in Average   |            |                                   |                    |
| R - Coincidence Corrected                                                                                    |      |            | C - Coincidence Peak |            |                                   |                    |
| H - Halflife limit exceeded                                                                                  |      |            |                      |            |                                   |                    |

\*\*\*\*\* D I S C A R D E D I S O T O P E P E A K S \*\*\*\*\*

| Nuclide | Centroid | Background | Net Area | Intensity | Uncert    | Activity |
|---------|----------|------------|----------|-----------|-----------|----------|
|         | Energy   | Counts     | Counts   | Cts/Sec   | 1 Sigma % |          |

P - Peakbackground subtraction

\*\*\*\*\* S U M M A R Y O F N U C L I D E S I N S A M P L E \*\*\*\*\*  
 Time of Count Time Corrected Uncertainty 1 Sigma  
 Nuclide Activity Activity Counting MDA  
 pCi/Sample pCi/Sample pCi/Sample

|        |            |            |            |          |
|--------|------------|------------|------------|----------|
| TC-99M | 2.1791E+02 | 4.3806E+02 | 6.824E+00% | 2.39E+01 |
|--------|------------|------------|------------|----------|

< - MDA value printed.  
 A - Activity printed, but activity < MDA.  
 B - Activity < MDA and failed test.  
 C - Area < Critical level.  
 F - Failed fraction or key line test.  
 H - Halflife limit exceeded

----- S U M M A R Y -----  
 Total Activity ( 37.6 to 2000.1 keV) 2.179E+02 pCi/Sample  
 Total Decayed Activity ( 37.6 to 2000.1 keV) 4.3806033E+02 pCi/Sample

The library has energies which are not separable.



-----  
Sample Description: 254155\_Gamma\_LCS 160-254155~2-A

Detector: Detector # 8

Batch ID: 254155

Work Order Number: Gamma

Lot Number: LCS 160-254155~2-A  
-----

Decay to Time: 6/1/2016 12:00

Live Time: 600 sec

Acquisition Time: 6/1/2016 18:05:09

Real Time: 618 sec

Analysis Time: 6/1/2016 18:15

Dead Time: 2.83 %

Analysis Quantity: 1.000E+00 Sample  
-----

Efficiency Cal File: 8\_Soil\_TunaCan.Clb

Efficiency Cal Desc: 8\_Soil\_TunaCan\_90099\_032712

Efficiency Cal Date: 3/28/2012 10:35

Energy Cal Date: 2/28/2012 10:34

Library: Client\_Tc-99m.lib

Bkgd Correction File: 8\_2016-05-07\_1503.PBC  
-----

| Nuclide | Activity<br>pCi/Sample | 1-Sigma<br>Counting<br>Uncert<br>% | 1-Sigma<br>Counting<br>Uncert<br>pCi/Sample | 1-Sigma<br>Total<br>Uncert<br>pCi/Sample | Minimum<br>Detectable<br>Activity<br>pCi/Sample |
|---------|------------------------|------------------------------------|---------------------------------------------|------------------------------------------|-------------------------------------------------|
| TC-99M  | 4.440E+02              | 7.9                                | 3.511E+01                                   | 4.176E+01                                | 2.754E+01                                       |
| Total   | 4.440E+02              |                                    |                                             |                                          |                                                 |

-----

Analyst: Mike Aldridge

Sample description

254155\_Gamma\_LCS 160-254155~2-A

Spectrum Filename: C:\User\SPC\Det8\8\_Gamma\_20160679.An1

Acquisition information

Start time: 6/1/2016 6:05:09 PM  
Live time: 600  
Real time: 618  
Dead time: 2.83 %  
Detector ID: 8

Detector system

Ge 8 SN/174

Calibration

Filename: 8\_Soil\_TunaCan.Clb  
8\_Soil\_TunaCan\_90099\_032712

Energy Calibration

Created: 2/28/2012 10:34:41 AM  
Zero offset: 0.052 keV  
Gain: 0.250 keV/channel  
Quadratic: 5.282E-10 keV/channel^2

Efficiency Calibration

Created: 3/28/2012 10:35:20 AM  
Knee Energy: 165.85 keV  
Above the Knee: Quadratic Uncertainty = 1.39 %  
Log(Eff):  $-1.098764E-01 + (-4.958544E-01 * \text{Log}(E)) + (-2.572270E-02 * \text{Log}(E)^2)$   
Below the Knee: Quadratic Uncertainty = 1.71 %  
Log(Eff):  $-2.525301E+01 + (9.398253E+00 * \text{Log}(E)) + (-1.000034E+00 * \text{Log}(E)^2)$

Library Files

Main analysis library: Client\_Tc-99m.lib  
Library Match Width: 0.500  
Peak stripping: Library based

Analysis parameters

Analysis engine: Env32 G800W064  
Start channel: 150 ( 37.55keV )  
Stop channel: 8000 ( 1999.97keV )  
Peak rejection level: 1000.000%  
Peak search sensitivity: 3  
Sample Size: 1.0000E+00 +/- 0.000E+00%  
Activity scaling factor:  $1.0000E+00 / (3.7000E-02 * 1.0000E+00) = 2.7027E+01$   
Detection limit method: Reg. Guide 4.16 Method

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Random error: 4.0000000E+00  
 Systematic error: 4.0000000E+00  
 Fraction Limit: 0.000%  
 Background width: 3  
 Half lives decay limit: 12.000  
 Activity range factor: 2.000  
 Min. step backg. energy 0.000  
 Multiplet shift channel 2.000

| Corrections                   | Status | Comments                                     |
|-------------------------------|--------|----------------------------------------------|
| Decay correct to date:        | YES    | 6/1/2016 12:00:00 PM                         |
| Decay during acquisition:     | YES    |                                              |
| Decay during collection:      | NO     |                                              |
| True coincidence correction:  | NO     |                                              |
| Peaked background correction: | YES    | 8_2016-05-07_1503.PBC<br>5/7/2016 3:03:11 PM |
| Absorption (Internal):        | NO     |                                              |
| Geometry correction:          | NO     |                                              |
| Random summing:               | NO     |                                              |

total peaks alloc. 1 cutoff: 5.00E+01 %  
 Energy Calibration  
 Normalized diff: 0.0177

\*\*\*\*\* S U M M A R Y O F P E A K S I N R A N G E \*\*\*\*\*

| Peak<br>Energy | Area | Uncert | FWHM | Corrctn<br>Factor | Nuclide<br>Energy | Brnch.<br>Ratio | Act.<br>pCi/Samp | Nuc   |
|----------------|------|--------|------|-------------------|-------------------|-----------------|------------------|-------|
| 140.53         | 170. | 7.91   | 0.88 | 3.945E-02         | 140.51            | 89.060          | 4.440E+02        | TC99M |

No unknown peaks passed sensitivity test.

-----  
 This section based on library: Client\_Tc-99m.lib

\*\*\*\*\* I D E N T I F I E D P E A K S U M M A R Y \*\*\*\*\*

| Nuclide | Peak<br>Channel | Centroid<br>Energy | Background<br>Counts | Net Area<br>Counts | Intensity<br>Cts/Sec | Uncert<br>1 Sigma | FWHM<br>% | FWHM<br>keV |
|---------|-----------------|--------------------|----------------------|--------------------|----------------------|-------------------|-----------|-------------|
| TC-99M  | 561.86          | 140.51             | 3.                   | 170.               | 0.284                | 7.91              | 0.884D    |             |

s - Peak fails shape tests.  
 D - Peak area deconvoluted.  
 A Derived peak area.

| ***** S U M M A R Y O F L I B R A R Y P E A K U S A G E *****                                                |      |            |                      |            |                                   |                    |
|--------------------------------------------------------------------------------------------------------------|------|------------|----------------------|------------|-----------------------------------|--------------------|
| - Nuclide -                                                                                                  |      | Average    | ----- Peak -----     |            |                                   |                    |
| Name                                                                                                         | Code | Activity   | Energy               | Activity   | Code                              | MDA Value          |
|                                                                                                              |      | pCi/Sample | keV                  | pCi/Sample |                                   | pCi/Sample         |
|                                                                                                              |      |            |                      |            |                                   | COMMENTS           |
| TC-99M                                                                                                       | I    | 4.4401E+02 |                      |            |                                   | 2.51E-01           |
|                                                                                                              |      |            |                      |            |                                   | Energy duplication |
|                                                                                                              |      |            | 140.51               | 4.440E+02  | ( 2.754E+01 7.91E+00 8.91E+01 G K |                    |
| ( - This peak used in the nuclide activity average.                                                          |      |            |                      |            |                                   |                    |
| * - Peak is too wide, but only one peak in library.                                                          |      |            |                      |            |                                   |                    |
| ! - Peak is part of a multiplet and this area went negative during deconvolution.                            |      |            |                      |            |                                   |                    |
| ? - Peak is too narrow.                                                                                      |      |            |                      |            |                                   |                    |
| @ - Peak is too wide at FW25M, but ok at FWHM.                                                               |      |            |                      |            |                                   |                    |
| % - Peak fails sensitivity test.                                                                             |      |            |                      |            |                                   |                    |
| \$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.                 |      |            |                      |            |                                   |                    |
| + - Peak activity higher than counting uncertainty range.                                                    |      |            |                      |            |                                   |                    |
| - - Peak activity lower than counting uncertainty range.                                                     |      |            |                      |            |                                   |                    |
| = - Peak outside analysis energy range.                                                                      |      |            |                      |            |                                   |                    |
| & - Calculated peak centroid is not close enough to the library energy centroid for positive identification. |      |            |                      |            |                                   |                    |
| P - Peakbackground subtraction                                                                               |      |            |                      |            |                                   |                    |
| } - Peak is too close to another for the activity to be found directly.                                      |      |            |                      |            |                                   |                    |
| Nuclide Codes:                                                                                               |      |            | Peak Codes:          |            |                                   |                    |
| T - Thermal Neutron Activation                                                                               |      |            | G - Gamma Ray        |            |                                   |                    |
| F - Fast Neutron Activation                                                                                  |      |            | X - X-Ray            |            |                                   |                    |
| I - Fission Product                                                                                          |      |            | P - Positron Decay   |            |                                   |                    |
| N - Naturally Occurring Isotope                                                                              |      |            | S - Single-Escape    |            |                                   |                    |
| P - Photon Reaction                                                                                          |      |            | D - Double-Escape    |            |                                   |                    |
| C - Charged Particle Reaction                                                                                |      |            | K - Key Line         |            |                                   |                    |
| M - No MDA Calculation                                                                                       |      |            | A - Not in Average   |            |                                   |                    |
| R - Coincidence Corrected                                                                                    |      |            | C - Coincidence Peak |            |                                   |                    |
| H - Halflife limit exceeded                                                                                  |      |            |                      |            |                                   |                    |

\*\*\*\*\* D I S C A R D E D I S O T O P E P E A K S \*\*\*\*\*

| Nuclide | Centroid | Background | Net Area | Intensity | Uncert    | Activity |
|---------|----------|------------|----------|-----------|-----------|----------|
|         | Energy   | Counts     | Counts   | Cts/Sec   | 1 Sigma % |          |

P - Peakbackground subtraction

\*\*\*\*\* S U M M A R Y O F N U C L I D E S I N S A M P L E \*\*\*\*\*  
 Time of Count Time Corrected Uncertainty 1 Sigma  
 Nuclide Activity Activity Counting MDA  
 pCi/Sample pCi/Sample pCi/Sample

|        |            |            |            |          |
|--------|------------|------------|------------|----------|
| TC-99M | 2.2031E+02 | 4.4401E+02 | 7.907E+00% | 2.75E+01 |
|--------|------------|------------|------------|----------|

< - MDA value printed.  
 A - Activity printed, but activity < MDA.  
 B - Activity < MDA and failed test.  
 C - Area < Critical level.  
 F - Failed fraction or key line test.  
 H - Halflife limit exceeded

----- S U M M A R Y -----  
 Total Activity ( 37.5 to 2000.0 keV) 2.203E+02 pCi/Sample  
 Total Decayed Activity ( 37.5 to 2000.0 keV) 4.4400641E+02 pCi/Sample

The library has energies which are not separable.



-----  
Sample Description: 254155\_Gamma\_160-17543-AD-1-D DU

Detector: Detector # 8

Batch ID: 254155

Work Order Number: Gamma

Lot Number: 160-17543-AD-1-D DU

-----  
Decay to Time: 6/1/2016 12:00

Live Time: 600 sec

Acquisition Time: 6/1/2016 18:30:48

Real Time: 618 sec

Analysis Time: 6/1/2016 18:41

Dead Time: 2.83 %

Analysis Quantity: 1.000E+00 Sample

-----  
Efficiency Cal File: 8\_Soil\_TunaCan.Clb

Efficiency Cal Desc: 8\_Soil\_TunaCan\_90099\_032712

Efficiency Cal Date: 3/28/2012 10:35

Energy Cal Date: 2/28/2012 10:34

Library: Client\_Tc-99m.lib

Bkgd Correction File: 8\_2016-05-07\_1503.PBC

-----  
Nuclide            Activity            1-Sigma            1-Sigma            1-Sigma            Minimum  
                 pCi/Sample       Counting       Counting       Total            Detectable  
                                  Uncert       Uncert       Uncert            Activity  
                                  %            pCi/Sample    pCi/Sample    pCi/Sample       pCi/Sample  
-----  
TC-99M           4.495E+02            7.8           3.510E+01       4.191E+01       2.020E+01  
-----  
Total            4.495E+02  
-----

Analyst: Mike Aldridge

Sample description

254155\_Gamma\_160-17543-AD-1-D DU

Spectrum Filename: C:\User\SPC\Det8\8\_Gamma\_20160680.An1

Acquisition information

Start time: 6/1/2016 6:30:48 PM  
Live time: 600  
Real time: 618  
Dead time: 2.83 %  
Detector ID: 8

Detector system

Ge 8 SN/174

Calibration

Filename: 8\_Soil\_TunaCan.Clb  
8\_Soil\_TunaCan\_90099\_032712

Energy Calibration

Created: 2/28/2012 10:34:41 AM  
Zero offset: 0.052 keV  
Gain: 0.250 keV/channel  
Quadratic: 5.282E-10 keV/channel^2

Efficiency Calibration

Created: 3/28/2012 10:35:20 AM  
Knee Energy: 165.85 keV  
Above the Knee: Quadratic Uncertainty = 1.39 %  
Log(Eff):  $-1.098764E-01 + (-4.958544E-01 * \text{Log}(E)) + (-2.572270E-02 * \text{Log}(E)^2)$   
Below the Knee: Quadratic Uncertainty = 1.71 %  
Log(Eff):  $-2.525301E+01 + (9.398253E+00 * \text{Log}(E)) + (-1.000034E+00 * \text{Log}(E)^2)$

Library Files

Main analysis library: Client\_Tc-99m.lib  
Library Match Width: 0.500  
Peak stripping: Library based

Analysis parameters

Analysis engine: Env32 G800W064  
Start channel: 150 ( 37.55keV )  
Stop channel: 8000 ( 1999.97keV )  
Peak rejection level: 1000.000%  
Peak search sensitivity: 3  
Sample Size: 1.0000E+00 +/- 0.000E+00%  
Activity scaling factor:  $1.0000E+00 / (3.7000E-02 * 1.0000E+00) = 2.7027E+01$   
Detection limit method: Reg. Guide 4.16 Method

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Random error: 4.0000000E+00  
 Systematic error: 4.0000000E+00  
 Fraction Limit: 0.000%  
 Background width: 3  
 Half lives decay limit: 12.000  
 Activity range factor: 2.000  
 Min. step backg. energy 0.000  
 Multiplet shift channel 2.000

| Corrections                   | Status | Comments                                     |
|-------------------------------|--------|----------------------------------------------|
| Decay correct to date:        | YES    | 6/1/2016 12:00:00 PM                         |
| Decay during acquisition:     | YES    |                                              |
| Decay during collection:      | NO     |                                              |
| True coincidence correction:  | NO     |                                              |
| Peaked background correction: | YES    | 8_2016-05-07_1503.PBC<br>5/7/2016 3:03:11 PM |
| Absorption (Internal):        | NO     |                                              |
| Geometry correction:          | NO     |                                              |
| Random summing:               | NO     |                                              |

total peaks alloc. 1 cutoff: 5.00E+01 %  
 Energy Calibration  
 Normalized diff: 0.0228

\*\*\*\*\* S U M M A R Y O F P E A K S I N R A N G E \*\*\*\*\*

| Peak<br>Energy | Area | Uncert | FWHM | Corrctn<br>Factor | Nuclide<br>Energy | Brnch.<br>Ratio | Act.<br>pCi/Samp | Nuc   |
|----------------|------|--------|------|-------------------|-------------------|-----------------|------------------|-------|
| 140.53         | 164. | 7.81   | 0.74 | 3.945E-02         | 140.51            | 89.060          | 4.495E+02        | TC99M |

No unknown peaks passed sensitivity test.

-----  
 This section based on library: Client\_Tc-99m.lib

\*\*\*\*\* I D E N T I F I E D P E A K S U M M A R Y \*\*\*\*\*

| Nuclide | Peak<br>Channel | Centroid<br>Energy | Background<br>Counts | Net Area<br>Counts | Intensity<br>Cts/Sec | Uncert<br>1 Sigma | FWHM<br>% | FWHM<br>keV |
|---------|-----------------|--------------------|----------------------|--------------------|----------------------|-------------------|-----------|-------------|
| TC-99M  | 561.86          | 140.51             | 0.                   | 164.               | 0.273                | 7.81              | 0.742D    |             |

s - Peak fails shape tests.  
 D - Peak area deconvoluted.  
 A Derived peak area.

| ***** S U M M A R Y O F L I B R A R Y P E A K U S A G E *****                                                |      |            |                      |            |                                   |                    |
|--------------------------------------------------------------------------------------------------------------|------|------------|----------------------|------------|-----------------------------------|--------------------|
| - Nuclide -                                                                                                  |      | Average    | ----- Peak -----     |            |                                   |                    |
| Name                                                                                                         | Code | Activity   | Energy               | Activity   | Code                              | MDA Value          |
|                                                                                                              |      | pCi/Sample | keV                  | pCi/Sample |                                   | pCi/Sample         |
| COMMENTS                                                                                                     |      |            |                      |            |                                   |                    |
| <hr/>                                                                                                        |      |            |                      |            |                                   |                    |
| TC-99M                                                                                                       | I    | 4.4951E+02 |                      |            |                                   | 2.51E-01           |
|                                                                                                              |      |            |                      |            |                                   | Energy duplication |
|                                                                                                              |      |            | 140.51               | 4.495E+02  | ( 2.020E+01 7.81E+00 8.91E+01 G K |                    |
| ( - This peak used in the nuclide activity average.                                                          |      |            |                      |            |                                   |                    |
| * - Peak is too wide, but only one peak in library.                                                          |      |            |                      |            |                                   |                    |
| ! - Peak is part of a multiplet and this area went negative during deconvolution.                            |      |            |                      |            |                                   |                    |
| ? - Peak is too narrow.                                                                                      |      |            |                      |            |                                   |                    |
| @ - Peak is too wide at FW25M, but ok at FWHM.                                                               |      |            |                      |            |                                   |                    |
| % - Peak fails sensitivity test.                                                                             |      |            |                      |            |                                   |                    |
| \$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.                 |      |            |                      |            |                                   |                    |
| + - Peak activity higher than counting uncertainty range.                                                    |      |            |                      |            |                                   |                    |
| - - Peak activity lower than counting uncertainty range.                                                     |      |            |                      |            |                                   |                    |
| = - Peak outside analysis energy range.                                                                      |      |            |                      |            |                                   |                    |
| & - Calculated peak centroid is not close enough to the library energy centroid for positive identification. |      |            |                      |            |                                   |                    |
| P - Peakbackground subtraction                                                                               |      |            |                      |            |                                   |                    |
| } - Peak is too close to another for the activity to be found directly.                                      |      |            |                      |            |                                   |                    |
|                                                                                                              |      |            |                      |            |                                   |                    |
| Nuclide Codes:                                                                                               |      |            | Peak Codes:          |            |                                   |                    |
| T - Thermal Neutron Activation                                                                               |      |            | G - Gamma Ray        |            |                                   |                    |
| F - Fast Neutron Activation                                                                                  |      |            | X - X-Ray            |            |                                   |                    |
| I - Fission Product                                                                                          |      |            | P - Positron Decay   |            |                                   |                    |
| N - Naturally Occurring Isotope                                                                              |      |            | S - Single-Escape    |            |                                   |                    |
| P - Photon Reaction                                                                                          |      |            | D - Double-Escape    |            |                                   |                    |
| C - Charged Particle Reaction                                                                                |      |            | K - Key Line         |            |                                   |                    |
| M - No MDA Calculation                                                                                       |      |            | A - Not in Average   |            |                                   |                    |
| R - Coincidence Corrected                                                                                    |      |            | C - Coincidence Peak |            |                                   |                    |
| H - Halflife limit exceeded                                                                                  |      |            |                      |            |                                   |                    |

\*\*\*\*\* D I S C A R D E D I S O T O P E P E A K S \*\*\*\*\*

| Nuclide | Centroid | Background | Net Area | Intensity | Uncert    | Activity |
|---------|----------|------------|----------|-----------|-----------|----------|
|         | Energy   | Counts     | Counts   | Cts/Sec   | 1 Sigma % |          |

P - Peakbackground subtraction

|         |                                                   |                |             |         |            |
|---------|---------------------------------------------------|----------------|-------------|---------|------------|
| *****   | S U M M A R Y O F N U C L I D E S I N S A M P L E |                |             |         | *****      |
|         | Time of Count                                     | Time Corrected | Uncertainty | 1 Sigma |            |
| Nuclide | Activity                                          | Activity       | Counting    |         | MDA        |
|         | pCi/Sample                                        | pCi/Sample     |             |         | pCi/Sample |

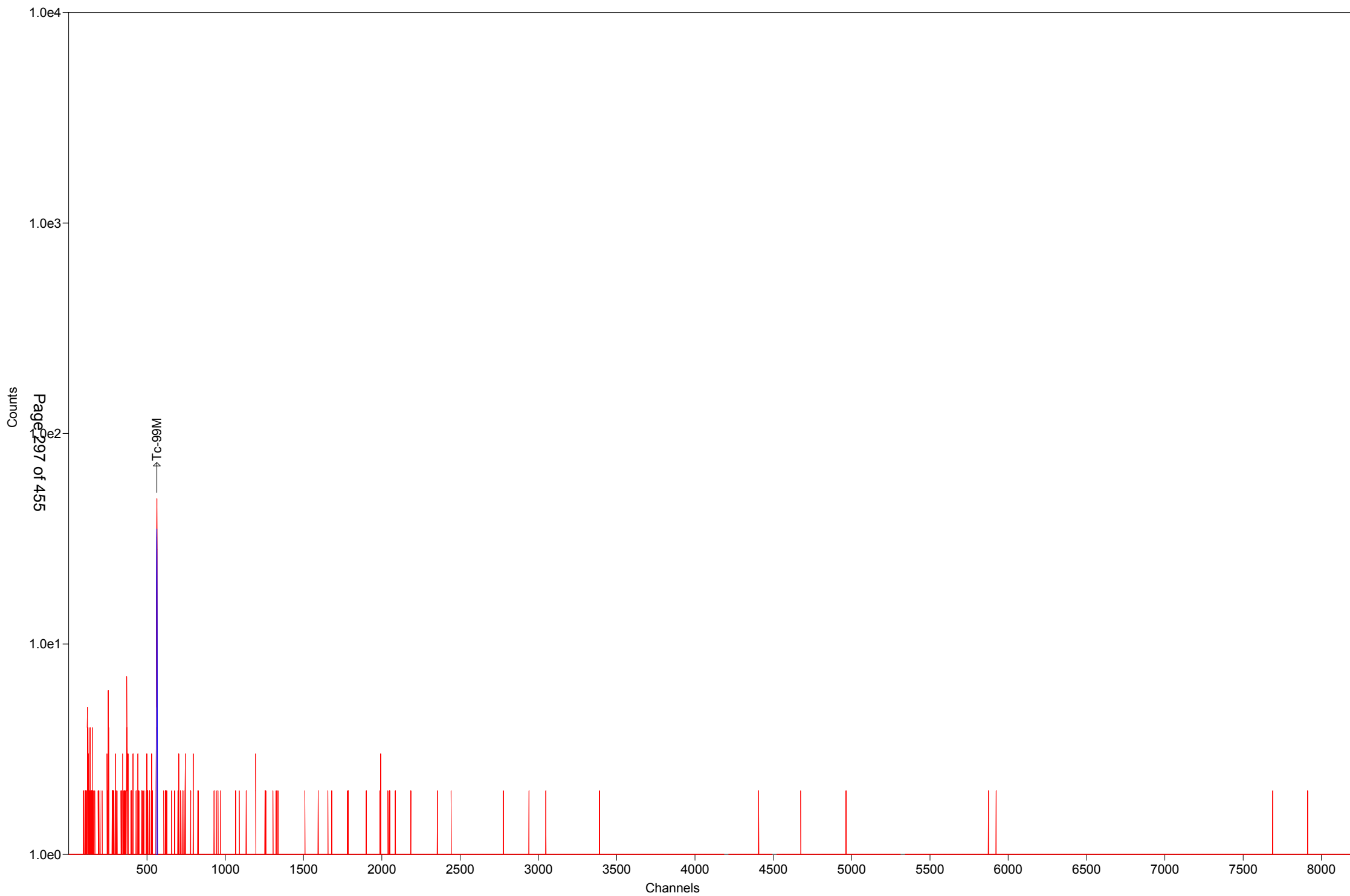
|        |            |            |            |  |          |
|--------|------------|------------|------------|--|----------|
| TC-99M | 2.1233E+02 | 4.4951E+02 | 7.809E+00% |  | 2.02E+01 |
|--------|------------|------------|------------|--|----------|

< - MDA value printed.  
 A - Activity printed, but activity < MDA.  
 B - Activity < MDA and failed test.  
 C - Area < Critical level.  
 F - Failed fraction or key line test.  
 H - Halflife limit exceeded

----- S U M M A R Y -----

|                                              |                          |
|----------------------------------------------|--------------------------|
| Total Activity ( 37.5 to 2000.0 keV)         | 2.123E+02 pCi/Sample     |
| Total Decayed Activity ( 37.5 to 2000.0 keV) | 4.4950821E+02 pCi/Sample |

The library has energies which are not separable.



---

Sample Description: 254155\_Gamma\_160-17563-B-1-B

Detector: Detector # 8

Batch ID: 254155

Work Order Number: Gamma

Lot Number: 160-17563-B-1-B

---

Decay to Time: 6/1/2016 12:00

Live Time: 600 sec

Acquisition Time: 6/1/2016 18:43:08

Real Time: 617 sec

Analysis Time: 6/1/2016 18:54

Dead Time: 2.83 %

Analysis Quantity: 1.000E+00 Sample

---

Efficiency Cal File: 8\_Soil\_TunaCan.Clb

Efficiency Cal Desc: 8\_Soil\_TunaCan\_90099\_032712

Efficiency Cal Date: 3/28/2012 10:35

Energy Cal Date: 2/28/2012 10:34

Library: Client\_Tc-99m.lib

Bkgd Correction File: 8\_2016-05-07\_1503.PBC

---

| Nuclide | Activity<br>pCi/Sample | 1-Sigma<br>Counting<br>Uncert<br>% | 1-Sigma<br>Counting<br>Uncert<br>pCi/Sample | 1-Sigma<br>Total<br>Uncert<br>pCi/Sample | Minimum<br>Detectable<br>Activity<br>pCi/Sample |
|---------|------------------------|------------------------------------|---------------------------------------------|------------------------------------------|-------------------------------------------------|
| TC-99M  | 3.742E+02              | 9.2                                | 3.425E+01                                   | 3.919E+01                                | 3.586E+01                                       |
| Total   | 3.742E+02              |                                    |                                             |                                          |                                                 |

---

Analyst: Mike Aldridge

Sample description  
254155\_Gamma\_160-17563-B-1-B

Spectrum Filename: C:\User\SPC\Det8\8\_Gamma\_20160681.An1

Acquisition information

Start time: 6/1/2016 6:43:08 PM  
Live time: 600  
Real time: 617  
Dead time: 2.83 %  
Detector ID: 8

Detector system

Ge 8 SN/174

Calibration

Filename: 8\_Soil\_TunaCan.Clb  
8\_Soil\_TunaCan\_90099\_032712

Energy Calibration

Created: 2/28/2012 10:34:41 AM  
Zero offset: 0.052 keV  
Gain: 0.250 keV/channel  
Quadratic: 5.282E-10 keV/channel^2

Efficiency Calibration

Created: 3/28/2012 10:35:20 AM  
Knee Energy: 165.85 keV  
Above the Knee: Quadratic Uncertainty = 1.39 %  
Log(Eff):  $-1.098764E-01 + (-4.958544E-01 * \text{Log}(E)) + (-2.572270E-02 * \text{Log}(E)^2)$   
Below the Knee: Quadratic Uncertainty = 1.71 %  
Log(Eff):  $-2.525301E+01 + (9.398253E+00 * \text{Log}(E)) + (-1.000034E+00 * \text{Log}(E)^2)$

Library Files

Main analysis library: Client\_Tc-99m.lib  
Library Match Width: 0.500  
Peak stripping: Library based

Analysis parameters

Analysis engine: Env32 G800W064  
Start channel: 150 ( 37.55keV )  
Stop channel: 8000 ( 1999.97keV )  
Peak rejection level: 1000.000%  
Peak search sensitivity: 3  
Sample Size: 1.0000E+00 +/- 0.000E+00%  
Activity scaling factor:  $1.0000E+00 / (3.7000E-02 * 1.0000E+00) = 2.7027E+01$   
Detection limit method: Reg. Guide 4.16 Method

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Random error: 4.0000000E+00  
 Systematic error: 4.0000000E+00  
 Fraction Limit: 0.000%  
 Background width: 3  
 Half lives decay limit: 12.000  
 Activity range factor: 2.000  
 Min. step backg. energy 0.000  
 Multiplet shift channel 2.000

| Corrections                   | Status | Comments                                     |
|-------------------------------|--------|----------------------------------------------|
| Decay correct to date:        | YES    | 6/1/2016 12:00:00 PM                         |
| Decay during acquisition:     | YES    |                                              |
| Decay during collection:      | NO     |                                              |
| True coincidence correction:  | NO     |                                              |
| Peaked background correction: | YES    | 8_2016-05-07_1503.PBC<br>5/7/2016 3:03:11 PM |
| Absorption (Internal):        | NO     |                                              |
| Geometry correction:          | NO     |                                              |
| Random summing:               | NO     |                                              |

total peaks alloc. 1 cutoff: 5.00E+01 %  
 Energy Calibration  
 Normalized diff: 0.0759

\*\*\*\*\* S U M M A R Y O F P E A K S I N R A N G E \*\*\*\*\*

| Peak<br>Energy | Area | Uncert | FWHM | Corrctn<br>Factor | Nuclide<br>Energy | Brnch.<br>Ratio | Act.<br>pCi/Samp | Nuc   |
|----------------|------|--------|------|-------------------|-------------------|-----------------|------------------|-------|
| 140.43         | 133. | 9.15   | 1.06 | 3.946E-02         | 140.51            | 89.060          | 3.742E+02        | TC99M |

No unknown peaks passed sensitivity test.

-----  
 This section based on library: Client\_Tc-99m.lib

\*\*\*\*\* I D E N T I F I E D P E A K S U M M A R Y \*\*\*\*\*

| Nuclide | Peak<br>Channel | Centroid<br>Energy | Background<br>Counts | Net Area<br>Counts | Intensity<br>Cts/Sec | Uncert<br>1 Sigma | FWHM<br>% | FWHM<br>keV |
|---------|-----------------|--------------------|----------------------|--------------------|----------------------|-------------------|-----------|-------------|
| TC-99M  | 561.86          | 140.51             | 5.                   | 133.               | 0.222                | 9.15              | 1.058D    |             |

s - Peak fails shape tests.  
 D - Peak area deconvoluted.  
 A Derived peak area.

| ***** S U M M A R Y O F L I B R A R Y P E A K U S A G E *****                                                |      |            |                      |            |             |                       |
|--------------------------------------------------------------------------------------------------------------|------|------------|----------------------|------------|-------------|-----------------------|
| - Nuclide -                                                                                                  |      | Average    | ----- Peak -----     |            |             |                       |
| Name                                                                                                         | Code | Activity   | Energy               | Activity   | Code        | MDA Value             |
|                                                                                                              |      | pCi/Sample | keV                  | pCi/Sample |             | pCi/Sample            |
| COMMENTS                                                                                                     |      |            |                      |            |             |                       |
| <hr/>                                                                                                        |      |            |                      |            |             |                       |
| TC-99M                                                                                                       | I    | 3.7421E+02 |                      |            |             | 2.51E-01              |
|                                                                                                              |      |            |                      |            |             | Energy duplication    |
|                                                                                                              |      |            | 140.51               | 3.742E+02  | ( 3.586E+01 | 9.15E+00 8.91E+01 G K |
| ( - This peak used in the nuclide activity average.                                                          |      |            |                      |            |             |                       |
| * - Peak is too wide, but only one peak in library.                                                          |      |            |                      |            |             |                       |
| ! - Peak is part of a multiplet and this area went negative during deconvolution.                            |      |            |                      |            |             |                       |
| ? - Peak is too narrow.                                                                                      |      |            |                      |            |             |                       |
| @ - Peak is too wide at FW25M, but ok at FWHM.                                                               |      |            |                      |            |             |                       |
| % - Peak fails sensitivity test.                                                                             |      |            |                      |            |             |                       |
| \$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.                 |      |            |                      |            |             |                       |
| + - Peak activity higher than counting uncertainty range.                                                    |      |            |                      |            |             |                       |
| - - Peak activity lower than counting uncertainty range.                                                     |      |            |                      |            |             |                       |
| = - Peak outside analysis energy range.                                                                      |      |            |                      |            |             |                       |
| & - Calculated peak centroid is not close enough to the library energy centroid for positive identification. |      |            |                      |            |             |                       |
| P - Peakbackground subtraction                                                                               |      |            |                      |            |             |                       |
| } - Peak is too close to another for the activity to be found directly.                                      |      |            |                      |            |             |                       |
|                                                                                                              |      |            |                      |            |             |                       |
| Nuclide Codes:                                                                                               |      |            | Peak Codes:          |            |             |                       |
| T - Thermal Neutron Activation                                                                               |      |            | G - Gamma Ray        |            |             |                       |
| F - Fast Neutron Activation                                                                                  |      |            | X - X-Ray            |            |             |                       |
| I - Fission Product                                                                                          |      |            | P - Positron Decay   |            |             |                       |
| N - Naturally Occurring Isotope                                                                              |      |            | S - Single-Escape    |            |             |                       |
| P - Photon Reaction                                                                                          |      |            | D - Double-Escape    |            |             |                       |
| C - Charged Particle Reaction                                                                                |      |            | K - Key Line         |            |             |                       |
| M - No MDA Calculation                                                                                       |      |            | A - Not in Average   |            |             |                       |
| R - Coincidence Corrected                                                                                    |      |            | C - Coincidence Peak |            |             |                       |
| H - Halflife limit exceeded                                                                                  |      |            |                      |            |             |                       |

\*\*\*\*\* D I S C A R D E D I S O T O P E P E A K S \*\*\*\*\*

| Nuclide | Centroid | Background | Net Area | Intensity | Uncert    | Activity |
|---------|----------|------------|----------|-----------|-----------|----------|
|         | Energy   | Counts     | Counts   | Cts/Sec   | 1 Sigma % |          |

P - Peakbackground subtraction

\*\*\*\*\* S U M M A R Y O F N U C L I D E S I N S A M P L E \*\*\*\*\*  
 Time of Count Time Corrected Uncertainty 1 Sigma  
 Nuclide Activity Activity Counting MDA  
 pCi/Sample pCi/Sample pCi/Sample

|        |            |            |            |          |
|--------|------------|------------|------------|----------|
| TC-99M | 1.7262E+02 | 3.7421E+02 | 9.152E+00% | 3.59E+01 |
|--------|------------|------------|------------|----------|

< - MDA value printed.  
 A - Activity printed, but activity < MDA.  
 B - Activity < MDA and failed test.  
 C - Area < Critical level.  
 F - Failed fraction or key line test.  
 H - Halflife limit exceeded

----- S U M M A R Y -----  
 Total Activity ( 37.5 to 2000.0 keV) 1.726E+02 pCi/Sample  
 Total Decayed Activity ( 37.5 to 2000.0 keV) 3.7420718E+02 pCi/Sample

The library has energies which are not separable.



Sample Description: 254155\_Gamma\_160-17563-B-2-C

Detector: Detector # 5

Batch ID: 254155

Work Order Number: Gamma

Lot Number: 160-17563-B-2-C

Decay to Time: 6/1/2016 12:00

Live Time: 600 sec

Acquisition Time: 6/1/2016 18:58:20

Real Time: 602 sec

Analysis Time: 6/1/2016 19:08

Dead Time: 0.35 %

Analysis Quantity: 1.000E+00 Sample

Efficiency Cal File: 5\_Soil\_TunaCan.Clb

Efficiency Cal Desc: 5\_Soil\_TunaCan\_90099\_032612

Efficiency Cal Date: 3/27/2012 17:20

Energy Cal Date: 2/28/2012 19:35

Library: Client\_Tc-99m.lib

Bkgd Correction File: 5\_2016-05-07\_0551.PBC

| Nuclide | Activity<br>pCi/Sample | 1-Sigma<br>Counting<br>Uncert<br>% | 1-Sigma<br>Counting<br>Uncert<br>pCi/Sample | 1-Sigma<br>Total<br>Uncert<br>pCi/Sample | Minimum<br>Detectable<br>Activity<br>pCi/Sample |
|---------|------------------------|------------------------------------|---------------------------------------------|------------------------------------------|-------------------------------------------------|
| TC-99M  | 3.765E+02              | 10.0                               | 3.757E+01                                   | 4.218E+01                                | 4.147E+01                                       |
| Total   | 3.765E+02              |                                    |                                             |                                          |                                                 |

Analyst: Mike Aldridge

Sample description  
254155\_Gamma\_160-17563-B-2-C

Spectrum Filename: C:\User\SPC\Det5\5\_Gamma\_20160970.An1

Acquisition information

Start time: 6/1/2016 6:58:20 PM  
Live time: 600  
Real time: 602  
Dead time: 0.35 %  
Detector ID: 5

Detector system

Ge 5 SN/157

Calibration

Filename: 5\_Soil\_TunaCan.Clb  
5\_Soil\_TunaCan\_90099\_032612

Energy Calibration

Created: 2/28/2012 7:35:48 PM  
Zero offset: 0.158 keV  
Gain: 0.250 keV/channel  
Quadratic: 3.911E-08 keV/channel^2

Efficiency Calibration

Created: 3/27/2012 5:20:37 PM  
Knee Energy: 165.85 keV  
Above the Knee: Quadratic Uncertainty = 0.87 %  
Log(Eff):  $6.466115E-01 + (-7.830454E-01 * \text{Log}(E)) + (-4.117504E-03 * \text{Log}(E)^2)$   
Below the Knee: Quadratic Uncertainty = 1.43 %  
Log(Eff):  $-2.462251E+01 + (9.075211E+00 * \text{Log}(E)) + (-9.664422E-01 * \text{Log}(E)^2)$

Library Files

Main analysis library: Client\_Tc-99m.lib  
Library Match Width: 0.500  
Peak stripping: Library based

Analysis parameters

Analysis engine: Env32 G800W064  
Start channel: 150 ( 37.62keV )  
Stop channel: 8000 ( 2000.81keV )  
Peak rejection level: 1000.000%  
Peak search sensitivity: 3  
Sample Size: 1.0000E+00 +/- 0.000E+00%  
Activity scaling factor:  $1.0000E+00 / (3.7000E-02 * 1.0000E+00) = 2.7027E+01$   
Detection limit method: Reg. Guide 4.16 Method

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Random error: 4.0000000E+00  
 Systematic error: 4.0000000E+00  
 Fraction Limit: 0.000%  
 Background width: 3  
 Half lives decay limit: 12.000  
 Activity range factor: 2.000  
 Min. step backg. energy 0.000  
 Multiplet shift channel 2.000

| Corrections                   | Status | Comments                                     |
|-------------------------------|--------|----------------------------------------------|
| Decay correct to date:        | YES    | 6/1/2016 12:00:00 PM                         |
| Decay during acquisition:     | YES    |                                              |
| Decay during collection:      | NO     |                                              |
| True coincidence correction:  | NO     |                                              |
| Peaked background correction: | YES    | 5_2016-05-07_0551.PBC<br>5/7/2016 5:51:59 AM |
| Absorption (Internal):        | NO     |                                              |
| Geometry correction:          | NO     |                                              |
| Random summing:               | NO     |                                              |

total peaks alloc. 1 cutoff: 5.00E+01 %  
 Energy Calibration  
 Normalized diff: 0.0954

\*\*\*\*\* S U M M A R Y O F P E A K S I N R A N G E \*\*\*\*\*

| Peak<br>Energy | Area | Uncert | FWHM | Corrctn<br>Factor | Nuclide<br>Energy | Brnch.<br>Ratio | Act.<br>pCi/Samp | Nuc   |
|----------------|------|--------|------|-------------------|-------------------|-----------------|------------------|-------|
| 140.43         | 113. | 9.98   | 0.90 | 3.412E-02         | 140.51            | 89.060          | 3.765E+02        | TC99M |

No unknown peaks passed sensitivity test.

-----  
 This section based on library: Client\_Tc-99m.lib

\*\*\*\*\* I D E N T I F I E D P E A K S U M M A R Y \*\*\*\*\*

| Nuclide | Peak<br>Channel | Centroid<br>Energy | Background<br>Counts | Net Area<br>Counts | Intensity<br>Cts/Sec | Uncert<br>1 Sigma | FWHM<br>% | FWHM<br>keV |
|---------|-----------------|--------------------|----------------------|--------------------|----------------------|-------------------|-----------|-------------|
| TC-99M  | 561.88          | 140.51             | 4.                   | 113.               | 0.188                | 9.98              | 0.903D    |             |

s - Peak fails shape tests.  
 D - Peak area deconvoluted.  
 A Derived peak area.

| ***** S U M M A R Y O F L I B R A R Y P E A K U S A G E *****                                                |      |            |                      |            |                                   |                    |
|--------------------------------------------------------------------------------------------------------------|------|------------|----------------------|------------|-----------------------------------|--------------------|
| - Nuclide -                                                                                                  |      | Average    | ----- Peak -----     |            |                                   |                    |
| Name                                                                                                         | Code | Activity   | Energy               | Activity   | Code                              | MDA Value          |
|                                                                                                              |      | pCi/Sample | keV                  | pCi/Sample |                                   | pCi/Sample         |
| COMMENTS                                                                                                     |      |            |                      |            |                                   |                    |
| <hr/>                                                                                                        |      |            |                      |            |                                   |                    |
| TC-99M                                                                                                       | I    | 3.7647E+02 |                      |            |                                   | 2.51E-01           |
|                                                                                                              |      |            |                      |            |                                   | Energy duplication |
|                                                                                                              |      |            | 140.51               | 3.765E+02  | ( 4.147E+01 9.98E+00 8.91E+01 G K |                    |
| ( - This peak used in the nuclide activity average.                                                          |      |            |                      |            |                                   |                    |
| * - Peak is too wide, but only one peak in library.                                                          |      |            |                      |            |                                   |                    |
| ! - Peak is part of a multiplet and this area went negative during deconvolution.                            |      |            |                      |            |                                   |                    |
| ? - Peak is too narrow.                                                                                      |      |            |                      |            |                                   |                    |
| @ - Peak is too wide at FW25M, but ok at FWHM.                                                               |      |            |                      |            |                                   |                    |
| % - Peak fails sensitivity test.                                                                             |      |            |                      |            |                                   |                    |
| \$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.                 |      |            |                      |            |                                   |                    |
| + - Peak activity higher than counting uncertainty range.                                                    |      |            |                      |            |                                   |                    |
| - - Peak activity lower than counting uncertainty range.                                                     |      |            |                      |            |                                   |                    |
| = - Peak outside analysis energy range.                                                                      |      |            |                      |            |                                   |                    |
| & - Calculated peak centroid is not close enough to the library energy centroid for positive identification. |      |            |                      |            |                                   |                    |
| P - Peakbackground subtraction                                                                               |      |            |                      |            |                                   |                    |
| } - Peak is too close to another for the activity to be found directly.                                      |      |            |                      |            |                                   |                    |
|                                                                                                              |      |            |                      |            |                                   |                    |
| Nuclide Codes:                                                                                               |      |            | Peak Codes:          |            |                                   |                    |
| T - Thermal Neutron Activation                                                                               |      |            | G - Gamma Ray        |            |                                   |                    |
| F - Fast Neutron Activation                                                                                  |      |            | X - X-Ray            |            |                                   |                    |
| I - Fission Product                                                                                          |      |            | P - Positron Decay   |            |                                   |                    |
| N - Naturally Occurring Isotope                                                                              |      |            | S - Single-Escape    |            |                                   |                    |
| P - Photon Reaction                                                                                          |      |            | D - Double-Escape    |            |                                   |                    |
| C - Charged Particle Reaction                                                                                |      |            | K - Key Line         |            |                                   |                    |
| M - No MDA Calculation                                                                                       |      |            | A - Not in Average   |            |                                   |                    |
| R - Coincidence Corrected                                                                                    |      |            | C - Coincidence Peak |            |                                   |                    |
| H - Halflife limit exceeded                                                                                  |      |            |                      |            |                                   |                    |

\*\*\*\*\* D I S C A R D E D I S O T O P E P E A K S \*\*\*\*\*

| Nuclide | Centroid | Background | Net Area | Intensity | Uncert    | Activity |
|---------|----------|------------|----------|-----------|-----------|----------|
|         | Energy   | Counts     | Counts   | Cts/Sec   | 1 Sigma % |          |

P - Peakbackground subtraction

|         |                                                           |                |             |         |            |
|---------|-----------------------------------------------------------|----------------|-------------|---------|------------|
| *****   | S U M M A R Y   O F   N U C L I D E S   I N   S A M P L E |                |             |         | *****      |
|         | Time of Count                                             | Time Corrected | Uncertainty | 1 Sigma |            |
| Nuclide | Activity                                                  | Activity       | Counting    |         | MDA        |
|         | pCi/Sample                                                | pCi/Sample     |             |         | pCi/Sample |

|        |            |            |            |  |          |
|--------|------------|------------|------------|--|----------|
| TC-99M | 1.6868E+02 | 3.7647E+02 | 9.978E+00% |  | 4.15E+01 |
|--------|------------|------------|------------|--|----------|

< - MDA value printed.  
 A - Activity printed, but activity < MDA.  
 B - Activity < MDA and failed test.  
 C - Area < Critical level.  
 F - Failed fraction or key line test.  
 H - Halflife limit exceeded

----- S U M M A R Y -----

|                          |         |             |               |            |
|--------------------------|---------|-------------|---------------|------------|
| Total Activity (         | 37.6 to | 2000.8 keV) | 1.687E+02     | pCi/Sample |
| Total Decayed Activity ( | 37.6 to | 2000.8 keV) | 3.7647183E+02 | pCi/Sample |

The library has energies which are not separable.



---

Sample Description: 254155\_Gamma\_160-17563-A-3-C

Detector: Detector # 8

Batch ID: 254155

Work Order Number: Gamma

Lot Number: 160-17563-A-3-C

---

Decay to Time: 6/1/2016 12:00

Live Time: 600 sec

Acquisition Time: 6/1/2016 22:38:08

Real Time: 618 sec

Analysis Time: 6/1/2016 22:48

Dead Time: 2.86 %

Analysis Quantity: 1.000E+00 Sample

---

Efficiency Cal File: 8\_Soil\_TunaCan.Clb

Efficiency Cal Desc: 8\_Soil\_TunaCan\_90099\_032712

Efficiency Cal Date: 3/28/2012 10:35

Energy Cal Date: 2/28/2012 10:34

Library: Client\_Tc-99m.lib

Bkgd Correction File: 8\_2016-05-07\_1503.PBC

---

| Nuclide | Activity<br>pCi/Sample | 1-Sigma<br>Counting<br>Uncert<br>% | 1-Sigma<br>Counting<br>Uncert<br>pCi/Sample | 1-Sigma<br>Total<br>Uncert<br>pCi/Sample | Minimum<br>Detectable<br>Activity<br>pCi/Sample |
|---------|------------------------|------------------------------------|---------------------------------------------|------------------------------------------|-------------------------------------------------|
| TC-99M  | 4.142E+02              | 10.3                               | 4.272E+01                                   | 4.764E+01                                | 3.247E+01                                       |
| Total   | 4.142E+02              |                                    |                                             |                                          |                                                 |

---

Analyst: Aaron Schroder

Sample description

254155\_Gamma\_160-17563-A-3-C

Spectrum Filename: C:\User\SPC\Det8\8\_Gamma\_20160683.An1

Acquisition information

Start time: 6/1/2016 10:38:08 PM  
Live time: 600  
Real time: 618  
Dead time: 2.86 %  
Detector ID: 8

Detector system

Ge 8 SN/174

Calibration

Filename: 8\_Soil\_TunaCan.Clb  
8\_Soil\_TunaCan\_90099\_032712

Energy Calibration

Created: 2/28/2012 10:34:41 AM  
Zero offset: 0.052 keV  
Gain: 0.250 keV/channel  
Quadratic: 5.282E-10 keV/channel^2

Efficiency Calibration

Created: 3/28/2012 10:35:20 AM  
Knee Energy: 165.85 keV  
Above the Knee: Quadratic Uncertainty = 1.39 %  
Log(Eff):  $-1.098764E-01 + (-4.958544E-01 * \text{Log}(E)) + (-2.572270E-02 * \text{Log}(E)^2)$   
Below the Knee: Quadratic Uncertainty = 1.71 %  
Log(Eff):  $-2.525301E+01 + (9.398253E+00 * \text{Log}(E)) + (-1.000034E+00 * \text{Log}(E)^2)$

Library Files

Main analysis library: Client\_Tc-99m.lib  
Library Match Width: 0.500  
Peak stripping: Library based

Analysis parameters

Analysis engine: Env32 G800W064  
Start channel: 150 ( 37.55keV )  
Stop channel: 8000 ( 1999.97keV )  
Peak rejection level: 1000.000%  
Peak search sensitivity: 3  
Sample Size: 1.0000E+00 +/- 0.000E+00%  
Activity scaling factor:  $1.0000E+00 / (3.7000E-02 * 1.0000E+00) = 2.7027E+01$   
Detection limit method: Reg. Guide 4.16 Method

(Page 2 of 5)

Random error: 4.0000000E+00  
 Systematic error: 4.0000000E+00  
 Fraction Limit: 0.000%  
 Background width: 3  
 Half lives decay limit: 12.000  
 Activity range factor: 2.000  
 Min. step backg. energy 0.000  
 Multiplet shift channel 2.000

| Corrections                   | Status | Comments                                     |
|-------------------------------|--------|----------------------------------------------|
| Decay correct to date:        | YES    | 6/1/2016 12:00:00 PM                         |
| Decay during acquisition:     | YES    |                                              |
| Decay during collection:      | NO     |                                              |
| True coincidence correction:  | NO     |                                              |
| Peaked background correction: | YES    | 8_2016-05-07_1503.PBC<br>5/7/2016 3:03:11 PM |
| Absorption (Internal):        | NO     |                                              |
| Geometry correction:          | NO     |                                              |
| Random summing:               | NO     |                                              |

total peaks alloc. 1 cutoff: 5.00E+01 %  
 Energy Calibration  
 Normalized diff: 0.0043

\*\*\*\*\* S U M M A R Y O F P E A K S I N R A N G E \*\*\*\*\*

| Peak<br>Energy | Area | Uncert | FWHM | Corrctn<br>Factor | Nuclide<br>Energy | Brnch.<br>Ratio | Act.<br>pCi/Samp | Nuc   |
|----------------|------|--------|------|-------------------|-------------------|-----------------|------------------|-------|
| 140.51         | 94.  | 10.31  | 0.89 | 3.945E-02         | 140.51            | 89.060          | 4.142E+02        | TC99M |

No unknown peaks passed sensitivity test.

-----  
 This section based on library: Client\_Tc-99m.lib

\*\*\*\*\* I D E N T I F I E D P E A K S U M M A R Y \*\*\*\*\*

| Nuclide | Peak<br>Channel | Centroid<br>Energy | Background<br>Counts | Net Area<br>Counts | Intensity<br>Cts/Sec | Uncert<br>1 Sigma | FWHM<br>% | FWHM<br>keV |
|---------|-----------------|--------------------|----------------------|--------------------|----------------------|-------------------|-----------|-------------|
| TC-99M  | 561.86          | 140.51             | 0.                   | 94.                | 0.157                | 10.31             | 0.894D    |             |

s - Peak fails shape tests.  
 D - Peak area deconvoluted.  
 A Derived peak area.

| ***** S U M M A R Y O F L I B R A R Y P E A K U S A G E *****                                                |      |            |                      |            |                                   |                    |
|--------------------------------------------------------------------------------------------------------------|------|------------|----------------------|------------|-----------------------------------|--------------------|
| - Nuclide -                                                                                                  |      | Average    | ----- Peak -----     |            |                                   |                    |
| Name                                                                                                         | Code | Activity   | Energy               | Activity   | Code                              | MDA Value          |
|                                                                                                              |      | pCi/Sample | keV                  | pCi/Sample |                                   | pCi/Sample         |
| COMMENTS                                                                                                     |      |            |                      |            |                                   |                    |
| <hr/>                                                                                                        |      |            |                      |            |                                   |                    |
| TC-99M                                                                                                       | I    | 4.1417E+02 |                      |            |                                   | 2.51E-01           |
|                                                                                                              |      |            |                      |            |                                   | Energy duplication |
|                                                                                                              |      |            | 140.51               | 4.142E+02  | ( 3.247E+01 1.03E+01 8.91E+01 G K |                    |
| ( - This peak used in the nuclide activity average.                                                          |      |            |                      |            |                                   |                    |
| * - Peak is too wide, but only one peak in library.                                                          |      |            |                      |            |                                   |                    |
| ! - Peak is part of a multiplet and this area went negative during deconvolution.                            |      |            |                      |            |                                   |                    |
| ? - Peak is too narrow.                                                                                      |      |            |                      |            |                                   |                    |
| @ - Peak is too wide at FW25M, but ok at FWHM.                                                               |      |            |                      |            |                                   |                    |
| % - Peak fails sensitivity test.                                                                             |      |            |                      |            |                                   |                    |
| \$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.                 |      |            |                      |            |                                   |                    |
| + - Peak activity higher than counting uncertainty range.                                                    |      |            |                      |            |                                   |                    |
| - - Peak activity lower than counting uncertainty range.                                                     |      |            |                      |            |                                   |                    |
| = - Peak outside analysis energy range.                                                                      |      |            |                      |            |                                   |                    |
| & - Calculated peak centroid is not close enough to the library energy centroid for positive identification. |      |            |                      |            |                                   |                    |
| P - Peakbackground subtraction                                                                               |      |            |                      |            |                                   |                    |
| } - Peak is too close to another for the activity to be found directly.                                      |      |            |                      |            |                                   |                    |
|                                                                                                              |      |            |                      |            |                                   |                    |
| Nuclide Codes:                                                                                               |      |            | Peak Codes:          |            |                                   |                    |
| T - Thermal Neutron Activation                                                                               |      |            | G - Gamma Ray        |            |                                   |                    |
| F - Fast Neutron Activation                                                                                  |      |            | X - X-Ray            |            |                                   |                    |
| I - Fission Product                                                                                          |      |            | P - Positron Decay   |            |                                   |                    |
| N - Naturally Occurring Isotope                                                                              |      |            | S - Single-Escape    |            |                                   |                    |
| P - Photon Reaction                                                                                          |      |            | D - Double-Escape    |            |                                   |                    |
| C - Charged Particle Reaction                                                                                |      |            | K - Key Line         |            |                                   |                    |
| M - No MDA Calculation                                                                                       |      |            | A - Not in Average   |            |                                   |                    |
| R - Coincidence Corrected                                                                                    |      |            | C - Coincidence Peak |            |                                   |                    |
| H - Halflife limit exceeded                                                                                  |      |            |                      |            |                                   |                    |

\*\*\*\*\* D I S C A R D E D I S O T O P E P E A K S \*\*\*\*\*

| Nuclide | Centroid | Background | Net Area | Intensity | Uncert    | Activity |
|---------|----------|------------|----------|-----------|-----------|----------|
|         | Energy   | Counts     | Counts   | Cts/Sec   | 1 Sigma % |          |

P - Peakbackground subtraction

\*\*\*\*\*

S U M M A R Y

O F

N U C L I D E S

I N

S A M P L E

\*\*\*\*\*

|                                                                       | Time of Count | Time Corrected | Uncertainty | 1 Sigma |            |
|-----------------------------------------------------------------------|---------------|----------------|-------------|---------|------------|
| Nuclide                                                               | Activity      | Activity       | Counting    |         | MDA        |
|                                                                       | pCi/Sample    | pCi/Sample     |             |         | pCi/Sample |
| TC-99M                                                                | 1.2170E+02    | 4.1417E+02     | 1.031E+01%  |         | 3.25E+01   |
| < - MDA value printed.                                                |               |                |             |         |            |
| A - Activity printed, but activity < MDA.                             |               |                |             |         |            |
| B - Activity < MDA and failed test.                                   |               |                |             |         |            |
| C - Area < Critical level.                                            |               |                |             |         |            |
| F - Failed fraction or key line test.                                 |               |                |             |         |            |
| H - Halflife limit exceeded                                           |               |                |             |         |            |
| ----- S U M M A R Y -----                                             |               |                |             |         |            |
| Total Activity ( 37.5 to 2000.0 keV) 1.217E+02 pCi/Sample             |               |                |             |         |            |
| Total Decayed Activity ( 37.5 to 2000.0 keV) 4.1416510E+02 pCi/Sample |               |                |             |         |            |

The library has energies which are not separable.



---

Sample Description: 254155\_Gamma\_160-17563-A-4-C

Detector: Detector # 8

Batch ID: 254155

Work Order Number: Gamma

Lot Number: 160-17563-A-4-C

---

Decay to Time: 6/1/2016 12:00

Live Time: 600 sec

Acquisition Time: 6/1/2016 18:55:52

Real Time: 617 sec

Analysis Time: 6/1/2016 19:06

Dead Time: 2.83 %

Analysis Quantity: 1.000E+00 Sample

---

Efficiency Cal File: 8\_Soil\_TunaCan.Clb

Efficiency Cal Desc: 8\_Soil\_TunaCan\_90099\_032712

Efficiency Cal Date: 3/28/2012 10:35

Energy Cal Date: 2/28/2012 10:34

Library: Client\_Tc-99m.lib

Bkgd Correction File: 8\_2016-05-07\_1503.PBC

---

| Nuclide | Activity<br>pCi/Sample | 1-Sigma<br>Counting<br>Uncert<br>% | 1-Sigma<br>Counting<br>Uncert<br>pCi/Sample | 1-Sigma<br>Total<br>Uncert<br>pCi/Sample | Minimum<br>Detectable<br>Activity<br>pCi/Sample |
|---------|------------------------|------------------------------------|---------------------------------------------|------------------------------------------|-------------------------------------------------|
| TC-99M  | 4.189E+02              | 9.0                                | 3.765E+01                                   | 4.327E+01                                | 4.409E+01                                       |
| Total   | 4.189E+02              |                                    |                                             |                                          |                                                 |

---

Analyst: Mike Aldridge

Sample description  
254155\_Gamma\_160-17563-A-4-C

Spectrum Filename: C:\User\SPC\Det8\8\_Gamma\_20160682.An1

Acquisition information

Start time: 6/1/2016 6:55:52 PM  
Live time: 600  
Real time: 617  
Dead time: 2.83 %  
Detector ID: 8

Detector system

Ge 8 SN/174

Calibration

Filename: 8\_Soil\_TunaCan.Clb  
8\_Soil\_TunaCan\_90099\_032712

Energy Calibration

Created: 2/28/2012 10:34:41 AM  
Zero offset: 0.052 keV  
Gain: 0.250 keV/channel  
Quadratic: 5.282E-10 keV/channel^2

Efficiency Calibration

Created: 3/28/2012 10:35:20 AM  
Knee Energy: 165.85 keV  
Above the Knee: Quadratic Uncertainty = 1.39 %  
Log(Eff):  $-1.098764E-01 + (-4.958544E-01 * \text{Log}(E)) + (-2.572270E-02 * \text{Log}(E)^2)$   
Below the Knee: Quadratic Uncertainty = 1.71 %  
Log(Eff):  $-2.525301E+01 + (9.398253E+00 * \text{Log}(E)) + (-1.000034E+00 * \text{Log}(E)^2)$

Library Files

Main analysis library: Client\_Tc-99m.lib  
Library Match Width: 0.500  
Peak stripping: Library based

Analysis parameters

Analysis engine: Env32 G800W064  
Start channel: 150 ( 37.55keV )  
Stop channel: 8000 ( 1999.97keV )  
Peak rejection level: 1000.000%  
Peak search sensitivity: 3  
Sample Size: 1.0000E+00 +/- 0.000E+00%  
Activity scaling factor:  $1.0000E+00 / (3.7000E-02 * 1.0000E+00) = 2.7027E+01$   
Detection limit method: Reg. Guide 4.16 Method

(Page 2 of 5)

Random error: 4.0000000E+00  
Systematic error: 4.0000000E+00  
Fraction Limit: 0.000%  
Background width: 3  
Half lives decay limit: 12.000  
Activity range factor: 2.000  
Min. step backg. energy 0.000  
Multiplet shift channel 2.000

| Corrections                   | Status | Comments                                     |
|-------------------------------|--------|----------------------------------------------|
| Decay correct to date:        | YES    | 6/1/2016 12:00:00 PM                         |
| Decay during acquisition:     | YES    |                                              |
| Decay during collection:      | NO     |                                              |
| True coincidence correction:  | NO     |                                              |
| Peaked background correction: | YES    | 8_2016-05-07_1503.PBC<br>5/7/2016 3:03:11 PM |
| Absorption (Internal):        | NO     |                                              |
| Geometry correction:          | NO     |                                              |
| Random summing:               | NO     |                                              |

total peaks alloc. 1 cutoff: 5.00E+01 %  
Energy Calibration  
Normalized diff: 1.0000

\*\*\*\*\* S U M M A R Y O F P E A K S I N R A N G E \*\*\*\*\*

| Peak<br>Energy | Area | Uncert | FWHM | Corrctn<br>Factor | Nuclide<br>Energy | Brnch.<br>Ratio | Act.<br>pCi/Samp | Nuc   |
|----------------|------|--------|------|-------------------|-------------------|-----------------|------------------|-------|
| 140.53         | 146. | 8.86   | 0.89 | 3.945E-02         | 140.51            | 89.060          | 4.209E+02        | TC99M |

No unknown peaks passed sensitivity test.

-----  
This section based on library: Client\_Tc-99m.lib

\*\*\*\*\* I D E N T I F I E D P E A K S U M M A R Y \*\*\*\*\*

| Nuclide | Peak<br>Channel | Centroid<br>Energy | Background<br>Counts | Net Area<br>Counts | Intensity<br>Cts/Sec | Uncert<br>1 Sigma | FWHM<br>keV |
|---------|-----------------|--------------------|----------------------|--------------------|----------------------|-------------------|-------------|
| TC-99M  | 561.86          | 140.51             | 7.                   | 146.               | 0.243                | 8.99              | 1.085D      |

s - Peak fails shape tests.  
D - Peak area deconvoluted.  
A Derived peak area.

| ***** S U M M A R Y O F L I B R A R Y P E A K U S A G E *****                                                |      |            |                      |            |              |                       |
|--------------------------------------------------------------------------------------------------------------|------|------------|----------------------|------------|--------------|-----------------------|
| - Nuclide -                                                                                                  |      | Average    | ----- Peak -----     |            |              |                       |
| Name                                                                                                         | Code | Activity   | Energy               | Activity   | Code         | MDA Value             |
|                                                                                                              |      | pCi/Sample | keV                  | pCi/Sample |              | pCi/Sample            |
|                                                                                                              |      |            |                      |            |              | COMMENTS              |
| TC-99M                                                                                                       | I    | 4.1894E+02 |                      |            |              | 2.51E-01              |
|                                                                                                              |      |            |                      |            |              | Energy duplication    |
|                                                                                                              |      |            | 140.51               | 4.189E+02  | ?( 4.409E+01 | 8.99E+00 8.91E+01 G K |
| ( - This peak used in the nuclide activity average.                                                          |      |            |                      |            |              |                       |
| * - Peak is too wide, but only one peak in library.                                                          |      |            |                      |            |              |                       |
| ! - Peak is part of a multiplet and this area went negative during deconvolution.                            |      |            |                      |            |              |                       |
| ? - Peak is too narrow.                                                                                      |      |            |                      |            |              |                       |
| @ - Peak is too wide at FW25M, but ok at FWHM.                                                               |      |            |                      |            |              |                       |
| % - Peak fails sensitivity test.                                                                             |      |            |                      |            |              |                       |
| \$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.                 |      |            |                      |            |              |                       |
| + - Peak activity higher than counting uncertainty range.                                                    |      |            |                      |            |              |                       |
| - - Peak activity lower than counting uncertainty range.                                                     |      |            |                      |            |              |                       |
| = - Peak outside analysis energy range.                                                                      |      |            |                      |            |              |                       |
| & - Calculated peak centroid is not close enough to the library energy centroid for positive identification. |      |            |                      |            |              |                       |
| P - Peakbackground subtraction                                                                               |      |            |                      |            |              |                       |
| } - Peak is too close to another for the activity to be found directly.                                      |      |            |                      |            |              |                       |
| Nuclide Codes:                                                                                               |      |            | Peak Codes:          |            |              |                       |
| T - Thermal Neutron Activation                                                                               |      |            | G - Gamma Ray        |            |              |                       |
| F - Fast Neutron Activation                                                                                  |      |            | X - X-Ray            |            |              |                       |
| I - Fission Product                                                                                          |      |            | P - Positron Decay   |            |              |                       |
| N - Naturally Occurring Isotope                                                                              |      |            | S - Single-Escape    |            |              |                       |
| P - Photon Reaction                                                                                          |      |            | D - Double-Escape    |            |              |                       |
| C - Charged Particle Reaction                                                                                |      |            | K - Key Line         |            |              |                       |
| M - No MDA Calculation                                                                                       |      |            | A - Not in Average   |            |              |                       |
| R - Coincidence Corrected                                                                                    |      |            | C - Coincidence Peak |            |              |                       |
| H - Halflife limit exceeded                                                                                  |      |            |                      |            |              |                       |

\*\*\*\*\* D I S C A R D E D I S O T O P E P E A K S \*\*\*\*\*

| Nuclide | Centroid | Background | Net Area | Intensity | Uncert    | Activity |
|---------|----------|------------|----------|-----------|-----------|----------|
|         | Energy   | Counts     | Counts   | Cts/Sec   | 1 Sigma % |          |

P - Peakbackground subtraction

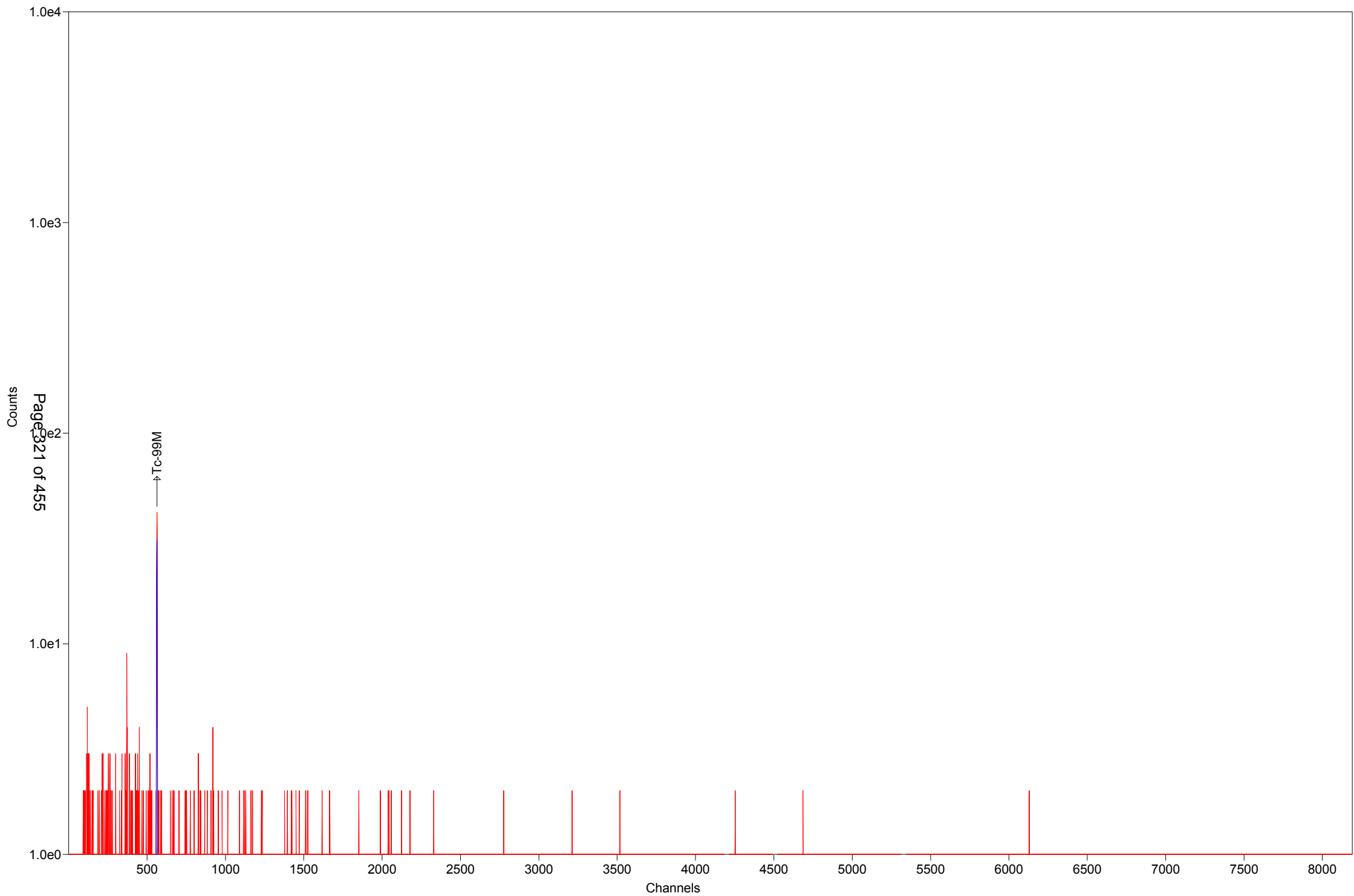
\*\*\*\*\* S U M M A R Y O F N U C L I D E S I N S A M P L E \*\*\*\*\*  
Time of Count Time Corrected Uncertainty 1 Sigma  
Nuclide Activity Activity Counting MDA  
pCi/Sample pCi/Sample pCi/Sample

| TC-99M # | 1.8859E+02 | 4.1894E+02 | 8.986E+00% | 4.41E+01 |
|----------|------------|------------|------------|----------|
|----------|------------|------------|------------|----------|

- # - All peaks for activity calculation had bad shape.
- \* - Activity omitted from total
- & - Activity omitted from total and all peaks had bad shape.
- < - MDA value printed.
- A - Activity printed, but activity < MDA.
- B - Activity < MDA and failed test.
- C - Area < Critical level.
- F - Failed fraction or key line test.
- H - Halflife limit exceeded

----- S U M M A R Y -----  
Total Activity ( 37.5 to 2000.0 keV) 1.886E+02 pCi/Sample  
Total Decayed Activity ( 37.5 to 2000.0 keV) 4.1893509E+02 pCi/Sample

The library has energies which are not separable.



# Daily Checks

Test America  
St. Louis  
Background Check

Spectrum: 5\_20160601001\_BG  
Description: Background Contamination Check  
Acquired: 6/1/2016 12:26:14 AM  
Detector: Detector # 5

Background Evaluation Criteria:

- 1) Place instrument out of service if Countrate exceeds Control Limits.
- 2) Investigate high countrate and take corrective action as necessary if Countrate exceeds Tolerance Limits.

|           | Target | L_Ctrl | L_Tol | Measured | H_Tol | H_Ctrl | Results |
|-----------|--------|--------|-------|----------|-------|--------|---------|
| Bkgd      |        |        |       |          |       |        |         |
| Countrate | 1.45   | 1.30   | 1.35  | 1.45     | 1.55  | 1.60   | PASS    |

Analyst: Aaron Schroder

Reviewer: kody Saulters

Test America  
St. Louis  
Quality Control Check

Spectrum: 5\_20160601002\_QCAsLeft  
Description: Quality control Check (QC Source 'A') Post Stabilization  
Acquired: 6/1/2016 5:44:46 AM  
Detector: Detector # 5

Quality Control Evaluation Criteria:

- 1) Notify Supervisor if 'AS FOUND' parameters exceed Tolerance or Control Limits.
- 2) Place out of service if 'AS LEFT' parameters exceed Tolerance or Control Limits.

|              | Target  | L_Ctrl  | L_Tol   | Measured | H_Tol   | H_Ctrl  | Results |
|--------------|---------|---------|---------|----------|---------|---------|---------|
| -----        |         |         |         |          |         |         |         |
| QA-60        |         |         |         |          |         |         |         |
| Channel      | 238.00  | 236.00  | 237.00  | 237.90   | 239.00  | 240.00  | PASS    |
| Energy       | 59.54   | 59.04   | 59.29   | 59.59    | 59.79   | 60.04   | PASS    |
| FWHM         | 0.74    | 0.00    | 0.00    | 0.73     | 1.84    | 1.94    | PASS    |
| ActivityDiff | 636.60  | -5.00   | -4.00   | -0.58    | 4.00    | 5.00    | PASS    |
| -----        |         |         |         |          |         |         |         |
| QA-662       |         |         |         |          |         |         |         |
| FWHM         | 1.36    | 0.00    | 0.00    | 1.35     | 3.06    | 3.16    | PASS    |
| ActivityDiff | 596.80  | -5.00   | -4.00   | -3.17    | 4.00    | 5.00    | PASS    |
| -----        |         |         |         |          |         |         |         |
| QA-1332      |         |         |         |          |         |         |         |
| Channel      | 5330.00 | 5327.00 | 5328.00 | 5330.20  | 5332.00 | 5333.00 | PASS    |
| Energy       | 1332.51 | 1331.76 | 1332.01 | 1332.59  | 1333.01 | 1333.26 | PASS    |
| FWHM         | 1.90    | 0.00    | 0.00    | 1.95     | 4.10    | 4.20    | PASS    |
| ActivityDiff | 1164.20 | -5.00   | -4.00   | -1.08    | 4.00    | 5.00    | PASS    |
| -----        |         |         |         |          |         |         |         |

Analyst: kody Saulters

Reviewer: kody Saulters

Test America  
St. Louis  
Background Check

Spectrum: 7\_20160601001\_BG  
Description: Background Contamination Check  
Acquired: 6/1/2016 12:27:07 AM  
Detector: Detector # 7

Background Evaluation Criteria:

- 1) Place instrument out of service if Countrate exceeds Control Limits.
- 2) Investigate high countrate and take corrective action as necessary if Countrate exceeds Tolerance Limits.

|           | Target | L_Ctrl | L_Tol | Measured | H_Tol | H_Ctrl | Results |
|-----------|--------|--------|-------|----------|-------|--------|---------|
| Bkgd      |        |        |       |          |       |        |         |
| Countrate | 1.30   | 1.16   | 1.21  | 1.29     | 1.40  | 1.45   | PASS    |

Analyst: Aaron Schroder

Reviewer: kody Saulters

Test America  
St. Louis  
Quality Control Check

Spectrum: 7\_20160601002\_QCAsLeft  
Description: Quality control Check (QC Source 'C') Post Stabilization  
Acquired: 6/1/2016 5:47:41 AM  
Detector: Detector # 7

Quality Control Evaluation Criteria:

- 1) Notify Supervisor if 'AS FOUND' parameters exceed Tolerance or Control Limits.
- 2) Place out of service if 'AS LEFT' parameters exceed Tolerance or Control Limits.

|              | Target  | L_Ctrl  | L_Tol   | Measured | H_Tol   | H_Ctrl  | Results |
|--------------|---------|---------|---------|----------|---------|---------|---------|
| -----        |         |         |         |          |         |         |         |
| QA-60        |         |         |         |          |         |         |         |
| Channel      | 238.00  | 236.00  | 237.00  | 237.80   | 239.00  | 240.00  | PASS    |
| Energy       | 59.58   | 59.04   | 59.29   | 59.58    | 59.79   | 60.04   | PASS    |
| FWHM         | 0.84    | 0.00    | 0.00    | 0.88     | 1.94    | 2.04    | PASS    |
| ActivityDiff | 647.00  | -5.00   | -4.00   | 1.18     | 4.00    | 5.00    | PASS    |
| -----        |         |         |         |          |         |         |         |
| QA-662       |         |         |         |          |         |         |         |
| FWHM         | 1.45    | 0.00    | 0.00    | 1.45     | 3.15    | 3.25    | PASS    |
| ActivityDiff | 606.50  | -5.00   | -4.00   | 1.11     | 4.00    | 5.00    | PASS    |
| -----        |         |         |         |          |         |         |         |
| QA-1332      |         |         |         |          |         |         |         |
| Channel      | 5330.00 | 5327.00 | 5328.00 | 5330.30  | 5332.00 | 5333.00 | PASS    |
| Energy       | 1332.51 | 1331.76 | 1332.01 | 1332.67  | 1333.01 | 1333.26 | PASS    |
| FWHM         | 1.98    | 0.00    | 0.00    | 1.83     | 4.18    | 4.28    | PASS    |
| ActivityDiff | 1183.00 | -5.00   | -4.00   | 0.94     | 4.00    | 5.00    | PASS    |
| -----        |         |         |         |          |         |         |         |

Analyst: kody Saulters

Reviewer: kody Saulters

Test America  
St. Louis  
Background Check

Spectrum: 8\_20160601001\_BG  
Description: Background Contamination Check  
Acquired: 6/1/2016 12:28:12 AM  
Detector: Detector # 8

Background Evaluation Criteria:

- 1) Place instrument out of service if Countrate exceeds Control Limits.
- 2) Investigate high countrate and take corrective action as necessary if Countrate exceeds Tolerance Limits.

|           | Target | L_Ctrl | L_Tol | Measured | H_Tol | H_Ctrl | Results |
|-----------|--------|--------|-------|----------|-------|--------|---------|
| Bkgd      |        |        |       |          |       |        |         |
| Countrate | 1.56   | 1.39   | 1.45  | 1.61     | 1.68  | 1.74   | PASS    |

Analyst: Aaron Schroder

Reviewer: kody Saulters

Test America  
St. Louis  
Quality Control Check

Spectrum: 8\_20160601002\_QCAsLeft  
Description: Quality control Check (QC Source 'D') Post Stabilization  
Acquired: 6/1/2016 5:48:45 AM  
Detector: Detector # 8

Quality Control Evaluation Criteria:

- 1) Notify Supervisor if 'AS FOUND' parameters exceed Tolerance or Control Limits.
- 2) Place out of service if 'AS LEFT' parameters exceed Tolerance or Control Limits.

|              | Target  | L_Ctrl  | L_Tol   | Measured | H_Tol   | H_Ctrl  | Results |
|--------------|---------|---------|---------|----------|---------|---------|---------|
| -----        |         |         |         |          |         |         |         |
| QA-60        |         |         |         |          |         |         |         |
| Channel      | 238.00  | 236.00  | 237.00  | 237.80   | 239.00  | 240.00  | PASS    |
| Energy       | 59.54   | 59.04   | 59.29   | 59.52    | 59.79   | 60.04   | PASS    |
| FWHM         | 1.10    | 0.00    | 0.00    | 0.85     | 2.20    | 2.30    | PASS    |
| ActivityDiff | 650.60  | -5.00   | -4.00   | -1.24    | 4.00    | 5.00    | PASS    |
| -----        |         |         |         |          |         |         |         |
| QA-662       |         |         |         |          |         |         |         |
| FWHM         | 1.53    | 0.00    | 0.00    | 1.33     | 3.23    | 3.33    | PASS    |
| ActivityDiff | 609.90  | -5.00   | -4.00   | 0.27     | 4.00    | 5.00    | PASS    |
| -----        |         |         |         |          |         |         |         |
| QA-1332      |         |         |         |          |         |         |         |
| Channel      | 5330.00 | 5327.00 | 5328.00 | 5330.70  | 5332.00 | 5333.00 | PASS    |
| Energy       | 1332.51 | 1331.76 | 1332.01 | 1332.66  | 1333.01 | 1333.26 | PASS    |
| FWHM         | 1.90    | 0.00    | 0.00    | 1.79     | 4.10    | 4.20    | PASS    |
| ActivityDiff | 1189.70 | -5.00   | -4.00   | -2.38    | 4.00    | 5.00    | PASS    |
| -----        |         |         |         |          |         |         |         |

Analyst: kody Saulters

Reviewer: kody Saulters

# Initial Calibrations

## Gamma Verification per Geometry

Detector: Ge5

Geometry: Tunacan

Reference date 1/1/2012

Calibration Standard: 90099

Standard volume g / vial 1550

Standard volume transferred in g / geometry 317.8

lab ID# of cal standard Rad12-0007

| Isotope | Certified Activity<br>gammas/sec | Geometry<br>Activity<br>gammas/sec | $\gamma$ abundance | Bq/sample | Count<br>Results | %recovery |
|---------|----------------------------------|------------------------------------|--------------------|-----------|------------------|-----------|
| Pb-210  | 3094                             | 634                                | 0.0425             | 14926     | 14353            | 96.2      |
| Am-241  | 2037                             | 418                                | 0.3590             | 1163      | 1230.2           | 105.7     |
| Cd-109  | 2881                             | 591                                | 0.0361             | 16363     | 16101            | 98.4      |
| Co-57   | 1511                             | 310                                | 0.8560             | 362       | 347.72           | 96.1      |
| Ce-139  | 2139                             | 439                                | 0.7990             | 549       | 538.4            | 98.1      |
| Hg-203  | 4651                             | 954                                | 0.8146             | 1171      | 1208.4           | 103.2     |
| Sn-113  | 3015                             | 618                                | 0.6400             | 966       | 972.07           | 100.6     |
| Cs-137  | 1938                             | 397                                | 0.8510             | 467       | 462.35           | 99.0      |
| Y-88    | 7264                             | 1489                               | 0.9370             | 1589      | 1559.3           | 98.1      |
| Co-60   | 3580                             | 734                                | 0.9997             | 734       | 722.51           | 98.4      |
| Co-60   | 3581                             | 734                                | 0.9999             | 734       | 739.67           | 100.7     |
| Y-88    | 7690                             | 1577                               | 0.9920             | 1589      | 1613.8           | 101.5     |

Reviewed By: Jody Watson

Date: 3/27/2012

Calibration Data from file: 5\_Soil\_TunaCan.Clb  
 Energy Calibration Date: 3/27/2012 Time: 5:20:02 PM  
 Efficiency Calibration Date: 3/27/2012 Time: 5:20:37 PM

Calibration Description:  
 5\_Soil\_TunaCan\_90099\_032612

#### Energy Calibration Fit

Energy =  $0.1351 + 0.249831 \cdot \text{Channel} + 2.72022e-008 \cdot \text{Channel}^2$   
 FWHM (ch) =  $2.8138 + 0.001050 \cdot \text{Channel} - 2.57606e-008 \cdot \text{Channel}^2$

#### Energy/FWHM Table

| Channel | Energy(keV) | Fit(keV) | Delta  | FWHM(keV) | Fit(keV) | Delta  |
|---------|-------------|----------|--------|-----------|----------|--------|
| 186.01  | 46.54       | 46.61    | -0.15% | 0.74      | 0.75     | -1.17% |
| 237.86  | 59.54       | 59.56    | -0.04% | 0.74      | 0.77     | -4.07% |
| 351.46  | 88.03       | 87.95    | 0.10%  | 0.80      | 0.79     | 1.28%  |
| 487.52  | 122.06      | 121.94   | 0.10%  | 0.85      | 0.83     | 2.66%  |
| 663.26  | 165.85      | 165.85   | 0.00%  | 0.88      | 0.87     | 0.98%  |
| 1116.90 | 279.17      | 279.20   | -0.01% | 0.97      | 0.99     | -2.35% |
| 1567.36 | 391.69      | 391.78   | -0.02% | 1.12      | 1.10     | 1.78%  |
| 2647.45 | 661.66      | 661.74   | -0.01% | 1.38      | 1.35     | 1.91%  |
| 3592.51 | 898.02      | 898.01   | 0.00%  | 1.55      | 1.56     | -1.11% |
| 4692.96 | 1173.24     | 1173.18  | 0.00%  | 1.77      | 1.79     | -1.18% |
| 5329.72 | 1332.50     | 1332.44  | 0.00%  | 1.93      | 1.92     | 0.31%  |
| 7342.77 | 1836.01     | 1836.05  | -0.00% | 2.29      | 2.29     | 0.24%  |

#### Efficiency Calibration Fit

Knee Energy = 165.85 keV  
 Above the Knee: Quadratic      Uncertainty = 0.8682 %  
 $\text{Ln}(\text{Eff}) = 0.6466 - 0.783045 \cdot \text{Ln}(\text{Eng}) - 0.0041175 \cdot (\text{Ln}(\text{Eng}))^2$   
 Below the Knee: Quadratic      Uncertainty = 1.4296 %  
 $\text{Ln}(\text{Eff}) = -24.6225 + 9.075211 \cdot \text{Ln}(\text{Eng}) - 0.966442 \cdot (\text{Ln}(\text{Eng}))^2$

#### Efficiency Table

| Energy  | Efficiency       | Fit         | Delta  |
|---------|------------------|-------------|--------|
| 46.54   | 1.7205E-002      | 1.7882E-002 | -3.93% |
| 59.54   | 2.6619E-002      | 2.5335E-002 | 4.82%  |
| 88.03   | 3.4045E-002      | 3.4617E-002 | -1.68% |
| 122.06  | 3.4394E-002      | 3.5819E-002 | -4.15% |
| 165.85  | ===== Knee ===== |             |        |
| 165.85  | 3.0704E-002      | 3.1331E-002 | -2.04% |
| 279.17  | 2.1030E-002      | 2.0365E-002 | 3.17%  |
| 391.69  | 1.5475E-002      | 1.5370E-002 | 0.68%  |
| 661.66  | 9.8486E-003      | 9.9244E-003 | -0.77% |
| 898.02  | 7.5404E-003      | 7.6837E-003 | -1.90% |
| 1173.24 | 6.0360E-003      | 6.1381E-003 | -1.69% |
| 1332.50 | 5.5560E-003      | 5.5144E-003 | 0.75%  |
| 1836.01 | 4.2722E-003      | 4.2078E-003 | 1.51%  |

#### Calibration Certificate Table

| Isotope | Energy  | Pct   | Half-life | Activity | GPS     | Error | Date & Time |             |
|---------|---------|-------|-----------|----------|---------|-------|-------------|-------------|
| Pb-210  | 46.54   | 4.25  | 8.15E+003 | 14918.00 | 634.00  | 4.10% | 1/1/2012    | 11:00:00 AM |
| Am-241  | 59.54   | 35.70 | 1.58E+005 | 1170.90  | 418.00  | 3.50% | 1/1/2012    | 11:00:00 AM |
| Cd-109  | 88.03   | 3.61  | 4.63E+002 | 16371.00 | 591.00  | 4.70% | 1/1/2012    | 11:00:00 AM |
| Co-57   | 122.06  | 85.60 | 2.72E+002 | 362.15   | 310.00  | 4.10% | 1/1/2012    | 11:00:00 AM |
| Ce-139  | 165.85  | 79.90 | 1.38E+002 | 549.44   | 439.00  | 3.90% | 1/1/2012    | 11:00:00 AM |
| Hg-203  | 279.17  | 81.50 | 4.66E+001 | 1170.60  | 954.00  | 3.80% | 1/1/2012    | 11:00:00 AM |
| Sn-113  | 391.69  | 64.00 | 1.15E+002 | 965.63   | 618.00  | 3.90% | 1/1/2012    | 11:00:00 AM |
| Cs-137  | 661.66  | 85.21 | 1.10E+004 | 465.91   | 397.00  | 4.00% | 1/1/2012    | 11:00:00 AM |
| Y-88    | 898.02  | 93.70 | 1.07E+002 | 1589.10  | 1489.00 | 3.90% | 1/1/2012    | 11:00:00 AM |
| Co-60   | 1173.24 | 99.90 | 1.93E+003 | 734.73   | 734.00  | 4.00% | 1/1/2012    | 11:00:00 AM |
| Co-60   | 1332.50 | 99.98 | 1.93E+003 | 734.15   | 734.00  | 4.00% | 1/1/2012    | 11:00:00 AM |
| Y-88    | 1836.01 | 99.20 | 1.07E+002 | 1589.70  | 1577.00 | 4.00% | 1/1/2012    | 11:00:00 AM |

ORTEC g v - i (1087) Env32 G53W4.25 3/27/2012 5:22:03 PM  
TestAmerica Spectrum name: 5\_TunaCan\_20120810.An1

Sample description  
5\_TunaCan\_90099\_032612

Spectrum Filename: C:\User\SPC\Det5\5\_TunaCan\_20120810.An1

Acquisition information

Start time: 3/26/2012 3:05:42 PM  
Live time: 3600  
Real time: 3652  
Dead time: 1.44 %  
Detector ID: 5

Detector system  
Ge 5 SN/157

Calibration

Filename: 5\_Soil\_TunaCan.Clb  
5\_Soil\_TunaCan\_90099\_032612

Energy Calibration

Created: 3/27/2012 5:20:02 PM  
Zero offset: 0.135 keV  
Gain: 0.250 keV/channel  
Quadratic: 2.720E-08 keV/channel^2

Efficiency Calibration

Created: 3/27/2012 5:20:37 PM  
Knee Energy: 165.85 keV  
Above the Knee: Quadratic Uncertainty = 0.87 %  
Log(Eff):  $6.466115E-01 + (-7.830454E-01 * \text{Log}(E)) + (-4.117504E-03 * \text{Log}(E)^2)$   
Below the Knee: Quadratic Uncertainty = 1.43 %  
Log(Eff):  $-2.462251E+01 + (9.075211E+00 * \text{Log}(E)) + (-9.664422E-01 * \text{Log}(E)^2)$

Library Files

Main analysis library: DET\_EnergyStandardMix & Pb.Lib  
Library Match Width: 0.500  
Peak stripping: Library based

Analysis parameters

Analysis engine: Env32 G53W4.25  
Start channel: 150 ( 37.61keV )  
Stop channel: 8000 ( 2000.53keV )  
Peak rejection level: 10.000%  
Peak search sensitivity: 3  
Sample Size: 1.0000E+00  
Activity scaling factor:  $1.0000E+00 / (1.0000E+00 * 1.0000E+00) = 1.0000E+00$   
Detection limit method: Reg. Guide 4.16 Method

ORTEC g v - i (1087) Env32 G53W4.25 3/27/2012 5:22:03 PM  
 TestAmerica Spectrum name: 5\_TunaCan\_20120810.An1

Random error: 4.0000000E+00  
 Systematic error: 4.0000000E+00  
 Fraction Limit: 0.000%  
 Background width: average of three points.  
 Half lives decay limit: 12.000  
 Activity range factor: 2.000  
 Min. step backg. energy 0.000  
 Multiplet shift channel 2.000

| Corrections                   | Status | Comments             |
|-------------------------------|--------|----------------------|
| Decay correct to date:        | YES    | 1/1/2012 11:00:00 AM |
| Decay during acquisition:     | NO     |                      |
| Decay during collection:      | NO     |                      |
| True coincidence correction:  | NO     |                      |
| Peaked background correction: | NO     |                      |
| Absorption (Internal):        | NO     |                      |
| Geometry correction:          | NO     |                      |
| Random summing:               | NO     |                      |

total peaks alloc. 12 cutoff: 5.00E+01%  
 Energy Calibration  
 Normalized diff: 0.0527

\*\*\*\*\* S U M M A R Y O F P E A K S I N R A N G E \*\*\*\*\*

| Peak<br>Energy | Area   | Uncert | FWHM | Corrctn<br>Factor | Nuclide<br>Energy | Brnch.<br>Ratio | Act.<br>Bq | Nuc    |
|----------------|--------|--------|------|-------------------|-------------------|-----------------|------------|--------|
| 46.61          | 38986. | 0.74   | 0.74 | 1.793E-02         | 46.54             | 4.250           | 1.435E+04  | Pb210  |
| 59.56          | 40041. | 0.74   | 0.74 | 2.535E-02         | 59.54             | 35.700          | 1.230E+03  | AM241  |
| 70.85          | 1493.  | 9.22   | 0.78 | 3.019E-02         |                   |                 |            |        |
| 72.87          | 2354.  | 5.96   | 0.78 | 3.089E-02         |                   |                 |            |        |
| 87.95          | 63754. | 0.53   | 0.80 | 3.460E-02         | 88.03             | 3.610           | 1.610E+04  | CD109  |
| 121.94         | 30888. | 0.76   | 0.85 | 3.583E-02         | 122.06            | 85.600          | 3.477E+02  | CO57   |
| 136.41         | 3768.  | 3.80   | 0.89 | 3.457E-02         |                   |                 |            |        |
| 165.85         | 31597. | 0.74   | 0.88 | 3.066E-02         | 165.85            | 79.900          | 5.384E+02  | Ce139  |
| 279.20         | 20358. | 0.87   | 0.97 | 2.036E-02         | 279.17            | 81.500          | 1.208E+03  | Hg203  |
| 391.78         | 20611. | 0.93   | 1.12 | 1.537E-02         | 391.69            | 64.000          | 9.721E+02  | SN113  |
| 661.74         | 14000. | 1.10   | 1.38 | 9.923E-03         | 661.66            | 85.210          | 4.623E+02  | CS137  |
| 898.01         | 23228. | 0.82   | 1.55 | 7.684E-03         | 898.02            | 93.700          | 1.559E+03  | Y898   |
| 1173.18        | 15468. | 0.93   | 1.77 | 6.138E-03         | 1173.24           | 99.900          | 7.225E+02  | Co1173 |
| 1332.44        | 14238. | 0.98   | 1.93 | 5.515E-03         | 1332.50           | 99.982          | 7.397E+02  | Co1332 |
| 1836.04        | 13938. | 0.87   | 2.30 | 4.208E-03         | 1836.01           | 99.200          | 1.614E+03  | Y1836  |

\*\*\*\*\* U N I D E N T I F I E D P E A K S U M M A R Y \*\*\*\*\*

| Peak Centroid<br>Channel Energy | Background<br>Counts | Net Area<br>Counts | Efficiency<br>* Area | Uncert<br>1 Sigma % | FWHM<br>keV | Suspected<br>Nuclide |
|---------------------------------|----------------------|--------------------|----------------------|---------------------|-------------|----------------------|
| 291.16 72.88                    | 8722.                | 2253.              | 7.295E+04            | 7.09                | 0.801       | -                    |
| 545.44 136.41                   | 5274.                | 3768.              | 1.090E+05            | 3.80                | 0.888       | -                    |

s - Peak fails shape tests.  
 D - Peak area deconvoluted.  
 L - Peak written from unknown list.  
 C - Area < Critical level.

-----  
 This section based on library: DET\_EnergyStandardMix & Pb.Lib

\*\*\*\*\* I D E N T I F I E D P E A K S U M M A R Y \*\*\*\*\*

| Nuclide | Peak<br>Channel | Centroid<br>Energy | Background<br>Counts | Net Area<br>Counts | Intensity<br>Cts/Sec | Uncert<br>1 Sigma % | FWHM<br>keV |
|---------|-----------------|--------------------|----------------------|--------------------|----------------------|---------------------|-------------|
| Pb-210  | 186.01          | 46.61              | 12895.               | 38986.             | 10.829               | 0.74                | 0.743       |
| AM-241  | 237.86          | 59.56              | 13293.               | 40041.             | 11.122               | 0.74                | 0.735       |
| CD-109  | 351.46          | 87.95              | 12894.               | 63754.             | 17.710               | 0.53                | 0.805       |
| CO-57   | 487.52          | 121.94             | 6935.                | 30888.             | 8.580                | 0.76                | 0.852       |
| Ce-139  | 663.26          | 165.85             | 5616.                | 31597.             | 8.777                | 0.74                | 0.883       |
| Hg-203  | 1116.90         | 279.20             | 2848.                | 20358.             | 5.655                | 0.87                | 0.966       |
| SN-113  | 1567.36         | 391.78             | 3046.                | 20611.             | 5.725                | 0.93                | 1.119       |
| CS-137  | 2647.45         | 661.74             | 1982.                | 14000.             | 3.889                | 1.10                | 1.380       |
| Y-898   | 3592.51         | 898.01             | 1944.                | 23228.             | 6.452                | 0.82                | 1.547       |
| Co-1173 | 4692.96         | 1173.18            | 847.                 | 15468.             | 4.297                | 0.93                | 1.774       |
| Co-1332 | 5329.75         | 1332.44            | 693.                 | 14238.             | 3.955                | 0.98                | 1.927       |
| Y-1836  | 7342.72         | 1836.04            | 102.                 | 13938.             | 3.872                | 0.87                | 2.295       |

s - Peak fails shape tests.  
 D - Peak area deconvoluted.  
 A - Derived peak area.

\*\*\*\*\* S U M M A R Y O F L I B R A R Y P E A K U S A G E \*\*\*\*\*

| - Nuclide -<br>Name | - Average<br>Code | Activity<br>Bq | Energy<br>keV | Activity<br>Bq | Peak<br>Code | MDA Value<br>Bq | COMMENTS                        |
|---------------------|-------------------|----------------|---------------|----------------|--------------|-----------------|---------------------------------|
| Pb-210              | N                 | 1.4353E+04     | 46.54         | 1.435E+04      | (            | 1.958E+02       | 8.15E+03<br>7.44E-01 4.25E+00 G |
| AM-241              |                   | 1.2302E+03     | 59.54         | 1.230E+03      | (            | 1.659E+01       | 1.58E+05<br>7.44E-01 3.57E+01 G |
| CD-109              |                   | 1.6101E+04     | 88.03         | 1.610E+04      | (            | 1.343E+02       | 4.63E+02<br>5.28E-01 3.61E+00 G |
| CO-57               |                   | 3.4772E+02     | 122.06        | 3.477E+02      | (            | 4.399E+00       | 2.72E+02<br>7.60E-01 8.56E+01 G |

| Nuclide | Ave activity | Energy  | Activity  | Code | Peak      | MDA      | Comments               |
|---------|--------------|---------|-----------|------|-----------|----------|------------------------|
| Ce-139  | 5.3840E+02   | 165.85  | 5.384E+02 | (    | 5.997E+00 | 7.36E-01 | 1.38E+02<br>7.99E+01 G |
| Hg-203  | 1.2084E+03   | 279.17  | 1.208E+03 | (    | 1.492E+01 | 8.69E-01 | 4.66E+01<br>8.15E+01 G |
| SN-113  | 9.7207E+02   | 391.69  | 9.721E+02 | (    | 1.226E+01 | 9.31E-01 | 1.15E+02<br>6.40E+01 G |
| CS-137  | 4.6235E+02   | 661.66  | 4.623E+02 | (    | 6.941E+00 | 1.10E+00 | 1.10E+04<br>8.52E+01 G |
| Y-898   | 1.5593E+03   | 898.02  | 1.559E+03 | (    | 1.397E+01 | 8.19E-01 | 1.07E+02<br>9.37E+01 G |
| Co-1173 | 7.2251E+02   | 1173.24 | 7.225E+02 | (    | 6.463E+00 | 9.30E-01 | 1.93E+03<br>9.99E+01 G |
| Co-1332 | 7.3967E+02   | 1332.50 | 7.397E+02 | (    | 6.515E+00 | 9.82E-01 | 1.93E+03<br>1.00E+02 G |
| Y-1836  | 1.6138E+03   | 1836.01 | 1.614E+03 | (    | 5.776E+00 | 8.71E-01 | 1.07E+02<br>9.92E+01 G |

( - This peak used in the nuclide activity average.

- \* - Peak is too wide, but only one peak in library.
- ! - Peak is part of a multiplet and this area went negative during deconvolution.
- ? - Peak is too narrow.
- @ - Peak is too wide at FW25M, but ok at FWHM.
- % - Peak fails sensitivity test.
- \$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.
- + - Peak activity higher than counting uncertainty range.
- - Peak activity lower than counting uncertainty range.
- = - Peak outside analysis energy range.
- & - Calculated peak centroid is not close enough to the library energy centroid for positive identification.
- P - Peakbackground subtraction
- } - Peak is too close to another for the activity to be found directly.

Nuclide Codes:

T - Thermal Neutron Activation  
 F - Fast Neutron Activation  
 I - Fission Product  
 N - Naturally Occurring Isotope

Peak Codes:

G - Gamma Ray  
 X - X-Ray  
 P - Positron Decay  
 S - Single-Escape

ORTEC g v - i (1087) Env32 G53W4.25 3/27/2012 5:22:03 PM  
 TestAmerica Spectrum name: 5\_TunaCan\_20120810.An1

P - Photon Reaction                      D - Double-Escape  
 C - Charged Particle Reaction          K - Key Line  
 M - No MDA Calculation                A - Not in Average  
 R - Coincidence Corrected            C - Coincidence Peak  
 H - Halflife limit exceeded

\*\*\*\*\* D I S C A R D E D I S O T O P E P E A K S \*\*\*\*\*  
 Nuclide Centroid Background Net Area Intensity Uncert Activity  
           Energy        Counts        Counts        Cts/Sec 1 Sigma %

P - Peakbackground subtraction

\*\*\*\*\* S U M M A R Y O F N U C L I D E S I N S A M P L E \*\*\*\*\*  
           Time of Count    Time Corrected    Uncertainty    1 Sigma  
 Nuclide        Activity        Activity        Counting                    MDA  
                  Bq                    Bq

|         |            |            |            |          |
|---------|------------|------------|------------|----------|
| Pb-210  | 1.4250E+04 | 1.4353E+04 | 7.439E-01% | 1.96E+02 |
| AM-241  | 1.2297E+03 | 1.2302E+03 | 7.442E-01% | 1.66E+01 |
| CD-109  | 1.4172E+04 | 1.6101E+04 | 5.277E-01% | 1.34E+02 |
| CO-57   | 2.7983E+02 | 3.4772E+02 | 7.604E-01% | 4.40E+00 |
| Ce-139  | 3.5061E+02 | 5.3840E+02 | 7.359E-01% | 6.00E+00 |
| Hg-203  | 3.4071E+02 | 1.2084E+03 | 8.687E-01% | 1.49E+01 |
| SN-113  | 5.8200E+02 | 9.7207E+02 | 9.315E-01% | 1.23E+01 |
| CS-137  | 4.5987E+02 | 4.6235E+02 | 1.097E+00% | 6.94E+00 |
| Y-898   | 8.9620E+02 | 1.5593E+03 | 8.189E-01% | 1.40E+01 |
| Co-1173 | 7.0069E+02 | 7.2251E+02 | 9.300E-01% | 6.46E+00 |
| Co-1332 | 7.1733E+02 | 7.3967E+02 | 9.821E-01% | 6.52E+00 |
| Y-1836  | 9.2756E+02 | 1.6138E+03 | 8.711E-01% | 5.78E+00 |

< - MDA value printed.  
 A - Activity printed, but activity < MDA.  
 B - Activity < MDA and failed test.  
 C - Area < Critical level.  
 F - Failed fraction or key line test.  
 H - Halflife limit exceeded

----- S U M M A R Y -----  
 Total Activity ( 37.6 to 2000.5 keV) 3.491E+04 Bq  
 Total Decayed Activity ( 37.6 to 2000.5 keV) 3.9848164E+04 Bq

Analyzed by: \_\_\_\_\_  
                                   Admin

Reviewed by: \_\_\_\_\_  
                                   Supervisor

Laboratory: TestAmerica

## Gamma Verification per Geometry

Detector: Ge7

Geometry: Tunacan

Reference date 1/1/2012

Calibration Standard: 90099

Standard volume g / vial 1550

Standard volume transferred in g / geometry 317.8

lab ID# of cal standard 6699

| Isotope | Certified Activity<br>gammas/sec | Geometry<br>Activity<br>gammas/sec | $\gamma$ abundance | Bq/sample | Count<br>Results | %recovery |
|---------|----------------------------------|------------------------------------|--------------------|-----------|------------------|-----------|
| Pb-210  | 3094                             | 634                                | 0.0425             | 14926     | 14726            | 98.7      |
| Am-241  | 2037                             | 418                                | 0.3590             | 1163      | 1241.6           | 106.7     |
| Cd-109  | 2881                             | 591                                | 0.0361             | 16363     | 15976            | 97.6      |
| Co-57   | 1511                             | 310                                | 0.8560             | 362       | 346.77           | 95.8      |
| Ce-139  | 2139                             | 439                                | 0.7990             | 549       | 539.48           | 98.3      |
| Hg-203  | 4651                             | 954                                | 0.8146             | 1171      | 1199.2           | 102.4     |
| Sn-113  | 3015                             | 618                                | 0.6400             | 966       | 976.76           | 101.1     |
| Cs-137  | 1938                             | 397                                | 0.8510             | 467       | 467.66           | 100.2     |
| Y-88    | 7264                             | 1489                               | 0.9370             | 1589      | 1567.3           | 98.6      |
| Co-60   | 3580                             | 734                                | 0.9997             | 734       | 726.23           | 98.9      |
| Co-60   | 3581                             | 734                                | 0.9999             | 734       | 719.64           | 98.0      |
| Y-88    | 7690                             | 1577                               | 0.9920             | 1589      | 1635.7           | 102.9     |

Reviewed By: Jody WatsonDate: 3/16/2012

Calibration Data from file: 7\_Soil\_TunaCan.Clb  
 Energy Calibration Date: 3/16/2012 Time: 11:44:50 AM  
 Efficiency Calibration Date: 3/16/2012 Time: 11:45:14 AM

Calibration Description:  
 7\_TunaCan\_90099\_030512

#### Energy Calibration Fit

Energy = 0.1533 +0.249954\*Channel +6.71576e-009\*Channel\*\*2  
 FWHM (ch) = 3.2969 +0.001030\*Channel -2.25091e-008\*Channel\*\*2

#### Energy/FWHM Table

| Channel | Energy(keV) | Fit(keV) | Delta  | FWHM(keV) | Fit(keV) | Delta  |
|---------|-------------|----------|--------|-----------|----------|--------|
| 185.73  | 46.54       | 46.58    | -0.08% | 0.86      | 0.87     | -1.80% |
| 237.72  | 59.54       | 59.57    | -0.06% | 0.86      | 0.88     | -3.29% |
| 351.56  | 88.03       | 88.03    | 0.00%  | 0.91      | 0.91     | -0.17% |
| 487.42  | 122.06      | 121.99   | 0.06%  | 0.97      | 0.95     | 2.36%  |
| 662.55  | 165.85      | 165.76   | 0.05%  | 1.00      | 0.99     | 1.26%  |
| 1116.52 | 279.17      | 279.24   | -0.03% | 1.13      | 1.10     | 1.85%  |
| 1566.54 | 391.69      | 391.73   | -0.01% | 1.21      | 1.21     | -0.23% |
| 2646.25 | 661.66      | 661.64   | 0.00%  | 1.47      | 1.47     | 0.54%  |
| 3591.85 | 898.02      | 898.04   | -0.00% | 1.66      | 1.68     | -1.15% |
| 4692.53 | 1173.24     | 1173.22  | 0.00%  | 1.92      | 1.91     | 0.69%  |
| 5329.58 | 1332.50     | 1332.49  | 0.00%  | 2.02      | 2.04     | -0.87% |
| 7343.37 | 1836.01     | 1836.02  | -0.00% | 2.42      | 2.41     | 0.28%  |

#### Efficiency Calibration Fit

Knee Energy = 165.85 keV  
 Above the Knee: Quadratic Uncertainty = 0.8690 %  
 Ln(Eff) = 0.6717 -0.616654\*Ln(Eng) -0.0206592\*(Ln(Eng))\*\*2  
 Below the Knee: Quadratic Uncertainty = 1.4845 %  
 Ln(Eff) = -26.8969 +10.195443\*Ln(Eng) -1.08167\*(Ln(Eng))\*\*2

#### Efficiency Table

| Energy  | Efficiency       | Fit         | Delta  |
|---------|------------------|-------------|--------|
| 46.54   | 2.3732E-002      | 2.4829E-002 | -4.62% |
| 59.54   | 3.9252E-002      | 3.7016E-002 | 5.70%  |
| 88.03   | 5.1999E-002      | 5.3285E-002 | -2.47% |
| 122.06  | 5.3679E-002      | 5.6057E-002 | -4.43% |
| 165.85  | ===== Knee ===== |             |        |
| 165.85  | 4.7932E-002      | 4.8811E-002 | -1.83% |
| 279.17  | 3.2322E-002      | 3.1541E-002 | 2.42%  |
| 391.69  | 2.3837E-002      | 2.3601E-002 | 0.99%  |
| 661.66  | 1.4947E-002      | 1.4924E-002 | 0.15%  |
| 898.02  | 1.1205E-002      | 1.1367E-002 | -1.45% |
| 1173.24 | 8.8255E-003      | 8.9287E-003 | -1.17% |
| 1332.50 | 7.7833E-003      | 7.9508E-003 | -2.15% |
| 1836.01 | 6.0876E-003      | 5.9192E-003 | 2.77%  |

#### Calibration Certificate Table

| Isotope | Energy  | Pct   | Halflife  | Activity | GPS     | Error | Date & Time |          |    |
|---------|---------|-------|-----------|----------|---------|-------|-------------|----------|----|
| Pb-210  | 46.54   | 4.25  | 8.15E+003 | 14941.00 | 635.00  | 4.10% | 1/1/2012    | 11:00:00 | AM |
| Am-241  | 59.54   | 35.70 | 1.58E+005 | 1170.90  | 418.00  | 3.50% | 1/1/2012    | 11:00:00 | AM |
| Cd-109  | 88.03   | 3.61  | 4.63E+002 | 16371.00 | 591.00  | 4.70% | 1/1/2012    | 11:00:00 | AM |
| Co-57   | 122.06  | 85.60 | 2.72E+002 | 362.15   | 310.00  | 4.10% | 1/1/2012    | 11:00:00 | AM |
| Ce-139  | 165.85  | 79.90 | 1.38E+002 | 549.44   | 439.00  | 3.90% | 1/1/2012    | 11:00:00 | AM |
| Hg-203  | 279.17  | 81.50 | 4.66E+001 | 1170.60  | 954.00  | 3.80% | 1/1/2012    | 11:00:00 | AM |
| Sn-113  | 391.69  | 64.00 | 1.15E+002 | 967.19   | 619.00  | 3.90% | 1/1/2012    | 11:00:00 | AM |
| Cs-137  | 661.66  | 85.21 | 1.10E+004 | 467.08   | 398.00  | 4.00% | 1/1/2012    | 11:00:00 | AM |
| Y-88    | 898.02  | 93.70 | 1.07E+002 | 1590.20  | 1490.00 | 3.90% | 1/1/2012    | 11:00:00 | AM |
| Co-60   | 1173.24 | 99.90 | 1.93E+003 | 734.73   | 734.00  | 4.00% | 1/1/2012    | 11:00:00 | AM |
| Co-60   | 1332.50 | 99.98 | 1.93E+003 | 735.15   | 735.00  | 4.00% | 1/1/2012    | 11:00:00 | AM |
| Y-88    | 1836.01 | 99.20 | 1.07E+002 | 1590.70  | 1578.00 | 4.00% | 1/1/2012    | 11:00:00 | AM |

ORTEC g v - i (1087) Env32 G53W4.25 2/28/2014 11:43:43 AM  
TestAmerica Spectrum name: 7\_TunaCan\_20120388.An1

Sample description  
7\_TunaCan\_90099\_030512

Spectrum Filename: C:\User\SPC\Det7\7\_TunaCan\_20120388.An1

Acquisition information

Start time: 3/5/2012 2:07:36 PM  
Live time: 3600  
Real time: 3721  
Dead time: 3.25 %  
Detector ID: 7

Detector system  
Ge 7 SN/154

Calibration

Filename: 7\_Soil\_TunaCan.Clb  
7\_TunaCan\_90099\_032712

Energy Calibration

Created: 3/16/2012 11:44:50 AM  
Zero offset: 0.153 keV  
Gain: 0.250 keV/channel  
Quadratic:  $6.716\text{E-}09 \text{ keV/channel}^2$

Efficiency Calibration

Created: 3/16/2012 11:45:14 AM  
Knee Energy: 165.85 keV  
Above the Knee: Quadratic Uncertainty = 0.87 %  
Log(Eff):  $6.716580\text{E-}01 + (-6.166540\text{E-}01 * \text{Log}(E)) + (-2.065917\text{E-}02 * \text{Log}(E)^2)$   
Below the Knee: Quadratic Uncertainty = 1.48 %  
Log(Eff):  $-2.689695\text{E+}01 + (1.019544\text{E+}01 * \text{Log}(E)) + (-1.081671\text{E+}00 * \text{Log}(E)^2)$

Library Files

Main analysis library: DET\_EnergyStandardMix & Pb.Lib  
Library Match Width: 0.500  
Peak stripping: Library based

Analysis parameters

Analysis engine: Env32 G53W4.25  
Start channel: 150 ( 37.65keV )  
Stop channel: 8000 ( 2000.21keV )  
Peak rejection level: 10.000%  
Peak search sensitivity: 3  
Sample Size: 1.0000E+00  
Activity scaling factor:  $1.0000\text{E+}00 / (1.0000\text{E+}00 * 1.0000\text{E+}00) = 1.0000\text{E+}00$   
Detection limit method: Reg. Guide 4.16 Method

ORTEC g v - i (1087) Env32 G53W4.25 2/28/2014 11:43:43 AM  
 TestAmerica Spectrum name: 7\_TunaCan\_20120388.An1

Random error: 4.0000000E+00  
 Systematic error: 4.0000000E+00  
 Fraction Limit: 0.000%  
 Background width: average of three points.  
 Half lives decay limit: 12.000  
 Activity range factor: 2.000  
 Min. step backg. energy 0.000  
 Multiplet shift channel 2.000

| Corrections                   | Status | Comments             |
|-------------------------------|--------|----------------------|
| Decay correct to date:        | YES    | 1/1/2012 11:00:00 AM |
| Decay during acquisition:     | NO     |                      |
| Decay during collection:      | NO     |                      |
| True coincidence correction:  | NO     |                      |
| Peaked background correction: | NO     |                      |
| Absorption (Internal):        | NO     |                      |
| Geometry correction:          | NO     |                      |
| Random summing:               | NO     |                      |

total peaks alloc. 12 cutoff: 5.00E+01%  
 Energy Calibration  
 Normalized diff: 0.0324

\*\*\*\*\* S U M M A R Y O F P E A K S I N R A N G E \*\*\*\*\*

| Peak<br>Energy | Area    | Uncert | FWHM | Corrctn<br>Factor | Nuclide<br>Energy | Brnch.<br>Ratio | Act.<br>Bq | Nuc    |
|----------------|---------|--------|------|-------------------|-------------------|-----------------|------------|--------|
| 46.63          | 53946.  | 0.53   | 0.87 | 2.487E-02         | 46.54             | 4.250           | 1.428E+04  | Pb210  |
| 59.57          | 59050.  | 0.65   | 0.86 | 3.704E-02         | 59.54             | 35.700          | 1.242E+03  | AM241  |
| 70.74          | 2770.   | 6.58   | 0.90 | 4.527E-02         |                   |                 |            |        |
| 72.95          | 4536.   | 4.27   | 0.90 | 4.661E-02         |                   |                 |            |        |
| 88.03          | 100494. | 0.43   | 0.91 | 5.328E-02         | 88.03             | 3.610           | 1.598E+04  | CD109  |
| 121.99         | 50865.  | 0.71   | 0.97 | 5.606E-02         | 122.06            | 85.600          | 3.468E+02  | CO57   |
| 136.41         | 6524.   | 3.77   | 0.93 | 5.411E-02         |                   |                 |            |        |
| 165.76         | 54838.  | 0.57   | 1.00 | 4.767E-02         | 165.85            | 79.900          | 5.395E+02  | Ce139  |
| 255.13         | 1772.   | 7.37   | 1.21 | 3.404E-02         |                   |                 |            |        |
| 279.24         | 42776.  | 0.59   | 1.13 | 3.153E-02         | 279.17            | 81.500          | 1.199E+03  | Hg203  |
| 391.73         | 36096.  | 0.66   | 1.21 | 2.360E-02         | 391.69            | 64.000          | 9.768E+02  | SN113  |
| 661.68         | 21323.  | 0.77   | 1.47 | 1.492E-02         | 661.66            | 85.210          | 4.677E+02  | CS137  |
| 898.03         | 39603.  | 0.63   | 1.66 | 1.137E-02         | 898.02            | 93.700          | 1.567E+03  | Y898   |
| 1173.21        | 22788.  | 0.85   | 1.92 | 8.929E-03         | 1173.24           | 99.900          | 7.262E+02  | Co1173 |
| 1332.49        | 20124.  | 0.85   | 2.02 | 7.951E-03         | 1332.50           | 99.982          | 7.196E+02  | Co1332 |
| 1836.00        | 22787.  | 0.70   | 2.43 | 5.919E-03         | 1836.01           | 99.200          | 1.636E+03  | Y1836  |

\*\*\*\*\* U N I D E N T I F I E D P E A K S U M M A R Y \*\*\*\*\*

| Peak<br>Channel | Centroid<br>Energy | Background<br>Counts | Net Area<br>Counts | Efficiency<br>* Area | Uncert<br>1 Sigma | FWHM<br>% | Suspected<br>Nuclide |
|-----------------|--------------------|----------------------|--------------------|----------------------|-------------------|-----------|----------------------|
| 282.41          | 70.73              | 15146.               | 2828.              | 6.248E+04            | 6.43              | 0.896     | - D                  |
| 291.25          | 72.94              | 16305.               | 4682.              | 1.005E+05            | 4.12              | 0.899     | - D                  |
| 545.11          | 136.41             | 12980.               | 6524.              | 1.206E+05            | 3.77              | 0.932     | -                    |
| 1020.07         | 255.13             | 4580.                | 1772.              | 5.204E+04            | 7.37              | 1.209     | -                    |

s - Peak fails shape tests.  
 D - Peak area deconvoluted.  
 L - Peak written from unknown list.  
 C - Area < Critical level.

-----  
 This section based on library: DET\_EnergyStandardMix & Pb.Lib

| ***** I D E N T I F I E D P E A K S U M M A R Y ***** |              |                 |                   |                 |                   |                  |          |
|-------------------------------------------------------|--------------|-----------------|-------------------|-----------------|-------------------|------------------|----------|
| Nuclide                                               | Peak Channel | Centroid Energy | Background Counts | Net Area Counts | Intensity Cts/Sec | Uncert 1 Sigma % | FWHM keV |
| Pb-210                                                | 185.73       | 46.58           | 19825.            | 55636.          | 15.454            | 0.65             | 0.856    |
| AM-241                                                | 237.72       | 59.57           | 21942.            | 59050.          | 16.403            | 0.65             | 0.857    |
| CD-109                                                | 351.56       | 88.03           | 21396.            | 100494.         | 27.915            | 0.43             | 0.912    |
| CO-57                                                 | 487.42       | 121.99          | 16859.            | 50865.          | 14.129            | 0.71             | 0.971    |
| Ce-139                                                | 662.55       | 165.76          | 9893.             | 54838.          | 15.233            | 0.57             | 1.005    |
| Hg-203                                                | 1116.52      | 279.24          | 5111.             | 42776.          | 11.882            | 0.59             | 1.126    |
| SN-113                                                | 1566.54      | 391.73          | 4106.             | 36096.          | 10.027            | 0.66             | 1.211    |
| CS-137                                                | 2646.33      | 661.66          | 2922.             | 21323.          | 5.923             | 0.77             | 1.466D   |
| Y-898                                                 | 3591.84      | 898.03          | 3210.             | 39603.          | 11.001            | 0.63             | 1.659    |
| Co-1173                                               | 4692.50      | 1173.21         | 1804.             | 22788.          | 6.330             | 0.85             | 1.924    |
| Co-1332                                               | 5329.58      | 1332.49         | 1286.             | 20124.          | 5.590             | 0.85             | 2.020    |
| Y-1836                                                | 7343.30      | 1836.00         | 283.              | 22787.          | 6.330             | 0.70             | 2.426    |

s - Peak fails shape tests.  
 D - Peak area deconvoluted.  
 A Derived peak area.

| ***** S U M M A R Y O F L I B R A R Y P E A K U S A G E ***** |         |                  |            |             |      |              |                              |
|---------------------------------------------------------------|---------|------------------|------------|-------------|------|--------------|------------------------------|
| - Nuclide -                                                   | Average | ----- Peak ----- |            |             |      |              |                              |
| Name                                                          | Code    | Activity Bq      | Energy keV | Activity Bq | Code | MDA Value Bq | COMMENTS                     |
| Pb-210                                                        | N       | 1.4726E+04       |            |             |      |              |                              |
|                                                               |         |                  | 46.54      | 1.473E+04   | (    | 1.744E+02    | 8.15E+03 6.52E-01 4.25E+00 G |
| AM-241                                                        |         | 1.2416E+03       |            |             |      |              |                              |
|                                                               |         |                  | 59.54      | 1.242E+03   | (    | 1.457E+01    | 1.58E+05 6.49E-01 3.57E+01 G |
| CD-109                                                        |         | 1.5976E+04       |            |             |      |              |                              |
|                                                               |         |                  | 88.03      | 1.598E+04   | (    | 1.088E+02    | 4.63E+02 4.29E-01 3.61E+00 G |
| CO-57                                                         |         | 3.4677E+02       |            |             |      |              |                              |
|                                                               |         |                  | 122.06     | 3.468E+02   | (    | 4.144E+00    | 2.72E+02 7.08E-01 8.56E+01 G |

| Nuclide | Ave activity | Energy  | Activity  | Code | Peak      | MDA      | Comments               |
|---------|--------------|---------|-----------|------|-----------|----------|------------------------|
| Ce-139  | 5.3948E+02   | 165.85  | 5.395E+02 | (    | 4.586E+00 | 5.65E-01 | 1.38E+02<br>7.99E+01 G |
| Hg-203  | 1.1992E+03   | 279.17  | 1.199E+03 | (    | 9.415E+00 | 5.92E-01 | 4.66E+01<br>8.15E+01 G |
| SN-113  | 9.7676E+02   | 391.69  | 9.768E+02 | (    | 8.153E+00 | 6.55E-01 | 1.15E+02<br>6.40E+01 G |
| CS-137  | 4.6766E+02   | 661.66  | 4.677E+02 | (    | 5.584E+00 | 7.73E-01 | 1.10E+04<br>8.52E+01 G |
| Y-898   | 1.5673E+03   | 898.02  | 1.567E+03 | (    | 1.056E+01 | 6.29E-01 | 1.07E+02<br>9.37E+01 G |
| Co-1173 | 7.2623E+02   | 1173.24 | 7.262E+02 | (    | 6.394E+00 | 8.53E-01 | 1.93E+03<br>9.99E+01 G |
| Co-1332 | 7.1964E+02   | 1332.50 | 7.196E+02 | (    | 6.072E+00 | 8.54E-01 | 1.93E+03<br>1.00E+02 G |
| Y-1836  | 1.6357E+03   | 1836.01 | 1.636E+03 | (    | 5.819E+00 | 7.02E-01 | 1.07E+02<br>9.92E+01 G |

( - This peak used in the nuclide activity average.

- \* - Peak is too wide, but only one peak in library.
- ! - Peak is part of a multiplet and this area went negative during deconvolution.
- ? - Peak is too narrow.
- @ - Peak is too wide at FW25M, but ok at FWHM.
- % - Peak fails sensitivity test.
- \$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.
- + - Peak activity higher than counting uncertainty range.
- - Peak activity lower than counting uncertainty range.
- = - Peak outside analysis energy range.
- & - Calculated peak centroid is not close enough to the library energy centroid for positive identification.
- P - Peakbackground subtraction
- } - Peak is too close to another for the activity to be found directly.

#### Nuclide Codes:

T - Thermal Neutron Activation  
 F - Fast Neutron Activation  
 I - Fission Product  
 N - Naturally Occurring Isotope

#### Peak Codes:

G - Gamma Ray  
 X - X-Ray  
 P - Positron Decay  
 S - Single-Escape

ORTEC g v - i (1087) Env32 G53W4.25 2/28/2014 11:43:43 AM  
 TestAmerica Spectrum name: 7\_TunaCan\_20120388.An1

P - Photon Reaction D - Double-Escape  
 C - Charged Particle Reaction K - Key Line  
 M - No MDA Calculation A - Not in Average  
 R - Coincidence Corrected C - Coincidence Peak  
 H - Halflife limit exceeded

\*\*\*\*\* D I S C A R D E D I S O T O P E P E A K S \*\*\*\*\*  
 Nuclide Centroid Background Net Area Intensity Uncert Activity  
 Energy Counts Counts Cts/Sec 1 Sigma %

P - Peakbackground subtraction

\*\*\*\*\* S U M M A R Y O F N U C L I D E S I N S A M P L E \*\*\*\*\*  
 Time of Count Time Corrected Uncertainty 1 Sigma  
 Nuclide Activity Activity Counting MDA  
 Bq Bq

|         |            |            |            |          |
|---------|------------|------------|------------|----------|
| Pb-210  | 1.4646E+04 | 1.4726E+04 | 6.521E-01% | 1.74E+02 |
| AM-241  | 1.2413E+03 | 1.2416E+03 | 6.489E-01% | 1.46E+01 |
| CD-109  | 1.4512E+04 | 1.5976E+04 | 4.292E-01% | 1.09E+02 |
| CO-57   | 2.9445E+02 | 3.4677E+02 | 7.076E-01% | 4.14E+00 |
| Ce-139  | 3.9059E+02 | 5.3948E+02 | 5.652E-01% | 4.59E+00 |
| Hg-203  | 4.6224E+02 | 1.1992E+03 | 5.917E-01% | 9.42E+00 |
| SN-113  | 6.6381E+02 | 9.7676E+02 | 6.552E-01% | 8.15E+00 |
| CS-137  | 4.6577E+02 | 4.6766E+02 | 7.730E-01% | 5.58E+00 |
| Y-898   | 1.0329E+03 | 1.5673E+03 | 6.291E-01% | 1.06E+01 |
| Co-1173 | 7.0966E+02 | 7.2623E+02 | 8.534E-01% | 6.39E+00 |
| Co-1332 | 7.0321E+02 | 7.1964E+02 | 8.542E-01% | 6.07E+00 |
| Y-1836  | 1.0780E+03 | 1.6357E+03 | 7.017E-01% | 5.82E+00 |

< - MDA value printed.  
 A - Activity printed, but activity < MDA.  
 B - Activity < MDA and failed test.  
 C - Area < Critical level.  
 F - Failed fraction or key line test.  
 H - Halflife limit exceeded

----- S U M M A R Y -----  
 Total Activity ( 701.8 to 2000.2 keV) 3.620E+04 Bq  
 Total Decayed Activity ( 701.8 to 2000.2 keV) 4.0121711E+04 Bq

Analyzed by: \_\_\_\_\_  
 Admin

Reviewed by: \_\_\_\_\_  
 Supervisor

Laboratory: TestAmerica

## Gamma Verification per Geometry

Detector: Ge8

Geometry: Tunacan

Reference date 1/1/2012

Calibration Standard: 90099

Standard volume g / vial 1550

Standard volume transferred in g / geometry 317.8

lab ID# of cal standard 6699

| Isotope | Certified Activity<br>gammas/sec | Geometry<br>Activity<br>gammas/sec | $\gamma$ abundance | Bq/sample | Count<br>Results | %recovery |
|---------|----------------------------------|------------------------------------|--------------------|-----------|------------------|-----------|
| Pb-210  | 3094                             | 634                                | 0.0425             | 14926     | 14960            | 100.2     |
| Am-241  | 2037                             | 418                                | 0.3590             | 1163      | 1240.5           | 106.6     |
| Cd-109  | 2881                             | 591                                | 0.0361             | 16363     | 16066            | 98.2      |
| Co-57   | 1511                             | 310                                | 0.8560             | 362       | 345.12           | 95.4      |
| Ce-139  | 2139                             | 439                                | 0.7990             | 549       | 536.34           | 97.7      |
| Hg-203  | 4651                             | 954                                | 0.8146             | 1171      | 1218.2           | 104.1     |
| Sn-113  | 3015                             | 618                                | 0.6400             | 966       | 967.15           | 100.1     |
| Cs-137  | 1938                             | 397                                | 0.8510             | 467       | 465.86           | 99.8      |
| Y-88    | 7264                             | 1489                               | 0.9370             | 1589      | 1552.1           | 97.6      |
| Co-60   | 3580                             | 734                                | 0.9997             | 734       | 724.48           | 98.7      |
| Co-60   | 3581                             | 734                                | 0.9999             | 734       | 729.98           | 99.4      |
| Y-88    | 7690                             | 1577                               | 0.9920             | 1589      | 1627.2           | 102.4     |

Reviewed By: Jody Watson

Date: 3/28/2012

Calibration Data from file: 8\_Soil\_TunaCan.Clb  
 Energy Calibration Date: 3/28/2012 Time: 10:35:07 AM  
 Efficiency Calibration Date: 3/28/2012 Time: 10:35:20 AM

Calibration Description:  
 8\_Soil\_TunaCan\_90099\_032712

#### Energy Calibration Fit

Energy = 0.0505 + 0.250025\*Channel + 8.06699e-010\*Channel\*\*2  
 FWHM (ch) = 3.6351 + 0.000832\*Channel - 2.49195e-008\*Channel\*\*2

#### Energy/FWHM Table

| Channel | Energy(keV) | Fit(keV) | Delta  | FWHM(keV) | Fit(keV) | Delta  |
|---------|-------------|----------|--------|-----------|----------|--------|
| 185.74  | 46.54       | 46.49    | 0.11%  | 0.94      | 0.95     | -0.61% |
| 237.86  | 59.54       | 59.52    | 0.03%  | 0.95      | 0.96     | -1.36% |
| 351.89  | 88.03       | 88.03    | -0.00% | 0.97      | 0.98     | -1.63% |
| 488.04  | 122.06      | 122.07   | -0.01% | 1.01      | 1.01     | 0.12%  |
| 663.26  | 165.85      | 165.88   | -0.02% | 1.07      | 1.04     | 2.17%  |
| 1116.59 | 279.17      | 279.23   | -0.02% | 1.15      | 1.13     | 1.73%  |
| 1566.40 | 391.69      | 391.69   | -0.00% | 1.22      | 1.22     | 0.24%  |
| 2645.92 | 661.66      | 661.60   | 0.01%  | 1.39      | 1.42     | -1.95% |
| 3591.62 | 898.02      | 898.05   | -0.00% | 1.61      | 1.58     | 2.16%  |
| 4692.17 | 1173.24     | 1173.23  | 0.00%  | 1.74      | 1.75     | -0.61% |
| 5329.14 | 1332.50     | 1332.49  | 0.00%  | 1.82      | 1.84     | -1.05% |
| 7342.97 | 1836.01     | 1836.02  | -0.00% | 2.11      | 2.10     | 0.42%  |

#### Efficiency Calibration Fit

Knee Energy = 165.85 keV

Above the Knee: Quadratic Uncertainty = 1.3942 %

Ln(Eff) = -0.1099 - 0.495854\*Ln(Eng) - 0.0257227\*(Ln(Eng))\*\*2

Below the Knee: Quadratic Uncertainty = 1.7131 %

Ln(Eff) = -25.2530 + 9.398253\*Ln(Eng) - 1.00003\*(Ln(Eng))\*\*2

#### Efficiency Table

| Energy  | Efficiency       | Fit         | Delta  |
|---------|------------------|-------------|--------|
| 46.54   | 1.9170E-002      | 2.0055E-002 | -4.62% |
| 59.54   | 3.0526E-002      | 2.8813E-002 | 5.61%  |
| 88.03   | 3.9175E-002      | 3.9918E-002 | -1.90% |
| 122.06  | 3.9509E-002      | 4.1457E-002 | -4.93% |
| 165.85  | ===== Knee ===== |             |        |
| 165.85  | 3.5429E-002      | 3.6291E-002 | -2.43% |
| 279.17  | 2.5270E-002      | 2.4275E-002 | 3.94%  |
| 391.69  | 1.8582E-002      | 1.8550E-002 | 0.17%  |
| 661.66  | 1.2089E-002      | 1.2090E-002 | -0.01% |
| 898.02  | 9.1435E-003      | 9.3604E-003 | -2.37% |
| 1173.24 | 7.3487E-003      | 7.4527E-003 | -1.42% |
| 1332.50 | 6.6398E-003      | 6.6776E-003 | -0.57% |
| 1836.01 | 5.1654E-003      | 5.0457E-003 | 2.32%  |

#### Calibration Certificate Table

| Isotope | Energy  | Pct   | Half-life | Activity | GPS     | Error | Date & Time |             |
|---------|---------|-------|-----------|----------|---------|-------|-------------|-------------|
| Pb-210  | 46.54   | 4.25  | 8.15E+003 | 14918.00 | 634.00  | 4.10% | 1/1/2012    | 11:00:00 AM |
| Am-241  | 59.54   | 35.70 | 1.58E+005 | 1170.90  | 418.00  | 3.50% | 1/1/2012    | 11:00:00 AM |
| Cd-109  | 88.03   | 3.61  | 4.63E+002 | 16371.00 | 591.00  | 4.70% | 1/1/2012    | 11:00:00 AM |
| Co-57   | 122.06  | 85.60 | 2.72E+002 | 362.15   | 310.00  | 4.10% | 1/1/2012    | 11:00:00 AM |
| Ce-139  | 165.85  | 79.90 | 1.38E+002 | 549.44   | 439.00  | 3.90% | 1/1/2012    | 11:00:00 AM |
| Hg-203  | 279.17  | 81.50 | 4.66E+001 | 1170.60  | 954.00  | 3.80% | 1/1/2012    | 11:00:00 AM |
| Sn-113  | 391.69  | 64.00 | 1.15E+002 | 965.63   | 618.00  | 3.90% | 1/1/2012    | 11:00:00 AM |
| Cs-137  | 661.66  | 85.21 | 1.10E+004 | 465.91   | 397.00  | 4.00% | 1/1/2012    | 11:00:00 AM |
| Y-88    | 898.02  | 93.70 | 1.07E+002 | 1589.10  | 1489.00 | 3.90% | 1/1/2012    | 11:00:00 AM |
| Co-60   | 1173.24 | 99.90 | 1.93E+003 | 734.73   | 734.00  | 4.00% | 1/1/2012    | 11:00:00 AM |
| Co-60   | 1332.50 | 99.98 | 1.93E+003 | 734.15   | 734.00  | 4.00% | 1/1/2012    | 11:00:00 AM |
| Y-88    | 1836.01 | 99.20 | 1.07E+002 | 1589.70  | 1577.00 | 4.00% | 1/1/2012    | 11:00:00 AM |

ORTEC g v - i (1087) Env32 G53W4.25 3/28/2012 10:36:01 AM  
TestAmerica Spectrum name: 8\_TunaCan\_20120676.An1

Sample description  
8\_TunaCan\_90099\_032712

Spectrum Filename: C:\User\SPC\Det8\8\_TunaCan\_20120676.An1

Acquisition information

Start time: 3/27/2012 10:58:29 AM  
Live time: 3600  
Real time: 3655  
Dead time: 1.49 %  
Detector ID: 8

Detector system  
Ge 8 SN/174

Calibration

Filename: 8\_Soil\_TunaCan.Clb  
8\_Soil\_TunaCan\_90099\_032712

Energy Calibration

Created: 3/28/2012 10:35:07 AM  
Zero offset: 0.050 keV  
Gain: 0.250 keV/channel  
Quadratic:  $8.067\text{E-}10 \text{ keV/channel}^2$

Efficiency Calibration

Created: 3/28/2012 10:35:20 AM  
Knee Energy: 165.85 keV  
Above the Knee: Quadratic Uncertainty = 1.39 %  
Log(Eff):  $-1.098764\text{E-}01 + (-4.958544\text{E-}01 * \text{Log}(E)) + (-2.572270\text{E-}02 * \text{Log}(E)^2)$   
Below the Knee: Quadratic Uncertainty = 1.71 %  
Log(Eff):  $-2.525301\text{E+}01 + (9.398253\text{E+}00 * \text{Log}(E)) + (-1.000034\text{E+}00 * \text{Log}(E)^2)$

Library Files

Main analysis library: DET\_EnergyStandardMix & Pb.Lib  
Library Match Width: 0.500  
Peak stripping: Library based

Analysis parameters

Analysis engine: Env32 G53W4.25  
Start channel: 150 ( 37.55keV )  
Stop channel: 8000 ( 2000.30keV )  
Peak rejection level: 10.000%  
Peak search sensitivity: 3  
Sample Size: 1.0000E+00  
Activity scaling factor:  $1.0000\text{E+}00 / (1.0000\text{E+}00 * 1.0000\text{E+}00) = 1.0000\text{E+}00$   
Detection limit method: Reg. Guide 4.16 Method

ORTEC g v - i (1087) Env32 G53W4.25 3/28/2012 10:36:01 AM  
 TestAmerica Spectrum name: 8\_TunaCan\_20120676.An1

Random error: 4.0000000E+00  
 Systematic error: 4.0000000E+00  
 Fraction Limit: 0.000%  
 Background width: average of three points.  
 Half lives decay limit: 12.000  
 Activity range factor: 2.000  
 Min. step backg. energy: 0.000  
 Multiplet shift channel: 2.000

| Corrections                   | Status | Comments             |
|-------------------------------|--------|----------------------|
| Decay correct to date:        | YES    | 1/1/2012 11:00:00 AM |
| Decay during acquisition:     | NO     |                      |
| Decay during collection:      | NO     |                      |
| True coincidence correction:  | NO     |                      |
| Peaked background correction: | NO     |                      |
| Absorption (Internal):        | NO     |                      |
| Geometry correction:          | NO     |                      |
| Random summing:               | NO     |                      |

total peaks alloc. 12 cutoff: 5.00E+01%

Energy Calibration  
 Normalized diff: 0.0205

\*\*\*\*\* S U M M A R Y O F P E A K S I N R A N G E \*\*\*\*\*

| Peak<br>Energy | Area   | Uncert | FWHM | Corrcn<br>Factor | Nuclide<br>Energy | Brnch.<br>Ratio | Act.<br>Bq | Nuc    |
|----------------|--------|--------|------|------------------|-------------------|-----------------|------------|--------|
| 46.54          | 43426. | 0.60   | 0.95 | 2.002E-02        | 46.54             | 4.250           | 1.426E+04  | Pb210  |
| 59.52          | 45918. | 0.77   | 0.95 | 2.880E-02        | 59.54             | 35.700          | 1.240E+03  | AM241  |
| 72.86          | 2434.  | 6.68   | 0.97 | 3.542E-02        |                   |                 |            |        |
| 88.03          | 73269. | 0.53   | 0.97 | 3.992E-02        | 88.03             | 3.610           | 1.607E+04  | CD109  |
| 122.07         | 35407. | 0.77   | 1.01 | 4.146E-02        | 122.06            | 85.600          | 3.451E+02  | CO57   |
| 136.51         | 4312.  | 4.44   | 1.06 | 3.999E-02        |                   |                 |            |        |
| 165.88         | 36308. | 0.76   | 1.07 | 3.629E-02        | 165.85            | 79.900          | 5.363E+02  | Ce139  |
| 279.23         | 24162. | 0.88   | 1.15 | 2.427E-02        | 279.17            | 81.500          | 1.218E+03  | Hg203  |
| 391.69         | 24625. | 0.77   | 1.22 | 1.855E-02        | 391.69            | 64.000          | 9.671E+02  | SN113  |
| 661.60         | 17184. | 1.10   | 1.39 | 1.209E-02        | 661.66            | 85.210          | 4.659E+02  | CS137  |
| 898.05         | 28015. | 0.71   | 1.61 | 9.360E-03        | 898.02            | 93.700          | 1.552E+03  | Y898   |
| 1173.23        | 18826. | 0.79   | 1.74 | 7.453E-03        | 1173.24           | 99.900          | 7.245E+02  | Co1173 |
| 1332.49        | 17010. | 0.84   | 1.82 | 6.678E-03        | 1332.50           | 99.982          | 7.300E+02  | Co1332 |
| 1836.02        | 16762. | 0.79   | 2.11 | 5.046E-03        | 1836.01           | 99.200          | 1.627E+03  | Y1836  |

\*\*\*\*\* U N I D E N T I F I E D P E A K S U M M A R Y \*\*\*\*\*

| Peak Centroid<br>Channel Energy | Background<br>Counts | Net Area<br>Counts | Efficiency<br>* Area | Uncert<br>1 Sigma % | FWHM<br>keV | Suspected<br>Nuclide |
|---------------------------------|----------------------|--------------------|----------------------|---------------------|-------------|----------------------|
| 291.19 72.85                    | 12003.               | 2434.              | 6.872E+04            | 6.68                | 0.969       | - D                  |
| 545.78 136.51                   | 8432.                | 4312.              | 1.078E+05            | 4.44                | 1.059       | -                    |

s - Peak fails shape tests.  
 D - Peak area deconvoluted.  
 L - Peak written from unknown list.  
 C - Area < Critical level.

-----  
 This section based on library: DET\_EnergyStandardMix & Pb.Lib

\*\*\*\*\* I D E N T I F I E D P E A K S U M M A R Y \*\*\*\*\*

| Nuclide | Peak<br>Channel | Centroid<br>Energy | Background<br>Counts | Net Area<br>Counts | Intensity<br>Cts/Sec | Uncert<br>1 Sigma | FWHM<br>% | keV |
|---------|-----------------|--------------------|----------------------|--------------------|----------------------|-------------------|-----------|-----|
| Pb-210  | 185.74          | 46.49              | 17505.               | 45568.             | 12.658               | 0.76              | 0.942     |     |
| AM-241  | 237.86          | 59.52              | 18397.               | 45918.             | 12.755               | 0.77              | 0.945     |     |
| CD-109  | 351.89          | 88.03              | 17370.               | 73269.             | 20.353               | 0.53              | 0.966     |     |
| CO-57   | 488.04          | 122.07             | 9639.                | 35407.             | 9.835                | 0.77              | 1.010     |     |
| Ce-139  | 663.26          | 165.88             | 8356.                | 36308.             | 10.085               | 0.76              | 1.067     |     |
| Hg-203  | 1116.59         | 279.23             | 4382.                | 24162.             | 6.712                | 0.88              | 1.153     |     |
| SN-113  | 1566.40         | 391.69             | 2677.                | 24625.             | 6.840                | 0.77              | 1.223     |     |
| CS-137  | 2645.92         | 661.60             | 3145.                | 17184.             | 4.773                | 1.10              | 1.389     |     |
| Y-898   | 3591.62         | 898.05             | 1881.                | 28015.             | 7.782                | 0.71              | 1.611     |     |
| Co-1173 | 4692.17         | 1173.23            | 650.                 | 18826.             | 5.229                | 0.79              | 1.738     |     |
| Co-1332 | 5329.14         | 1332.49            | 576.                 | 17010.             | 4.725                | 0.84              | 1.822     |     |
| Y-1836  | 7342.97         | 1836.02            | 111.                 | 16762.             | 4.656                | 0.79              | 2.110     |     |

s - Peak fails shape tests.  
 D - Peak area deconvoluted.  
 A Derived peak area.

\*\*\*\*\* S U M M A R Y O F L I B R A R Y P E A K U S A G E \*\*\*\*\*

| - Nuclide - | Average | ----- Peak ----- |        |           |      |           |          |            |
|-------------|---------|------------------|--------|-----------|------|-----------|----------|------------|
| Name        | Code    | Activity         | Energy | Activity  | Code | MDA       | Value    | COMMENTS   |
|             |         | Bq               | keV    | Bq        |      | Bq        |          |            |
| Pb-210      | N       | 1.4960E+04       |        |           |      |           | 8.15E+03 |            |
|             |         |                  | 46.54  | 1.496E+04 | (    | 2.033E+02 | 7.55E-01 | 4.25E+00 G |
| AM-241      |         | 1.2405E+03       |        |           |      |           | 1.58E+05 |            |
|             |         |                  | 59.54  | 1.240E+03 | (    | 1.715E+01 | 7.72E-01 | 3.57E+01 G |
| CD-109      |         | 1.6066E+04       |        |           |      |           | 4.63E+02 |            |
|             |         |                  | 88.03  | 1.607E+04 | (    | 1.353E+02 | 5.26E-01 | 3.61E+00 G |
| CO-57       |         | 3.4512E+02       |        |           |      |           | 2.72E+02 |            |
|             |         |                  | 122.06 | 3.451E+02 | (    | 4.486E+00 | 7.68E-01 | 8.56E+01 G |

| Nuclide | Ave activity | Energy  | Activity  | Code | Peak      | MDA      | Comments               |
|---------|--------------|---------|-----------|------|-----------|----------|------------------------|
| Ce-139  | 5.3634E+02   | 165.85  | 5.363E+02 | (    | 6.333E+00 | 7.56E-01 | 1.38E+02<br>7.99E+01 G |
| Hg-203  | 1.2182E+03   | 279.17  | 1.218E+03 | (    | 1.569E+01 | 8.81E-01 | 4.66E+01<br>8.15E+01 G |
| SN-113  | 9.6715E+02   | 391.69  | 9.671E+02 | (    | 9.575E+00 | 7.73E-01 | 1.15E+02<br>6.40E+01 G |
| CS-137  | 4.6586E+02   | 661.66  | 4.659E+02 | (    | 7.158E+00 | 1.10E+00 | 1.10E+04<br>8.52E+01 G |
| Y-898   | 1.5521E+03   | 898.02  | 1.552E+03 | (    | 1.135E+01 | 7.10E-01 | 1.07E+02<br>9.37E+01 G |
| Co-1173 | 7.2448E+02   | 1173.24 | 7.245E+02 | (    | 4.676E+00 | 7.93E-01 | 1.93E+03<br>9.99E+01 G |
| Co-1332 | 7.2998E+02   | 1332.50 | 7.300E+02 | (    | 4.916E+00 | 8.45E-01 | 1.93E+03<br>1.00E+02 G |
| Y-1836  | 1.6272E+03   | 1836.01 | 1.627E+03 | (    | 5.029E+00 | 7.91E-01 | 1.07E+02<br>9.92E+01 G |

( - This peak used in the nuclide activity average.

- \* - Peak is too wide, but only one peak in library.
- ! - Peak is part of a multiplet and this area went negative during deconvolution.
- ? - Peak is too narrow.
- @ - Peak is too wide at FW25M, but ok at FWHM.
- % - Peak fails sensitivity test.
- \$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.
- + - Peak activity higher than counting uncertainty range.
- - Peak activity lower than counting uncertainty range.
- = - Peak outside analysis energy range.
- & - Calculated peak centroid is not close enough to the library energy centroid for positive identification.
- P - Peakbackground subtraction
- } - Peak is too close to another for the activity to be found directly.

Nuclide Codes:

T - Thermal Neutron Activation  
 F - Fast Neutron Activation  
 I - Fission Product  
 N - Naturally Occurring Isotope

Peak Codes:

G - Gamma Ray  
 X - X-Ray  
 P - Positron Decay  
 S - Single-Escape

P - Photon Reaction D - Double-Escape  
 C - Charged Particle Reaction K - Key Line  
 M - No MDA Calculation A - Not in Average  
 R - Coincidence Corrected C - Coincidence Peak  
 H - Halflife limit exceeded

\*\*\*\*\* D I S C A R D E D I S O T O P E P E A K S \*\*\*\*\*  
 Nuclide Centroid Background Net Area Intensity Uncert Activity  
 Energy Counts Counts Cts/Sec 1 Sigma %

P - Peakbackground subtraction

| ***** S U M M A R Y O F N U C L I D E S I N S A M P L E ***** |                                 |                                  |                         |         |          |
|---------------------------------------------------------------|---------------------------------|----------------------------------|-------------------------|---------|----------|
| Nuclide                                                       | Time of Count<br>Activity<br>Bq | Time Corrected<br>Activity<br>Bq | Uncertainty<br>Counting | 1 Sigma | MDA      |
| Pb-210                                                        | 1.4851E+04                      | 1.4960E+04                       | 7.555E-01%              |         | 2.03E+02 |
| AM-241                                                        | 1.2400E+03                      | 1.2405E+03                       | 7.719E-01%              |         | 1.71E+01 |
| CD-109                                                        | 1.4124E+04                      | 1.6066E+04                       | 5.260E-01%              |         | 1.35E+02 |
| CO-57                                                         | 2.7715E+02                      | 3.4512E+02                       | 7.681E-01%              |         | 4.49E+00 |
| Ce-139                                                        | 3.4782E+02                      | 5.3634E+02                       | 7.558E-01%              |         | 6.33E+00 |
| Hg-203                                                        | 3.3925E+02                      | 1.2182E+03                       | 8.812E-01%              |         | 1.57E+01 |
| SN-113                                                        | 5.7617E+02                      | 9.6715E+02                       | 7.729E-01%              |         | 9.58E+00 |
| CS-137                                                        | 4.6334E+02                      | 4.6586E+02                       | 1.105E+00%              |         | 7.16E+00 |
| Y-898                                                         | 8.8728E+02                      | 1.5521E+03                       | 7.104E-01%              |         | 1.13E+01 |
| Co-1173                                                       | 7.0239E+02                      | 7.2448E+02                       | 7.931E-01%              |         | 4.68E+00 |
| Co-1332                                                       | 7.0772E+02                      | 7.2998E+02                       | 8.450E-01%              |         | 4.92E+00 |
| Y-1836                                                        | 9.3024E+02                      | 1.6272E+03                       | 7.905E-01%              |         | 5.03E+00 |

< - MDA value printed.  
 A - Activity printed, but activity < MDA.  
 B - Activity < MDA and failed test.  
 C - Area < Critical level.  
 F - Failed fraction or key line test.  
 H - Halflife limit exceeded

----- S U M M A R Y -----  
 Total Activity ( 82.3 to 2000.3 keV) 3.545E+04 Bq  
 Total Decayed Activity ( 82.3 to 2000.3 keV) 4.0432598E+04 Bq

Analyzed by: \_\_\_\_\_  
 Admin

Reviewed by: \_\_\_\_\_  
 Supervisor

Laboratory: TestAmerica

# **Initial Calibration Verifications**

## 2nd Source Verification

Detector: Ge5

Geometry: Tunacan

Reference date 1/1/2010

Source: 81427-334

Standard volume g / vial 1550

Standard volume transferred in g / geometry 318.5

lab ID# of cal standard 6665

| Isotope | Certified Activity<br>gammas/sec | Geometry<br>Activity | $\gamma$ abundance | Bq/sample | Count<br>Results | %recovery |
|---------|----------------------------------|----------------------|--------------------|-----------|------------------|-----------|
| Am-241  | 2034                             | 418                  | 0.359              | 1164      | 1160.9           | 99.7      |
| Cs-137  | 1926                             | 396                  | 0.851              | 465       | 442.36           | 95.1      |
| Co-60   | 3611                             | 742                  | 0.99974            | 742       | 700.21           | 94.3      |
| Co-60   | 3612                             | 742                  | 0.999856           | 742       | 701.86           | 94.6      |

Reviewed By: Jody Watson

Date: 3/27/2012

# 5\_TunaCan2nd\_20120813

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TestAmerica Spectrum name: 5\_TunaCan2nd\_20120813.An1

Sample description  
5\_TunaCan2nd\_Rad10\_032712

Spectrum Filename: C:\User\SPC\Det5\5\_TunaCan2nd\_20120813.An1

## Acquisition information

Start time: 3/27/2012 10:12:05 AM  
Live time: 7200  
Real time: 7250  
Dead time: 0.69 %  
Detector ID: 5

Detector system  
Ge 5 SN/157

## Calibration

Filename: 5\_Soil\_TunaCan.Clb  
5\_Soil\_TunaCan\_90099\_032612

### Energy Calibration

Created: 3/27/2012 5:20:02 PM  
Zero offset: 0.135 keV  
Gain: 0.250 keV/channel  
Quadratic: 2.720E-08 keV/channel<sup>2</sup>

### Efficiency Calibration

Created: 3/27/2012 5:20:37 PM  
Knee Energy: 165.85 keV  
Above the Knee: Quadratic Uncertainty = 0.87 %  
Log(Eff):  $6.466115E-01 + (-7.830454E-01 * \text{Log}(E)) + (-4.117504E-03 * \text{Log}(E)^2)$   
Below the Knee: Quadratic Uncertainty = 1.43 %  
Log(Eff):  $-2.462251E+01 + (9.075211E+00 * \text{Log}(E)) + (-9.664422E-01 * \text{Log}(E)^2)$

## Library Files

Main analysis library: DET\_EnergyStandardMix & Pb.Lib  
Library Match width: 0.500  
Peak stripping: Library based

## Analysis parameters

Analysis engine: Env32 G53W4.25  
Start channel: 150 ( 37.61keV )  
Stop channel: 8000 ( 2000.53keV )  
Peak rejection level: 1000.000%  
Peak search sensitivity: 3  
Sample Size: 1.0000E+00  
Activity scaling factor: 1.0000E+00/( 1.0000E+00\* 1.0000E+00) = 1.0000E+00  
Detection limit method: Reg. Guide 4.16 Method

□

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TestAmerica Spectrum name: 5\_TunaCan2nd\_20120813.An1  
Page 1

5\_TunaCan2nd\_20120813

Random error: 4.0000000E+00  
 Systematic error: 4.0000000E+00  
 Fraction Limit: 0.000%  
 Background width: average of three points.

Half lives decay limit: 12.000  
 Activity range factor: 2.000  
 Min. step backg. energy: 0.000  
 Multiplet shift channel: 2.000

| Corrections                   | Status | Comments                                      |
|-------------------------------|--------|-----------------------------------------------|
| Decay correct to date:        | YES    | 1/1/2010 11:00:00 AM                          |
| Decay during acquisition:     | YES    |                                               |
| Decay during collection:      | NO     |                                               |
| True coincidence correction:  | NO     |                                               |
| Peaked background correction: | YES    | 5_2012-02-26_0305.PBC<br>2/26/2012 3:05:30 AM |
| Absorption (Internal):        | NO     |                                               |
| Geometry correction:          | NO     |                                               |
| Random summing:               | NO     |                                               |

total peaks alloc. 12 cutoff: 5.00E+01%  
 Energy Calibration  
 Normalized diff: 33.1557

\*\*\*\*\* S U M M A R Y O F P E A K S I N R A N G E \*\*\*\*\*

| Peak Energy | Area   | Uncert | FWHM | Corrctn Factor | Nuclide Energy | Brnch. Ratio | Act. Bq/Samp | Nuc   |
|-------------|--------|--------|------|----------------|----------------|--------------|--------------|-------|
| 36.81       | 1005.  | 12.08  | 0.62 | 1.151E-02      |                |              |              |       |
| 46.61       | 72616. | 0.49   | 0.73 | 1.792E-02      | 46.54          | 4.250        | 1.421E+04    | Pb210 |
| 49.73       | 1326.  | 15.18  | 0.68 | 1.987E-02      |                |              |              |       |
| 59.57       | 75329. | 0.49   | 0.74 | 2.535E-02      | 59.54          | 35.700       | 1.161E+03    | AM241 |
| 87.94       | 40851. | 0.68   | 0.80 | 3.460E-02      | 88.03          | 3.610        | 1.542E+04    | CD109 |
| 96.44       | 148.   | 47.31  | 0.80 | 3.568E-02      |                |              |              |       |
| 99.01       | 160.   | 48.52  | 0.81 | 3.589E-02      |                |              |              |       |
| 105.59      | 109.   | 69.79  | 0.52 | 3.619E-02      |                |              |              |       |
| 121.94      | 9225.  | 1.66   | 0.84 | 3.583E-02      | 122.06         | 85.600       | 3.348E+02    | CO57  |
| 129.89      | 126.   | 62.97  | 0.30 | 3.522E-02      |                |              |              |       |
| 136.43      | 1263.  | 7.42   | 0.90 | 3.457E-02      |                |              |              |       |
| 165.86      | 1574.  | 6.14   | 0.84 | 3.133E-02      | 165.85         | 79.900       | 5.319E+02    | Ce139 |
| 238.72      | 327.   | 27.04  | 0.86 | 2.319E-02      |                |              |              |       |
| 247.25      | 57.    | 84.47  | 0.31 | 2.252E-02      |                |              |              |       |
| 259.02      | 93.    | 60.17  | 0.97 | 2.167E-02      |                |              |              |       |
| 260.46      | 98.    | 58.62  | 0.97 | 2.157E-02      |                |              |              |       |
| 322.65      | 45.    | 91.14  | 0.46 | 1.806E-02      |                |              |              |       |
| 351.63      | 256.   | 27.79  | 1.06 | 1.681E-02      |                |              |              |       |
| 391.95      | 494.   | 16.33  | 1.15 | 1.536E-02      | 391.69         | 64.000       | 9.501E+02    | SN113 |
| 407.02      | 43.    | 90.43  | 0.56 | 1.489E-02      |                |              |              |       |
| 412.80      | 202.   | 35.90  | 0.77 | 1.471E-02      |                |              |              |       |
| 420.83      | 123.   | 52.91  | 0.72 | 1.448E-02      |                |              |              |       |
| 510.72      | 188.   | 44.32  | 0.50 | 1.232E-02      |                |              |              |       |
| 542.81      | 148.   | 28.69  | 0.36 | 1.171E-02      |                |              |              |       |
| 583.30      | 161.   | 33.50  | 0.69 | 1.103E-02      |                |              |              |       |
| 661.70      | 25605. | 0.71   | 1.39 | 9.924E-03      | 661.66         | 85.210       | 4.424E+02    | CS137 |
| 762.61      | 129.   | 36.06  | 0.79 | 8.812E-03      |                |              |              |       |
| 796.90      | 151.   | 38.71  | 0.30 | 8.493E-03      |                |              |              |       |
| 886.67      | 129.   | 46.77  | 0.30 | 7.766E-03      |                |              |              |       |
| 897.77      | 428.   | 19.21  | 1.38 | 7.686E-03      | 898.02         | 93.700       | 1.665E+03    | Y898  |
| 932.49      | 230.   | 35.52  | 0.82 | 7.445E-03      |                |              |              |       |

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|         |        |       |      |           |         |        |           |        |
|---------|--------|-------|------|-----------|---------|--------|-----------|--------|
| 1008.65 | 104.   | 56.29 | 0.28 | 6.970E-03 |         |        |           |        |
| 1173.15 | 23044. | 0.73  | 1.79 | 6.138E-03 | 1173.24 | 99.900 | 7.002E+02 | Co1173 |
| 1332.39 | 20769. | 0.71  | 1.87 | 5.515E-03 | 1332.50 | 99.982 | 7.019E+02 | Co1332 |
| 1836.05 | 245.   | 7.47  | 1.56 | 4.208E-03 | 1836.01 | 99.200 | 1.642E+03 | Y1836  |

\*\*\*\*\* U N I D E N T I F I E D P E A K S U M M A R Y \*\*\*\*\*

| Peak Channel | Centroid Energy | Background Counts | Net Area Counts | Efficiency * Area | Uncert 1 Sigma % | FWHM keV | Suspected Nuclide |
|--------------|-----------------|-------------------|-----------------|-------------------|------------------|----------|-------------------|
| 146.78       | 36.81           | 4847.             | 1005.           | 8.731E+04         | 12.08            | 0.625    | -                 |
| 198.52       | 49.73           | 12365.            | 1326.           | 6.673E+04         | 15.18            | 0.681    | - S               |
| 385.40       | 96.42           | 1874.             | 90.             | 2.532E+03         | 71.31            | 0.588    | - SC              |
| 395.68       | 98.99           | 2103.             | 121.            | 3.381E+03         | 58.44            | 0.394    | - S               |

ORTEC g v - i (3263) Env32 G53W4.25 3/28/2012 7:35:49 AM Page 3  
TestAmerica Spectrum name: 5\_TunaCan2nd\_20120813.An1

| Channel | Energy  | Background | Net area | Eff*Area  | Uncert | FWHM  | Suspected |
|---------|---------|------------|----------|-----------|--------|-------|-----------|
| 422.09  | 105.59  | 2271.      | 109.     | 3.012E+03 | 69.79  | 0.518 | - SC      |
| 519.32  | 129.89  | 2194.      | 126.     | 3.592E+03 | 62.97  | 0.298 | - S       |
| 545.51  | 136.43  | 2377.      | 1263.    | 3.654E+04 | 7.42   | 0.900 | - S       |
| 954.90  | 238.72  | 2247.      | 327.     | 1.410E+04 | 27.04  | 0.863 | - SM      |
| 989.00  | 247.25  | 1031.      | 57.      | 2.516E+03 | 84.47  | 0.312 | - SC      |
| 1036.13 | 259.01  | 1532.      | 93.      | 4.309E+03 | 60.17  | 0.968 | - D       |
| 1041.90 | 260.46  | 1588.      | 98.      | 4.525E+03 | 58.62  | 0.970 | - D       |
| 1290.76 | 322.65  | 744.       | 45.      | 2.473E+03 | 91.14  | 0.455 | - C       |
| 1406.70 | 351.63  | 1442.      | 256.     | 1.523E+04 | 27.79  | 1.058 | - S       |
| 1628.36 | 407.02  | 667.       | 43.      | 2.866E+03 | 90.43  | 0.562 | - SC      |
| 1651.47 | 412.80  | 1438.      | 202.     | 1.370E+04 | 35.90  | 0.775 | - S       |
| 1683.60 | 420.83  | 1291.      | 123.     | 8.472E+03 | 52.91  | 0.720 | - S       |
| 2043.25 | 510.72  | 1553.      | 188.     | 1.523E+04 | 44.32  | 0.503 | - S       |
| 2171.67 | 542.81  | 587.       | 148.     | 1.267E+04 | 28.69  | 0.362 | - S       |
| 2333.63 | 583.30  | 785.       | 161.     | 1.460E+04 | 33.50  | 0.694 | - S       |
| 3050.97 | 762.61  | 614.       | 129.     | 1.468E+04 | 36.06  | 0.794 | - S       |
| 3188.11 | 796.90  | 856.       | 151.     | 1.782E+04 | 38.71  | 0.295 | - S       |
| 3547.15 | 886.67  | 963.       | 129.     | 1.665E+04 | 46.77  | 0.296 | - S       |
| 3730.41 | 932.49  | 1438.      | 230.     | 3.096E+04 | 35.52  | 0.818 | - S       |
| 4035.01 | 1008.65 | 864.       | 104.     | 1.490E+04 | 56.29  | 0.275 | - S       |

s - Peak fails shape tests.  
D - Peak area deconvoluted.  
L - Peak written from unknown list.  
C - Area < Critical level.  
M - Peak is close to a library peak.

-----  
This section based on library: DET\_EnergyStandardMix & Pb.Lib

\*\*\*\*\* I D E N T I F I E D P E A K S U M M A R Y \*\*\*\*\*

| Nuclide | Peak Channel | Centroid Energy | Background Counts | Net Area Counts | Intensity Cts/Sec | Uncert 1 Sigma % | FWHM keV |
|---------|--------------|-----------------|-------------------|-----------------|-------------------|------------------|----------|
| Pb-210  | 186.01       | 46.61           | 16470.            | 72552.          | 10.077            | 0.49             | 0.733    |
| AM-241  | 237.88       | 59.57           | 15419.            | 75329.          | 10.462            | 0.49             | 0.735    |
| CD-109  | 351.46       | 87.94           | 8772.             | 40851.          | 5.674             | 0.68             | 0.804    |
| CO-57   | 487.54       | 121.94          | 3880.             | 9225.           | 1.281             | 1.66             | 0.838    |
| Ce-139  | 663.30       | 165.86          | 2329.             | 1574.           | 0.219             | 6.14             | 0.840    |
| SN-113  | 1568.04      | 391.95          | 1640.             | 494.            | 0.069             | 16.33            | 1.153    |
| CS-137  | 2647.28      | 661.70          | 1362.             | 25582.          | 3.553             | 0.71             | 1.394    |
| Y-898   | 3591.55      | 897.77          | 1410.             | 428.            | 0.060             | 19.21            | 1.376    |

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|         |         |         |      |        |       |      |        |
|---------|---------|---------|------|--------|-------|------|--------|
| Co-1173 | 4692.83 | 1173.15 | 788. | 23044. | 3.201 | 0.73 | 1.786  |
| Co-1332 | 5329.55 | 1332.39 | 98.  | 20769. | 2.885 | 0.71 | 1.870  |
| Y-1836  | 7342.76 | 1836.05 | 15.  | 245.   | 0.034 | 7.47 | 1.556s |

s - Peak fails shape tests.

D - Peak area deconvoluted.

A Derived peak area.

□

ORTEC g v - i (3263) Env32 G53W4.25 3/28/2012 7:35:49 AM Page 4  
TestAmerica Spectrum name: 5\_TunaCan2nd\_20120813.An1

| ***** S U M M A R Y |         | O F L I B R A R Y |         | P E A K    |       | U S A G E |          | *****      |
|---------------------|---------|-------------------|---------|------------|-------|-----------|----------|------------|
| - Nuclide -         | Average | ----- Peak        | -----   | -----      | ----- | -----     | -----    |            |
| Name                | Code    | Activity          | Energy  | Activity   | Code  | MDA Value |          | COMMENTS   |
|                     |         | Bq/Sample         | keV     | Bq/Sample  |       | Bq/Sample |          |            |
| Pb-210              | N       | 1.4212E+04        |         |            |       |           |          |            |
|                     |         |                   | 46.54   | 1.421E+04  | (P    | 1.177E+02 | 4.91E-01 | 4.25E+00 G |
| AM-241              |         | 1.1609E+03        |         |            |       |           |          |            |
|                     |         |                   | 59.54   | 1.161E+03  | (     | 8.959E+00 | 4.87E-01 | 3.57E+01 G |
| CD-109              |         | 1.5419E+04        |         |            |       |           |          |            |
|                     |         |                   | 88.03   | 1.542E+04  | (     | 1.658E+02 | 6.81E-01 | 3.61E+00 G |
| CO-57               |         | 3.3478E+02        |         |            |       |           |          |            |
|                     |         |                   | 122.06  | 3.348E+02  | (     | 1.063E+01 | 1.66E+00 | 8.56E+01 G |
| Ce-139              |         | 5.3191E+02        |         |            |       |           |          |            |
|                     |         |                   | 165.85  | 5.319E+02  | (     | 7.689E+01 | 6.14E+00 | 7.99E+01 G |
| Hg-203              |         | -6.5193E-03       |         |            |       |           |          |            |
|                     |         |                   | 279.17  | -6.519E-03 | %(    | 1.788E+00 | 8.22E+03 | 8.15E+01 G |
| SN-113              |         | 9.5011E+02        |         |            |       |           |          |            |
|                     |         |                   | 391.69  | 9.501E+02  | (     | 3.682E+02 | 1.63E+01 | 6.40E+01 G |
| CS-137              |         | 4.4236E+02        |         |            |       |           |          |            |
|                     |         |                   | 661.66  | 4.424E+02  | (P    | 3.020E+00 | 7.12E-01 | 8.52E+01 G |
| Y-898               |         | 1.6655E+03        |         |            |       |           |          |            |
|                     |         |                   | 898.02  | 1.665E+03  | (     | 6.908E+02 | 1.92E+01 | 9.37E+01 G |
| Co-1173             |         | 7.0021E+02        |         |            |       |           |          |            |
|                     |         |                   | 1173.24 | 7.002E+02  | (     | 4.056E+00 | 7.32E-01 | 9.99E+01 G |
| Co-1332             |         | 7.0186E+02        |         |            |       |           |          |            |
|                     |         |                   | 1332.50 | 7.019E+02  | (     | 1.651E+00 | 7.07E-01 | 1.00E+02 G |
| Y-1836              |         | 1.6424E+03        |         |            |       |           |          |            |
|                     |         |                   | 1836.01 | 1.642E+03  | (     | 1.392E+02 | 7.47E+00 | 9.92E+01 G |

( - This peak used in the nuclide activity average.

\* - Peak is too wide, but only one peak in library.

! - Peak is part of a multiplet and this area went negative during deconvolution.

? - Peak is too narrow.

□

@ - Peak is too wide at FW25M, but ok at FWHM.  
 % - Peak fails sensitivity test.  
 \$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.  
 + - Peak activity higher than counting uncertainty range.  
 - - Peak activity lower than counting uncertainty range.  
 = - Peak outside analysis energy range.  
 & - Calculated peak centroid is not close enough to the library energy centroid for positive identification.  
 P - Peakbackground subtraction  
 } - Peak is too close to another for the activity to be found directly.

Nuclide Codes: Peak Codes:  
 T - Thermal Neutron Activation G - Gamma Ray  
 F - Fast Neutron Activation X - X-Ray  
 I - Fission Product P - Positron Decay  
 N - Naturally Occurring Isotope S - Single-Escape  
 P - Photon Reaction D - Double-Escape  
 C - Charged Particle Reaction K - Key Line  
 M - No MDA Calculation A - Not in Average  
 R - Coincidence Corrected C - Coincidence Peak  
 H - Halflife limit exceeded

\*\*\*\*\* D I S C A R D E D I S O T O P E P E A K S \*\*\*\*\*

| Nuclide | Centroid Energy | Background Counts | Net Area Counts | Intensity Cts/Sec | Uncert 1 Sigma | Activity % |
|---------|-----------------|-------------------|-----------------|-------------------|----------------|------------|
|---------|-----------------|-------------------|-----------------|-------------------|----------------|------------|

P - Peakbackground subtraction

| ***** S U M M A R Y O F N U C L I D E S I N S A M P L E ***** |                                  |                                   |                      |               |
|---------------------------------------------------------------|----------------------------------|-----------------------------------|----------------------|---------------|
| Nuclide                                                       | Time of Count Activity Bq/Sample | Time Corrected Activity Bq/Sample | Uncertainty Counting | MDA Bq/Sample |
| Pb-210                                                        | 1.3259E+04                       | 1.4212E+04                        | 4.918E-01%           | 1.18E+02      |
| AM-241                                                        | 1.1568E+03                       | 1.1609E+03                        | 4.867E-01%           | 8.96E+00      |
| CD-109                                                        | 4.5403E+03                       | 1.5419E+04                        | 6.810E-01%           | 1.66E+02      |
| CO-57                                                         | 4.1787E+01                       | 3.3478E+02                        | 1.660E+00%           | 1.06E+01      |
| Ce-139                                                        | 8.7347E+00                       | 5.3191E+02                        | 6.138E+00%           | 7.69E+01      |
| Hg-203 #A                                                     | -6.5193E-03                      | >12 Halflives                     | 8.2197E+03%          | 1.7882E+00    |
| SN-113                                                        | 6.9747E+00                       | 9.5011E+02                        | 1.633E+01%           | 3.68E+02      |
| CS-137                                                        | 4.2015E+02                       | 4.4236E+02                        | 7.122E-01%           | 3.02E+00      |
| Y-898                                                         | 8.2662E+00                       | 1.6655E+03                        | 1.921E+01%           | 6.91E+02      |
| Co-1173                                                       | 5.2196E+02                       | 7.0021E+02                        | 7.316E-01%           | 4.06E+00      |
| Co-1332                                                       | 5.2320E+02                       | 7.0186E+02                        | 7.069E-01%           | 1.65E+00      |
| Y-1836                                                        | 8.1520E+00                       | 1.6424E+03                        | 7.471E+00%           | 1.39E+02      |

□

# - All peaks for activity calculation had bad shape.  
 \* - Activity omitted from total  
 & - Activity omitted from total and all peaks had bad shape.

5\_TunaCan2nd\_20120813

< - MDA value printed.

A - Activity printed, but activity < MDA.

B - Activity < MDA and failed test.

C - Area < Critical level.

F - Failed fraction or key line test.

H - Halflife limit exceeded

S U M M A R Y

-----  
Total Activity ( 279.0 to 2000.5 keV) 2.050E+04 Bq/Sample  
Total Decayed Activity ( 279.0 to 2000.5 keV) 3.7761527E+04 Bq/Sample

## 2nd Source Verification

Detector: Ge7

Geometry: Tunacan

Reference date 1/1/2010

Source: 81427-334

Standard volume g / vial 1550

Standard volume transferred in g / geometry 318.5

lab ID# of cal standard 6665

| Isotope | Certified Activity<br>gammas/sec | Geometry<br>Activity | $\gamma$ abundance | Bq/sample | Count<br>Results | %recovery |
|---------|----------------------------------|----------------------|--------------------|-----------|------------------|-----------|
| Am-241  | 2034                             | 418                  | 0.359              | 1164      | 1150.4           | 98.8      |
| Cs-137  | 1926                             | 396                  | 0.851              | 465       | 440.47           | 94.7      |
| Co-60   | 3611                             | 742                  | 0.99974            | 742       | 681.72           | 91.9      |
| Co-60   | 3612                             | 742                  | 0.999856           | 742       | 692.1            | 93.2      |

Reviewed By: Jody Watson

Date: 3/27/2012

ORTEC g v - i (3263) Env32 G53W4.25 3/28/2012 8:52:25 AM  
TestAmerica Spectrum name: 7\_TunaCan2ndSource\_20120479.An1

Sample description  
7\_TunaCan2ndSource\_81427-334\_032712

Spectrum Filename: C:\User\SPC\Det7\7\_TunaCan2ndSource\_20120479.An1

Acquisition information

Start time: 3/27/2012 3:25:25 PM  
Live time: 3600  
Real time: 3684  
Dead time: 2.28 %  
Detector ID: 7

Detector system  
Ge 7 SN/154

Calibration

Filename: 7\_Soil\_TunaCan.Clb  
7\_TunaCan\_90099\_032712

Energy Calibration

Created: 3/16/2012 11:44:50 AM  
Zero offset: 0.153 keV  
Gain: 0.250 keV/channel  
Quadratic:  $6.716\text{E-}09 \text{ keV/channel}^2$

Efficiency Calibration

Created: 3/16/2012 11:45:14 AM  
Knee Energy: 165.85 keV  
Above the Knee: Quadratic Uncertainty = 0.87 %  
Log(Eff):  $6.716580\text{E-}01 + (-6.166540\text{E-}01 * \text{Log}(E)) + (-2.065917\text{E-}02 * \text{Log}(E)^2)$   
Below the Knee: Quadratic Uncertainty = 1.48 %  
Log(Eff):  $-2.689695\text{E+}01 + (1.019544\text{E+}01 * \text{Log}(E)) + (-1.081671\text{E+}00 * \text{Log}(E)^2)$

Library Files

Main analysis library: DET\_EnergyStandardMix & Pb.Lib  
Library Match Width: 0.500  
Peak stripping: Library based

Analysis parameters

Analysis engine: Env32 G53W4.25  
Start channel: 150 ( 37.65keV )  
Stop channel: 8000 ( 2000.21keV )  
Peak rejection level: 1000.000%  
Peak search sensitivity: 3  
Sample Size: 1.0000E+00  
Activity scaling factor:  $1.0000\text{E+}00 / (1.0000\text{E+}00 * 1.0000\text{E+}00) = 1.0000\text{E+}00$   
Detection limit method: Reg. Guide 4.16 Method

ORTEC g v - i (3263) Env32 G53W4.25 3/28/2012 8:52:25 AM  
 TestAmerica Spectrum name: 7\_TunaCan2ndSource\_20120479.An1

Random error: 4.0000000E+00  
 Systematic error: 4.0000000E+00  
 Fraction Limit: 0.000%  
 Background width: average of three points.  
 Half lives decay limit: 12.000  
 Activity range factor: 2.000  
 Min. step backg. energy 0.000  
 Multiplet shift channel 2.000

| Corrections                   | Status | Comments                                      |
|-------------------------------|--------|-----------------------------------------------|
| Decay correct to date:        | YES    | 1/1/2010 11:00:00 AM                          |
| Decay during acquisition:     | YES    |                                               |
| Decay during collection:      | NO     |                                               |
| True coincidence correction:  | NO     |                                               |
| Peaked background correction: | YES    | 7 2012-02-26_0327.PBC<br>2/26/2012 3:27:47 AM |
| Absorption (Internal):        | NO     |                                               |
| Geometry correction:          | NO     |                                               |
| Random summing:               | NO     |                                               |

total peaks alloc. 11 cutoff: 5.00E+01%  
 Energy Calibration  
 Normalized diff: 0.0270

\*\*\*\*\* S U M M A R Y O F P E A K S I N R A N G E \*\*\*\*\*

| Peak<br>Energy | Area   | Uncert | FWHM | Corrctn<br>Factor | Nuclide<br>Energy | Brnch.<br>Ratio | Act.<br>Bq/Samp1 | Nuc    |
|----------------|--------|--------|------|-------------------|-------------------|-----------------|------------------|--------|
| 36.65          | 788.   | 12.78  | 0.82 | 1.487E-02         |                   |                 |                  |        |
| 40.49          | 109.   | 96.90  | 0.59 | 1.869E-02         |                   |                 |                  |        |
| 46.62          | 49142. | 0.63   | 0.84 | 2.491E-02         | 46.54             | 4.250           | 1.386E+04        | Pb210  |
| 49.64          | 876.   | 18.72  | 0.86 | 2.792E-02         |                   |                 |                  |        |
| 59.61          | 54530. | 0.58   | 0.87 | 3.707E-02         | 59.54             | 35.700          | 1.150E+03        | AM241  |
| 76.99          | 260.   | 38.90  | 1.03 | 4.881E-02         |                   |                 |                  |        |
| 88.06          | 31019. | 0.77   | 0.89 | 5.329E-02         | 88.03             | 3.610           | 1.522E+04        | CD109  |
| 122.04         | 6834.  | 2.04   | 0.94 | 5.606E-02         | 122.06            | 85.600          | 3.171E+02        | CO57   |
| 136.41         | 810.   | 9.51   | 1.00 | 5.411E-02         |                   |                 |                  |        |
| 165.84         | 1193.  | 6.45   | 0.96 | 4.765E-02         | 165.85            | 79.900          | 5.180E+02        | Ce139  |
| 185.66         | 92.    | 57.01  | 0.73 | 4.445E-02         |                   |                 |                  |        |
| 213.19         | 122.   | 50.56  | 0.75 | 3.960E-02         |                   |                 |                  |        |
| 272.80         | 146.   | 47.29  | 0.28 | 3.217E-02         |                   |                 |                  |        |
| 391.67         | 372.   | 19.60  | 1.11 | 2.360E-02         | 391.69            | 64.000          | 9.332E+02        | SN113  |
| 442.91         | 47.    | 93.72  | 0.45 | 2.122E-02         |                   |                 |                  |        |
| 483.77         | 95.    | 38.10  | 0.62 | 1.965E-02         |                   |                 |                  |        |
| 524.63         | 67.    | 65.12  | 0.73 | 1.831E-02         |                   |                 |                  |        |
| 604.78         | 31.    | 59.37  | 0.27 | 1.616E-02         |                   |                 |                  |        |
| 628.99         | 32.    | 94.37  | 0.58 | 1.561E-02         |                   |                 |                  |        |
| 661.67         | 19152. | 0.86   | 1.47 | 1.492E-02         | 661.66            | 85.210          | 4.405E+02        | CS137  |
| 898.03         | 322.   | 23.53  | 1.90 | 1.137E-02         | 898.02            | 93.700          | 1.694E+03        | Y898   |
| 910.18         | 180.   | 33.99  | 0.85 | 1.123E-02         |                   |                 |                  |        |
| 963.79         | 49.    | 71.39  | 0.69 | 1.067E-02         |                   |                 |                  |        |
| 1173.23        | 16317. | 0.86   | 1.89 | 8.929E-03         | 1173.24           | 99.900          | 6.817E+02        | Co1173 |
| 1332.49        | 14763. | 0.85   | 2.04 | 7.951E-03         | 1332.50           | 99.982          | 6.921E+02        | Co1332 |
| 1836.09        | 186.   | 9.19   | 1.40 | 5.919E-03         | 1836.01           | 99.200          | 1.780E+03        | Y1836  |

\*\*\*\*\* U N I D E N T I F I E D P E A K S U M M A R Y \*\*\*\*\*

| Peak<br>Channel | Centroid<br>Energy | Background<br>Counts | Net Area<br>Counts | Efficiency<br>* Area | Uncert<br>1 Sigma % | FWHM<br>keV | Suspected<br>Nuclide |
|-----------------|--------------------|----------------------|--------------------|----------------------|---------------------|-------------|----------------------|
| 146.00          | 36.65              | 3116.                | 788.               | 5.300E+04            | 12.78               | 0.819       | -                    |
| 161.37          | 40.49              | 4419.                | 109.               | 5.831E+03            | 96.90               | 0.587       | - c                  |
| 197.99          | 49.64              | 8222.                | 876.               | 2.792E+02            | 18.72               | 0.855       | - sM                 |

|        |       |       |                |       |       |   |
|--------|-------|-------|----------------|-------|-------|---|
| 307.39 | 76.99 | 3728. | 260. 5.319E+03 | 38.90 | 1.033 | - |
|--------|-------|-------|----------------|-------|-------|---|

| Channel | Energy | Background | Net area | Eff*Area  | Uncert | FWHM  | Suspected |
|---------|--------|------------|----------|-----------|--------|-------|-----------|
| 545.11  | 136.41 | 1706.      | 810.     | 1.497E+04 | 9.51   | 1.002 | -         |
| 742.15  | 185.66 | 1076.      | 92.      | 2.081E+03 | 57.01  | 0.725 | - s       |
| 852.30  | 213.19 | 1296.      | 122.     | 3.077E+03 | 50.56  | 0.748 | - s       |
| 1090.74 | 272.80 | 1320.      | 146.     | 4.539E+03 | 47.29  | 0.283 | - s       |
| 1771.26 | 442.91 | 710.       | 47.      | 2.215E+03 | 93.72  | 0.453 | - sc      |
| 1934.71 | 483.77 | 486.       | 95.      | 4.835E+03 | 38.10  | 0.616 | - s       |
| 2098.18 | 524.63 | 583.       | 67.      | 3.669E+03 | 65.12  | 0.732 | - s       |
| 2418.80 | 604.78 | 172.       | 31.      | 1.939E+03 | 59.37  | 0.268 | - s       |
| 2515.62 | 628.99 | 330.       | 32.      | 2.050E+03 | 94.37  | 0.581 | - sc      |
| 3640.41 | 910.18 | 855.       | 180.     | 1.603E+04 | 33.99  | 0.852 | - s       |
| 3854.87 | 963.79 | 447.       | 49.      | 4.625E+03 | 71.39  | 0.695 | - s       |

s - Peak fails shape tests.  
 D - Peak area deconvoluted.  
 L - Peak written from unknown list.  
 C - Area < Critical level.  
 M - Peak is close to a library peak.

-----  
 This section based on library: DET\_EnergyStandardMix & Pb.Lib

| ***** I D E N T I F I E D P E A K S U M M A R Y ***** |              |                 |                   |                 |                   |                |            |
|-------------------------------------------------------|--------------|-----------------|-------------------|-----------------|-------------------|----------------|------------|
| Nuclide                                               | Peak Channel | Centroid Energy | Background Counts | Net Area Counts | Intensity Cts/Sec | Uncert 1 Sigma | FWHM % keV |
| Pb-210                                                | 185.90       | 46.62           | 12530.            | 49107.          | 13.641            | 0.63           | 0.840      |
| AM-241                                                | 237.87       | 59.61           | 10985.            | 54530.          | 15.147            | 0.58           | 0.871      |
| CD-109                                                | 351.70       | 88.06           | 6100.             | 31019.          | 8.616             | 0.77           | 0.892      |
| CO-57                                                 | 487.62       | 122.04          | 3040.             | 6834.           | 1.898             | 2.04           | 0.937      |
| Ce-139                                                | 662.88       | 165.84          | 1495.             | 1193.           | 0.331             | 6.45           | 0.956      |
| Hg-203                                                | 1114.79      | 278.81          | 2119.             | -42.            | -0.012            | 155.58         | 1.105s     |
| SN-113                                                | 1566.31      | 391.67          | 1236.             | 372.            | 0.103             | 19.60          | 1.107      |
| CS-137                                                | 2646.35      | 661.67          | 1156.             | 19152.          | 5.320             | 0.86           | 1.474      |
| Y-898                                                 | 3591.81      | 898.03          | 1084.             | 322.            | 0.089             | 23.53          | 1.897      |
| Co-1173                                               | 4692.59      | 1173.23         | 493.              | 16317.          | 4.532             | 0.86           | 1.893      |
| Co-1332                                               | 5329.55      | 1332.49         | 127.              | 14763.          | 4.101             | 0.85           | 2.038      |
| Y-1836                                                | 7343.66      | 1836.09         | 16.               | 186.            | 0.052             | 9.19           | 1.399s     |

s - Peak fails shape tests.  
 D - Peak area deconvoluted.  
 A Derived peak area.

| ***** S U M M A R Y O F L I B R A R Y P E A K U S A G E ***** |             |            |         |            |      |           |          |            |  |
|---------------------------------------------------------------|-------------|------------|---------|------------|------|-----------|----------|------------|--|
| - Nuclide -                                                   |             | Average    |         | Peak       |      |           |          |            |  |
| Name                                                          | Code        | Activity   | Energy  | Activity   | Code | MDA       | Value    |            |  |
|                                                               |             | Bq/Sample  | keV     | Bq/Sample  |      | Bq/Sample |          | COMMENTS   |  |
| Pb-210                                                        | N           | 1.3857E+04 |         |            |      |           |          | 8.15E+03   |  |
|                                                               |             |            | 46.54   | 1.386E+04  | (P   | 1.480E+02 | 6.34E-01 | 4.25E+00 G |  |
| AM-241                                                        |             | 1.1504E+03 |         |            |      |           |          | 1.58E+05   |  |
|                                                               |             |            | 59.54   | 1.150E+03  | (    | 1.036E+01 | 5.81E-01 | 3.57E+01 G |  |
| CD-109                                                        |             | 1.5217E+04 |         |            |      |           |          | 4.63E+02   |  |
|                                                               |             |            | 88.03   | 1.522E+04  | (    | 1.799E+02 | 7.73E-01 | 3.61E+00 G |  |
| CO-57                                                         |             | 3.1712E+02 |         |            |      |           |          | 2.72E+02   |  |
|                                                               |             |            | 122.06  | 3.171E+02  | (    | 1.205E+01 | 2.04E+00 | 8.56E+01 G |  |
| Ce-139                                                        |             | 5.1801E+02 |         |            |      |           |          | 1.38E+02   |  |
|                                                               |             |            | 165.85  | 5.180E+02  | (    | 7.941E+01 | 6.45E+00 | 7.99E+01 G |  |
| Hg-203                                                        | -4.5441E-01 |            |         |            |      |           |          | 4.66E+01   |  |
|                                                               |             |            | 279.17  | -4.544E-01 | ?(   | 2.347E+00 | 1.56E+02 | 8.15E+01 G |  |
| SN-113                                                        |             | 9.3315E+02 |         |            |      |           |          | 1.15E+02   |  |
|                                                               |             |            | 391.69  | 9.332E+02  | (    | 4.178E+02 | 1.96E+01 | 6.40E+01 G |  |
| CS-137                                                        |             | 4.4047E+02 |         |            |      |           |          | 1.10E+04   |  |
|                                                               |             |            | 661.66  | 4.405E+02  | (    | 3.706E+00 | 8.56E-01 | 8.52E+01 G |  |
| Y-898                                                         |             | 1.6944E+03 |         |            |      |           |          | 1.07E+02   |  |
|                                                               |             |            | 898.02  | 1.694E+03  | (    | 8.216E+02 | 2.35E+01 | 9.37E+01 G |  |
| Co-1173                                                       |             | 6.8172E+02 |         |            |      |           |          | 1.93E+03   |  |
|                                                               |             |            | 1173.24 | 6.817E+02  | (    | 4.436E+00 | 8.58E-01 | 9.99E+01 G |  |
| Co-1332                                                       |             | 6.9210E+02 |         |            |      |           |          | 1.93E+03   |  |
|                                                               |             |            | 1332.50 | 6.921E+02  | (    | 2.586E+00 | 8.49E-01 | 1.00E+02 G |  |
| Y-1836                                                        |             | 1.7801E+03 |         |            |      |           |          | 1.07E+02   |  |
|                                                               |             |            | 1836.01 | 1.780E+03  | (    | 2.065E+02 | 9.19E+00 | 9.92E+01 G |  |

( - This peak used in the nuclide activity average.

\* - Peak is too wide, but only one peak in library.

! - Peak is part of a multiplet and this area went negative during deconvolution.

? - Peak is too narrow.

- @ - Peak is too wide at FW25M, but ok at FWHM.
- % - Peak fails sensitivity test.
- \$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.
- + - Peak activity higher than counting uncertainty range.
- - Peak activity lower than counting uncertainty range.
- = - Peak outside analysis energy range.
- & - Calculated peak centroid is not close enough to the library energy centroid for positive identification.
- P - Peakbackground subtraction
- } - Peak is too close to another for the activity to be found directly.

|                                 |                      |
|---------------------------------|----------------------|
| Nuclide Codes:                  | Peak Codes:          |
| T - Thermal Neutron Activation  | G - Gamma Ray        |
| F - Fast Neutron Activation     | X - X-Ray            |
| I - Fission Product             | P - Positron Decay   |
| N - Naturally Occurring Isotope | S - Single-Escape    |
| P - Photon Reaction             | D - Double-Escape    |
| C - Charged Particle Reaction   | K - Key Line         |
| M - No MDA Calculation          | A - Not in Average   |
| R - Coincidence Corrected       | C - Coincidence Peak |
| H - Halflife limit exceeded     |                      |

\*\*\*\*\* D I S C A R D E D I S O T O P E P E A K S \*\*\*\*\*

| Nuclide | Centroid Energy | Background Counts | Net Area Counts | Intensity Cts/Sec | Uncert 1 Sigma | Activity % |
|---------|-----------------|-------------------|-----------------|-------------------|----------------|------------|
|---------|-----------------|-------------------|-----------------|-------------------|----------------|------------|

|                                |        |       |      |        |        |           |
|--------------------------------|--------|-------|------|--------|--------|-----------|
| Hg-203                         | 278.81 | 2119. | -42. | -0.012 | 155.58 | 0.000E+00 |
| P - Peakbackground subtraction |        |       |      |        |        |           |

\*\*\*\*\* S U M M A R Y O F N U C L I D E S I N S A M P L E \*\*\*\*\*

| Nuclide   | Time of Count Activity Bq/Sample | Time Corrected Activity Bq/Sample | Uncertainty Counting | 1 Sigma    | MDA Bq/Sample |
|-----------|----------------------------------|-----------------------------------|----------------------|------------|---------------|
| Pb-210    | 1.2927E+04                       | 1.3857E+04                        | 6.344E-01%           |            | 1.48E+02      |
| AM-241    | 1.1462E+03                       | 1.1504E+03                        | 5.808E-01%           |            | 1.04E+01      |
| CD-109    | 4.4794E+03                       | 1.5217E+04                        | 7.727E-01%           |            | 1.80E+02      |
| CO-57     | 3.9561E+01                       | 3.1712E+02                        | 2.043E+00%           |            | 1.20E+01      |
| Ce-139    | 8.4971E+00                       | 5.1801E+02                        | 6.453E+00%           |            | 7.94E+01      |
| Hg-203 #A | -4.5441E-01                      | >12 Halflives                     | 1.5558E+02%          | 2.3474E+00 |               |
| SN-113    | 6.8413E+00                       | 9.3315E+02                        | 1.960E+01%           |            | 4.18E+02      |
| CS-137    | 4.1835E+02                       | 4.4047E+02                        | 8.557E-01%           |            | 3.71E+00      |
| Y-898     | 8.3979E+00                       | 1.6944E+03                        | 2.353E+01%           |            | 8.22E+02      |
| Co-1173   | 5.0814E+02                       | 6.8172E+02                        | 8.581E-01%           |            | 4.44E+00      |
| Co-1332   | 5.1588E+02                       | 6.9210E+02                        | 8.485E-01%           |            | 2.59E+00      |
| Y-1836    | 8.8227E+00                       | 1.7801E+03                        | 9.190E+00%           |            | 2.07E+02      |

# - All peaks for activity calculation had bad shape.  
\* - Activity omitted from total  
& - Activity omitted from total and all peaks had bad shape.  
< - MDA value printed.  
A - Activity printed, but activity < MDA.  
B - Activity < MDA and failed test.  
C - Area < Critical level.  
F - Failed fraction or key line test.  
H - Halflife limit exceeded

----- S U M M A R Y -----  
Total Activity ( 37.6 to 2000.2 keV) 2.007E+04 Bq/Sample  
Total Decayed Activity ( 37.6 to 2000.2 keV) 3.7281199E+04 Bq/Sample

Analyzed by: \_\_\_\_\_  
Admin

Reviewed by: \_\_\_\_\_  
Supervisor

Laboratory: TestAmerica

## 2nd Source Verification

Detector: Ge8

Geometry: Tunacan

Reference date 1/1/2010

Source: 81427-334

Standard volume g / vial 1550

Standard volume transferred in g / geometry 318.5

lab ID# of cal standard 6665

| Isotope | Certified Activity<br>gammas/sec | Geometry<br>Activity | $\gamma$ abundance | Bq/sample | Count<br>Results | %recovery |
|---------|----------------------------------|----------------------|--------------------|-----------|------------------|-----------|
| Am-241  | 2034                             | 418                  | 0.359              | 1164      | 1175.4           | 101.0     |
| Cs-137  | 1926                             | 396                  | 0.851              | 465       | 446.61           | 96.0      |
| Co-60   | 3611                             | 742                  | 0.99974            | 742       | 697.22           | 93.9      |
| Co-60   | 3612                             | 742                  | 0.999856           | 742       | 691.92           | 93.2      |

Reviewed By: Jody Watson

Date: 3/29/2012

8\_TunaCan2nd\_20120697

ORTEC g v - i (3263) Env32 G53W4.25 3/29/2012 7:45:38 AM Page 1  
TestAmerica Spectrum name: 8\_TunaCan2nd\_20120697.An1

Sample description  
8\_TunaCan\_81427-334\_2ndsource\_032912

Spectrum Filename: C:\User\SPC\Det8\8\_TunaCan2nd\_20120697.An1

Acquisition information  
Start time: 3/29/2012 1:58:04 AM  
Live time: 3600  
Real time: 3622  
Dead time: 0.61 %  
Detector ID: 8

Detector system  
Ge 8 SN/174

Calibration  
Filename: 8\_Soil\_TunaCan.Clb  
8\_Soil\_TunaCan\_90099\_032712

Energy Calibration  
Created: 3/28/2012 10:35:07 AM  
Zero offset: 0.050 keV  
Gain: 0.250 keV/channel  
Quadratic:  $8.067\text{E-}10 \text{ keV/channel}^2$

Efficiency Calibration  
Created: 3/28/2012 10:35:20 AM  
Knee Energy: 165.85 keV  
Above the Knee: Quadratic Uncertainty = 1.39 %  
Log(Eff):  $-1.098764\text{E-}01 + (-4.958544\text{E-}01 * \text{Log}(E)) + (-2.572270\text{E-}02 * \text{Log}(E)^2)$   
Below the Knee: Quadratic Uncertainty = 1.71 %  
Log(Eff):  $-2.525301\text{E+}01 + (9.398253\text{E+}00 * \text{Log}(E)) + (-1.000034\text{E+}00 * \text{Log}(E)^2)$

Library Files  
Main analysis library: DET\_EnergyStandardMix & Pb.Lib  
Library Match width: 0.500  
Peak stripping: Library based

Analysis parameters  
Analysis engine: Env32 G53W4.25  
Start channel: 150 ( 37.55keV )  
Stop channel: 8000 ( 2000.30keV )  
Peak rejection level: 1000.000%  
Peak search sensitivity: 3  
Sample Size: 1.0000E+00  
Activity scaling factor:  $1.0000\text{E+}00 / (1.0000\text{E+}00 * 1.0000\text{E+}00) = 1.0000\text{E+}00$   
Detection limit method: Reg. Guide 4.16 Method

□

ORTEC g v - i (3263) Env32 G53W4.25 3/29/2012 7:45:38 AM Page 2  
TestAmerica Spectrum name: 8\_TunaCan2nd\_20120697.An1  
Page 1

# 8\_TunaCan2nd\_20120697

Random error: 4.0000000E+00  
 Systematic error: 4.0000000E+00  
 Fraction Limit: 0.000%  
 Background width: average of three points.

Half lives decay limit: 12.000  
 Activity range factor: 2.000  
 Min. step backg. energy: 0.000  
 Multiplet shift channel: 2.000

| Corrections                   | Status | Comments                                     |
|-------------------------------|--------|----------------------------------------------|
| Decay correct to date:        | YES    | 1/1/2010 11:00:00 AM                         |
| Decay during acquisition:     | YES    |                                              |
| Decay during collection:      | NO     |                                              |
| True coincidence correction:  | NO     |                                              |
| Peaked background correction: | YES    | 8_2012-03-02_0402.PBC<br>3/2/2012 4:02:11 AM |

Absorption (Internal): NO  
 Geometry correction: NO  
 Random summing: NO

total peaks alloc. 12 cutoff: 5.00E+01%  
 Energy Calibration  
 Normalized diff: 27.9595

| ***** S U M M A R Y O F P E A K S I N R A N G E ***** |        |        |      |                |                |              |              |        |
|-------------------------------------------------------|--------|--------|------|----------------|----------------|--------------|--------------|--------|
| Peak Energy                                           | Area   | Uncert | FWHM | Corrctn Factor | Nuclide Energy | Brnch. Ratio | Act. Bq/Samp | Nuc    |
| 36.61                                                 | 594.   | 17.47  | 1.15 | 1.254E-02      |                |              |              |        |
| 46.53                                                 | 38495. | 0.62   | 0.95 | 2.001E-02      | 46.54          | 4.250        | 1.345E+04    | Pb210  |
| 49.81                                                 | 542.   | 25.92  | 1.04 | 2.243E-02      |                |              |              |        |
| 59.48                                                 | 43371. | 0.71   | 0.98 | 2.878E-02      | 59.54          | 35.700       | 1.175E+03    | AM241  |
| 84.86                                                 | 327.   | 26.82  | 0.98 | 3.922E-02      |                |              |              |        |
| 88.03                                                 | 22911. | 0.76   | 0.98 | 3.992E-02      | 88.03          | 3.610        | 1.504E+04    | CD109  |
| 122.06                                                | 5318.  | 2.55   | 1.03 | 4.146E-02      | 122.06         | 85.600       | 3.349E+02    | CO57   |
| 136.54                                                | 691.   | 14.03  | 0.89 | 3.998E-02      |                |              |              |        |
| 165.93                                                | 1033.  | 8.62   | 1.19 | 3.628E-02      | 165.85         | 79.900       | 6.077E+02    | Ce139  |
| 177.05                                                | 71.    | 70.08  | 0.69 | 3.453E-02      |                |              |              |        |
| 185.74                                                | 128.   | 40.98  | 0.85 | 3.329E-02      |                |              |              |        |
| 227.93                                                | 52.    | 65.04  | 0.45 | 2.844E-02      |                |              |              |        |
| 270.79                                                | 87.    | 50.41  | 0.41 | 2.486E-02      |                |              |              |        |
| 278.94                                                | 44.    | 131.33 | 1.13 | 2.428E-02      | 279.17         | 81.500       | HL>Cutoff    | Hg203  |
| 302.52                                                | 63.    | 54.81  | 0.69 | 2.279E-02      |                |              |              |        |
| 370.09                                                | 35.    | 84.23  | 0.41 | 1.941E-02      |                |              |              |        |
| 391.61                                                | 316.   | 17.91  | 0.81 | 1.855E-02      | 391.69         | 64.000       | 1.016E+03    | SN113  |
| 409.22                                                | 93.    | 50.95  | 0.41 | 1.791E-02      |                |              |              |        |
| 428.24                                                | 88.    | 46.51  | 0.39 | 1.726E-02      |                |              |              |        |
| 564.57                                                | 72.    | 45.26  | 0.57 | 1.378E-02      |                |              |              |        |
| 591.73                                                | 73.    | 42.60  | 0.61 | 1.326E-02      |                |              |              |        |
| 661.62                                                | 15734. | 0.88   | 1.38 | 1.209E-02      | 661.66         | 85.210       | 4.466E+02    | CS137  |
| 720.39                                                | 41.    | 72.89  | 0.46 | 1.126E-02      |                |              |              |        |
| 831.73                                                | 36.    | 50.61  | 0.44 | 9.986E-03      |                |              |              |        |
| 897.91                                                | 396.   | 17.93  | 1.52 | 9.360E-03      | 898.02         | 93.700       | 2.554E+03    | Y898   |
| 1092.31                                               | 69.    | 44.41  | 0.50 | 7.924E-03      |                |              |              |        |
| 1173.30                                               | 13922. | 0.92   | 1.73 | 7.452E-03      | 1173.24        | 99.900       | 6.972E+02    | Co1173 |
| 1332.56                                               | 12390. | 0.92   | 1.75 | 6.677E-03      | 1332.50        | 99.982       | 6.919E+02    | Co1332 |
| 1836.18                                               | 152.   | 9.00   | 1.63 | 5.046E-03      | 1836.01        | 99.200       | 1.724E+03    | Y1836  |

# 8\_TunaCan2nd\_20120697

\*\*\*\*\* U N I D E N T I F I E D P E A K S U M M A R Y \*\*\*\*\*

| Peak Channel | Centroid Energy | Background Counts | Net Area Counts | Efficiency * Area | Uncert 1 Sigma % | FWHM keV | Suspected Nuclide |
|--------------|-----------------|-------------------|-----------------|-------------------|------------------|----------|-------------------|
| 146.23       | 36.61           | 3218.             | 594.            | 4.742E+04         | 17.47            | 1.147    | - S               |
| 199.01       | 49.81           | 6400.             | 542.            | 2.416E+04         | 25.92            | 1.039    | - SM              |
| 339.16       | 84.85           | 3491.             | 236.            | 6.026E+03         | 42.58            | 0.697    | - SM              |

□

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TestAmerica Spectrum name: 8\_TunaCan2nd\_20120697.An1

| Channel | Energy  | Background | Net area | Eff*Area  | Uncert | FWHM  | Suspected |
|---------|---------|------------|----------|-----------|--------|-------|-----------|
| 545.91  | 136.54  | 2178.      | 691.     | 1.728E+04 | 14.03  | 0.888 | -         |
| 707.94  | 177.05  | 893.       | 71.      | 2.046E+03 | 70.08  | 0.693 | - SM      |
| 742.68  | 185.74  | 978.       | 128.     | 3.835E+03 | 40.98  | 0.847 | - SM      |
| 911.43  | 227.93  | 546.       | 52.      | 1.829E+03 | 65.04  | 0.445 | - SC      |
| 1082.86 | 270.79  | 683.       | 87.      | 3.486E+03 | 50.41  | 0.413 | - SM      |
| 1209.76 | 302.52  | 484.       | 63.      | 2.765E+03 | 54.81  | 0.692 | - S       |
| 1480.00 | 370.09  | 385.       | 35.      | 1.803E+03 | 84.23  | 0.412 | - SC      |
| 1636.49 | 409.22  | 685.       | 93.      | 5.212E+03 | 50.95  | 0.407 | - S       |
| 1712.56 | 428.24  | 565.       | 88.      | 5.117E+03 | 46.51  | 0.393 | - S       |
| 2257.86 | 564.57  | 330.       | 72.      | 5.224E+03 | 45.26  | 0.565 | - S       |
| 2366.45 | 591.73  | 298.       | 73.      | 5.505E+03 | 42.60  | 0.613 | - S       |
| 2881.06 | 720.39  | 284.       | 41.      | 3.640E+03 | 72.89  | 0.464 | - S       |
| 3326.37 | 831.73  | 148.       | 36.      | 3.605E+03 | 50.61  | 0.439 | - S       |
| 4368.55 | 1092.31 | 290.       | 69.      | 8.708E+03 | 44.41  | 0.495 | - S       |

s - Peak fails shape tests.  
D - Peak area deconvoluted.  
L - Peak written from unknown list.  
C - Area < Critical level.  
M - Peak is close to a library peak.

-----  
This section based on library: DET\_EnergyStandardMix & Pb.Lib

\*\*\*\*\* I D E N T I F I E D P E A K S U M M A R Y \*\*\*\*\*

| Nuclide | Peak Channel | Centroid Energy | Background Counts | Net Area Counts | Intensity Cts/Sec | Uncert 1 Sigma % | FWHM keV |
|---------|--------------|-----------------|-------------------|-----------------|-------------------|------------------|----------|
| Pb-210  | 185.71       | 46.48           | 12173.            | 40702.          | 11.306            | 0.74             | 0.992    |
| AM-241  | 237.70       | 59.48           | 10649.            | 43371.          | 12.047            | 0.71             | 0.984    |
| CD-109  | 351.85       | 88.02           | 4506.             | 23196.          | 6.443             | 0.88             | 1.056    |
| CO-57   | 487.99       | 122.06          | 2908.             | 5318.           | 1.477             | 2.55             | 1.026    |
| Ce-139  | 663.47       | 165.93          | 1722.             | 1033.           | 0.287             | 8.62             | 1.189s   |
| Hg-203  | 1115.46      | 278.94          | 1642.             | 44.             | 0.012             | 131.33           | 1.133    |
| SN-113  | 1566.07      | 391.61          | 822.              | 316.            | 0.088             | 17.91            | 0.806s   |
| CS-137  | 2646.01      | 661.62          | 665.              | 15731.          | 4.370             | 0.88             | 1.379    |
| Y-898   | 3591.03      | 897.91          | 871.              | 396.            | 0.110             | 17.93            | 1.524    |
| Co-1173 | 4692.46      | 1173.30         | 374.              | 13922.          | 3.867             | 0.92             | 1.726    |
| Co-1332 | 5329.42      | 1332.56         | 82.               | 12390.          | 3.442             | 0.92             | 1.753    |
| Y-1836  | 7343.62      | 1836.18         | 6.                | 152.            | 0.042             | 9.00             | 1.626s   |

s - Peak fails shape tests.  
D - Peak area deconvoluted.  
A Derived peak area.

□

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TestAmerica Spectrum name: 8\_TunaCan2nd\_20120697.An1  
Page 3

# 8\_TunaCan2nd\_20120697

| ***** S U M M A R Y O F L I B R A R Y P E A K U S A G E ***** |      |                                  |               |                               |      |                        |          |          |            |
|---------------------------------------------------------------|------|----------------------------------|---------------|-------------------------------|------|------------------------|----------|----------|------------|
| - Nuclide -<br>Name                                           | Code | Average<br>Activity<br>Bq/Sample | Energy<br>keV | Peak<br>Activity<br>Bq/Sample | Code | MDA Value<br>Bq/Sample | COMMENTS |          |            |
| Pb-210                                                        | N    | 1.4221E+04                       | 46.54         | 1.422E+04                     | (    | 1.806E+02              | 7.43E-01 | 8.15E+03 | 4.25E+00 G |
| AM-241                                                        |      | 1.1754E+03                       | 59.54         | 1.175E+03                     | (    | 1.311E+01              | 7.10E-01 | 1.58E+05 | 3.57E+01 G |
| CD-109                                                        |      | 1.5223E+04                       | 88.03         | 1.522E+04                     | (    | 2.071E+02              | 8.83E-01 | 4.63E+02 | 3.61E+00 G |
| CO-57                                                         |      | 3.3494E+02                       | 122.06        | 3.349E+02                     | (    | 1.600E+01              | 2.55E+00 | 2.72E+02 | 8.56E+01 G |
| Ce-139                                                        |      | 6.0766E+02                       | 165.85        | 6.077E+02                     | *(   | 1.153E+02              | 8.62E+00 | 1.38E+02 | 7.99E+01 G |
| Hg-203                                                        |      | 6.1671E-01                       | 279.17        | 6.167E-01                     | (    | 2.689E+00              | 1.31E+02 | 4.66E+01 | 8.15E+01 G |
| SN-113                                                        |      | 1.0157E+03                       | 391.69        | 1.016E+03                     | (    | 4.390E+02              | 1.79E+01 | 1.15E+02 | 6.40E+01 G |
| CS-137                                                        |      | 4.4661E+02                       | 661.66        | 4.466E+02                     | (P   | 3.489E+00              | 8.85E-01 | 1.10E+04 | 8.52E+01 G |
| Y-898                                                         |      | 2.5543E+03                       | 898.02        | 2.554E+03                     | (    | 9.046E+02              | 1.79E+01 | 1.07E+02 | 9.37E+01 G |
| Co-1173                                                       |      | 6.9722E+02                       | 1173.24       | 6.972E+02                     | (    | 4.649E+00              | 9.19E-01 | 1.93E+03 | 9.99E+01 G |
| Co-1332                                                       |      | 6.9192E+02                       | 1332.50       | 6.919E+02                     | (    | 2.515E+00              | 9.18E-01 | 1.93E+03 | 1.00E+02 G |
| Y-1836                                                        |      | 1.7236E+03                       | 1836.01       | 1.724E+03                     | (    | 1.542E+02              | 9.00E+00 | 1.07E+02 | 9.92E+01 G |

( - This peak used in the nuclide activity average.

\* - Peak is too wide, but only one peak in library.

! - Peak is part of a multiplet and this area went negative during deconvolution.

? - Peak is too narrow.

□

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TestAmerica Spectrum name: 8\_TunaCan2nd\_20120697.An1

@ - Peak is too wide at FW25M, but ok at FWHM.

% - Peak fails sensitivity test.

\$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.

+ - Peak activity higher than counting uncertainty range.

- - Peak activity lower than counting uncertainty range.

= - Peak outside analysis energy range.

& - Calculated peak centroid is not close enough to the library energy centroid for positive identification.

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# 8\_TunaCan2nd\_20120697

P - Peakbackground subtraction  
 } - Peak is too close to another for the activity to be found directly.

|                                 |                      |
|---------------------------------|----------------------|
| Nuclide Codes:                  | Peak Codes:          |
| T - Thermal Neutron Activation  | G - Gamma Ray        |
| F - Fast Neutron Activation     | X - X-Ray            |
| I - Fission Product             | P - Positron Decay   |
| N - Naturally Occurring Isotope | S - Single-Escape    |
| P - Photon Reaction             | D - Double-Escape    |
| C - Charged Particle Reaction   | K - Key Line         |
| M - No MDA Calculation          | A - Not in Average   |
| R - Coincidence Corrected       | C - Coincidence Peak |
| H - Halflife limit exceeded     |                      |

## \*\*\*\*\* D I S C A R D E D I S O T O P E P E A K S \*\*\*\*\*

| Nuclide                                                       | Centroid Energy | Background Counts  | Net Area Counts | Intensity Cts/Sec  | Uncert 1 Sigma       | Activity %    |
|---------------------------------------------------------------|-----------------|--------------------|-----------------|--------------------|----------------------|---------------|
| P - Peakbackground subtraction                                |                 |                    |                 |                    |                      |               |
| ***** S U M M A R Y O F N U C L I D E S I N S A M P L E ***** |                 |                    |                 |                    |                      |               |
| Nuclide                                                       | Time of Count   | Activity Bq/Sample | Time Corrected  | Activity Bq/Sample | Uncertainty Counting | MDA Bq/Sample |
| Pb-210                                                        | 1.3265E+04      | 1.4221E+04         | 7.429E-01%      |                    |                      | 1.81E+02      |
| AM-241                                                        | 1.1712E+03      | 1.1754E+03         | 7.101E-01%      |                    |                      | 1.31E+01      |
| CD-109                                                        | 4.4713E+03      | 1.5223E+04         | 8.832E-01%      |                    |                      | 2.07E+02      |
| CO-57                                                         | 4.1631E+01      | 3.3494E+02         | 2.551E+00%      |                    |                      | 1.60E+01      |
| Ce-139 #                                                      | 9.8959E+00      | 6.0766E+02         | 8.616E+00%      |                    |                      | 1.15E+02      |
| Hg-203 A                                                      | 6.1671E-01      | >12 Halflives      | 1.3133E+02%     | 2.6892E+00         |                      |               |
| SN-113                                                        | 7.3819E+00      | 1.0157E+03         | 1.791E+01%      |                    |                      | 4.39E+02      |
| CS-137                                                        | 4.2415E+02      | 4.4661E+02         | 8.848E-01%      |                    |                      | 3.49E+00      |
| Y-898                                                         | 1.2542E+01      | 2.5543E+03         | 1.793E+01%      |                    |                      | 9.05E+02      |
| Co-1173                                                       | 5.1942E+02      | 6.9722E+02         | 9.185E-01%      |                    |                      | 4.65E+00      |
| Co-1332                                                       | 5.1548E+02      | 6.9192E+02         | 9.176E-01%      |                    |                      | 2.52E+00      |
| Y-1836                                                        | 8.4633E+00      | 1.7236E+03         | 8.997E+00%      |                    |                      | 1.54E+02      |

ORTEC g v - i (3263) Env32 G53W4.25 3/29/2012 7:45:38 AM Page 6  
 TestAmerica Spectrum name: 8\_TunaCan2nd\_20120697.An1

# - All peaks for activity calculation had bad shape.  
 \* - Activity omitted from total  
 & - Activity omitted from total and all peaks had bad shape.  
 < - MDA value printed.  
 A - Activity printed, but activity < MDA.  
 B - Activity < MDA and failed test.  
 C - Area < Critical level.  
 F - Failed fraction or key line test.  
 H - Halflife limit exceeded

----- S U M M A R Y -----  
 Total Activity ( 37.6 to 2000.3 keV) 2.045E+04 Bq/Sample  
 Total Decayed Activity ( 37.6 to 2000.3 keV) 3.8690848E+04 Bq/Sample

# **Annual Calibration Verifications**

## ANNUAL CALIBRATION VERIFICATION

Detector ID: **Detector # 5**  
 SpectrumID: **5\_20160128006\_EffVerif**  
 Analysis Description: ACVTop-776670;TunaCan2006  
 Calibration: 5\_Soil\_TunaCan\_90099\_032612  
 Detector: Ge 5 SN/157

Verification Date: 2016-01-28 10:21  
 Source Assay Date/Time: 2006-10-01 11:00

| Isotope | Gamma Energy (kev) | Source Emission Rate (GPS)<br>(Assay) | Observed Activity (GPS)<br>(Actual) | Percent Difference (%)<br><u>Assay-Actual</u><br>Assay |
|---------|--------------------|---------------------------------------|-------------------------------------|--------------------------------------------------------|
| Am-241  | 59.54              | 449                                   | 4.57E+02                            | -1.7%                                                  |
| Cs-137  | 661.66             | 400                                   | 3.97E+02                            | 0.7%                                                   |
| Co-1332 | 1332.5             | 777                                   | 7.71E+02                            | 0.8%                                                   |

Comments:

Perform \_\_\_Jody Watson 1/28/16\_\_\_\_\_

Review \_\_\_Rachel Mueller 1/28/16\_\_\_\_\_

C:\User\CRpt\5\_20160128006\_EffVerif.xls

-----

Sample Description: ACVTop-776670;TunaCan2006

Detector: Ge 5 SN/157

Source Date: 10/1/2006 11:00

Acquired: 1/28/2016 10:21:33

Analyzed: 2/4/2016 10:52

---

Analyst: Jody Watson

Efficiency: 5\_Soil\_TunaCan\_90099\_032612

Library: DET\_EfficiencyVerification.lib

| Nuclide | Activity<br>uCi/Source | Uncertainty<br>% |
|---------|------------------------|------------------|
| AM-241  | 4.566E+02              | 0.45             |
| CS-137  | 3.974E+02              | 0.71             |
| Co-1332 | 7.707E+02              | 1.09             |
| Total   | 1.625E+03              |                  |

-----

Sample description  
ACVTop-776670;TunaCan2006

Spectrum Filename: C:\User\SPC\Det5\5\_20160128006\_EffVerif.An1

Acquisition information

Start time: 1/28/2016 10:21:33 AM  
Live time: 7200  
Real time: 7242  
Dead time: 0.59 %  
Detector ID: 5

Detector system

Ge 5 SN/157

Calibration

Filename: 5\_Soil\_TunaCan.Clb  
5\_Soil\_TunaCan\_90099\_032612

Energy Calibration

Created: 2/28/2012 7:35:48 PM  
Zero offset: 0.158 keV  
Gain: 0.250 keV/channel  
Quadratic: 3.911E-08 keV/channel<sup>2</sup>

Efficiency Calibration

Created: 3/27/2012 5:20:37 PM  
Knee Energy: 165.85 keV  
Above the Knee: Quadratic Uncertainty = 0.87 %  
Log(Eff):  $6.466115E-01 + (-7.830454E-01 * \text{Log}(E)) + (-4.117504E-03 * \text{Log}(E)^2)$   
Below the Knee: Quadratic Uncertainty = 1.43 %  
Log(Eff):  $-2.462251E+01 + (9.075211E+00 * \text{Log}(E)) + (-9.664422E-01 * \text{Log}(E)^2)$

Library Files

Main analysis library: DET\_EfficiencyVerification.lib  
Library Match Width: 0.500  
Peak stripping: Library based

Analysis parameters

Analysis engine: Env32 G53W4.25  
Start channel: 150 ( 37.62keV )  
Stop channel: 8000 ( 2000.81keV )  
Peak rejection level: 10.000%  
Peak search sensitivity: 3  
Sample Size: 1.0000E+00  
Activity scaling factor:  $1.0000E+00 / (1.0000E+00 * 1.0000E+00) = 1.0000E+00$   
Detection limit method: Reg. Guide 4.16 Method

Random error: 4.0000000E+00  
Systematic error: 4.0000000E+00  
Fraction Limit: 0.000%  
Background width: average of three points.  
Half lives decay limit: 12.000  
Activity range factor: 2.000  
Min. step backg. energy 0.000  
Multiplet shift channel 2.000

| Corrections                   | Status | Comments              |
|-------------------------------|--------|-----------------------|
| Decay correct to date:        | YES    | 10/1/2006 11:00:00 AM |
| Decay during acquisition:     | YES    |                       |
| Decay during collection:      | NO     |                       |
| True coincidence correction:  | NO     |                       |
| Peaked background correction: | NO     |                       |
| Absorption (Internal):        | NO     |                       |
| Geometry correction:          | NO     |                       |
| Random summing:               | NO     |                       |

total peaks alloc. 3 cutoff: 5.00E+01%

Energy Calibration  
Normalized diff: 0.0281

| ***** S U M M A R Y O F P E A K S I N R A N G E ***** |        |        |      |                |                |              |               |        |
|-------------------------------------------------------|--------|--------|------|----------------|----------------|--------------|---------------|--------|
| Peak Energy                                           | Area   | Uncert | FWHM | Corrctn Factor | Nuclide Energy | Brnch. Ratio | Act. uCi/Sour | Nuc    |
| 46.59                                                 | 62614. | 0.54   | 0.73 | 1.791E-02      |                |              |               |        |
| 59.55                                                 | 82059. | 0.45   | 0.73 | 2.534E-02      | 59.54          | 100.000      | 4.566E+02     | AM241  |
| 87.79                                                 | 1068.  | 8.88   | 0.81 | 3.458E-02      |                |              |               |        |
| 661.63                                                | 22901. | 0.71   | 1.29 | 9.925E-03      | 661.66         | 100.000      | 3.973E+02     | CS137  |
| 1173.12                                               | 9966.  | 1.10   | 1.75 | 6.139E-03      |                |              |               |        |
| 1332.41                                               | 8977.  | 1.09   | 1.90 | 5.515E-03      | 1332.50        | 100.000      | 7.707E+02     | Co1332 |

| ***** U N I D E N T I F I E D P E A K S U M M A R Y ***** |                 |                   |                 |                   |                  |          |                   |   |
|-----------------------------------------------------------|-----------------|-------------------|-----------------|-------------------|------------------|----------|-------------------|---|
| Peak Channel                                              | Centroid Energy | Background Counts | Net Area Counts | Efficiency * Area | Uncert 1 Sigma % | FWHM keV | Suspected Nuclide |   |
| 185.88                                                    | 46.59           | 15162.            | 62614.          | 3.496E+06         | 0.54             | 0.733    | -                 |   |
| 350.82                                                    | 87.79           | 2502.             | 1068.           | 3.087E+04         | 8.88             | 0.809    | -                 | s |
| 4692.76                                                   | 1173.12         | 266.              | 9966.           | 1.624E+06         | 1.10             | 1.754    | -                 |   |

s - Peak fails shape tests.  
D - Peak area deconvoluted.  
L - Peak written from unknown list.  
C - Area < Critical level.

-----  
This section based on library: DET\_EfficiencyVerification.lib

\*\*\*\*\* I D E N T I F I E D P E A K S U M M A R Y \*\*\*\*\*

| Nuclide | Peak<br>Channel | Centroid<br>Energy | Background<br>Counts | Net Area<br>Counts | Intensity<br>Cts/Sec | Uncert<br>1 Sigma | FWHM<br>% |
|---------|-----------------|--------------------|----------------------|--------------------|----------------------|-------------------|-----------|
| AM-241  | 237.79          | 59.55              | 13086.               | 82059.             | 11.397               | 0.45              | 0.731     |
| CS-137  | 2647.26         | 661.63             | 612.                 | 22901.             | 3.181                | 0.71              | 1.293     |
| Co-1332 | 5329.50         | 1332.41            | 77.                  | 8977.              | 1.247                | 1.09              | 1.898     |

s - Peak fails shape tests.  
D - Peak area deconvoluted.  
A Derived peak area.

\*\*\*\*\* S U M M A R Y O F L I B R A R Y P E A K U S A G E \*\*\*\*\*

| - Nuclide -<br>Name | Average<br>Code | Activity<br>uCi/Source | Energy<br>keV | Peak<br>Activity<br>uCi/Source | MDA Value<br>Code | Value<br>uCi/Source | COMMENTS |
|---------------------|-----------------|------------------------|---------------|--------------------------------|-------------------|---------------------|----------|
|---------------------|-----------------|------------------------|---------------|--------------------------------|-------------------|---------------------|----------|

|                                                    |            |  |         |           |   |                             |   |
|----------------------------------------------------|------------|--|---------|-----------|---|-----------------------------|---|
| AM-241                                             | 4.5663E+02 |  | 59.54   | 4.566E+02 | ( | 2.981E+00 4.47E-01 1.00E+02 | G |
| CS-137                                             | 3.9735E+02 |  | 661.66  | 3.973E+02 | ( | 2.047E+00 7.08E-01 1.00E+02 | G |
| Co-1332                                            | 7.7068E+02 |  | 1332.50 | 7.707E+02 | ( | 3.743E+00 1.09E+00 1.00E+02 | G |
| (- This peak used in the nuclide activity average. |            |  |         |           |   |                             |   |

\* - Peak is too wide, but only one peak in library.  
! - Peak is part of a multiplet and this area went negative during deconvolution.  
? - Peak is too narrow.  
@ - Peak is too wide at FW25M, but ok at FWHM.  
% - Peak fails sensitivity test.  
\$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.  
+ - Peak activity higher than counting uncertainty range.  
- - Peak activity lower than counting uncertainty range.  
= - Peak outside analysis energy range.  
& - Calculated peak centroid is not close enough to the library energy centroid for positive identification.  
P - Peakbackground subtraction  
} - Peak is too close to another for the activity to be found directly.

Nuclide Codes:

T - Thermal Neutron Activation  
F - Fast Neutron Activation  
I - Fission Product

Peak Codes:

G - Gamma Ray  
X - X-Ray  
P - Positron Decay

|                                 |                      |
|---------------------------------|----------------------|
| N - Naturally Occurring Isotope | S - Single-Escape    |
| P - Photon Reaction             | D - Double-Escape    |
| C - Charged Particle Reaction   | K - Key Line         |
| M - No MDA Calculation          | A - Not in Average   |
| R - Coincidence Corrected       | C - Coincidence Peak |
| H - Halflife limit exceeded     |                      |

\*\*\*\*\* D I S C A R D E D I S O T O P E P E A K S \*\*\*\*\*

| Nuclide | Centroid Energy | Background Counts | Net Area Counts | Intensity Cts/Sec | Uncert 1 Sigma % | Activity |
|---------|-----------------|-------------------|-----------------|-------------------|------------------|----------|
|---------|-----------------|-------------------|-----------------|-------------------|------------------|----------|

P - Peakbackground subtraction

\*\*\*\*\* S U M M A R Y O F N U C L I D E S I N S A M P L E \*\*\*\*\*

| Nuclide | Time of Count       | Time Corrected      | Uncertainty 1 Sigma | MDA |
|---------|---------------------|---------------------|---------------------|-----|
|         | Activity uCi/Source | Activity uCi/Source | Counting            |     |

|         |            |            |            |          |
|---------|------------|------------|------------|----------|
| AM-241  | 4.4986E+02 | 4.5663E+02 | 4.468E-01% | 2.98E+00 |
| CS-137  | 3.2049E+02 | 3.9735E+02 | 7.077E-01% | 2.05E+00 |
| Co-1332 | 2.2610E+02 | 7.7068E+02 | 1.091E+00% | 3.74E+00 |

< - MDA value printed.  
A - Activity printed, but activity < MDA.  
B - Activity < MDA and failed test.  
C - Area < Critical level.  
F - Failed fraction or key line test.  
H - Halflife limit exceeded

----- S U M M A R Y -----

|                                              |                          |
|----------------------------------------------|--------------------------|
| Total Activity ( 37.6 to 2000.8 keV)         | 9.965E+02 uCi/Source     |
| Total Decayed Activity ( 37.6 to 2000.8 keV) | 1.6246621E+03 uCi/Source |

## ANNUAL CALIBRATION VERIFICATION

Detector ID: **Detector # 7**  
 SpectrumID: 7\_20160123003\_EffVerif  
 Analysis Description: ACVTop-776670;TunaCan2006  
 Calibration: 7\_TunaCan\_90099\_032712  
 Detector: Ge 7 SN/154

Verification Date: 2016-01-23 19:25  
 Source Assay Date/Time: 2006-10-01 11:00

| Isotope | Gamma Energy (kev) | Source Emission Rate (GPS)<br>(Assay) | Observed Activity (GPS)<br>(Actual) | Percent Difference (%)       |
|---------|--------------------|---------------------------------------|-------------------------------------|------------------------------|
|         |                    |                                       |                                     | <u>Assay-Actual</u><br>Assay |
| Am-241  | 59.54              | 449                                   | 4.38E+02                            | 2.5%                         |
| Cs-137  | 661.66             | 400                                   | 3.86E+02                            | 3.6%                         |
| Co-1332 | 1332.5             | 777                                   | 7.19E+02                            | 7.5%                         |

Comments:

Perform \_\_\_\_ Kody Saulters 2/4/16 \_\_\_\_

Review \_\_\_\_ Jody Watson 2/4/16 \_\_\_\_

C:\User\CRpt\7\_20160123003\_EffVerif.xls

-----

Sample Description: ACVTop-776670;TunaCan2006

Detector: Ge 7 SN/154

Source Date: 10/1/2006 11:00

Acquired: 1/23/2016 19:25:53

Analyzed: 2/4/2016 10:49

-----

Analyst: Jody Watson

Efficiency: 7\_TunaCan\_90099\_032712

Library: DET\_EfficiencyVerification.lib

| Nuclide | Activity<br>uCi/Source | Uncertainty<br>% |
|---------|------------------------|------------------|
| AM-241  | 4.380E+02              | 0.38             |
| CS-137  | 3.857E+02              | 0.59             |
| Co-1332 | 7.189E+02              | 0.94             |
| Total   | 1.543E+03              |                  |

-----

Sample description  
ACVTop-776670;TunaCan2006

Spectrum Filename: C:\User\SPC\Det7\7\_20160123003\_EffVerif.An1

Acquisition information

Start time: 1/23/2016 7:25:53 PM  
Live time: 7200  
Real time: 7361  
Dead time: 2.18 %  
Detector ID: 7

Detector system

Ge 7 SN/154

Calibration

Filename: 7\_Soil\_TunaCan.Clb  
7\_TunaCan\_90099\_032712

Energy Calibration

Created: 2/23/2012 8:40:56 AM  
Zero offset: 0.117 keV  
Gain: 0.250 keV/channel  
Quadratic: 3.508E-09 keV/channel^2

Efficiency Calibration

Created: 3/16/2012 11:45:14 AM  
Knee Energy: 165.85 keV  
Above the Knee: Quadratic Uncertainty = 0.87 %  
Log(Eff):  $6.716580E-01 + (-6.166540E-01 * \text{Log}(E)) + (-2.065917E-02 * \text{Log}(E)^2)$   
Below the Knee: Quadratic Uncertainty = 1.48 %  
Log(Eff):  $-2.689695E+01 + (1.019544E+01 * \text{Log}(E)) + (-1.081671E+00 * \text{Log}(E)^2)$

Library Files

Main analysis library: DET\_EfficiencyVerification.lib  
Library Match Width: 0.500  
Peak stripping: Library based

Analysis parameters

Analysis engine: Env32 G53W4.25  
Start channel: 150 ( 37.61keV )  
Stop channel: 8000 ( 2000.12keV )  
Peak rejection level: 10.000%  
Peak search sensitivity: 3  
Sample Size: 1.0000E+00  
Activity scaling factor:  $1.0000E+00 / (1.0000E+00 * 1.0000E+00) = 1.0000E+00$   
Detection limit method: Reg. Guide 4.16 Method

Random error: 4.0000000E+00  
Systematic error: 4.0000000E+00  
Fraction Limit: 0.000%  
Background width: average of three points.  
Half lives decay limit: 12.000  
Activity range factor: 2.000  
Min. step backg. energy 0.000  
Multiplet shift channel 2.000

| Corrections                   | Status | Comments              |
|-------------------------------|--------|-----------------------|
| Decay correct to date:        | YES    | 10/1/2006 11:00:00 AM |
| Decay during acquisition:     | YES    |                       |
| Decay during collection:      | NO     |                       |
| True coincidence correction:  | NO     |                       |
| Peaked background correction: | NO     |                       |
| Absorption (Internal):        | NO     |                       |
| Geometry correction:          | NO     |                       |
| Random summing:               | NO     |                       |

total peaks alloc. 3 cutoff: 5.00E+01%

Energy Calibration  
Normalized diff: 0.0434

| ***** S U M M A R Y O F P E A K S I N R A N G E ***** |         |        |      |                |                |              |               |        |
|-------------------------------------------------------|---------|--------|------|----------------|----------------|--------------|---------------|--------|
| Peak Energy                                           | Area    | Uncert | FWHM | Corrctn Factor | Nuclide Energy | Brnch. Ratio | Act. uCi/Sour | Nuc    |
| 36.52                                                 | 1402.   | 9.33   | 1.11 | 1.474E-02      |                |              |               |        |
| 46.60                                                 | 75982.  | 0.45   | 0.84 | 2.485E-02      |                |              |               |        |
| 59.55                                                 | 114994. | 0.38   | 0.89 | 3.702E-02      | 59.54          | 100.000      | 4.380E+02     | AM241  |
| 87.94                                                 | 1428.   | 8.44   | 0.97 | 5.326E-02      |                |              |               |        |
| 661.74                                                | 33440.  | 0.59   | 1.49 | 1.492E-02      | 661.66         | 100.000      | 3.857E+02     | CS137  |
| 1173.38                                               | 13650.  | 0.99   | 1.95 | 8.928E-03      |                |              |               |        |
| 1332.63                                               | 12093.  | 0.94   | 1.99 | 7.950E-03      | 1332.50        | 100.000      | 7.189E+02     | Co1332 |

| ***** U N I D E N T I F I E D P E A K S U M M A R Y ***** |                   |                 |                   |                |        |                   |   |  |
|-----------------------------------------------------------|-------------------|-----------------|-------------------|----------------|--------|-------------------|---|--|
| Peak Centroid Channel                                     | Background Energy | Net Area Counts | Efficiency * Area | Uncert 1 Sigma | FWHM % | Suspected Nuclide |   |  |
| 145.62                                                    | 36.52             | 4964.           | 1402. 9.512E+04   | 9.33           | 1.111  | -                 | s |  |
| 185.78                                                    | 46.56             | 20640.          | 82430. 3.318E+06  | 0.48           | 0.912  | -                 |   |  |
| 351.31                                                    | 87.94             | 3932.           | 1428. 2.682E+04   | 8.44           | 0.972  | -                 | s |  |
| 4693.26                                                   | 1173.38           | 567.            | 13650. 1.529E+06  | 0.99           | 1.950  | -                 |   |  |

s - Peak fails shape tests.  
D - Peak area deconvoluted.  
L - Peak written from unknown list.  
C - Area < Critical level.

-----  
This section based on library: DET\_EfficiencyVerification.lib

\*\*\*\*\* I D E N T I F I E D P E A K S U M M A R Y \*\*\*\*\*  
Nuclide Peak Centroid Background Net Area Intensity Uncert FWHM  
Channel Energy Counts Counts Cts/Sec 1 Sigma % keV

|         |         |         |        |         |        |      |       |
|---------|---------|---------|--------|---------|--------|------|-------|
| AM-241  | 237.75  | 59.55   | 18759. | 114994. | 15.971 | 0.38 | 0.895 |
| CS-137  | 2646.69 | 661.74  | 882.   | 33440.  | 4.644  | 0.59 | 1.494 |
| Co-1332 | 5330.24 | 1332.63 | 117.   | 12093.  | 1.680  | 0.94 | 1.990 |

s - Peak fails shape tests.  
D - Peak area deconvoluted.  
A Derived peak area.

\*\*\*\*\* S U M M A R Y O F L I B R A R Y P E A K U S A G E \*\*\*\*\*  
- Nuclide - Average ----- Peak -----  
Name Code Activity Energy Activity Code MDA Value  
uCi/Source keV uCi/Source uCi/Source COMMENTS

|                                                    |  |            |         |           |   |           |          |            |
|----------------------------------------------------|--|------------|---------|-----------|---|-----------|----------|------------|
| AM-241                                             |  | 4.3796E+02 |         |           |   |           | 1.58E+05 |            |
|                                                    |  |            | 59.54   | 4.380E+02 | ( | 2.441E+00 | 3.82E-01 | 1.00E+02 G |
| CS-137                                             |  | 3.8573E+02 |         |           |   |           | 1.10E+04 |            |
|                                                    |  |            | 661.66  | 3.857E+02 | ( | 1.628E+00 | 5.85E-01 | 1.00E+02 G |
| Co-1332                                            |  | 7.1885E+02 |         |           |   |           | 1.93E+03 |            |
|                                                    |  |            | 1332.50 | 7.189E+02 | ( | 3.157E+00 | 9.42E-01 | 1.00E+02 G |
| (- This peak used in the nuclide activity average. |  |            |         |           |   |           |          |            |

\* - Peak is too wide, but only one peak in library.  
! - Peak is part of a multiplet and this area went negative during deconvolution.  
? - Peak is too narrow.  
@ - Peak is too wide at FW25M, but ok at FWHM.  
% - Peak fails sensitivity test.  
\$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.  
+ - Peak activity higher than counting uncertainty range.  
- - Peak activity lower than counting uncertainty range.  
= - Peak outside analysis energy range.  
& - Calculated peak centroid is not close enough to the library energy centroid for positive identification.  
P - Peakbackground subtraction  
} - Peak is too close to another for the activity to be found directly.

Nuclide Codes: Peak Codes:  
T - Thermal Neutron Activation G - Gamma Ray  
F - Fast Neutron Activation X - X-Ray  
I - Fission Product P - Positron Decay

N - Naturally Occurring Isotope S - Single-Escape  
P - Photon Reaction D - Double-Escape  
C - Charged Particle Reaction K - Key Line  
M - No MDA Calculation A - Not in Average  
R - Coincidence Corrected C - Coincidence Peak  
H - Halflife limit exceeded

\*\*\*\*\* D I S C A R D E D I S O T O P E P E A K S \*\*\*\*\*  
Nuclide Centroid Background Net Area Intensity Uncert Activity  
Energy Counts Counts Cts/Sec 1 Sigma %

P - Peakbackground subtraction

\*\*\*\*\* S U M M A R Y O F N U C L I D E S I N S A M P L E \*\*\*\*\*  
Time of Count Time Corrected Uncertainty 1 Sigma  
Nuclide Activity Activity Counting MDA  
uCi/Source uCi/Source

|         |            |            |            |          |
|---------|------------|------------|------------|----------|
| AM-241  | 4.3147E+02 | 4.3796E+02 | 3.822E-01% | 2.44E+00 |
| CS-137  | 3.1121E+02 | 3.8573E+02 | 5.852E-01% | 1.63E+00 |
| Co-1332 | 2.1125E+02 | 7.1885E+02 | 9.418E-01% | 3.16E+00 |

< - MDA value printed.  
A - Activity printed, but activity < MDA.  
B - Activity < MDA and failed test.  
C - Area < Critical level.  
F - Failed fraction or key line test.  
H - Halflife limit exceeded

----- S U M M A R Y -----  
Total Activity ( 37.6 to 2000.1 keV) 9.539E+02 uCi/Source  
Total Decayed Activity ( 37.6 to 2000.1 keV) 1.5425436E+03 uCi/Source

## ANNUAL CALIBRATION VERIFICATION

Detector ID: **Detector # 8**  
 SpectrumID: **8\_20160128004\_EffVerif**  
 Analysis Description: ACVTop-776670;TunaCan2006  
 Calibration: 8\_Soil\_TunaCan\_90099\_032712  
 Detector: Ge 8 SN/174

Verification Date: 2016-01-28 18:34  
 Source Assay Date/Time: 2006-10-01 11:00

| Isotope | Gamma Energy (kev) | Source Emission Rate (GPS)<br>(Assay) | Observed Activity (GPS)<br>(Actual) | Percent Difference (%)       |
|---------|--------------------|---------------------------------------|-------------------------------------|------------------------------|
|         |                    |                                       |                                     | <u>Assay-Actual</u><br>Assay |
| Am-241  | 59.54              | 449                                   | 4.79E+02                            | -6.7%                        |
| Cs-137  | 661.66             | 400                                   | 3.90E+02                            | 2.5%                         |
| Co-1332 | 1332.5             | 777                                   | 7.56E+02                            | 2.7%                         |

Comments:

Perform Aaron Schroder 1/28/16

Review \_\_Jody Watson\_\_\_\_ 1/29/16\_\_\_\_\_

C:\User\CRpt\8\_20160128004\_EffVerif.xls

-----

Sample Description: ACVTop-776670;TunaCan2006

Detector: Ge 8 SN/174

Source Date: 10/1/2006 11:00

Acquired: 1/28/2016 18:34:05

Analyzed: 2/4/2016 10:51

-----

Analyst: Jody Watson

Efficiency: 8\_Soil\_TunaCan\_90099\_032712

Library: DET\_EfficiencyVerification.lib

| Nuclide | Activity<br>uCi/Source | Uncertainty<br>% |
|---------|------------------------|------------------|
| AM-241  | 4.789E+02              | 0.41             |
| CS-137  | 3.899E+02              | 0.64             |
| Co-1332 | 7.564E+02              | 0.99             |
| Total   | 1.625E+03              |                  |

-----

Sample description  
ACVTop-776670;TunaCan2006

Spectrum Filename: C:\User\SPC\Det8\8\_20160128004\_EffVerif.An1

Acquisition information

Start time: 1/28/2016 6:34:05 PM  
Live time: 7200  
Real time: 7434  
Dead time: 3.15 %  
Detector ID: 8

Detector system

Ge 8 SN/174

Calibration

Filename: 8\_Soil\_TunaCan.Clb  
8\_Soil\_TunaCan\_90099\_032712

Energy Calibration

Created: 2/28/2012 10:34:41 AM  
Zero offset: 0.052 keV  
Gain: 0.250 keV/channel  
Quadratic: 5.282E-10 keV/channel^2

Efficiency Calibration

Created: 3/28/2012 10:35:20 AM  
Knee Energy: 165.85 keV  
Above the Knee: Quadratic Uncertainty = 1.39 %  
Log(Eff):  $-1.098764E-01 + (-4.958544E-01 * \text{Log}(E)) + (-2.572270E-02 * \text{Log}(E)^2)$   
Below the Knee: Quadratic Uncertainty = 1.71 %  
Log(Eff):  $-2.525301E+01 + (9.398253E+00 * \text{Log}(E)) + (-1.000034E+00 * \text{Log}(E)^2)$

Library Files

Main analysis library: DET\_EfficiencyVerification.lib  
Library Match Width: 0.500  
Peak stripping: Library based

Analysis parameters

Analysis engine: Env32 G53W4.25  
Start channel: 150 ( 37.55keV )  
Stop channel: 8000 ( 1999.96keV )  
Peak rejection level: 10.000%  
Peak search sensitivity: 3  
Sample Size: 1.0000E+00  
Activity scaling factor:  $1.0000E+00 / (1.0000E+00 * 1.0000E+00) = 1.0000E+00$   
Detection limit method: Reg. Guide 4.16 Method

Random error: 4.0000000E+00  
 Systematic error: 4.0000000E+00  
 Fraction Limit: 0.000%  
 Background width: average of three points.  
 Half lives decay limit: 12.000  
 Activity range factor: 2.000  
 Min. step backg. energy 0.000  
 Multiplet shift channel 2.000

| Corrections                   | Status | Comments              |
|-------------------------------|--------|-----------------------|
| Decay correct to date:        | YES    | 10/1/2006 11:00:00 AM |
| Decay during acquisition:     | YES    |                       |
| Decay during collection:      | NO     |                       |
| True coincidence correction:  | NO     |                       |
| Peaked background correction: | NO     |                       |
| Absorption (Internal):        | NO     |                       |
| Geometry correction:          | NO     |                       |
| Random summing:               | NO     |                       |

total peaks alloc. 3 cutoff: 5.00E+01%

Energy Calibration  
 Normalized diff: 0.0632

| ***** S U M M A R Y O F P E A K S I N R A N G E ***** |         |        |      |                |                |              |               |        |
|-------------------------------------------------------|---------|--------|------|----------------|----------------|--------------|---------------|--------|
| Peak Energy                                           | Area    | Uncert | FWHM | Corrctn Factor | Nuclide Energy | Brnch. Ratio | Act. uCi/Sour | Nuc    |
| 46.57                                                 | 74004.  | 0.44   | 1.01 | 2.005E-02      |                |              |               |        |
| 59.58                                                 | 102880. | 0.35   | 1.02 | 2.881E-02      | 59.54          | 100.000      | 5.034E+02     | AM241  |
| 88.09                                                 | 1218.   | 9.96   | 0.76 | 3.993E-02      |                |              |               |        |
| 661.54                                                | 27378.  | 0.64   | 1.34 | 1.209E-02      | 661.66         | 100.000      | 3.899E+02     | CS137  |
| 1173.07                                               | 11810.  | 1.00   | 1.56 | 7.454E-03      |                |              |               |        |
| 1332.31                                               | 10667.  | 0.99   | 1.75 | 6.678E-03      | 1332.50        | 100.000      | 7.564E+02     | Co1332 |

| ***** U N I D E N T I F I E D P E A K S U M M A R Y ***** |                 |                   |                 |                   |                  |          |                   |   |
|-----------------------------------------------------------|-----------------|-------------------|-----------------|-------------------|------------------|----------|-------------------|---|
| Peak Channel                                              | Centroid Energy | Background Counts | Net Area Counts | Efficiency * Area | Uncert 1 Sigma % | FWHM keV | Suspected Nuclide |   |
| 185.94                                                    | 46.53           | 19029.            | 71370.          | 3.560E+06         | 0.54             | 0.847    | -                 |   |
| 352.16                                                    | 88.09           | 3683.             | 1218.           | 3.051E+04         | 9.96             | 0.764    | -                 | s |
| 4692.32                                                   | 1173.07         | 306.              | 11810.          | 1.584E+06         | 1.00             | 1.561    | -                 |   |

s - Peak fails shape tests.  
 D - Peak area deconvoluted.  
 L - Peak written from unknown list.  
 C - Area < Critical level.

-----  
 This section based on library: DET\_EfficiencyVerification.lib

\*\*\*\*\* I D E N T I F I E D P E A K S U M M A R Y \*\*\*\*\*  
Nuclide Peak Centroid Background Net Area Intensity Uncert FWHM  
Channel Energy Counts Counts Cts/Sec 1 Sigma % keV

|         |         |         |        |        |        |      |        |
|---------|---------|---------|--------|--------|--------|------|--------|
| AM-241  | 237.97  | 59.54   | 15110. | 97876. | 13.594 | 0.41 | 0.867D |
| CS-137  | 2646.10 | 661.54  | 638.   | 27378. | 3.802  | 0.64 | 1.335  |
| Co-1332 | 5329.28 | 1332.31 | 68.    | 10667. | 1.482  | 0.99 | 1.753  |

s - Peak fails shape tests.  
D - Peak area deconvoluted.  
A Derived peak area.

\*\*\*\*\* S U M M A R Y O F L I B R A R Y P E A K U S A G E \*\*\*\*\*  
- Nuclide - Average ----- Peak -----  
Name Code Activity Energy Activity Code MDA Value  
uCi/Source keV uCi/Source uCi/Source COMMENTS

|                                                    |            |         |           |   |           |          |            |
|----------------------------------------------------|------------|---------|-----------|---|-----------|----------|------------|
| AM-241                                             | 4.7889E+02 |         |           |   |           | 1.58E+05 |            |
|                                                    |            | 59.54   | 4.789E+02 | ( | 2.816E+00 | 4.13E-01 | 1.00E+02 G |
| CS-137                                             | 3.8993E+02 |         |           |   |           | 1.10E+04 |            |
|                                                    |            | 661.66  | 3.899E+02 | ( | 1.714E+00 | 6.40E-01 | 1.00E+02 G |
| Co-1332                                            | 7.5635E+02 |         |           |   |           | 1.93E+03 |            |
|                                                    |            | 1332.50 | 7.564E+02 | ( | 2.913E+00 | 9.90E-01 | 1.00E+02 G |
| (- This peak used in the nuclide activity average. |            |         |           |   |           |          |            |

\* - Peak is too wide, but only one peak in library.  
! - Peak is part of a multiplet and this area went negative during deconvolution.  
? - Peak is too narrow.  
@ - Peak is too wide at FW25M, but ok at FWHM.  
% - Peak fails sensitivity test.  
\$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.  
+ - Peak activity higher than counting uncertainty range.  
- - Peak activity lower than counting uncertainty range.  
= - Peak outside analysis energy range.  
& - Calculated peak centroid is not close enough to the library energy centroid for positive identification.  
P - Peakbackground subtraction  
} - Peak is too close to another for the activity to be found directly.

Nuclide Codes: Peak Codes:  
T - Thermal Neutron Activation G - Gamma Ray  
F - Fast Neutron Activation X - X-Ray  
I - Fission Product P - Positron Decay

|                                 |                      |
|---------------------------------|----------------------|
| N - Naturally Occurring Isotope | S - Single-Escape    |
| P - Photon Reaction             | D - Double-Escape    |
| C - Charged Particle Reaction   | K - Key Line         |
| M - No MDA Calculation          | A - Not in Average   |
| R - Coincidence Corrected       | C - Coincidence Peak |
| H - Halflife limit exceeded     |                      |

\*\*\*\*\* D I S C A R D E D I S O T O P E P E A K S \*\*\*\*\*

| Nuclide | Centroid Energy | Background Counts | Net Area Counts | Intensity Cts/Sec | Uncert 1 Sigma % | Activity |
|---------|-----------------|-------------------|-----------------|-------------------|------------------|----------|
|---------|-----------------|-------------------|-----------------|-------------------|------------------|----------|

P - Peakbackground subtraction

\*\*\*\*\* S U M M A R Y O F N U C L I D E S I N S A M P L E \*\*\*\*\*

| Nuclide | Time of Count | Time Corrected | Uncertainty 1 Sigma | Activity uCi/Source | Activity uCi/Source | Counting | MDA |
|---------|---------------|----------------|---------------------|---------------------|---------------------|----------|-----|
|---------|---------------|----------------|---------------------|---------------------|---------------------|----------|-----|

|         |            |            |            |  |  |  |          |
|---------|------------|------------|------------|--|--|--|----------|
| AM-241  | 4.7179E+02 | 4.7889E+02 | 4.129E-01% |  |  |  | 2.82E+00 |
| CS-137  | 3.1450E+02 | 3.8993E+02 | 6.397E-01% |  |  |  | 1.71E+00 |
| Co-1332 | 2.2187E+02 | 7.5635E+02 | 9.900E-01% |  |  |  | 2.91E+00 |

< - MDA value printed.  
 A - Activity printed, but activity < MDA.  
 B - Activity < MDA and failed test.  
 C - Area < Critical level.  
 F - Failed fraction or key line test.  
 H - Halflife limit exceeded

----- S U M M A R Y -----

|                                              |                          |
|----------------------------------------------|--------------------------|
| Total Activity ( 37.5 to 2000.0 keV)         | 1.008E+03 uCi/Source     |
| Total Decayed Activity ( 37.5 to 2000.0 keV) | 1.6251797E+03 uCi/Source |

# Monthly Backgrounds

Test America  
St. Louis  
Background Check

Spectrum: 5\_20160506004\_BGLong  
Description: Background Long PBC Count  
Acquired: 5/6/2016 5:48:10 PM  
Detector: Detector # 5

Background Evaluation Criteria:

- 1) Place instrument out of service if Countrate exceeds Control Limits.
- 2) Investigate high countrate and take corrective action as necessary if Countrate exceeds Tolerance Limits.

|           | Target | L_Ctrl | L_Tol | Measured | H_Tol | H_Ctrl | Results |
|-----------|--------|--------|-------|----------|-------|--------|---------|
| Bkgd      |        |        |       |          |       |        |         |
| Countrate | 1.45   | 1.30   | 1.35  | 1.46     | 1.55  | 1.60   | PASS    |

Analyst: Aaron Schroder      Reviewer:

Sample description  
Background Long PBC Count

Spectrum Filename: C:\User\SPC\Det5\5\_20160506004\_BGLong.An1

Acquisition information

Start time: 5/6/2016 5:48:10 PM  
Live time: 43200  
Real time: 43369  
Dead time: 0.39 %  
Detector ID: 5

Detector system

Ge 5 SN/157

Calibration

Filename: 5\_QC.Clb  
Ge5\_QC

Energy Calibration

Created: 2/28/2012 7:35:48 PM  
Zero offset: 0.158 keV  
Gain: 0.250 keV/channel  
Quadratic:  $3.911\text{E-}08 \text{ keV/channel}^2$

Efficiency Calibration

Created: 1/6/2011 8:03:22 AM  
Knee Energy: 0.00 keV  
Above the Knee: Interpolative Uncertainty = 0.00 %  
Below the Knee: Interpolative Uncertainty = 0.00 %

Library Files

Main analysis library: DET\_Long Background PBC.lib  
Library Match Width: 0.500  
Peak stripping: Library based

Analysis parameters

Analysis engine: Env32 G800W064  
Start channel: 150 ( 37.62keV )  
Stop channel: 8000 ( 2000.81keV )  
Peak rejection level: 30.000%  
Peak search sensitivity: 3  
Sample Size:  $1.0000\text{E}+00 \pm 0.000\text{E}+00\%$   
Activity scaling factor:  $1.0000\text{E}+00 / ( 1.0000\text{E}+00 * 1.0000\text{E}+00 ) = 1.0000\text{E}+00$   
Detection limit method: Reg. Guide 4.16 Method  
Random error:  $4.0000000\text{E}+00$   
Systematic error:  $4.0000000\text{E}+00$   
Fraction Limit: 0.000%  
Background width: average of three points.

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Half lives decay limit: 12.000  
 Activity range factor: 2.000  
 Min. step backg. energy 0.000  
 Multiplet shift channel 2.000

| Corrections                   | Status | Comments |
|-------------------------------|--------|----------|
| Decay correct to date:        | NO     |          |
| Decay during acquisition:     | NO     |          |
| Decay during collection:      | NO     |          |
| True coincidence correction:  | NO     |          |
| Peaked background correction: | NO     |          |
| Absorption (Internal):        | NO     |          |
| Geometry correction:          | NO     |          |
| Random summing:               | NO     |          |

total peaks alloc. 17 cutoff: 5.00E+01 %  
 Energy Calibration  
 Normalized diff: 0.1008

| ***** S U M M A R Y O F P E A K S I N R A N G E ***** |      |        |      |                   |                   |                 |             |       |
|-------------------------------------------------------|------|--------|------|-------------------|-------------------|-----------------|-------------|-------|
| Peak<br>Energy                                        | Area | Uncert | FWHM | Corrctn<br>Factor | Nuclide<br>Energy | Brnch.<br>Ratio | Act.<br>DPS | Nuc   |
| 46.57                                                 | 350. | 12.29  | 0.71 | 5.679E-02         | 46.54             | 4.250           | 3.354E+00   | PB210 |
| 59.39                                                 | 116. | 29.17  | 0.84 | 7.400E-02         | 59.54             | 35.900          | 1.008E-01   | AM241 |
| 63.33                                                 | 376. | 8.24   | 0.78 | 7.928E-02         | 63.29             | 3.810           | 2.881E+00   | TH234 |
| 74.90                                                 | 156. | 17.77  | 0.81 | 9.497E-02         |                   |                 |             |       |
| 77.12                                                 | 161. | 17.57  | 0.82 | 9.795E-02         |                   |                 |             |       |
| 87.19                                                 | 103. | 28.95  | 1.27 | 1.104E-01         | 86.49             | 13.100          | 1.649E-01   | Np237 |
|                                                       |      |        |      |                   | 86.54             | 30.700          | 7.032E-02   | EU155 |
| 92.55                                                 | 496. | 8.81   | 0.94 | 1.129E-01         | 92.59             | 5.584           | 1.822E+00   | TH234 |
|                                                       |      |        |      |                   | 93.35             | 5.561           | 1.828E+00   | AC228 |
| 185.84                                                | 238. | 17.13  | 0.87 | 9.604E-02         | 185.72            | 54.000          | 1.061E-01   | U235  |
|                                                       |      |        |      |                   | 185.99            | 3.280           | 1.748E+00   | Ra226 |
| 238.67                                                | 126. | 25.10  | 0.78 | 8.322E-02         | 238.63            | 43.300          | 8.114E-02   | PB212 |
| 294.99                                                | 136. | 21.92  | 0.77 | 6.955E-02         | 295.09            | 19.300          | 2.346E-01   | PB214 |
| 351.82                                                | 235. | 14.93  | 1.27 | 5.576E-02         | 351.93            | 37.600          | 2.596E-01   | PB214 |
| 437.86                                                | 52.  | 29.81  | 1.36 | 4.310E-02         |                   |                 |             |       |
| 609.28                                                | 186. | 16.62  | 1.27 | 3.200E-02         | 609.31            | 46.090          | 2.920E-01   | BI214 |
|                                                       |      |        |      |                   | 610.30            | 5.750           | 2.345E+00   | RU103 |
| 661.59                                                | 136. | 22.17  | 0.56 | 2.861E-02         | 661.66            | 85.210          | 1.287E-01   | CS137 |
| 1460.92                                               | 72.  | 16.40  | 1.74 | 1.300E-02         | 1460.83           | 10.670          | 1.207E+00   | K40   |
| 1764.97                                               | 52.  | 19.79  | 1.00 | 1.105E-02         | 1764.49           | 15.400          | 7.027E-01   | BI214 |

\*\*\*\*\* U N I D E N T I F I E D P E A K S U M M A R Y \*\*\*\*\*

| Peak Centroid<br>Channel Energy | Background<br>Counts | Net Area<br>Counts | Efficiency<br>* Area | Uncert<br>1 Sigma | FWHM<br>keV | Suspected<br>Nuclide |
|---------------------------------|----------------------|--------------------|----------------------|-------------------|-------------|----------------------|
| 299.22 75.01                    | 305.                 | 156.               | 1.640E+03            | 17.77             | 0.813       | - D                  |
| 308.11 77.23                    | 318.                 | 161.               | 1.641E+03            | 17.57             | 0.815       | - D                  |
| 1751.94 437.86                  | 72.                  | 52.                | 1.214E+03            | 29.81             | 1.362       | - s                  |

s - Peak fails shape tests.  
 D - Peak area deconvoluted.  
 L - Peak written from unknown list.  
 C - Area < Critical level.

-----  
 This section based on library: DET\_Long Background PBC.lib

\*\*\*\*\* I D E N T I F I E D P E A K S U M M A R Y \*\*\*\*\*

| Nuclide | Peak<br>Channel Energy | Centroid<br>Energy | Background<br>Counts | Net Area<br>Counts | Intensity<br>Cts/Sec | Uncert<br>1 Sigma | FWHM<br>keV |
|---------|------------------------|--------------------|----------------------|--------------------|----------------------|-------------------|-------------|
| PB-210  | 185.81                 | 46.57              | 428.                 | 350.               | 0.008                | 12.29             | 0.714       |
| AM-241  | 237.12                 | 59.39              | 325.                 | 116.               | 0.003                | 29.17             | 0.842       |
| TH-234  | 252.89                 | 63.33              | 218.                 | 376.               | 0.009                | 8.24              | 0.783       |
| Np-237  | 348.43                 | 87.19              | 262.                 | 103.               | 0.002                | 28.95             | 1.266s      |
| TH-234  | 369.89                 | 92.55              | 387.                 | 496.               | 0.011                | 8.81              | 0.940       |
| Ra-226  | 743.35                 | 185.84             | 371.                 | 238.               | 0.006                | 17.13             | 0.869       |
| PB-212  | 954.79                 | 238.67             | 264.                 | 126.               | 0.003                | 25.10             | 0.780       |
| PB-214  | 1180.19                | 294.99             | 215.                 | 136.               | 0.003                | 21.92             | 0.772s      |
| PB-214  | 1407.63                | 351.82             | 249.                 | 235.               | 0.005                | 14.93             | 1.272       |
| BI-214  | 2437.81                | 609.28             | 165.                 | 186.               | 0.004                | 16.62             | 1.270       |
| CS-137  | 2647.07                | 661.59             | 140.                 | 136.               | 0.003                | 22.17             | 0.565s      |
| K-40    | 5843.11                | 1460.92            | 19.                  | 72.                | 0.002                | 16.40             | 1.744       |
| BI-214  | 7057.96                | 1764.97            | 9.                   | 52.                | 0.001                | 19.79             | 1.003s      |

s - Peak fails shape tests.  
 D - Peak area deconvoluted.  
 A - Derived peak area.

\*\*\*\*\* S U M M A R Y O F L I B R A R Y P E A K U S A G E \*\*\*\*\*

| Name | Code | Average<br>Activity<br>DPS | Energy<br>keV | Activity<br>DPS | Code | MDA Value<br>DPS            | COMMENTS |
|------|------|----------------------------|---------------|-----------------|------|-----------------------------|----------|
| K-40 | N    | 1.2073E+00                 |               |                 |      |                             |          |
|      |      |                            | 1460.83       | 1.207E+00       | ?(   | 3.813E-01 1.64E+01 1.07E+01 | G        |

| Nuclide | Ave activity | Energy     | Activity  | Code | Peak | MDA       | Comments             |
|---------|--------------|------------|-----------|------|------|-----------|----------------------|
| CS-137  | I            | 1.2869E-01 |           |      |      |           | 1.10E+04             |
|         |              | 661.66     | 1.287E-01 | @    | (    | 5.485E-02 | 2.22E+01 8.52E+01 G  |
| PB-210  | N            | 3.3541E+00 |           |      |      |           | 8.14E+03             |
|         |              | 46.54      | 3.354E+00 | (    |      | 9.507E-01 | 1.23E+01 4.25E+00 G  |
| PB-212  | N            | 8.1144E-02 |           |      |      |           | 6.98E+02             |
|         |              | 238.63     | 8.114E-02 | (    |      | 5.034E-02 | 2.51E+01 4.33E+01 G  |
|         |              | 300.03     | 0.000E+00 | %    |      | 4.585E-01 | 4.18E+01 3.28E+00 GA |
| PB-214  | N            | 2.5111E-01 |           |      |      |           | 5.84E+05             |
|         |              | 351.93     | 2.596E-01 | (    |      | 8.422E-02 | 1.49E+01 3.76E+01 G  |
|         |              | 295.09     | 2.346E-01 | (    |      | 1.225E-01 | 2.19E+01 1.93E+01 G  |
|         |              | 242.00     | 0.000E+00 |      |      | 2.852E-01 | 0.00E+00 7.43E+00 GA |
| BI-214  | N            | 2.9199E-01 |           |      |      |           | 5.84E+05             |
|         |              | 609.31     | 2.920E-01 | (    |      | 9.822E-02 | 1.66E+01 4.61E+01 G  |
|         |              | 1120.29    | 0.000E+00 | &    |      | 2.569E-01 | 4.16E+01 1.51E+01 G  |
|         |              | 1764.49    | 7.027E-01 | +    |      | 2.305E-01 | 1.98E+01 1.54E+01 G  |
| TH-234  | N            | 2.8806E+00 |           |      |      |           | 1.63E+12             |
|         |              | 63.29      | 2.881E+00 | (    |      | 5.488E-01 | 8.24E+00 3.81E+00 G  |
|         |              | 92.59      | 1.822E+00 | -    |      | 3.464E-01 | 8.81E+00 5.58E+00 G  |
| Ra-226  |              | 1.7483E+00 |           |      |      |           | 5.84E+05             |
|         |              | 185.99     | 1.748E+00 | (    |      | 6.799E-01 | 1.71E+01 3.28E+00 G  |
| AM-241  | T            | 1.0081E-01 |           |      |      |           | 1.58E+05             |
|         |              | 59.54      | 1.008E-01 | (    |      | 7.536E-02 | 2.92E+01 3.59E+01 G  |
| Np-237  | F            | 1.6490E-01 |           |      |      |           | 2.14E+06             |
|         |              | 86.49      | 1.649E-01 | &    | (    | 1.251E-01 | 2.89E+01 1.31E+01 G  |

( - This peak used in the nuclide activity average.

- \* - Peak is too wide, but only one peak in library.
- ! - Peak is part of a multiplet and this area went negative during deconvolution.
- ? - Peak is too narrow.
- @ - Peak is too wide at FW25M, but ok at FWHM.
- % - Peak fails sensitivity test.
- \$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.
- + - Peak activity higher than counting uncertainty range.
- - Peak activity lower than counting uncertainty range.
- = - Peak outside analysis energy range.
- & - Calculated peak centroid is not close enough to the

library energy centroid for positive identification.  
P - Peakbackground subtraction  
} - Peak is too close to another for the activity  
to be found directly.

|                                 |                      |
|---------------------------------|----------------------|
| Nuclide Codes:                  | Peak Codes:          |
| T - Thermal Neutron Activation  | G - Gamma Ray        |
| F - Fast Neutron Activation     | X - X-Ray            |
| I - Fission Product             | P - Positron Decay   |
| N - Naturally Occurring Isotope | S - Single-Escape    |
| P - Photon Reaction             | D - Double-Escape    |
| C - Charged Particle Reaction   | K - Key Line         |
| M - No MDA Calculation          | A - Not in Average   |
| R - Coincidence Corrected       | C - Coincidence Peak |
| H - Halflife limit exceeded     |                      |

\*\*\*\*\* D I S C A R D E D I S O T O P E P E A K S \*\*\*\*\*  
Nuclide Centroid Background Net Area Intensity Uncert Activity  
Energy Counts Counts Cts/Sec 1 Sigma %

P - Peakbackground subtraction

\*\*\*\*\* S U M M A R Y O F N U C L I D E S I N S A M P L E \*\*\*\*\*  
Time of Count Uncertainty 1 Sigma  
Nuclide Activity Counting MDA  
DPS

|         |   |            |             |           |
|---------|---|------------|-------------|-----------|
| BE-7    | < | 3.6625E-01 |             |           |
| NA-22   | < | 3.9414E-02 |             |           |
| K-40    | # | 1.2073E+00 | 1.6403E+01% | 3.813E-01 |
| Sc-46   | < | 4.1938E-02 |             |           |
| CR-51   | < | 1.6682E-01 |             |           |
| MN-54   | < | 3.7706E-02 |             |           |
| FE-59   | < | 7.0222E-02 |             |           |
| Co-56   | < | 3.1089E-02 |             |           |
| CO-57   | < | 1.4961E-02 |             |           |
| CO-58   | < | 3.0495E-02 |             |           |
| CO-60   | < | 3.6252E-02 |             |           |
| ZN-65   | < | 7.6264E-02 |             |           |
| NB-94   | < | 2.7117E-02 |             |           |
| ZR-95   | < | 5.0047E-02 |             |           |
| NB-95   | < | 3.9443E-02 |             |           |
| RU-103  | < | 2.1845E-02 |             |           |
| RH-106  | < | 2.4337E-01 |             |           |
| AG-108M | < | 2.2605E-02 |             |           |
| AG-110M | < | 5.0138E-02 |             |           |
| SN-113  | < | 3.4324E-02 |             |           |
| SB-124  | < | 3.1908E-02 |             |           |
| SB-125  | < | 6.4730E-02 |             |           |
| I-131   | < | 2.1661E-02 |             |           |

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|         |   |            |             |           |
|---------|---|------------|-------------|-----------|
| BA-133  | < | 4.4212E-02 |             |           |
| CS-134  | < | 4.6344E-02 |             |           |
| CS-137  | # | 1.2869E-01 | 2.2174E+01% | 5.485E-02 |
| CE-139  | < | 1.4652E-02 |             |           |
| Ba-140  | < | 9.5398E-02 |             |           |
| La-140  | < | 4.0297E-02 |             |           |
| CE-141  | < | 3.1818E-02 |             |           |
| CE-144  | < | 9.0104E-02 |             |           |
| PM-144  | < | 2.8440E-02 |             |           |
| EU-152  | < | 1.1452E-01 |             |           |
| EU-154  | < | 1.4782E-01 |             |           |
| EU-155  | < | 5.0001E-02 |             |           |
| HF-181  | < | 1.6453E-02 |             |           |
| Ta-182  | < | 1.9603E-01 |             |           |
| Hg-203  | < | 1.8791E-02 |             |           |
| TL-208  | < | 3.2274E-02 |             |           |
| pm-146  | < | 7.9131E-02 |             |           |
| y-88    | < | 4.2690E-02 |             |           |
| PB-210  |   | 3.3541E+00 | 1.2292E+01% | 9.507E-01 |
| PB-212  |   | 8.1144E-02 | 2.5096E+01% | 5.034E-02 |
| PB-214  |   | 2.5111E-01 | 1.3260E+01% | 8.422E-02 |
| BI-207  | < | 4.3374E-02 |             |           |
| BI-212  | < | 6.8689E-01 |             |           |
| BI-214  |   | 2.9199E-01 | 1.6623E+01% | 9.822E-02 |
| BI-210M | < | 2.7593E-02 |             |           |
| RA-224  | < | 5.5960E-01 |             |           |
| AC-228  | < | 1.3954E-01 |             |           |
| TH-227  | < | 1.5867E-01 |             |           |
| TH-229  | < | 2.8397E-01 |             |           |
| TH-234  |   | 2.8806E+00 | 8.2386E+00% | 5.488E-01 |
| PA-231  | < | 6.7266E-01 |             |           |
| PA-233  | < | 4.5912E-02 |             |           |
| PA-234  | < | 8.2941E-02 |             |           |
| PA-234M | < | 6.7152E+00 |             |           |
| Ra-226  |   | 1.7483E+00 | 1.7134E+01% | 6.799E-01 |
| U-235   | < | 1.0324E-01 |             |           |
| AM-241  |   | 1.0081E-01 | 2.9173E+01% | 7.536E-02 |
| Np-237  | # | 1.6490E-01 | 2.8948E+01% | 1.251E-01 |

# - All peaks for activity calculation had bad shape.  
 \* - Activity omitted from total  
 & - Activity omitted from total and all peaks had bad shape.  
 < - MDA value printed.  
 A - Activity printed, but activity < MDA.  
 B - Activity < MDA and failed test.  
 C - Area < Critical level.  
 F - Failed fraction or key line test.  
 H - Halflife limit exceeded

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ORTEC g v - i (1087) Env32 G800W064 5/7/2016 5:51:57 AMPage 7  
TestAmerica Inc Spectrum name: 5\_20160506004\_BGLong.An1

----- S U M M A R Y -----  
Total Activity ( 37.6 to 2000.8 keV) 1.021E+01 DPS

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Test America  
St. Louis  
Background Check

Spectrum: 5\_20160506004\_BGLong  
Description: Background Long PBC Count  
Acquired: 5/6/2016 5:48:10 PM  
Detector: Detector # 5

Background Evaluation Criteria:

- 1) Place instrument out of service if Countrate exceeds Control Limits.
- 2) Investigate high countrate and take corrective action as necessary if Countrate exceeds Tolerance Limits.

|           | Target | L_Ctrl | L_Tol | Measured | H_Tol | H_Ctrl | Results |
|-----------|--------|--------|-------|----------|-------|--------|---------|
| Bkgd      |        |        |       |          |       |        |         |
| Countrate | 1.45   | 1.30   | 1.35  | 1.46     | 1.55  | 1.60   | PASS    |

Analyst: Aaron Schroder

Reviewer: Aaron Schroder

(Page 1 of 1)

Test America  
St. Louis  
Background Check

Spectrum: 7\_20160506004\_BGLong  
Description: Background Long PBC Count  
Acquired: 5/6/2016 5:49:06 PM  
Detector: Detector # 7

Background Evaluation Criteria:

- 1) Place instrument out of service if Countrate exceeds Control Limits.
- 2) Investigate high countrate and take corrective action as necessary if Countrate exceeds Tolerance Limits.

|           | Target | L_Ctrl | L_Tol | Measured | H_Tol | H_Ctrl | Results |
|-----------|--------|--------|-------|----------|-------|--------|---------|
| Bkgd      |        |        |       |          |       |        |         |
| Countrate | 1.30   | 1.16   | 1.21  | 1.29     | 1.40  | 1.45   | PASS    |

Analyst: Aaron Schroder      Reviewer:

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Sample description  
Background Long PBC Count

Spectrum Filename: C:\User\SPC\Det7\7\_20160506004\_BGLong.An1

Acquisition information

Start time: 5/6/2016 5:49:06 PM  
Live time: 43200  
Real time: 43817  
Dead time: 1.41 %  
Detector ID: 7

Detector system

Ge 7 SN/154

Calibration

Filename: 7\_QC.Clb  
Ge7\_QC

Energy Calibration

Created: 2/23/2012 8:40:56 AM  
Zero offset: 0.117 keV  
Gain: 0.250 keV/channel  
Quadratic: 3.508E-09 keV/channel^2

Efficiency Calibration

Created: 1/6/2011 8:06:10 AM  
Knee Energy: 0.00 keV  
Above the Knee: Interpolative Uncertainty = 0.00 %  
Below the Knee: Interpolative Uncertainty = 0.00 %

Library Files

Main analysis library: DET\_Long Background PBC.lib  
Library Match Width: 0.500  
Peak stripping: Library based

Analysis parameters

Analysis engine: Env32 G800W064  
Start channel: 150 ( 37.61keV )  
Stop channel: 8000 ( 2000.13keV )  
Peak rejection level: 30.000%  
Peak search sensitivity: 3  
Sample Size: 1.0000E+00 +/- 0.000E+00%  
Activity scaling factor: 1.0000E+00/( 1.0000E+00\* 1.0000E+00) = 1.0000E+00  
Detection limit method: Reg. Guide 4.16 Method  
Random error: 4.0000000E+00  
Systematic error: 4.0000000E+00  
Fraction Limit: 0.000%  
Background width: average of three points.

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Half lives decay limit: 12.000  
 Activity range factor: 2.000  
 Min. step backg. energy 0.000  
 Multiplet shift channel 2.000

| Corrections                   | Status | Comments |
|-------------------------------|--------|----------|
| Decay correct to date:        | NO     |          |
| Decay during acquisition:     | NO     |          |
| Decay during collection:      | NO     |          |
| True coincidence correction:  | NO     |          |
| Peaked background correction: | NO     |          |
| Absorption (Internal):        | NO     |          |
| Geometry correction:          | NO     |          |
| Random summing:               | NO     |          |

total peaks alloc. 7 cutoff: 5.00E+01 %  
 Energy Calibration  
 Normalized diff: 0.1084

| ***** S U M M A R Y O F P E A K S I N R A N G E ***** |      |        |      |                  |                   |                 |             |       |
|-------------------------------------------------------|------|--------|------|------------------|-------------------|-----------------|-------------|-------|
| Peak<br>Energy                                        | Area | Uncert | FWHM | Corrcn<br>Factor | Nuclide<br>Energy | Brnch.<br>Ratio | Act.<br>DPS | Nuc   |
| 46.45                                                 | 422. | 11.15  | 0.93 | 8.093E-02        | 46.54             | 4.250           | 2.836E+00   | PB210 |
| 63.26                                                 | 476. | 8.44   | 1.02 | 1.228E-01        | 63.29             | 3.810           | 2.354E+00   | TH234 |
| 74.90                                                 | 109. | 23.06  | 0.87 | 1.520E-01        |                   |                 |             |       |
| 77.08                                                 | 114. | 23.30  | 0.87 | 1.574E-01        |                   |                 |             |       |
| 92.57                                                 | 577. | 7.07   | 1.15 | 1.861E-01        | 92.59             | 5.584           | 1.285E+00   | TH234 |
|                                                       |      |        |      |                  | 93.35             | 5.561           | 1.288E+00   | AC228 |
| 185.44                                                | 297. | 13.71  | 1.15 | 1.634E-01        | 185.72            | 54.000          | 7.792E-02   | U235  |
|                                                       |      |        |      |                  | 185.99            | 3.280           | 1.284E+00   | Ra226 |
| 238.66                                                | 178. | 19.69  | 0.82 | 1.417E-01        | 238.63            | 43.300          | 6.703E-02   | PB212 |
| 511.09                                                | 879. | 6.15   | 2.00 | 6.487E-02        | 511.86            | 20.000          | 1.571E+00   | RH106 |
| 1461.27                                               | 106. | 16.92  | 2.42 | 1.997E-02        | 1460.83           | 10.670          | 1.148E+00   | K40   |

| ***** U N I D E N T I F I E D P E A K S U M M A R Y ***** |                      |                    |                      |                   |           |                      |    |  |
|-----------------------------------------------------------|----------------------|--------------------|----------------------|-------------------|-----------|----------------------|----|--|
| Peak Centroid<br>Channel Energy                           | Background<br>Counts | Net Area<br>Counts | Efficiency<br>* Area | Uncert<br>1 Sigma | FWHM<br>% | Suspected<br>Nuclide |    |  |
| 299.17 74.97                                              | 259.                 | 109.               | 7.144E+02            | 23.06             | 0.867     | -                    | D  |  |
| 307.89 77.15                                              | 294.                 | 114.               | 7.225E+02            | 23.30             | 0.869     | -                    | sD |  |
| 2044.04 511.09                                            | 279.                 | 879.               | 1.356E+04            | 6.15              | 2.003     | -                    |    |  |

s - Peak fails shape tests.  
 D - Peak area deconvoluted.  
 L - Peak written from unknown list.  
 C - Area < Critical level.

-----  
 This section based on library: DET\_Long Background PBC.lib

| ***** I D E N T I F I E D P E A K S U M M A R Y ***** |              |                 |                   |                 |                   |                |            |
|-------------------------------------------------------|--------------|-----------------|-------------------|-----------------|-------------------|----------------|------------|
| Nuclide                                               | Peak Channel | Centroid Energy | Background Counts | Net Area Counts | Intensity Cts/Sec | Uncert 1 Sigma | FWHM % keV |
| PB-210                                                | 185.41       | 46.46           | 411.              | 417.            | 0.010             | 10.89          | 0.927      |
| TH-234                                                | 252.60       | 63.26           | 325.              | 476.            | 0.011             | 8.44           | 1.023s     |
| TH-234                                                | 369.84       | 92.57           | 342.              | 577.            | 0.013             | 7.07           | 1.155s     |
| Ra-226                                                | 741.38       | 185.44          | 326.              | 297.            | 0.007             | 13.71          | 1.155s     |
| PB-212                                                | 954.26       | 238.66          | 285.              | 178.            | 0.004             | 19.69          | 0.824      |
| K-40                                                  | 5844.77      | 1461.27         | 27.               | 106.            | 0.002             | 16.92          | 2.420      |

s - Peak fails shape tests.  
 D - Peak area deconvoluted.  
 A - Derived peak area.

| ***** S U M M A R Y O F L I B R A R Y P E A K U S A G E ***** |      |                      |            |                   |      |               |                                 |
|---------------------------------------------------------------|------|----------------------|------------|-------------------|------|---------------|---------------------------------|
| - Nuclide - Name                                              | Code | Average Activity DPS | Energy keV | Peak Activity DPS | Code | MDA Value DPS | COMMENTS                        |
| K-40                                                          | N    | 1.1481E+00           | 1460.83    | 1.148E+00         | (    | 2.942E-01     | 4.66E+11<br>1.69E+01 1.07E+01 G |
| PB-210                                                        | N    | 2.7999E+00           | 46.54      | 2.800E+00         | (    | 6.525E-01     | 8.14E+03<br>1.09E+01 4.25E+00 G |
| PB-212                                                        | N    | 6.7031E-02           | 238.63     | 6.703E-02         | (    | 3.072E-02     | 6.98E+02<br>1.97E+01 4.33E+01 G |
|                                                               |      |                      | 300.03     | 0.000E+00         | %    | 2.565E-01     | 2.14E+02 3.28E+00 GA            |
| TH-234                                                        | N    | 2.3541E+00           | 63.29      | 2.354E+00         | @(   | 4.289E-01     | 1.63E+12<br>8.44E+00 3.81E+00 G |
|                                                               |      |                      | 92.59      | 1.285E+00         | -    | 1.981E-01     | 7.07E+00 5.58E+00 G             |
| Ra-226                                                        |      | 1.2836E+00           | 185.99     | 1.284E+00         | &(   | 3.757E-01     | 5.84E+05<br>1.37E+01 3.28E+00 G |

( - This peak used in the nuclide activity average.

\* - Peak is too wide, but only one peak in library.  
 ! - Peak is part of a multiplet and this area went negative during deconvolution.  
 ? - Peak is too narrow.  
 @ - Peak is too wide at FW25M, but ok at FWHM.  
 % - Peak fails sensitivity test.  
 \$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.  
 + - Peak activity higher than counting uncertainty range.

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- - Peak activity lower than counting uncertainty range.
- = - Peak outside analysis energy range.
- & - Calculated peak centroid is not close enough to the library energy centroid for positive identification.
- P - Peakbackground subtraction
- } - Peak is too close to another for the activity to be found directly.

|                                 |                      |
|---------------------------------|----------------------|
| Nuclide Codes:                  | Peak Codes:          |
| T - Thermal Neutron Activation  | G - Gamma Ray        |
| F - Fast Neutron Activation     | X - X-Ray            |
| I - Fission Product             | P - Positron Decay   |
| N - Naturally Occurring Isotope | S - Single-Escape    |
| P - Photon Reaction             | D - Double-Escape    |
| C - Charged Particle Reaction   | K - Key Line         |
| M - No MDA Calculation          | A - Not in Average   |
| R - Coincidence Corrected       | C - Coincidence Peak |
| H - Halflife limit exceeded     |                      |

\*\*\*\*\* D I S C A R D E D I S O T O P E P E A K S \*\*\*\*\*

| Nuclide | Centroid Energy | Background Counts | Net Area Counts | Intensity Cts/Sec | Uncert 1 Sigma % | Activity |
|---------|-----------------|-------------------|-----------------|-------------------|------------------|----------|
|---------|-----------------|-------------------|-----------------|-------------------|------------------|----------|

P - Peakbackground subtraction

\*\*\*\*\* S U M M A R Y O F N U C L I D E S I N S A M P L E \*\*\*\*\*

| Nuclide | Time of Count | Activity   | Uncertainty Counting | 1 Sigma | MDA       |
|---------|---------------|------------|----------------------|---------|-----------|
|         | DPS           |            |                      |         |           |
| BE-7    | <             | 1.1531E-01 |                      |         |           |
| NA-22   | <             | 4.1676E-02 |                      |         |           |
| K-40    |               | 1.1481E+00 | 1.6923E+01%          |         | 2.942E-01 |
| Sc-46   | <             | 3.9167E-02 |                      |         |           |
| CR-51   | <             | 8.0047E-02 |                      |         |           |
| MN-54   | <             | 2.0589E-02 |                      |         |           |
| FE-59   | <             | 3.6770E-02 |                      |         |           |
| Co-56   | <             | 2.0464E-02 |                      |         |           |
| CO-57   | <             | 5.5107E-03 |                      |         |           |
| CO-58   | <             | 1.4763E-02 |                      |         |           |
| CO-60   | <             | 2.7031E-02 |                      |         |           |
| ZN-65   | <             | 5.3962E-02 |                      |         |           |
| NB-94   | <             | 1.9331E-02 |                      |         |           |
| ZR-95   | <             | 3.4422E-02 |                      |         |           |
| NB-95   | <             | 3.1504E-02 |                      |         |           |
| RU-103  | <             | 1.5956E-02 |                      |         |           |
| RH-106  | <             | 2.5145E-01 |                      |         |           |
| AG-108M | <             | 1.1422E-02 |                      |         |           |
| AG-110M | <             | 1.3917E-02 |                      |         |           |
| SN-113  | <             | 1.4840E-02 |                      |         |           |

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|         |   |            |             |           |
|---------|---|------------|-------------|-----------|
| SB-124  | < | 2.0728E-02 |             |           |
| SB-125  | < | 3.6391E-02 |             |           |
| I-131   | < | 1.2098E-02 |             |           |
| BA-133  | < | 2.9076E-02 |             |           |
| CS-134  | < | 2.4504E-02 |             |           |
| CS-137  | < | 2.1597E-02 |             |           |
| CE-139  | < | 8.2012E-03 |             |           |
| Ba-140  | < | 5.4914E-02 |             |           |
| La-140  | < | 3.2035E-02 |             |           |
| CE-141  | < | 1.3043E-02 |             |           |
| CE-144  | < | 7.6739E-02 |             |           |
| PM-144  | < | 2.0289E-02 |             |           |
| EU-152  | < | 3.3726E-02 |             |           |
| EU-154  | < | 1.6740E-01 |             |           |
| EU-155  | < | 3.0920E-02 |             |           |
| HF-181  | < | 1.5810E-02 |             |           |
| Ta-182  | < | 1.1057E-01 |             |           |
| Hg-203  | < | 1.3137E-02 |             |           |
| TL-208  | < | 1.7018E-02 |             |           |
| pm-146  | < | 4.7629E-02 |             |           |
| Y-88    | < | 2.3415E-02 |             |           |
| PB-210  |   | 2.7999E+00 | 1.0887E+01% | 6.525E-01 |
| PB-212  |   | 6.7031E-02 | 1.9691E+01% | 3.072E-02 |
| PB-214  | < | 2.9739E-02 |             |           |
| BI-207  | < | 2.3768E-02 |             |           |
| BI-212  | < | 2.4009E-01 |             |           |
| BI-214  | < | 6.0881E-02 |             |           |
| BI-210M | < | 1.5108E-02 |             |           |
| RA-224  | < | 2.5676E-01 |             |           |
| AC-228  | < | 8.7191E-02 |             |           |
| TH-227  | < | 8.8235E-02 |             |           |
| TH-229  | < | 1.6264E-01 |             |           |
| TH-234  | # | 2.3541E+00 | 8.4387E+00% | 4.289E-01 |
| PA-231  | < | 3.8986E-01 |             |           |
| PA-233  | < | 2.5548E-02 |             |           |
| PA-234  | < | 3.8548E-02 |             |           |
| PA-234M | < | 2.9618E+00 |             |           |
| Ra-226  | # | 1.2836E+00 | 1.3709E+01% | 3.757E-01 |
| U-235   | < | 5.9234E-02 |             |           |
| AM-241  | < | 3.1235E-02 |             |           |
| Np-237  | < | 8.5949E-02 |             |           |

# - All peaks for activity calculation had bad shape.  
 \* - Activity omitted from total  
 & - Activity omitted from total and all peaks had bad shape.

< - MDA value printed.  
A - Activity printed, but activity < MDA.  
B - Activity < MDA and failed test.  
C - Area < Critical level.  
F - Failed fraction or key line test.  
H - Halflife limit exceeded

----- S U M M A R Y -----  
Total Activity ( 37.6 to 2000.1 keV) 7.653E+00 DPS

Test America  
St. Louis  
Background Check

Spectrum: 7\_20160506004\_BGLong  
Description: Background Long PBC Count  
Acquired: 5/6/2016 5:49:06 PM  
Detector: Detector # 7

Background Evaluation Criteria:

- 1) Place instrument out of service if Countrate exceeds Control Limits.
- 2) Investigate high countrate and take corrective action as necessary if Countrate exceeds Tolerance Limits.

|           | Target | L_Ctrl | L_Tol | Measured | H_Tol | H_Ctrl | Results |
|-----------|--------|--------|-------|----------|-------|--------|---------|
| Bkgd      |        |        |       |          |       |        |         |
| Countrate | 1.30   | 1.16   | 1.21  | 1.29     | 1.40  | 1.45   | PASS    |

Analyst: Aaron Schroder

Reviewer: Aaron Schroder

(Page 1 of 1)

Test America  
St. Louis  
Background Check

Spectrum: 8\_20160506004\_BGLong  
Description: Background Long PBC Count  
Acquired: 5/6/2016 6:28:03 PM  
Detector: Detector # 8

Background Evaluation Criteria:

- 1) Place instrument out of service if Countrate exceeds Control Limits.
- 2) Investigate high countrate and take corrective action as necessary if Countrate exceeds Tolerance Limits.

|           | Target | L_Ctrl | L_Tol | Measured | H_Tol | H_Ctrl | Results |
|-----------|--------|--------|-------|----------|-------|--------|---------|
| Bkgd      |        |        |       |          |       |        |         |
| Countrate | 1.56   | 1.39   | 1.45  | 1.60     | 1.68  | 1.74   | PASS    |

Analyst: Aaron Schroder      Reviewer:

Sample description  
Background Long PBC Count

Spectrum Filename: C:\User\SPC\Det8\8\_20160506004\_BGLong.An1

Acquisition information

Start time: 5/6/2016 6:28:03 PM  
Live time: 72000  
Real time: 74084  
Dead time: 2.81 %  
Detector ID: 8

Detector system

Ge 8 SN/174

Calibration

Filename: 8\_QC.Clb  
Ge8\_QC

Energy Calibration

Created: 2/28/2012 10:34:41 AM  
Zero offset: 0.052 keV  
Gain: 0.250 keV/channel  
Quadratic: 5.282E-10 keV/channel^2

Efficiency Calibration

Created: 1/6/2011 8:07:20 AM  
Knee Energy: 0.00 keV  
Above the Knee: Interpolative Uncertainty = 0.00 %  
Below the Knee: Interpolative Uncertainty = 0.00 %

Library Files

Main analysis library: DET\_Long Background PBC.lib  
Library Match Width: 0.500  
Peak stripping: Library based

Analysis parameters

Analysis engine: Env32 G800W064  
Start channel: 150 ( 37.55keV )  
Stop channel: 8000 ( 1999.97keV )  
Peak rejection level: 30.000%  
Peak search sensitivity: 3  
Sample Size: 1.0000E+00 +/- 0.000E+00%  
Activity scaling factor: 1.0000E+00/( 1.0000E+00\* 1.0000E+00) = 1.0000E+00  
Detection limit method: Reg. Guide 4.16 Method  
Random error: 4.0000000E+00  
Systematic error: 4.0000000E+00  
Fraction Limit: 0.000%  
Background width: average of three points.

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Half lives decay limit: 12.000  
 Activity range factor: 2.000  
 Min. step backg. energy 0.000  
 Multiplet shift channel 2.000

| Corrections                   | Status | Comments |
|-------------------------------|--------|----------|
| Decay correct to date:        | NO     |          |
| Decay during acquisition:     | NO     |          |
| Decay during collection:      | NO     |          |
| True coincidence correction:  | NO     |          |
| Peaked background correction: | NO     |          |
| Absorption (Internal):        | NO     |          |
| Geometry correction:          | NO     |          |
| Random summing:               | NO     |          |

total peaks alloc. 19 cutoff: 5.00E+01 %  
 Energy Calibration  
 Normalized diff: 0.1076

| ***** S U M M A R Y O F P E A K S I N R A N G E ***** |       |        |      |                   |                   |                 |             |        |
|-------------------------------------------------------|-------|--------|------|-------------------|-------------------|-----------------|-------------|--------|
| Peak<br>Energy                                        | Area  | Uncert | FWHM | Corrctn<br>Factor | Nuclide<br>Energy | Brnch.<br>Ratio | Act.<br>DPS | Nuc    |
| 59.63                                                 | 448.  | 9.09   | 1.02 | 8.708E-02         | 59.54             | 35.900          | 1.992E-01   | AM241  |
| 63.28                                                 | 1027. | 4.75   | 1.03 | 9.247E-02         | 63.29             | 3.810           | 4.049E+00   | TH234  |
| 84.56                                                 | 200.  | 27.20  | 0.72 | 1.238E-01         |                   |                 |             |        |
| 92.67                                                 | 2009. | 3.97   | 1.06 | 1.295E-01         | 92.59             | 5.584           | 3.859E+00   | TH234  |
|                                                       |       |        |      |                   | 93.35             | 5.561           | 3.872E+00   | AC228  |
| 143.87                                                | 260.  | 15.10  | 1.04 | 1.247E-01         | 143.79            | 10.960          | 2.642E-01   | U235   |
| 163.30                                                | 197.  | 26.31  | 1.14 | 1.171E-01         | 163.38            | 5.080           | 4.606E-01   | U235   |
|                                                       |       |        |      |                   | 162.66            | 6.220           | 3.753E-01   | Ba140  |
| 185.76                                                | 1082. | 6.35   | 1.06 | 1.108E-01         | 185.72            | 54.000          | 2.511E-01   | U235   |
|                                                       |       |        |      |                   | 185.99            | 3.280           | 4.137E+00   | Ra226  |
| 238.63                                                | 314.  | 14.21  | 1.01 | 9.639E-02         | 238.63            | 43.300          | 1.043E-01   | PB212  |
| 295.36                                                | 204.  | 21.75  | 1.32 | 8.103E-02         | 295.09            | 19.300          | 1.812E-01   | PB214  |
| 351.95                                                | 171.  | 22.89  | 1.40 | 6.558E-02         | 351.93            | 37.600          | 9.623E-02   | PB214  |
| 511.00                                                | 1410. | 5.67   | 2.35 | 4.530E-02         | 511.86            | 20.000          | 2.165E+00   | RH106  |
| 583.51                                                | 162.  | 18.95  | 1.63 | 3.958E-02         | 583.02            | 84.500          | 6.727E-02   | TL208  |
| 609.11                                                | 152.  | 22.91  | 1.54 | 3.750E-02         | 609.31            | 46.090          | 1.219E-01   | BI214  |
|                                                       |       |        |      |                   | 610.30            | 5.750           | 9.791E-01   | RU103  |
| 661.76                                                | 276.  | 13.85  | 1.17 | 3.334E-02         | 661.66            | 85.210          | 1.348E-01   | CS137  |
| 803.09                                                | 93.   | 29.60  | 0.90 | 2.746E-02         |                   |                 |             |        |
| 1000.95                                               | 105.  | 20.82  | 1.22 | 2.158E-02         | 1001.00           | 0.837           | 8.101E+00   | PA234M |
| 1172.96                                               | 140.  | 18.96  | 1.50 | 1.834E-02         | 1173.24           | 99.900          | 1.065E-01   | CO60   |
| 1332.86                                               | 130.  | 18.68  | 1.89 | 1.637E-02         | 1332.50           | 99.980          | 1.106E-01   | CO60   |
| 1460.60                                               | 164.  | 13.91  | 0.89 | 1.543E-02         | 1460.83           | 10.670          | 1.388E+00   | K40    |

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| ***** U N I D E N T I F I E D P E A K S U M M A R Y ***** |                      |                   |                 |                   |                |        |                   |    |
|-----------------------------------------------------------|----------------------|-------------------|-----------------|-------------------|----------------|--------|-------------------|----|
| Channel                                                   | Peak Centroid Energy | Background Counts | Net Area Counts | Efficiency * Area | Uncert 1 Sigma | FWHM % | Suspected Nuclide |    |
| 338.04                                                    | 84.56                | 792.              | 200.            | 1.619E+03         | 27.20          | 0.715  | -                 | s  |
| 2043.91                                                   | 511.00               | 575.              | 1410.           | 3.113E+04         | 5.67           | 2.348  | -                 | s  |
| 3212.32                                                   | 803.09               | 158.              | 93.             | 3.374E+03         | 29.60          | 0.902  | -                 | sM |

s - Peak fails shape tests.  
 D - Peak area deconvoluted.  
 L - Peak written from unknown list.  
 C - Area < Critical level.  
 M - Peak is close to a library peak.

-----  
 This section based on library: DET\_Long Background PBC.lib

| ***** I D E N T I F I E D P E A K S U M M A R Y ***** |              |                 |                   |                 |                   |                |            |
|-------------------------------------------------------|--------------|-----------------|-------------------|-----------------|-------------------|----------------|------------|
| Nuclide                                               | Peak Channel | Centroid Energy | Background Counts | Net Area Counts | Intensity Cts/Sec | Uncert 1 Sigma | FWHM % keV |
| AM-241                                                | 237.95       | 59.54           | 603.              | 448.            | 0.006             | 9.08           | 1.022D     |
| TH-234                                                | 252.96       | 63.29           | 677.              | 1027.           | 0.014             | 4.75           | 1.025D     |
| TH-234                                                | 370.48       | 92.67           | 1045.             | 2009.           | 0.028             | 3.97           | 1.056      |
| U-235                                                 | 575.30       | 143.87          | 453.              | 260.            | 0.004             | 15.10          | 1.038      |
| U-235                                                 | 653.02       | 163.30          | 652.              | 197.            | 0.003             | 26.31          | 1.142s     |
| U-235                                                 | 742.71       | 185.72          | 808.              | 1090.           | 0.015             | 4.23           | 1.064D     |
| PB-212                                                | 954.38       | 238.63          | 478.              | 314.            | 0.004             | 14.21          | 1.014      |
| PB-214                                                | 1181.31      | 295.36          | 441.              | 204.            | 0.003             | 21.75          | 1.318      |
| PB-214                                                | 1407.67      | 351.95          | 354.              | 171.            | 0.002             | 22.89          | 1.404      |
| TL-208                                                | 2333.94      | 583.51          | 195.              | 162.            | 0.002             | 18.95          | 1.628      |
| BI-214                                                | 2436.37      | 609.11          | 253.              | 152.            | 0.002             | 22.91          | 1.544      |
| CS-137                                                | 2646.98      | 661.76          | 229.              | 276.            | 0.004             | 13.85          | 1.169      |
| PA-234M                                               | 4003.81      | 1000.95         | 87.               | 105.            | 0.001             | 20.82          | 1.222s     |
| CO-60                                                 | 4691.85      | 1172.96         | 104.              | 140.            | 0.002             | 18.96          | 1.498      |
| CO-60                                                 | 5331.48      | 1332.86         | 87.               | 130.            | 0.002             | 18.68          | 1.891      |
| K-40                                                  | 5842.47      | 1460.60         | 52.               | 164.            | 0.002             | 13.91          | 0.895s     |

s - Peak fails shape tests.  
 D - Peak area deconvoluted.  
 A Derived peak area.

| ***** S U M M A R Y O F L I B R A R Y P E A K U S A G E ***** |      |                         |                  |                 |      |           |          |          |    |
|---------------------------------------------------------------|------|-------------------------|------------------|-----------------|------|-----------|----------|----------|----|
| - Nuclide -                                                   | Code | Average Activity<br>DPS | ----- Peak ----- |                 | Code | MDA       | Value    |          |    |
| Name                                                          |      |                         | Energy<br>keV    | Activity<br>DPS |      |           | DPS      | COMMENTS |    |
| <hr/>                                                         |      |                         |                  |                 |      |           |          |          |    |
| K-40                                                          | N    | 1.3880E+00              |                  |                 |      |           | 4.66E+11 |          |    |
|                                                               |      |                         | 1460.83          | 1.388E+00       | ?(   | 3.078E-01 | 1.39E+01 | 1.07E+01 | G  |
| CO-60                                                         | F    | 1.0855E-01              |                  |                 |      |           | 1.93E+03 |          |    |
|                                                               |      |                         | 1332.50          | 1.106E-01       | ?(   | 3.911E-02 | 1.87E+01 | 1.00E+02 | G  |
|                                                               |      |                         | 1173.24          | 1.065E-01       | (    | 3.800E-02 | 1.90E+01 | 9.99E+01 | G  |
| CS-137                                                        | I    | 1.3485E-01              |                  |                 |      |           | 1.10E+04 |          |    |
|                                                               |      |                         | 661.66           | 1.348E-01       | (    | 3.581E-02 | 1.39E+01 | 8.52E+01 | G  |
| TL-208                                                        | N    | 6.7270E-02              |                  |                 |      |           | 6.98E+02 |          |    |
|                                                               |      |                         | 583.02           | 6.727E-02       | (    | 2.815E-02 | 1.89E+01 | 8.45E+01 | G  |
|                                                               |      |                         | 277.28           | 0.000E+00       | %    | 1.600E-01 | 4.69E+01 | 6.31E+00 | G  |
|                                                               |      |                         | 860.56           | 0.000E+00       | %    | 1.708E-01 | 5.56E+01 | 1.24E+01 | G  |
| PB-212                                                        | N    | 1.0433E-01              |                  |                 |      |           | 6.98E+02 |          |    |
|                                                               |      |                         | 238.63           | 1.043E-01       | (    | 3.479E-02 | 1.42E+01 | 4.33E+01 | G  |
|                                                               |      |                         | 300.03           | 0.000E+00       | &    | 5.414E-01 | 0.00E+00 | 3.28E+00 | GA |
| PB-214                                                        | N    | 9.6226E-02              |                  |                 |      |           | 5.84E+05 |          |    |
|                                                               |      |                         | 351.93           | 9.623E-02       | (    | 5.092E-02 | 2.29E+01 | 3.76E+01 | G  |
|                                                               |      |                         | 295.09           | 1.812E-01       | +    | 8.931E-02 | 2.17E+01 | 1.93E+01 | G  |
|                                                               |      |                         | 242.00           | 0.000E+00       |      | 1.954E-01 | 0.00E+00 | 7.43E+00 | GA |
| BI-214                                                        | N    | 1.2189E-01              |                  |                 |      |           | 5.84E+05 |          |    |
|                                                               |      |                         | 609.31           | 1.219E-01       | (    | 6.179E-02 | 2.29E+01 | 4.61E+01 | G  |
|                                                               |      |                         | 1120.29          | 0.000E+00       | %    | 2.010E-01 | 1.10E+02 | 1.51E+01 | G  |
|                                                               |      |                         | 1764.49          | 0.000E+00       | %    | 1.747E-01 | 5.37E+01 | 1.54E+01 | G  |
| TH-234                                                        | N    | 3.9360E+00              |                  |                 |      |           | 1.63E+12 |          |    |
|                                                               |      |                         | 63.29            | 4.049E+00       | (    | 4.888E-01 | 4.75E+00 | 3.81E+00 | G  |
|                                                               |      |                         | 92.59            | 3.859E+00       | (    | 2.945E-01 | 3.97E+00 | 5.58E+00 | G  |
| PA-234M                                                       | N    | 8.1005E+00              |                  |                 |      |           | 1.63E+12 |          |    |
|                                                               |      |                         | 1001.00          | 8.101E+00       | (    | 3.545E+00 | 2.08E+01 | 8.37E-01 | G  |
|                                                               |      |                         | 766.41           | 0.000E+00       | %    | 7.156E+00 | 6.06E+01 | 2.94E-01 | G  |
| U-235                                                         | N    | 2.6425E-01              |                  |                 |      |           | 2.57E+11 |          |    |
|                                                               |      |                         | 185.72           | 2.531E-01       | }    | 3.139E-02 | 4.23E+00 | 5.40E+01 | GA |
|                                                               |      |                         | 143.79           | 2.642E-01       | (    | 1.035E-01 | 1.51E+01 | 1.10E+01 | G  |
|                                                               |      |                         | 205.33           | 0.000E+00       | %    | 1.906E-01 | 4.24E+01 | 5.01E+00 | G  |
|                                                               |      |                         | 163.38           | 4.606E-01       | +    | 2.840E-01 | 2.63E+01 | 5.08E+00 | G  |

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Nuclide Ave activity Energy Activity Code Peak MDA Comments

AM-241 T 1.9950E-01 59.54 1.995E-01 ( 5.215E-02 9.08E+00 3.59E+01 G  
 ( - This peak used in the nuclide activity average.

- \* - Peak is too wide, but only one peak in library.
- ! - Peak is part of a multiplet and this area went negative during deconvolution.
- ? - Peak is too narrow.
- @ - Peak is too wide at FW25M, but ok at FWHM.
- % - Peak fails sensitivity test.
- \$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.
- + - Peak activity higher than counting uncertainty range.
- - Peak activity lower than counting uncertainty range.
- = - Peak outside analysis energy range.
- & - Calculated peak centroid is not close enough to the library energy centroid for positive identification.
- P - Peakbackground subtraction
- } - Peak is too close to another for the activity to be found directly.

Nuclide Codes:

T - Thermal Neutron Activation  
 F - Fast Neutron Activation  
 I - Fission Product  
 N - Naturally Occurring Isotope  
 P - Photon Reaction  
 C - Charged Particle Reaction  
 M - No MDA Calculation  
 R - Coincidence Corrected  
 H - Halflife limit exceeded

Peak Codes:

G - Gamma Ray  
 X - X-Ray  
 P - Positron Decay  
 S - Single-Escape  
 D - Double-Escape  
 K - Key Line  
 A - Not in Average  
 C - Coincidence Peak

\*\*\*\*\* D I S C A R D E D I S O T O P E P E A K S \*\*\*\*\*

| Nuclide | Centroid Energy | Background Counts | Net Area Counts | Intensity Cts/Sec | Uncert 1 Sigma | Activity % |
|---------|-----------------|-------------------|-----------------|-------------------|----------------|------------|
|---------|-----------------|-------------------|-----------------|-------------------|----------------|------------|

P - Peakbackground subtraction

\*\*\*\*\* S U M M A R Y O F N U C L I D E S I N S A M P L E \*\*\*\*\*

| Nuclide | Time of Count | Activity   | Uncertainty | Counting | 1 Sigma | MDA       |
|---------|---------------|------------|-------------|----------|---------|-----------|
| BE-7    | <             | 1.4018E-01 |             |          |         |           |
| NA-22   | <             | 1.6882E-02 |             |          |         |           |
| K-40    | #             | 1.3880E+00 | 1.3906E+01% |          |         | 3.078E-01 |
| Sc-46   | <             | 1.4292E-02 |             |          |         |           |

|         |   |            |             |           |
|---------|---|------------|-------------|-----------|
| CR-51   | < | 1.0118E-01 |             |           |
| MN-54   | < | 1.9972E-02 |             |           |
| FE-59   | < | 4.8912E-02 |             |           |
| Co-56   | < | 2.1881E-02 |             |           |
| CO-57   | < | 1.3021E-02 |             |           |
| CO-58   | < | 2.1785E-02 |             |           |
| CO-60   |   | 1.0855E-01 | 1.3308E+01% | 3.911E-02 |
| ZN-65   | < | 7.8339E-02 |             |           |
| NB-94   | < | 2.2024E-02 |             |           |
| ZR-95   | < | 3.3544E-02 |             |           |
| NB-95   | < | 3.9632E-02 |             |           |
| RU-103  | < | 1.8742E-02 |             |           |
| RH-106  | < | 1.9339E-01 |             |           |
| AG-108M | < | 1.6281E-02 |             |           |
| AG-110M | < | 4.0779E-02 |             |           |
| SN-113  | < | 2.3283E-02 |             |           |
| SB-124  | < | 2.1286E-02 |             |           |
| SB-125  | < | 5.2923E-02 |             |           |
| I-131   | < | 1.6192E-02 |             |           |
| BA-133  | < | 2.6470E-02 |             |           |
| CS-134  | < | 3.0684E-02 |             |           |
| CS-137  |   | 1.3485E-01 | 1.3852E+01% | 3.581E-02 |
| CE-139  | < | 1.5981E-02 |             |           |
| Ba-140  | < | 6.8895E-02 |             |           |
| La-140  | < | 2.6479E-02 |             |           |
| CE-141  | < | 1.2916E-02 |             |           |
| CE-144  | < | 7.9022E-02 |             |           |
| PM-144  | < | 2.4203E-02 |             |           |
| EU-152  | < | 5.7202E-02 |             |           |
| EU-154  | < | 1.9230E-01 |             |           |
| EU-155  | < | 3.8659E-02 |             |           |
| HF-181  | < | 2.1461E-02 |             |           |
| Ta-182  | < | 4.3992E-02 |             |           |
| Hg-203  | < | 1.4348E-02 |             |           |
| TL-208  |   | 6.7270E-02 | 1.8946E+01% | 2.815E-02 |
| pm-146  | < | 5.7185E-02 |             |           |
| y-88    | < | 2.4808E-02 |             |           |
| PB-210  | < | 3.7204E-01 |             |           |
| PB-212  |   | 1.0433E-01 | 1.4211E+01% | 3.479E-02 |
| PB-214  |   | 9.6226E-02 | 2.2885E+01% | 5.092E-02 |
| BI-207  | < | 3.1387E-02 |             |           |
| BI-212  | < | 2.2580E-01 |             |           |
| BI-214  |   | 1.2189E-01 | 2.2909E+01% | 6.179E-02 |
| BI-210M | < | 1.9293E-02 |             |           |
| RA-224  | < | 3.8987E-01 |             |           |
| AC-228  | < | 1.1196E-01 |             |           |
| TH-227  | < | 1.0710E-01 |             |           |
| TH-229  | < | 2.0366E-01 |             |           |
| TH-234  |   | 3.9360E+00 | 3.0961E+00% | 4.888E-01 |

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|         |   |            |             |           |
|---------|---|------------|-------------|-----------|
| PA-231  | < | 7.2277E-01 |             |           |
| PA-233  | < | 2.6955E-02 |             |           |
| PA-234  | < | 7.6557E-02 |             |           |
| PA-234M |   | 8.1005E+00 | 2.0819E+01% | 3.545E+00 |
| U-235   |   | 2.6425E-01 | 1.5099E+01% | 1.035E-01 |
| AM-241  |   | 1.9950E-01 | 9.0754E+00% | 5.215E-02 |
| Np-237  | < | 4.9564E-02 |             |           |

# - All peaks for activity calculation had bad shape.  
 \* - Activity omitted from total  
 & - Activity omitted from total and all peaks had bad shape.  
 < - MDA value printed.  
 A - Activity printed, but activity < MDA.  
 B - Activity < MDA and failed test.  
 C - Area < Critical level.  
 F - Failed fraction or key line test.  
 H - Halflife limit exceeded

----- S U M M A R Y -----  
 Total Activity ( 37.5 to 2000.0 keV) 1.452E+01 DPS

Test America  
St. Louis  
Background Check

Spectrum: 8\_20160506004\_BGLong  
Description: Background Long PBC Count  
Acquired: 5/6/2016 6:28:03 PM  
Detector: Detector # 8

Background Evaluation Criteria:

- 1) Place instrument out of service if Countrate exceeds Control Limits.
- 2) Investigate high countrate and take corrective action as necessary if Countrate exceeds Tolerance Limits.

|           | Target | L_Ctrl | L_Tol | Measured | H_Tol | H_Ctrl | Results |
|-----------|--------|--------|-------|----------|-------|--------|---------|
| Bkgd      |        |        |       |          |       |        |         |
| Countrate | 1.56   | 1.39   | 1.45  | 1.60     | 1.68  | 1.74   | PASS    |

Analyst: Aaron Schroder

Reviewer: Aaron Schroder

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# Run Logs

# Gamma Spectroscopy Run Log

## Detector: GV5

| Analysis Date  | Count<br>Minutes | Lab Sample ID            | Client Sample ID | Analysis<br>Batch | Prep<br>Batch | Method   | Analyst<br>Initials |
|----------------|------------------|--------------------------|------------------|-------------------|---------------|----------|---------------------|
| 03/26/12 15:05 |                  | IC 160-12297/1           |                  | 12297             |               |          | JLW                 |
| 03/27/12 10:12 |                  | ICV 160-12297/2          |                  | 12297             |               |          | JLW                 |
| 01/28/16 10:21 |                  | ACVTOP 160-236240/1      |                  | 236240            |               |          | PS                  |
| 05/06/16 17:48 |                  | ICB 160-250688/1         |                  | 250688            |               |          | ALS                 |
| 06/01/16 00:26 |                  | CCB 160-254162/1         |                  | 254162            |               |          | ALS                 |
| 06/01/16 05:22 |                  | CCV 160-254162/2         |                  | 254162            |               |          |                     |
| 06/01/16 05:44 |                  | CCV 160-254162/3         |                  | 254162            |               |          | ALS                 |
| 06/01/16 08:24 | 30               | ZZZZZ                    |                  | 254162            |               |          |                     |
| 06/01/16 09:03 | 30               | ZZZZZ                    |                  | 254162            |               |          |                     |
| 06/01/16 09:47 |                  | ZZZZZ                    |                  | 254162            |               |          |                     |
| 06/01/16 10:12 | 30               | ZZZZZ                    |                  | 254162            |               |          |                     |
| 06/01/16 11:12 | 30               | ZZZZZ                    |                  | 254162            |               |          |                     |
| 06/01/16 12:47 | 30               | ZZZZZ                    |                  | 254162            |               |          |                     |
| 06/01/16 13:43 | 30               | ZZZZZ                    |                  | 254162            |               |          |                     |
| 06/01/16 14:29 | 30               | ZZZZZ                    |                  | 254162            |               |          |                     |
| 06/01/16 15:26 |                  | TCCLBA<br>160-254137/1-A |                  | 254162            | 254137        | TC-02-RC | ALS                 |
| 06/01/16 15:45 |                  | TCCLBC<br>160-254137/3-A |                  | 254162            | 254137        | TC-02-RC | ALS                 |
| 06/01/16 16:18 |                  | TCCLBB<br>160-254137/2-A |                  | 254162            | 254137        | TC-02-RC | ALS                 |
| 06/01/16 17:33 |                  | ZZZZZ                    |                  | 254162            |               |          |                     |
| 06/01/16 18:02 |                  | ZZZZZ                    |                  | 254162            |               |          |                     |
| 06/01/16 18:33 |                  | ZZZZZ                    |                  | 254162            |               |          |                     |
| 06/01/16 18:45 |                  | ZZZZZ                    |                  | 254162            |               |          |                     |
| 06/01/16 18:58 |                  | 160-17563-2              | GW-NB34-052616   | 254162            | 254155        | TC-02-RC | ALS                 |
| 06/01/16 22:37 |                  | ZZZZZ                    |                  | 254162            |               |          |                     |

## Detector: GV7

| Analysis Date  | Count<br>Minutes | Lab Sample ID            | Client Sample ID | Analysis<br>Batch | Prep<br>Batch | Method   | Analyst<br>Initials |
|----------------|------------------|--------------------------|------------------|-------------------|---------------|----------|---------------------|
| 03/27/12 08:10 |                  | IC 160-12302/1           |                  | 12302             |               |          | JLW                 |
| 03/27/12 15:25 |                  | ICV 160-12302/2          |                  | 12302             |               |          | JLW                 |
| 01/23/16 19:25 |                  | ACVTOP 160-236241/1      |                  | 236241            |               |          | PS                  |
| 05/06/16 17:49 |                  | ICB 160-250689/1         |                  | 250689            |               |          | ALS                 |
| 06/01/16 00:27 |                  | CCB 160-254163/1         |                  | 254163            |               |          | ALS                 |
| 06/01/16 05:25 |                  | CCV 160-254163/2         |                  | 254163            |               |          |                     |
| 06/01/16 05:47 |                  | CCV 160-254163/3         |                  | 254163            |               |          | ALS                 |
| 06/01/16 08:10 | 30               | ZZZZZ                    |                  | 254163            |               |          |                     |
| 06/01/16 09:07 | 30               | ZZZZZ                    |                  | 254163            |               |          |                     |
| 06/01/16 09:41 |                  | ZZZZZ                    |                  | 254163            |               |          |                     |
| 06/01/16 10:03 | 30               | ZZZZZ                    |                  | 254163            |               |          |                     |
| 06/01/16 11:05 | 30               | ZZZZZ                    |                  | 254163            |               |          |                     |
| 06/01/16 11:56 | 30               | ZZZZZ                    |                  | 254163            |               |          |                     |
| 06/01/16 12:35 | 30               | ZZZZZ                    |                  | 254163            |               |          |                     |
| 06/01/16 13:42 | 30               | ZZZZZ                    |                  | 254163            |               |          |                     |
| 06/01/16 14:27 | 30               | ZZZZZ                    |                  | 254163            |               |          |                     |
| 06/01/16 15:27 |                  | TCCLBB<br>160-254137/2-A |                  | 254163            | 254137        | TC-02-RC | ALS                 |
| 06/01/16 15:44 |                  | TCCLBA<br>160-254137/1-A |                  | 254163            | 254137        | TC-02-RC | ALS                 |
| 06/01/16 16:19 |                  | TCCLBC<br>160-254137/3-A |                  | 254163            | 254137        | TC-02-RC | ALS                 |

# Gamma Spectroscopy Run Log

## Detector: GV7 (Continued)

| Analysis Date  | Count<br>Minutes | Lab Sample ID     | Client Sample ID | Analysis<br>Batch | Prep<br>Batch | Method   | Analyst<br>Initials |
|----------------|------------------|-------------------|------------------|-------------------|---------------|----------|---------------------|
| 06/01/16 17:32 |                  | ZZZZZ             |                  | 254163            |               |          |                     |
| 06/01/16 18:03 |                  | MB 160-254155/1-A |                  | 254163            | 254155        | TC-02-RC | ALS                 |
| 06/01/16 18:31 |                  | ZZZZZ             |                  | 254163            |               |          |                     |
| 06/01/16 18:44 |                  | ZZZZZ             |                  | 254163            |               |          |                     |
| 06/01/16 18:56 |                  | ZZZZZ             |                  | 254163            |               |          |                     |

## Detector: GV8

| Analysis Date  | Count<br>Minutes | Lab Sample ID            | Client Sample ID | Analysis<br>Batch | Prep<br>Batch | Method   | Analyst<br>Initials |
|----------------|------------------|--------------------------|------------------|-------------------|---------------|----------|---------------------|
| 03/27/12 10:58 |                  | IC 160-12311/1           |                  | 12311             |               |          | JLW                 |
| 03/29/12 01:58 |                  | ICV 160-12311/2          |                  | 12311             |               |          | JLW                 |
| 01/28/16 18:34 |                  | ACVTOP 160-236248/1      |                  | 236248            |               |          | PS                  |
| 05/06/16 18:28 |                  | ICB 160-250690/1         |                  | 250690            |               |          | ALS                 |
| 06/01/16 00:28 |                  | CCB 160-254166/1         |                  | 254166            |               |          | ALS                 |
| 06/01/16 05:26 |                  | CCV 160-254166/2         |                  | 254166            |               |          |                     |
| 06/01/16 05:48 |                  | CCV 160-254166/3         |                  | 254166            |               |          | ALS                 |
| 06/01/16 08:20 | 30               | ZZZZZ                    |                  | 254166            |               |          |                     |
| 06/01/16 09:02 | 30               | ZZZZZ                    |                  | 254166            |               |          |                     |
| 06/01/16 09:42 |                  | ZZZZZ                    |                  | 254166            |               |          |                     |
| 06/01/16 10:10 | 30               | ZZZZZ                    |                  | 254166            |               |          |                     |
| 06/01/16 11:11 | 30               | ZZZZZ                    |                  | 254166            |               |          |                     |
| 06/01/16 12:46 | 30               | ZZZZZ                    |                  | 254166            |               |          |                     |
| 06/01/16 13:44 | 30               | ZZZZZ                    |                  | 254166            |               |          |                     |
| 06/01/16 14:26 | 30               | ZZZZZ                    |                  | 254166            |               |          |                     |
| 06/01/16 15:29 |                  | TCCLBC<br>160-254137/3-A |                  | 254166            | 254137        | TC-02-RC | ALS                 |
| 06/01/16 15:43 |                  | TCCLBB<br>160-254137/2-A |                  | 254166            | 254137        | TC-02-RC | ALS                 |
| 06/01/16 16:21 |                  | TCCLBA<br>160-254137/1-A |                  | 254166            | 254137        | TC-02-RC | ALS                 |
| 06/01/16 17:31 |                  | ZZZZZ                    |                  | 254166            |               |          |                     |
| 06/01/16 18:05 |                  | LCS 160-254155/2-A       |                  | 254166            | 254155        | TC-02-RC | ALS                 |
| 06/01/16 18:30 |                  | 160-17543-AD-1-D DU      |                  | 254166            | 254155        | TC-02-RC | ALS                 |
| 06/01/16 18:43 |                  | 160-17563-1              | GW-GWW-052616    | 254166            | 254155        | TC-02-RC | ALS                 |
| 06/01/16 18:55 |                  | 160-17563-4              | GW-PZ02-052616   | 254166            | 254155        | TC-02-RC | ALS                 |
| 06/01/16 22:38 |                  | 160-17563-3              | GW-GWY-052616    | 254166            | 254155        | TC-02-RC | ALS                 |

# **LIQUID SCINTILLATION COUNTER**

# Method TC-02-RC

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Technetium-99 (LSC) by Method  
TC-02-RC

# Prep Batch: 254090

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Preparation, Extraction  
Chromatography

# Liquid Scintillation Counter Analysis Detail Report

## Prep Batch: 254090

|                           |                          |            |                     |        |
|---------------------------|--------------------------|------------|---------------------|--------|
| Lab ID: MB 160-254090/1-A | Analyzed: 06/06/16 19:47 | Sigma: 2   | Decay Corrected: No | Ts: 45 |
| Client ID:                | Detector: LSCBrown       | Dil Fac: 1 | Yield Truncated: No | Tb: 45 |

| Analyte       | MB Result | Count Unc | Total Unc | Qualifier | Unit  | RL   | MDC         | Cs    | Cb           | CPMs  | CPMb  | EFFs    | EFFb    | Anly Batch |
|---------------|-----------|-----------|-----------|-----------|-------|------|-------------|-------|--------------|-------|-------|---------|---------|------------|
| Technetium 99 | 0.7917    | 1.20      | 1.20      | U         | pCi/L | 3.00 | 1.99        | 359.1 | 324.9        | 7.980 | 7.220 | 0.92460 | 0.92540 | 255164     |
| Tracer        | MB Result | Count Unc | Total Unc | Qualifier | Unit  | MDC  | Spike Added | % Rec | % Rec Limits |       |       |         |         |            |
| Tc-99m        | 219.1     |           |           |           | pCi/L |      | 232         | 94.5  | 30 - 110     |       |       |         |         |            |

|                            |                          |            |                     |        |
|----------------------------|--------------------------|------------|---------------------|--------|
| Lab ID: LCS 160-254090/2-A | Analyzed: 06/06/16 20:37 | Sigma: 2   | Decay Corrected: No | Ts: 45 |
| Client ID:                 | Detector: LSCBrown       | Dil Fac: 1 | Yield Truncated: No | Tb: 45 |

| Analyte       | LCS Result | Count Unc | Total Unc | Qualifier | Unit  | RL   | MDC         | Cs    | Cb           | CPMs    | CPMb  | EFFs    | EFFb    | Anly Batch |
|---------------|------------|-----------|-----------|-----------|-------|------|-------------|-------|--------------|---------|-------|---------|---------|------------|
| Technetium 99 | 208.5      | 4.45      | 20.5      |           | pCi/L | 3.00 | 1.93        | 9675  | 324.9        | 215.000 | 7.220 | 0.90960 | 0.92540 | 255164     |
| Tracer        | LCS Result | Count Unc | Total Unc | Qualifier | Unit  | MDC  | Spike Added | % Rec | % Rec Limits |         |       |         |         |            |
| Tc-99m        | 222.0      |           |           |           | pCi/L |      | 224         | 99.0  | 30 - 110     |         |       |         |         |            |

|                             |                          |            |                     |        |
|-----------------------------|--------------------------|------------|---------------------|--------|
| Lab ID: 160-17543-AD-1-B DU | Analyzed: 06/06/16 23:07 | Sigma: 2   | Decay Corrected: No | Ts: 45 |
| Client ID:                  | Detector: LSCBrown       | Dil Fac: 1 | Yield Truncated: No | Tb: 45 |

| Analyte       | DU Result | Count Unc | Total Unc | Qualifier | Unit  | RL   | MDC         | Cs     | Cb           | CPMs  | CPMb  | EFFs    | EFFb    | Anly Batch |
|---------------|-----------|-----------|-----------|-----------|-------|------|-------------|--------|--------------|-------|-------|---------|---------|------------|
| Technetium 99 | -1.267    | 1.08      | 1.08      | U         | pCi/L | 3.00 | 1.94        | 256.95 | 324.9        | 5.710 | 7.220 | 0.89420 | 0.92540 | 255164     |
| Tracer        | DU Result | Count Unc | Total Unc | Qualifier | Unit  | MDC  | Spike Added | % Rec  | % Rec Limits |       |       |         |         |            |
| Tc-99m        | 224.8     |           |           |           | pCi/L |      | 224         | 100    | 30 - 110     |       |       |         |         |            |

|                          |                          |            |                     |        |
|--------------------------|--------------------------|------------|---------------------|--------|
| Lab ID: 160-17563-1      | Analyzed: 06/07/16 01:37 | Sigma: 2   | Decay Corrected: No | Ts: 45 |
| Client ID: GW-GWW-052616 | Detector: LSCBrown       | Dil Fac: 1 | Yield Truncated: No | Tb: 45 |

| Analyte       | Result | Count Unc | Total Unc | Qualifier | Unit  | RL   | MDC         | Cs    | Cb           | CPMs  | CPMb  | EFFs    | EFFb    | Anly Batch |
|---------------|--------|-----------|-----------|-----------|-------|------|-------------|-------|--------------|-------|-------|---------|---------|------------|
| Technetium 99 | 1.17   | 1.36      | 1.37      | U         | pCi/L | 3.00 | 2.25        | 366.3 | 324.9        | 8.140 | 7.220 | 0.91670 | 0.92540 | 255164     |
| Tracer        | Result | Count Unc | Total Unc | Qualifier | Unit  | MDC  | Spike Added | % Rec | % Rec Limits |       |       |         |         |            |
| Tc-99m        | 187    |           |           |           | pCi/L |      | 224         | 83.5  | 30 - 110     |       |       |         |         |            |

|                           |                          |            |                     |        |
|---------------------------|--------------------------|------------|---------------------|--------|
| Lab ID: 160-17563-2       | Analyzed: 06/07/16 02:27 | Sigma: 2   | Decay Corrected: No | Ts: 45 |
| Client ID: GW-NB34-052616 | Detector: LSCBrown       | Dil Fac: 1 | Yield Truncated: No | Tb: 45 |

| Analyte       | Result | Count Unc | Total Unc | Qualifier | Unit  | RL   | MDC         | Cs    | Cb           | CPMs  | CPMb  | EFFs    | EFFb    | Anly Batch |
|---------------|--------|-----------|-----------|-----------|-------|------|-------------|-------|--------------|-------|-------|---------|---------|------------|
| Technetium 99 | 2.27   | 1.38      | 1.40      |           | pCi/L | 3.00 | 2.22        | 412.2 | 324.9        | 9.160 | 7.220 | 0.92020 | 0.92540 | 255164     |
| Tracer        | Result | Count Unc | Total Unc | Qualifier | Unit  | MDC  | Spike Added | % Rec | % Rec Limits |       |       |         |         |            |
| Tc-99m        | 188    |           |           |           | pCi/L |      | 221         | 85.0  | 30 - 110     |       |       |         |         |            |

# Liquid Scintillation Counter Analysis Detail Report

## Prep Batch: 254090

|                          |                          |            |                     |        |
|--------------------------|--------------------------|------------|---------------------|--------|
| Lab ID: 160-17563-3      | Analyzed: 06/07/16 03:16 | Sigma: 2   | Decay Corrected: No | Ts: 45 |
| Client ID: GW-GWY-052616 | Detector: LSCBrown       | Dil Fac: 1 | Yield Truncated: No | Tb: 45 |

| Analyte       | Result | Count Unc | Total Unc | Qualifier | Unit  | RL   | MDC         | Cs    | Cb           | CPMs   | CPMb  | EFFs    | EFFb    | Anly Batch |
|---------------|--------|-----------|-----------|-----------|-------|------|-------------|-------|--------------|--------|-------|---------|---------|------------|
| Technetium 99 | 3.29   | 1.32      | 1.36      |           | pCi/L | 3.00 | 2.04        | 459   | 324.9        | 10.200 | 7.220 | 0.91410 | 0.92540 | 255164     |
| Tracer        | Result | Count Unc | Total Unc | Qualifier | Unit  | MDC  | Spike Added | % Rec | % Rec Limits |        |       |         |         |            |
| Tc-99m        | 207    |           |           |           | pCi/L |      | 224         | 92.4  | 30 - 110     |        |       |         |         |            |

|                           |                          |            |                     |        |
|---------------------------|--------------------------|------------|---------------------|--------|
| Lab ID: 160-17563-4       | Analyzed: 06/07/16 04:06 | Sigma: 2   | Decay Corrected: No | Ts: 45 |
| Client ID: GW-PZ02-052616 | Detector: LSCBrown       | Dil Fac: 1 | Yield Truncated: No | Tb: 45 |

| Analyte       | Result | Count Unc | Total Unc | Qualifier | Unit  | RL   | MDC         | Cs     | Cb           | CPMs  | CPMb  | EFFs    | EFFb    | Anly Batch |
|---------------|--------|-----------|-----------|-----------|-------|------|-------------|--------|--------------|-------|-------|---------|---------|------------|
| Technetium 99 | 2.50   | 1.28      | 1.31      |           | pCi/L | 3.00 | 2.03        | 427.05 | 324.9        | 9.490 | 7.220 | 0.91130 | 0.92540 | 255164     |
| Tracer        | Result | Count Unc | Total Unc | Qualifier | Unit  | MDC  | Spike Added | % Rec  | % Rec Limits |       |       |         |         |            |
| Tc-99m        | 209    |           |           |           | pCi/L |      | 224         | 93.4   | 30 - 110     |       |       |         |         |            |

### Quality Control Summary

| Method Blank ID:       | Analyte       | Parent Result | Spike Added | MB Result  | Qualifier | Unit  | % Rec | % Rec Limits | RPD | RER  | DER  | RER Limit | Z Factor        |
|------------------------|---------------|---------------|-------------|------------|-----------|-------|-------|--------------|-----|------|------|-----------|-----------------|
| MB 160-254090/1-A      | Technetium 99 |               |             | 0.7917     | U         | pCi/L |       |              |     |      |      |           | 1.317789<br>02  |
| Lab Control Sample ID: | Analyte       | Parent Result | Spike Added | LCS Result | Qualifier | Unit  | % Rec | % Rec Limits | RPD | RER  | DER  | RER Limit | Z Factor        |
| LCS 160-254090/2-A     | Technetium 99 |               | 206         | 208.5      |           | pCi/L | 101   | 75 - 125     |     |      |      |           | .1666893<br>486 |
| Duplicate ID:          | Analyte       | Parent Result | Spike Added | DU Result  | Qualifier | Unit  | % Rec | % Rec Limits | RPD | RER  | DER  | RER Limit | Z Factor        |
| 160-17543-AD-1-B DU    | Technetium 99 | -0.341        |             | -1.267     | U         | pCi/L |       |              | 115 | 0.39 | 1.10 | 1         |                 |

#### Glossary:

Ts = Count Duration, Sample  
 Tb = Count Duration, Background  
 Cs = Total Counts, Sample  
 Cb = Total Counts, Background  
 CPMs = Counts Per Minute, Sample  
 CPMb = Counts Per Minute, Background  
 EFFs = Efficiency, Sample  
 EFFb = Efficiency, Background

## LIQUID SCINTILLATION COUNTER BATCH WORKSHEET

Lab Name: TestAmerica St. Louis Job No.: 160-17563-1

SDG No.: \_\_\_\_\_

Batch Number: 254090 Batch Start Date: 06/01/16 10:11 Batch Analyst: Minier, Mark FBatch Method: Ext\_Chrom\_LSC Batch End Date: 06/01/16 17:00

| Lab Sample ID        | Client Sample ID | Method Chain                | Basis | InitialAmount | Tc (T) Dil #2<br>00229 | Tc-99 00019 |  |  |  |
|----------------------|------------------|-----------------------------|-------|---------------|------------------------|-------------|--|--|--|
| MB 160-254090/1      |                  | Ext_Chrom_LS<br>C, TC-02-RC |       | 500.00 mL     | 0.1 mL                 |             |  |  |  |
| LCS<br>160-254090/2  |                  | Ext_Chrom_LS<br>C, TC-02-RC |       | 500.00 mL     | 0.1 mL                 | 1 mL        |  |  |  |
| 160-17543-AD-1<br>DU |                  | Ext_Chrom_LS<br>C, TC-02-RC | T     | 500.24 mL     | 0.1 mL                 |             |  |  |  |
| 160-17563-B-1        | GW-GWW-052616    | Ext_Chrom_LS<br>C, TC-02-RC | T     | 504.61 mL     | 0.1 mL                 |             |  |  |  |
| 160-17563-B-2        | GW-NB34-052616   | Ext_Chrom_LS<br>C, TC-02-RC | T     | 501.60 mL     | 0.1 mL                 |             |  |  |  |
| 160-17563-A-3        | GW-GWY-052616    | Ext_Chrom_LS<br>C, TC-02-RC | T     | 503.61 mL     | 0.1 mL                 |             |  |  |  |
| 160-17563-A-4        | GW-PZ02-052616   | Ext_Chrom_LS<br>C, TC-02-RC | T     | 502.10 mL     | 0.1 mL                 |             |  |  |  |

| Batch Notes                       |             |
|-----------------------------------|-------------|
| Balance ID                        | 1125353055  |
| Analyst ID - Reagent Drop Witness | Jody Watson |
| Analyst ID - Reagent Drop         | 401513      |
| SOP Number                        | ST-RC-0125  |

| Basis | Basis Description |
|-------|-------------------|
| T     | Total/NA          |

The pound sign (#) in the amount added field denotes that the reagent was used undiluted. All calculations are performed using the stated concentration for this reagent.

### Assay Definition

Assay Description:

Assay Type: DPM (Single)  
 Report Name: Tc99\_Protocol 17  
 Output Data Path: \Stlfs01\Rad\Upload\PACK\_LSC\_Brown  
 Raw Results Path: C:\Packard\Tricarb\Results\Default\Tc99\_2015 Protocol 17\20160606\_1857  
 \20160606\_1857.results  
 Assay File Name: C:\Packard\TriCarb\Assays\Tc99\_2015 Protocol 17.lsa

Additional Data Files Generated with this Protocol:

17Tc99 [Auto] 17Tc99.001

### Count Conditions

Nuclide: Tc99\_2015  
 Quench Indicator: tSIE/AEC  
 External Std Terminator (sec): 15 sec  
 Pre-Count Delay (min): 0.00  
 Quench Set:  
 Low Energy: Tc99\_2015  
 Count Time (min): 45.00  
 Count Mode: Normal  
 Assay Count Cycles: 1 Repeat Sample Count: 1  
 #Vials/Sample: 1 Calculate % Reference: Off

### Background Subtract

Background Subtract: Off  
 Low CPM Threshold: Off  
 2 Sigma % Terminator: On - Any Region

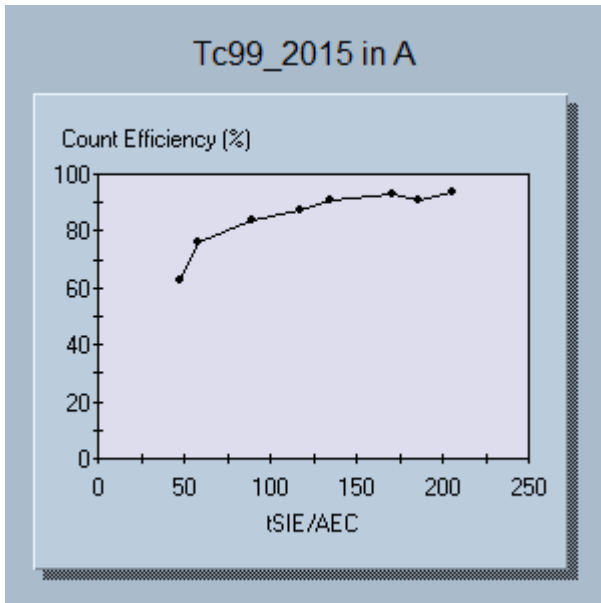
| Regions | LL    | UL    | 2Sigma % Terminator |
|---------|-------|-------|---------------------|
| A       | 0.0   | 292.0 | 1.50                |
| B       | 2.0   | 292.0 | 0.00                |
| C       | 292.1 | 450.0 | 0.00                |

### Count Corrections

Static Controller: On Luminescence Correction: Off  
 Colored Samples: Off Heterogeneity Monitor: Off  
 Coincidence Time (nsec): 18 Delay Before Burst (nsec): 75

Cycle 1 Results

### Quench Curve Block Data

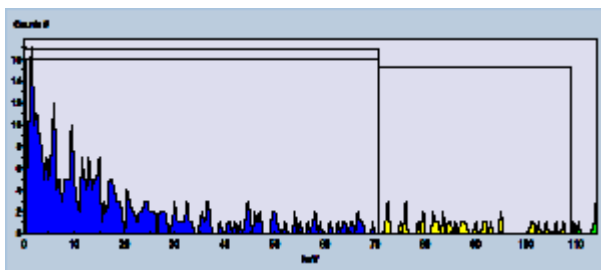


Date Acquired: 09/01/2015  
 Date Modified:  
 Tc99\_2015 in A

| tSIE/AEC | Count Efficiency (%) |
|----------|----------------------|
| 205.51   | 93.76                |
| 186.27   | 90.90                |
| 170.51   | 92.82                |
| 135.18   | 91.19                |
| 117.14   | 87.58                |
| 89.96    | 83.50                |
| 58.58    | 75.92                |
| 47.61    | 62.77                |

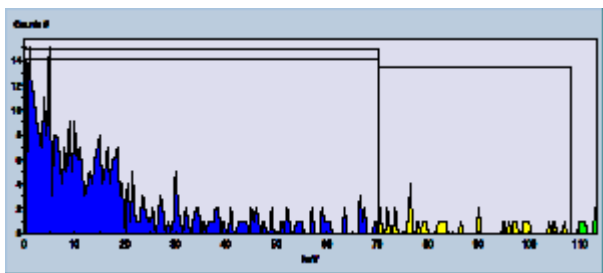
| S#       | SMPL ID |        |     | Count    | Time  | CPMA      | DPM1      | TIME       |
|----------|---------|--------|-----|----------|-------|-----------|-----------|------------|
| DATE     | EFF     | tSIE   | LUM | MESSAGES |       |           |           |            |
| 1        |         |        |     | BKG      | 45.00 | 7.22e+000 | 7.80e+000 | 6:58:00 PM |
| 6/6/2016 | 0.925   | 164.44 | 100 |          |       |           |           |            |

SpectraView Block Data



|          |                   |            |           |           |            |
|----------|-------------------|------------|-----------|-----------|------------|
| 2        | MB 160-254090/1-A | 45.00      | 7.98e+000 | 8.63e+000 | 7:47:55 PM |
| 6/6/2016 | 0.925             | 162.73 100 |           |           |            |

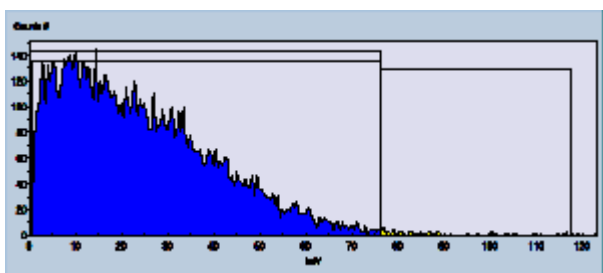
SpectraView Block Data



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|          |                    |       |           |           |            |
|----------|--------------------|-------|-----------|-----------|------------|
| 3        | LCS 160-254090/2-A | 45.00 | 2.15e+002 | 2.37e+002 | 8:37:47 PM |
| 6/6/2016 | 0.910 185.80 100   |       |           |           |            |

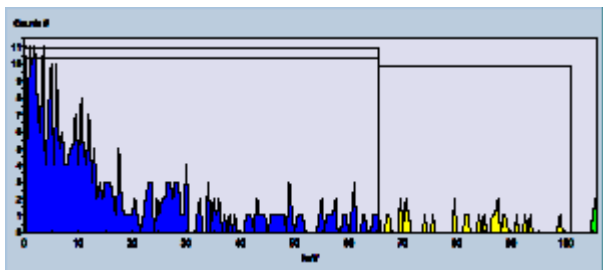
SpectraView Block Data



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|          |                  |       |           |           |            |
|----------|------------------|-------|-----------|-----------|------------|
| 4        | 160-17522-V-1-A  | 45.00 | 6.44e+000 | 7.03e+000 | 9:27:39 PM |
| 6/6/2016 | 0.916 144.80 100 |       |           |           |            |

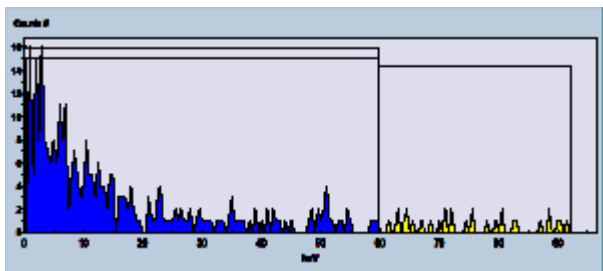
SpectraView Block Data



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|          |                  |       |           |           |             |
|----------|------------------|-------|-----------|-----------|-------------|
| 5        | 160-17543-AD-1-A | 45.00 | 6.63e+000 | 7.47e+000 | 10:17:31 PM |
| 6/6/2016 | 0.887 122.94 100 |       |           |           |             |

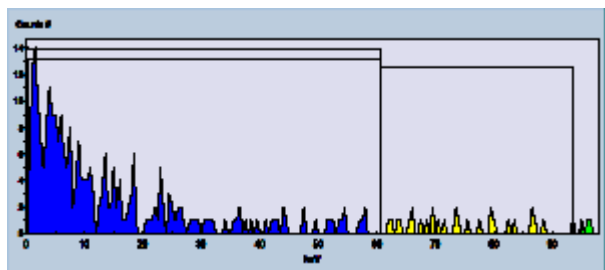
SpectraView Block Data



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|          |                     |       |           |           |             |
|----------|---------------------|-------|-----------|-----------|-------------|
| 6        | 160-17543-AD-1-B DU | 45.00 | 5.71e+000 | 6.39e+000 | 11:07:26 PM |
| 6/6/2016 | 0.894 126.30 100    |       |           |           |             |

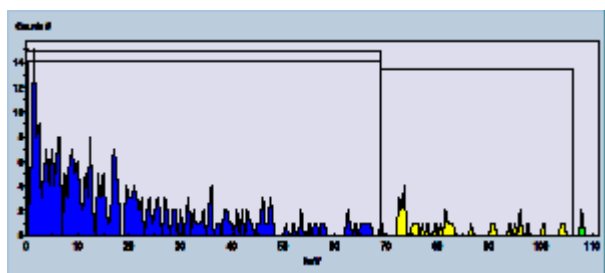
SpectraView Block Data



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|          |                  |       |           |           |             |
|----------|------------------|-------|-----------|-----------|-------------|
| 7        | 160-17468-A-1-A  | 45.00 | 6.29e+000 | 6.82e+000 | 11:57:18 PM |
| 6/6/2016 | 0.922 157.54 100 |       |           |           |             |

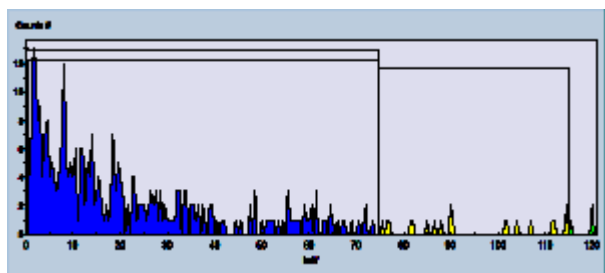
SpectraView Block Data



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|          |                  |       |           |           |             |
|----------|------------------|-------|-----------|-----------|-------------|
| 8        | 160-17562-A-1-A  | 45.00 | 7.04e+000 | 7.68e+000 | 12:47:14 AM |
| 6/7/2016 | 0.917 179.86 100 |       |           |           |             |

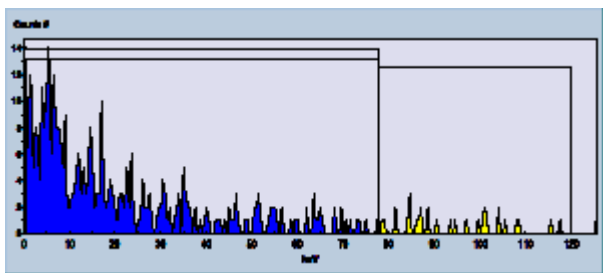
SpectraView Block Data



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|          |                  |       |           |           |            |
|----------|------------------|-------|-----------|-----------|------------|
| 9        | 160-17563-B-1-A  | 45.00 | 8.14e+000 | 8.89e+000 | 1:37:08 AM |
| 6/7/2016 | 0.917 191.43 100 |       |           |           |            |

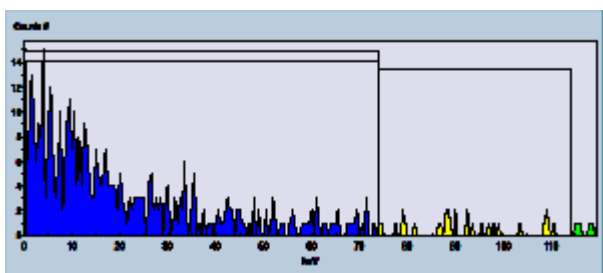
SpectraView Block Data



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|          |                  |       |           |           |            |
|----------|------------------|-------|-----------|-----------|------------|
| 10       | 160-17563-B-2-B  | 45.00 | 9.16e+000 | 9.95e+000 | 2:27:04 AM |
| 6/7/2016 | 0.920 177.12 100 |       |           |           |            |

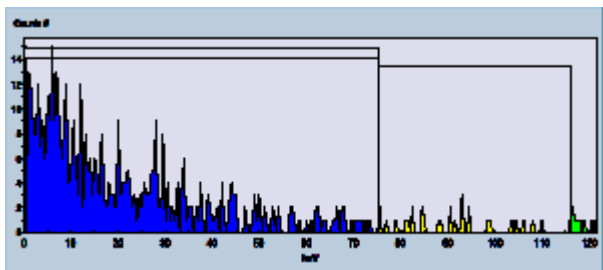
SpectraView Block Data



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|          |                  |       |           |           |            |
|----------|------------------|-------|-----------|-----------|------------|
| 11       | 160-17563-A-3-B  | 45.00 | 1.02e+001 | 1.12e+001 | 3:16:58 AM |
| 6/7/2016 | 0.914 182.10 100 |       |           |           |            |

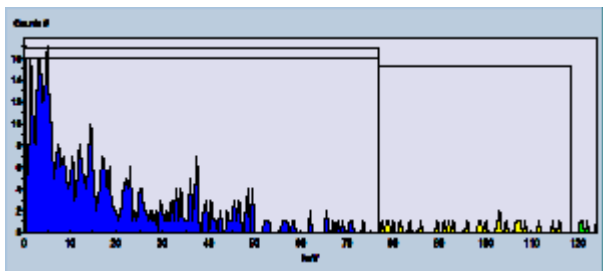
SpectraView Block Data



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|          |                  |       |           |           |            |
|----------|------------------|-------|-----------|-----------|------------|
| 12       | 160-17563-A-4-B  | 45.00 | 9.49e+000 | 1.04e+001 | 4:06:50 AM |
| 6/7/2016 | 0.911 187.86 100 |       |           |           |            |

SpectraView Block Data





# Daily Checks

## SNC Protocol

## Calibration Information

Software Version IC: 3.04

Software Version EC: 4.00

Instrument Model: Tri-Carb 3180TR/SL

Instrument Serial Number: 117382

3H Chi Square: Not Processed

14C Chi Square: Not Processed

3H E<sup>2</sup>/B (1-18.6 keV): 1959.71 Date Processed: 6/6/2016 3:10:27 AM14C E<sup>2</sup>/B (4-156 keV): 9395.56 Date Processed: 6/6/2016 3:10:27 AM

3H Efficiency (1-18.6 keV): 62.34 Date Processed: 6/6/2016 3:10:27 AM

14C Efficiency (4-156 keV): 93.01 Date Processed: 6/6/2016 3:10:27 AM

IPA Background Date Processed: 6/6/2016 3:10:27 AM

3H Background CPM (1-18.6 keV): 1.98 Date Processed: 6/6/2016 3:10:27 AM

14C Background CPM (4-156 keV): 0.92 Date Processed: 6/6/2016 3:10:27 AM

3H Calibration DPM: 270300

3H Reference Date: 5/4/2015

14C Calibration DPM: 122100

# Initial Calibrations



**Tc-99 Initial Calibration  
2015  
LSC Brown**



### **Tc-99 Initial Calibration**

**STD:** Tc-99\_00007 (6345)  
**Activity:** 22186dpm/mL  
**Reference Date:** 1/1/2000

| Vial # | Insta Gel (mL) | Teva Column (mL) | Tc-99_00007 (6345) (mL) | DI Water (mL) | Nitromethane (uL) |
|--------|----------------|------------------|-------------------------|---------------|-------------------|
| 1      | 11             | 2                | 0.1                     | 3.9           | 0                 |
| 2      | 10.5           | 2                | 0.1                     | 4.4           | 0                 |
| 3      | 10             | 2                | 0.1                     | 4.9           | 0                 |
| 4      | 10             | 2                | 0.1                     | 4.9           | 10                |
| 5      | 10             | 2                | 0.1                     | 4.9           | 25                |
| 6      | 10             | 2                | 0.1                     | 4.9           | 50                |
| 7      | 10             | 2                | 0.1                     | 4.9           | 100               |
| 8      | 10             | 2                | 0.1                     | 4.9           | 150               |

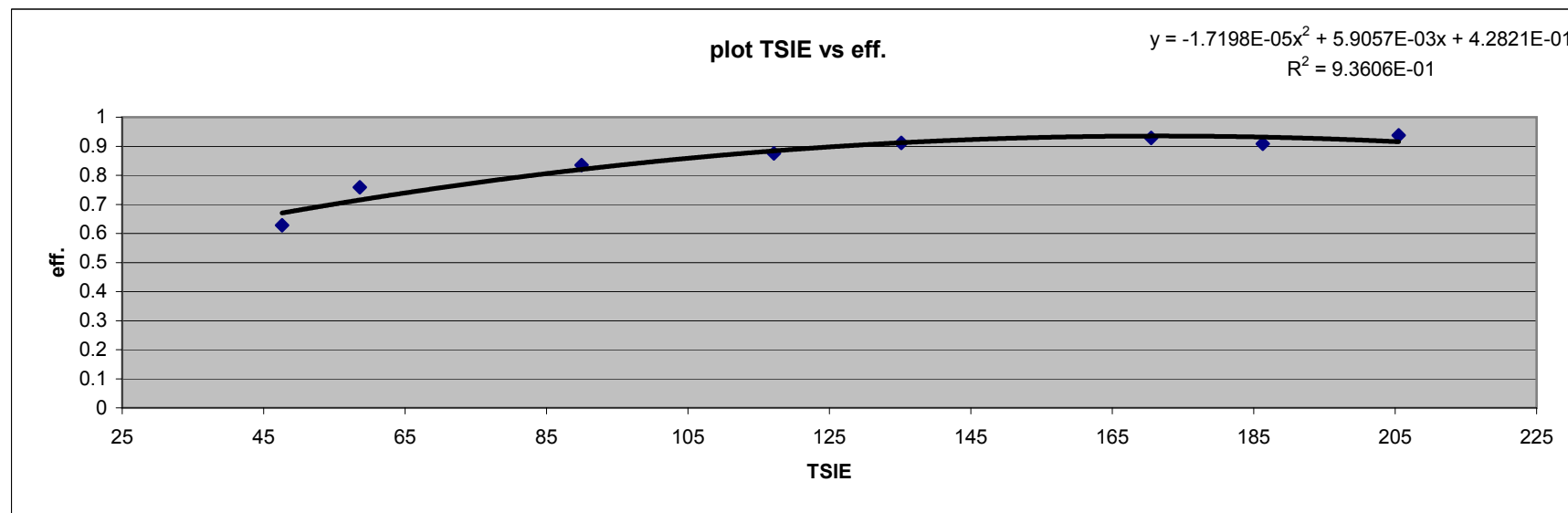
0.25mL of 2M HNO<sub>3</sub> was added to vials to mimic the tracer amount added to counting standards (A, B, C).

Teva column: conditioned with 5mL 0.01M HNO<sub>3</sub>.

Prepared by: Rachel T. Mueller  
Date: 7/20/2015

Technecium-99 quench curve validation 2015, LSC Brown

| STD # | source activity, dpm | cpm  | count time | total counts | Calculated<br>efficiency | TSIE   | quench curve<br>efficiency | curve<br>projected<br>efficiency | decimal<br>discrepancy |
|-------|----------------------|------|------------|--------------|--------------------------|--------|----------------------------|----------------------------------|------------------------|
| 1     | 2219                 | 2081 | 8.55       | 17792.55     | 0.9378                   | 205.51 | 0.9376                     | 0.9155                           | -0.0221                |
| 2     | 2219                 | 2017 | 8.82       | 17789.94     | 0.9090                   | 186.27 | 0.909                      | 0.9316                           | 0.0226                 |
| 3     | 2219                 | 2060 | 8.64       | 17798.40     | 0.9283                   | 170.51 | 0.9282                     | 0.9352                           | 0.0070                 |
| 4     | 2219                 | 2024 | 8.79       | 17790.96     | 0.9121                   | 135.18 | 0.9119                     | 0.9123                           | 0.0004                 |
| 5     | 2219                 | 1943 | 9.16       | 17797.88     | 0.8756                   | 117.14 | 0.8758                     | 0.8840                           | 0.0082                 |
| 6     | 2219                 | 1853 | 9.6        | 17788.80     | 0.8351                   | 89.96  | 0.835                      | 0.8203                           | -0.0147                |
| 7     | 2219                 | 1685 | 10.56      | 17793.60     | 0.7594                   | 58.58  | 0.7592                     | 0.7151                           | -0.0441                |
| 8     | 2219                 | 1393 | 12.77      | 17788.61     | 0.6278                   | 47.61  | 0.6277                     | 0.6704                           | 0.0427                 |



### Assay Definition

Assay Description:

Assay Type: Quench Standards

Report Name: Report1

Output Data Path: C:\Packard\Tricarb\Results\

Raw Results Path: C:\Packard\Tricarb\Results\Default\Tc99\_2015 Quench Curve\20150831\_2248  
 \20150831\_2248.results

Assay File Name: C:\Packard\TriCarb\Assays\Tc99\_2015 Quench Curve.lsa

### Count Conditions

Nuclide: Tc99\_2015

Quench Indicator: tSIE/AEC

External Std Terminator (sec): 15 sec

Pre-Count Delay (min): 0.00

Quench Set: n/a

Count Time (min): 60.00

Count Mode: Normal

Assay Count Cycles: 1

Repeat Sample Count: n/a

#Vials/Sample: n/a

Calculate % Reference: n/a

### Background Subtract

Background Subtract: Off

Low CPM Threshold: Off

2 Sigma % Terminator: On - Any Region

|         |     |       |                     |
|---------|-----|-------|---------------------|
| Regions | LL  | UL    | 2Sigma % Terminator |
| A       | 0.0 | 292.0 | 1.50                |

### Count Corrections

Static Controller: On

Luminescence Correction: n/a

Colored Samples: On

Heterogeneity Monitor: n/a

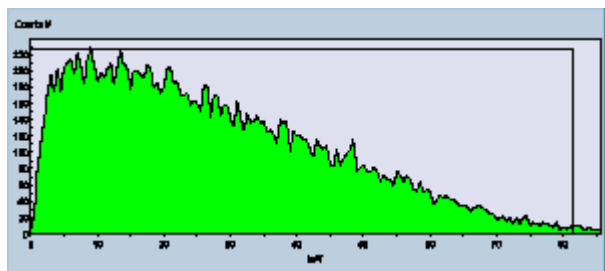
Coincidence Time (nsec): 18

Delay Before Burst (nsec): 75

### Cycle 1 Results

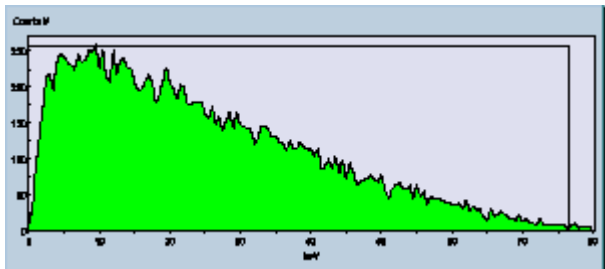
| S# | Count Time | CPMA | SIS   | tSIE   | MESSAGES |
|----|------------|------|-------|--------|----------|
| 1  | 8.55       | 2081 | 94.71 | 205.51 | S        |

### SpectraView Block Data



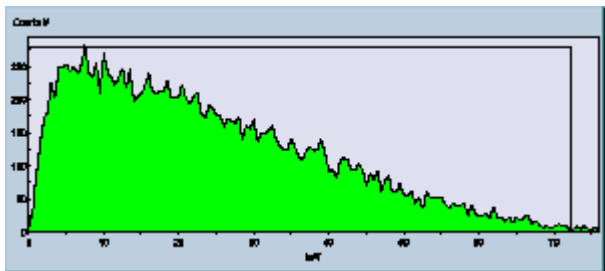
|   |      |      |       |        |   |
|---|------|------|-------|--------|---|
| 2 | 8.82 | 2017 | 84.37 | 186.27 | S |
|---|------|------|-------|--------|---|

SpectraView Block Data



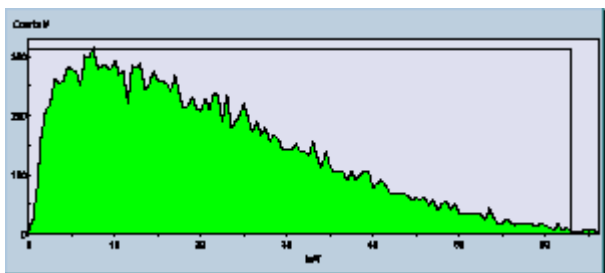
|   |      |      |       |        |   |
|---|------|------|-------|--------|---|
| 3 | 8.64 | 2060 | 81.84 | 170.51 | S |
|---|------|------|-------|--------|---|

SpectraView Block Data



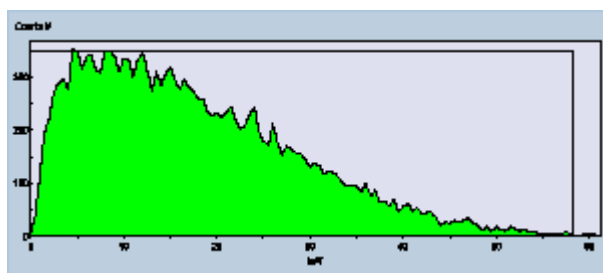
|   |      |      |       |        |   |
|---|------|------|-------|--------|---|
| 4 | 8.79 | 2024 | 70.85 | 135.18 | S |
|---|------|------|-------|--------|---|

SpectraView Block Data



|   |      |      |       |        |   |
|---|------|------|-------|--------|---|
| 5 | 9.16 | 1943 | 62.07 | 117.14 | S |
|---|------|------|-------|--------|---|

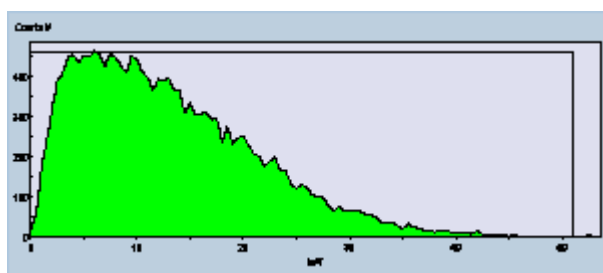
SpectraView Block Data



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|   |      |      |       |       |   |
|---|------|------|-------|-------|---|
| 6 | 9.60 | 1853 | 46.71 | 89.96 | S |
|---|------|------|-------|-------|---|

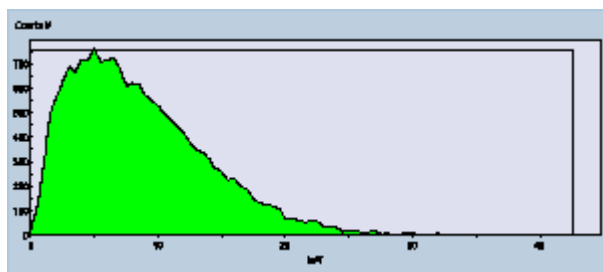
SpectraView Block Data



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|   |       |      |       |       |   |
|---|-------|------|-------|-------|---|
| 7 | 10.56 | 1685 | 31.12 | 58.58 | S |
|---|-------|------|-------|-------|---|

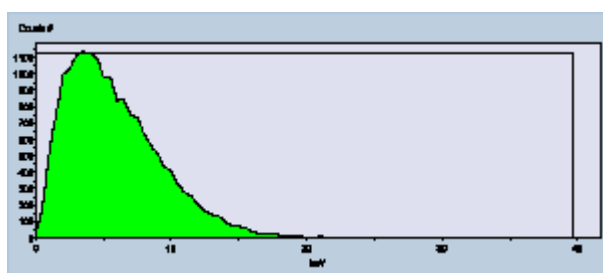
SpectraView Block Data



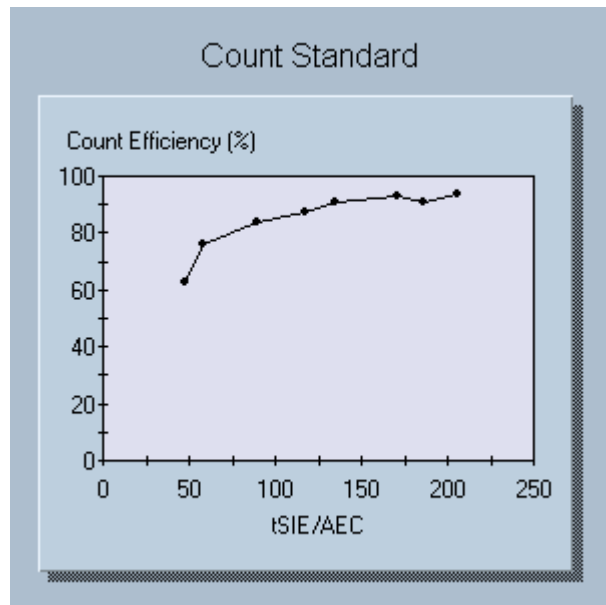
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|   |       |      |       |       |   |
|---|-------|------|-------|-------|---|
| 8 | 12.77 | 1393 | 22.66 | 47.61 | S |
|---|-------|------|-------|-------|---|

SpectraView Block Data



Quench Curve Block Data



Date Acquired: 9/1/2015  
Date Modified:  
Count Standard

| tSIE/AEC | Count Efficiency (%) |
|----------|----------------------|
| 205.51   | 93.76                |
| 186.27   | 90.90                |
| 170.51   | 92.82                |
| 135.18   | 91.19                |
| 117.14   | 87.58                |
| 89.96    | 83.50                |
| 58.58    | 75.92                |
| 47.61    | 62.77                |

# **Initial Calibration Verifications**



THE LEADER IN ENVIRONMENTAL TESTING

**Tc-99 Initial Calibration  
Verification  
2015  
LSC Brown**



**Tc-99 Initial Calibration Verification:**

Std #: Tc-99\_00016 (582609)  
Activity: 228.82dpm/mL  
Reference Date: 9/1/1996

| Vial # | InstaGel<br>(mL) | Teva<br>Column | Tc-99_00016<br>(582609)<br>(mL) | DI Water<br>(mL) | Nitromethane<br>(uL) |
|--------|------------------|----------------|---------------------------------|------------------|----------------------|
| 1      | 10               | 2              | 1                               | 4                | 0                    |
| 2      | 10               | 2              | 1                               | 4                | 25                   |
| 3      | 10               | 2              | 1                               | 4                | 100                  |

0.25mL of 2M HNO<sub>3</sub> was added to vials to mimic the tracer amount added to counting standards (A, B, C).

Teva column: conditioned with 5mL 0.01M HNO<sub>3</sub>.

Prepared By: Rachel T. Mueller  
Date: 7/20/2015



Tc99 Quench Curve 2015, Brown  
Second Source Verification  
Tc-99\_00016 (582609)  
Activity: 228.82 dpm/mL  
Reference date: 9/1/1996

| Std #  | DPM Measured | BKG | Corrected   True Value |               | % Recovery |
|--------|--------------|-----|------------------------|---------------|------------|
| STD 1  |              | 231 | 9.59                   | 221.41 228.82 | 96.76%     |
| STD 2  |              | 233 | 9.59                   | 223.41 228.82 | 97.64%     |
| STD 3  |              | 233 | 9.59                   | 223.41 228.82 | 97.64%     |
| Mean = |              |     |                        |               | 97.34%     |

**Assay Definition**

Assay Description:

Assay Type: DPM (Single)  
Report Name: Tc99\_Protocol 17  
Output Data Path: \Slsvr01\RAD\Upload\PACK\_LSC\_Brown  
Raw Results Path: C:\Packard\Tricarb\Results\Default\Tc99\_2015 Protocol 17\20150901\_0214  
\20150901\_0214.results  
Assay File Name: C:\Packard\TriCarb\Assays\Tc99\_2015 Protocol 17.lsa

Additional Data Files Generated with this Protocol:

17Tc99  
[Auto] 17Tc99.001

**Count Conditions**

Nuclide: Tc99\_2015  
Quench Indicator: tSIE  
External Std Terminator (sec): 15 sec  
Pre-Count Delay (min): 0.00  
Quench Set:  
Low Energy: Tc99\_2015  
Count Time (min): 20.00  
Count Mode: Normal  
Assay Count Cycles: 1 Repeat Sample Count: 1  
#Vials/Sample: 1 Calculate % Reference: Off

**Background Subtract**

Background Subtract: Off  
Low CPM Threshold: Off  
2 Sigma % Terminator: On - Any Region

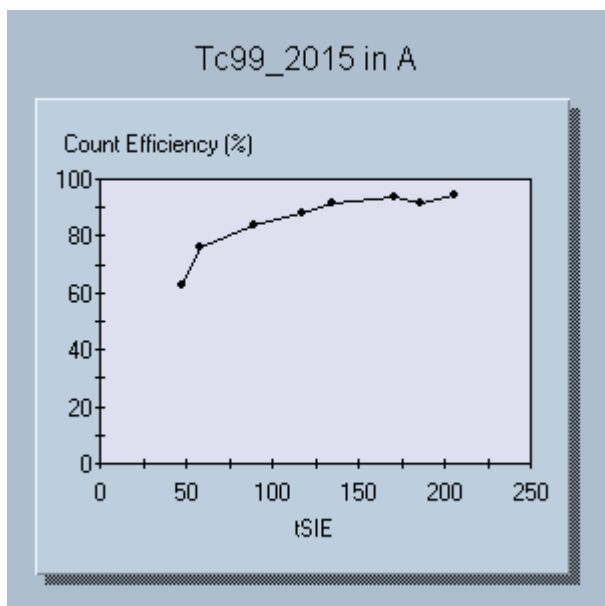
| Regions | LL    | UL    | 2Sigma % Terminator |
|---------|-------|-------|---------------------|
| A       | 0.0   | 292.0 | 1.50                |
| B       | 2.0   | 292.0 | 0.00                |
| C       | 292.1 | 450.0 | 0.00                |

**Count Corrections**

Static Controller: On Luminescence Correction: Off  
Colored Samples: Off Heterogeneity Monitor: Off  
Coincidence Time (nsec): 18 Delay Before Burst (nsec): 75

Cycle 1 Results

**Quench Curve Block Data**

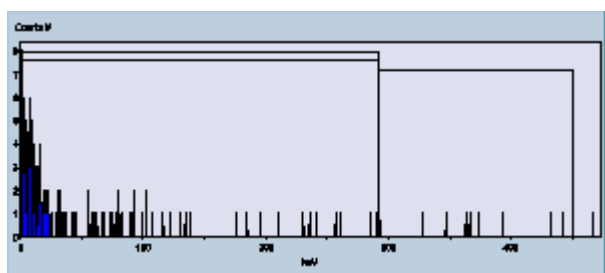


Date Acquired: 09/01/2015  
 Date Modified:  
 Tc99\_2015 in A

| tSIE   | Count Efficiency (%) |
|--------|----------------------|
| 205.51 | 94.55                |
| 186.27 | 91.60                |
| 170.51 | 93.55                |
| 135.18 | 91.71                |
| 117.14 | 87.94                |
| 89.96  | 83.77                |
| 58.58  | 76.10                |
| 47.61  | 62.92                |

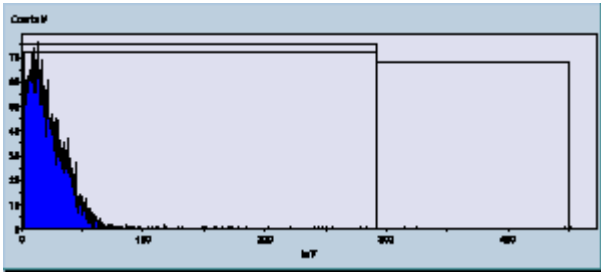
| S#       | SMPL ID |        |     | Count    | Time  | CPMA      | DPM1      | TIME       |
|----------|---------|--------|-----|----------|-------|-----------|-----------|------------|
| DATE     | EFF     | tSIE   | LUM | MESSAGES |       |           |           |            |
| 1        |         |        |     | BKG      | 20.00 | 8.95e+000 | 9.59e+000 | 2:15:27 AM |
| 9/1/2015 | 0.933   | 166.32 | 100 |          |       |           |           |            |

SpectraView Block Data



|          |       |            |           |           |            |
|----------|-------|------------|-----------|-----------|------------|
| 2        | ICV 1 | 20.00      | 2.12e+002 | 2.31e+002 | 2:38:14 AM |
| 9/1/2015 | 0.919 | 139.26 100 |           |           |            |

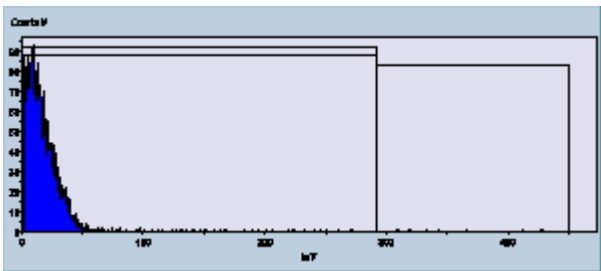
SpectraView Block Data



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|          |       |        |       |       |           |           |            |
|----------|-------|--------|-------|-------|-----------|-----------|------------|
| 3        |       |        | ICV 2 | 20.00 | 2.05e+002 | 2.33e+002 | 3:01:00 AM |
| 9/1/2015 | 0.880 | 117.59 | 100   |       |           |           |            |

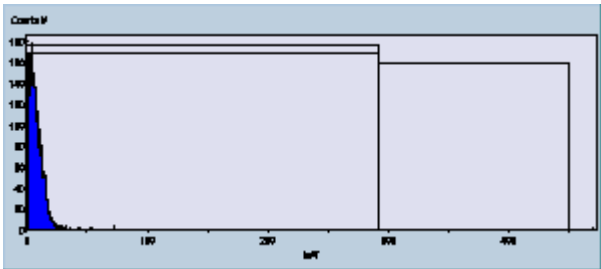
SpectraView Block Data



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|          |       |       |       |       |           |           |            |
|----------|-------|-------|-------|-------|-----------|-----------|------------|
| 4        |       |       | ICV 3 | 20.00 | 1.73e+002 | 2.33e+002 | 3:23:46 AM |
| 9/1/2015 | 0.744 | 57.13 | 100   |       |           |           |            |

SpectraView Block Data



# Run Logs

# Liquid Scintillation Counter Run Log

**Detector: LSCBrown**

**Serial Number: 117382**

| Analysis Date  | Count<br>Minutes | Lab Sample ID       | Client Sample ID | Analysis<br>Batch | Prep<br>Batch | Method   | Analyst<br>Initials |
|----------------|------------------|---------------------|------------------|-------------------|---------------|----------|---------------------|
| 08/31/15 22:48 |                  | IC 160-213481/1     |                  | 213481            |               |          | RTM                 |
| 09/01/15 02:14 |                  | ICV 160-213481/2    |                  | 213481            |               |          | RTM                 |
| 06/06/16 03:10 |                  | CCV 160-255172/1    |                  | 255172            |               |          | ALD                 |
| 06/06/16 18:58 |                  | BBKG 160-255164/1   |                  | 255164            |               |          |                     |
| 06/06/16 19:47 | 45               | MB 160-254090/1-A   |                  | 255164            | 254090        | TC-02-RC | ALD                 |
| 06/06/16 20:37 | 45               | LCS 160-254090/2-A  |                  | 255164            | 254090        | TC-02-RC | ALD                 |
| 06/06/16 21:27 | 45               | ZZZZZ               |                  | 255164            |               |          |                     |
| 06/06/16 22:17 | 45               | ZZZZZ               |                  | 255164            |               |          |                     |
| 06/06/16 23:07 | 45               | 160-17543-AD-1-B DU |                  | 255164            | 254090        | TC-02-RC | ALD                 |
| 06/06/16 23:57 | 45               | ZZZZZ               |                  | 255164            |               |          |                     |
| 06/07/16 00:47 | 45               | ZZZZZ               |                  | 255164            |               |          |                     |
| 06/07/16 01:37 | 45               | 160-17563-1         | GW-GWW-052616    | 255164            | 254090        | TC-02-RC | ALD                 |
| 06/07/16 02:27 | 45               | 160-17563-2         | GW-NB34-052616   | 255164            | 254090        | TC-02-RC | ALD                 |
| 06/07/16 03:16 | 45               | 160-17563-3         | GW-GWY-052616    | 255164            | 254090        | TC-02-RC | ALD                 |
| 06/07/16 04:06 | 45               | 160-17563-4         | GW-PZ02-052616   | 255164            | 254090        | TC-02-RC | ALD                 |

# Shipping and Receiving Documents

|                                                                                                                                                                                                                                                                                                     |           |                                                                                                  |                                   |             |                                                                                                                  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|--------------------------------------------------------------------------------------------------|-----------------------------------|-------------|------------------------------------------------------------------------------------------------------------------|
| Hematite<br>Decommissioning<br>Project                                                                                                                                                                                                                                                              |           | Procedure HDP-PR-QA-006, Chain of Custody<br>Revision: 4<br>Westinghouse Non-Proprietary Class 3 |                                   | Page 1 of 1 |                                                                                                                  |
| FORM HDP-PR-QA-006-1<br>CHAIN OF CUSTODY                                                                                                                                                                                                                                                            |           |                                                                                                  |                                   |             |                                                                                                                  |
| Instructions: Each time the container is transferred to another organization, a person from each organization should sign the CoC. The Laboratory/End User must verify that the sample is correctly identified before the sample is released for use or analysis and send the completed CoC to HDP. |           |                                                                                                  |                                   |             |                                                                                                                  |
| Chain of Custody ID No. 052616-03 Page 1/1                                                                                                                                                                                                                                                          |           | Requested Analysis                                                                               |                                   |             |                                                                                                                  |
| Project Name:<br>Westinghouse Electric Company                                                                                                                                                                                                                                                      |           | Laboratory Name:<br>TA-MO                                                                        |                                   |             |                                                                                                                  |
| Contact Person:<br>W. Clark Evers                                                                                                                                                                                                                                                                   |           | Laboratory Address:<br>13715 Rider Trail North<br>Earth City, MO 63045                           |                                   |             |                                                                                                                  |
| Phone Number:<br>314-810-3336                                                                                                                                                                                                                                                                       |           | Phone No.<br>314-298-8566                                                                        |                                   |             |                                                                                                                  |
| Sampler Name:<br>Thomas Yardy                                                                                                                                                                                                                                                                       |           | Laboratory Contact Person:<br>Ivan Vania                                                         |                                   |             |                                                                                                                  |
|                                                                                                                                                                                                                                                                                                     |           | Phone No.<br>708-870-8453                                                                        |                                   |             |                                                                                                                  |
|                                                                                                                                                                                                                                                                                                     |           | Turn Around Time<br>(21 days)                                                                    |                                   |             |                                                                                                                  |
|                                                                                                                                                                                                                                                                                                     |           | Normal                                                                                           |                                   |             |                                                                                                                  |
|                                                                                                                                                                                                                                                                                                     |           | Remarks                                                                                          |                                   |             |                                                                                                                  |
| Sample ID                                                                                                                                                                                                                                                                                           |           | Date                                                                                             | Time                              | Matrix      |                                                                                                                  |
| GW-GWW-052616                                                                                                                                                                                                                                                                                       | 5/26/2016 | 10:50                                                                                            | L                                 | G           | 2 2Q16 Post Remediation                                                                                          |
| GW-NB34-052616                                                                                                                                                                                                                                                                                      | 5/26/2016 | 14:00                                                                                            | L                                 | G           | 2 2Q16 Post Remediation                                                                                          |
| GW-GWY-052616                                                                                                                                                                                                                                                                                       | 5/26/2016 | 15:15                                                                                            | L                                 | G           | 2 2Q16 Post Remediation                                                                                          |
| GW-PZ02-052616                                                                                                                                                                                                                                                                                      | 5/26/2016 | 14:35                                                                                            | L                                 | G           | 2 2Q16 Post Remediation                                                                                          |
|                                                                                                                                                                                                                                                                                                     |           |                                                                                                  |                                   |             | <br>160-17563 Chain of Custody |
|                                                                                                                                                                                                                                                                                                     |           |                                                                                                  |                                   |             |                                                                                                                  |
|                                                                                                                                                                                                                                                                                                     |           |                                                                                                  |                                   |             |                                                                                                                  |
|                                                                                                                                                                                                                                                                                                     |           |                                                                                                  |                                   |             |                                                                                                                  |
|                                                                                                                                                                                                                                                                                                     |           |                                                                                                  |                                   |             |                                                                                                                  |
| Relinquished by:<br>M. DeKeyser                                                                                                                                                                                                                                                                     |           | Date/Time<br>5-27-16                                                                             | Received by:<br>R. G. [Signature] |             | Date/Time<br>5-27-16                                                                                             |
| Company Name:<br>WEC                                                                                                                                                                                                                                                                                |           | Date/Time<br>10:00                                                                               | Company Name:<br>CRSS Roads       |             | Date/Time<br>10:00                                                                                               |
| Received by:                                                                                                                                                                                                                                                                                        |           | Date/Time                                                                                        | Relinquished by:                  |             | Date/Time                                                                                                        |
| Company Name:                                                                                                                                                                                                                                                                                       |           |                                                                                                  | Company Name:                     |             |                                                                                                                  |
| Relinquished by:<br>R. G. [Signature]                                                                                                                                                                                                                                                               |           | Date/Time<br>5-27-16                                                                             | Received by:<br>R. G. [Signature] |             | Date/Time<br>5-27-16                                                                                             |
| Company Name:<br>CRSS Roads                                                                                                                                                                                                                                                                         |           | Date/Time<br>11:30                                                                               | Company Name:<br>CRSS Roads       |             | Date/Time<br>5-27-16                                                                                             |
|                                                                                                                                                                                                                                                                                                     |           |                                                                                                  |                                   |             | Verified By:<br>M. DeKeyser                                                                                      |
|                                                                                                                                                                                                                                                                                                     |           |                                                                                                  |                                   |             | Comments: PO #4500404709                                                                                         |
|                                                                                                                                                                                                                                                                                                     |           |                                                                                                  |                                   |             | Container ID:<br>0526-01                                                                                         |
|                                                                                                                                                                                                                                                                                                     |           |                                                                                                  |                                   |             | Total Number of Containers:<br>8                                                                                 |
|                                                                                                                                                                                                                                                                                                     |           |                                                                                                  |                                   |             | Cooler Temperature:<br>Ambient                                                                                   |
|                                                                                                                                                                                                                                                                                                     |           |                                                                                                  |                                   |             | Shipper and Number:                                                                                              |

## Login Sample Receipt Checklist

Client: Westinghouse Electric Company LLC

Job Number: 160-17563-1

**Login Number: 17563**

**List Source: TestAmerica St. Louis**

**List Number: 1**

**Creator: Dedner, Connie L**

| Question                                                                                 | Answer | Comment |
|------------------------------------------------------------------------------------------|--------|---------|
| Radioactivity wasn't checked or is $\leq$ background as measured by a survey meter.      | True   |         |
| The cooler's custody seal, if present, is intact.                                        | True   |         |
| Sample custody seals, if present, are intact.                                            | N/A    |         |
| The cooler or samples do not appear to have been compromised or tampered with.           | True   |         |
| Samples were received on ice.                                                            | N/A    |         |
| Cooler Temperature is acceptable.                                                        | True   |         |
| Cooler Temperature is recorded.                                                          | True   |         |
| COC is present.                                                                          | True   |         |
| COC is filled out in ink and legible.                                                    | True   |         |
| COC is filled out with all pertinent information.                                        | True   |         |
| Is the Field Sampler's name present on COC?                                              | True   |         |
| There are no discrepancies between the containers received and the COC.                  | True   |         |
| Samples are received within Holding Time (excluding tests with immediate HTs)            | True   |         |
| Sample containers have legible labels.                                                   | True   |         |
| Containers are not broken or leaking.                                                    | True   |         |
| Sample collection date/times are provided.                                               | True   |         |
| Appropriate sample containers are used.                                                  | True   |         |
| Sample bottles are completely filled.                                                    | True   |         |
| Sample Preservation Verified.                                                            | True   |         |
| There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs         | True   |         |
| Containers requiring zero headspace have no headspace or bubble is $<6\text{mm}$ (1/4"). | N/A    |         |
| Multiphasic samples are not present.                                                     | True   |         |
| Samples do not require splitting or compositing.                                         | True   |         |
| Residual Chlorine Checked.                                                               | N/A    |         |