Operate Canberra Alpha Analyzer Using Apex-Alpha Software

Tank Farm Plant Operating Procedure  RADCON

USQ # GCX-2

CHANGE HISTORY (≤ LAST 5 REV-MODS)

<table>
<thead>
<tr>
<th>Rev-Mod</th>
<th>Release Date</th>
<th>Justification</th>
<th>Summary of Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-1</td>
<td>09/01/2016</td>
<td>PER</td>
<td>Updated Records section to current standard.</td>
</tr>
<tr>
<td>B-0</td>
<td>05/02/2014</td>
<td>Periodic Review</td>
<td>Deleted unneeded RadCon steps, corrected spelling, replaced notes, changed action words, deleted warnings corrected conditional statements, added attachment 2.</td>
</tr>
<tr>
<td>A-0</td>
<td>05/03/2012</td>
<td>New Procedure</td>
<td>New procedure.</td>
</tr>
</tbody>
</table>

Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Purpose and Scope</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Purpose and Scope</td>
<td>3</td>
</tr>
<tr>
<td>1.1</td>
<td>Purpose</td>
<td>3</td>
</tr>
<tr>
<td>1.2</td>
<td>Scope</td>
<td>3</td>
</tr>
<tr>
<td>2.0</td>
<td>Information</td>
<td>3</td>
</tr>
<tr>
<td>2.1</td>
<td>Terms and Definitions</td>
<td>3</td>
</tr>
<tr>
<td>3.0</td>
<td>Precautions and Limitations</td>
<td>4</td>
</tr>
<tr>
<td>3.1</td>
<td>Personnel Safety</td>
<td>4</td>
</tr>
<tr>
<td>3.2</td>
<td>Equipment Safety</td>
<td>4</td>
</tr>
<tr>
<td>3.3</td>
<td>Radiation and Contamination Control</td>
<td>4</td>
</tr>
<tr>
<td>4.0</td>
<td>Prerequisites</td>
<td>5</td>
</tr>
<tr>
<td>4.1</td>
<td>Special Tools, Equipment and Supplies</td>
<td>5</td>
</tr>
<tr>
<td>4.2</td>
<td>Performance Documents</td>
<td>5</td>
</tr>
<tr>
<td>4.3</td>
<td>Field Preparation</td>
<td>5</td>
</tr>
<tr>
<td>5.0</td>
<td>Procedure</td>
<td>6</td>
</tr>
<tr>
<td>5.1</td>
<td>Apex Software Start-Up.</td>
<td>6</td>
</tr>
<tr>
<td>5.2</td>
<td>Daily Calibration Check</td>
<td>7</td>
</tr>
<tr>
<td>5.3</td>
<td>Daily Sample Background Check</td>
<td>9</td>
</tr>
<tr>
<td>5.4</td>
<td>Response to Failed Check</td>
<td>10</td>
</tr>
<tr>
<td>5.5</td>
<td>System Background Check</td>
<td>11</td>
</tr>
<tr>
<td>5.6</td>
<td>Sample Counting</td>
<td>13</td>
</tr>
</tbody>
</table>
Operate Canberra Alpha Analyzer Using Apex-Alpha Software

5.7 Counting Sample to Down Post Airborne Radioactivity Area .............................................. 15
5.8 Records .................................................................................................................................. 17

Attachment 1 – Airborne Radioactivity Area Worksheet .................................................................. 18
Attachment 2 – Acceptable Background Values ............................................................................. 19
1.0 PURPOSE AND SCOPE

1.1 Purpose

This procedure provides instruction to Radiological Control personnel for operating the Alpha Analyst Spectroscopy System using the Apex-Alpha Spectroscopy software.

1.2 Scope

This procedure involves Daily & Monthly Background checks, Daily Calibration Checks, and the counting of samples for tank farm Contractors with Apex-Alpha Analyst spectroscopy system. This procedure does not include calibration of the Apex-Alpha Analyst spectroscopy system.

2.0 INFORMATION

2.1 Terms and Definitions

CRFLM - Count Room First Line Manager

dpm - disintegrations per minute

DAC - Derived Air Concentration

MDC - Minimum Detectable Concentration

ROI - Region of Interest
3.0 PRECAUTIONS AND LIMITATIONS

3.1 Personnel Safety

3.1.1 Failure to use caution when handling radioactive sources and radioactive samples may expose handler to radiation.

3.2 Equipment Safety

CAUTION - Use of the Alpha Analyst System to analyze samples with greater than 6,000 dpm alpha or greater than 50,000 dpm beta activity may result in contamination of detectors.

3.3 Radiation and Contamination Control

3.3.1 Radioactive samples will be stored in RMA storage cabinet and/or disposed of as radioactive material after analysis has been completed.
4.0 PREREQUISITES

4.1 Special Tools, Equipment and Supplies

The following supplies may be needed to perform this procedure:
- CRFLM or designee shall specify which standards are to be used for Daily Calibration checks
- Maintain accurate certificate files that contain the current calibration data from the sources
- Operable Alpha Analyst
- Operable computer system with the Apex-Al pha software
- Operable vacuum pump
- 47mm disc $^{239}$Pu sources
- Count Room Quality Control log number.

4.2 Performance Documents

The following documents may be needed to perform this procedure:

4.3 Field Preparation

4.3.1 CONFIRM calibration sticker is current for chambers being operated.
5.0 PROCEDURE

NOTE - The Alpha Analyst system shall be used only to measure and report alpha radiation for samples in accordance with approved procedures, system calibrations, and geometry.

- At various points in this procedure the technician is directed to enter a sample log number or quality control number into the computer and/or on the analysis report. For the purpose of sample tracking, it is necessary to use the sample log number rather than the sequential file number provided by the software.

- Performance tests and documentation of results assure reliable sample analysis and provide an administrative record for tracking and trending system operation.

5.1 Apex Software Start-Up

NOTE - Sections 5.1 through 5.6 in this procedure may be performed or re-performed independently or in any logical order on any chamber, unless otherwise specified by CRFLM or analyst.

Start-Up Checks

5.1.1 ENSURE power to Apex Alpha Analyst AND CONFIRM the power light is illuminated.

5.1.2 CONFIRM vacuum pump is operating by touch and sound.

5.1.3 CONFIRM vacuum pump oil is at proper level.

Apex Software Start-Up

5.1.4 IF system is not running, DOUBLE CLICK on “Apex-Alpa” icon.

5.1.5 IF system is already running, GO TO appropriate step in procedure to be performed.

5.1.6 LOG ON as Administrator.
5.2 Daily Calibration Check

NOTE - Sections 5.1 through 5.6 in this procedure may be performed or re-performed independently or in any logical order on any chamber, unless otherwise specified by CRFLM or analyst.

5.2.1 LEFT CLICK on Sample Assigner icon from main tool bar.

5.2.2 HIGHLIGHT each chamber to be run.

5.2.3 LEFT CLICK the “Cal Check” button.

5.2.4 LEFT CLICK the “Load Samples” button, located at the top right corner.

5.2.5 CLICK “yes” to vent chambers.

5.2.6 OPEN the door of the chamber to be tested.

5.2.7 PLACE calibration check source assigned to the chamber on the source tray (shelf 3) active side up.

5.2.8 CLOSE the chamber door.

5.2.9 REPEAT source loading for each chamber.

5.2.10 CLICK “ok” to begin daily cal check.

5.2.11 AFTER the source check is complete, REVIEW the QA summary report AND

PERFORM the following:

5.2.11.1 RECORD Quality Control Number on report,

5.2.11.2 SIGN PRINT DATE report.

5.2.11.3 SUBMIT to CRFLM for review.
5.2 Daily Calibration Check (Cont.)

5.2.12 RIGHT click on detector just source checked AND CLICK “Vent” in the menu.

5.2.13 UNLOAD sources from each chamber when complete.

5.2.14 REALIGN the source tray AND CLOSE the door.

5.2.15 REPEAT daily source check for each chamber to be source checked.

5.2.16 IF daily source check fails on a chamber, PROCEED to Section 5.4.
5.3 Daily Sample Background Check

NOTE - Sections 5.1 through 5.6 in this procedure may be performed or re-performed independently or in any logical order on any chamber, unless otherwise specified by CRFLM or analyst.

CAUTION
Use of the Alpha Analyst System to analyze samples with greater than 6,000 dpm alpha or greater than 50,000 dpm beta activity may result in contamination of detectors.

5.3.1 LEFT CLICK on “Sample Assigner” icon in the main task bar.
5.3.2 HIGHLIGHT each chamber(s) to be run.
5.3.3 LEFT CLICK on “Background Check” button.
5.3.4 LEFT CLICK the “Load Samples” button, located at the top right corner.
5.3.5 CLICK “yes” to vent chambers.
5.3.6 CLICK “ok” when ready to begin background count.
5.3.7 REPEAT for each chamber that underwent a source check.
5.3.8 REVIEW the QA summary report for the detectors background checked for that day AND
PERFORM the following:

5.3.8.1 RECORD Quality Control Number on report.
5.3.8.2 SIGN PRINT DATE report.
5.3.8.3 SUBMIT to CRFLM for review.
5.3.9 FORWARD the QA summary reports to the CRFLM for review.
Operate Canberra Alpha Analyzer Using Apex-Alpha Software

5.4  Response to Failed Check

NOTE - Sections 5.1 through 5.6 in this procedure may be performed or re-performed independently or in any logical order on any chamber, unless otherwise specified by CRFLM or analyst.

5.4.1  IF failed check resulted in a “red” chamber lockout, LEFT CLICK the “main” icon.

5.4.2  RIGHT CLICK within the red colored region of the out of service detector.

5.4.3  SELECT “MCA”.

5.4.4  LEFT CLICK “In Service”.

5.4.5  IF the chamber does not return to standard operational blue color, NOTIFY CRFLM or delegate.

5.4.6  RETRY the appropriate Daily or Monthly Check.

5.4.7  IF the chamber fails a second time, NOTIFY CRFLM or delegate for further instruction.
5.5 **System Background Check**

**NOTE** - Sections 5.1 through 5.6 in this procedure may be performed or re-performed independently or in any logical order on any chamber, unless otherwise specified by CRFLM or analyst.

- Each month a system background count must be performed to determine if the chamber needs decontamination or further evaluation. The system background count determines the background counts in the 3-8 MeV ROI.

- Background verification results are automatically saved to the database at the end of the run and a report will automatically print.

- System backgrounds greater than 15 counts will make the detector unavailable.

5.5.1 **IF** system background is greater than 15 counts, **CONTACT** count room lead technician for further evaluation.

5.5.2 **IF** system is not running, **SELECT** “Apex-Alpha” icon.

5.5.3 **IF** system is running, **GO TO** Step 5.5.5.

5.5.4 **LEFT CLICK** on “Sample Assigner”, located in the system tool bar.

5.5.5 **LOG ON** as Administrator.

5.5.6 **HIGHLIGHT** each chamber to be run.

5.5.7 **LEFT CLICK** the “System Background” button, located at the far right side of the screen.

5.5.8 **HIGHLIGHT** shelf 3 AND **CLICK** “ok”.

5.5.9 **LEFT CLICK** on “Load Samples” in the top right corner.

5.5.10 **OPEN** chamber door.

5.5.11 **CONFIRM** the following:
- The source holder is on shelf 3
- There are no samples in chamber.

5.5.12 **CLOSE** chamber door.
5.5 System Background Check (Cont.)

5.5.13 SELECT “ok” to begin count AND CONFIRM the following:
- The icon by the chamber running changes color to green
- The acquisition state is counting.

5.5.14 REPEAT for each chamber to receive a system background count.

5.5.15 CHECK report for accuracy when count has completed.

5.5.16 REVIEW QA summary report AND CONFIRM monthly background counts are ≤15 cpm.

5.5.17 IF monthly background fails (counts are >15 cpm), PERFORM the following:

5.5.17.1 CONTACT CRFLM or designee to determine if detector chamber needs decontamination.

5.5.17.2 PROCEED to Section 5.4.

5.5.18 RECORD Quality Control Number on report for the detectors for Monthly Background AND PERFORM the following:

5.5.18.1 SIGN PRINT DATE report.

5.5.18.2 FORWARD the report to be reviewed by CRFLM or designee.
5.6 Sample Counting

NOTE - Sections 5.1 through 5.6 in this procedure may be performed or re-performed independently or in any logical order on any chamber, unless otherwise specified by CRFLM or analyst.

CAUTION
Use of the Alpha Analyst System to analyze samples with greater than 6,000 dpm alpha or greater than 50,000 dpm beta activity may result in contamination of detectors.

5.6.1 LEFT CLICK on “Batches” icon on main taskbar.

5.6.2 ENTER current date and time in batch ID.

5.6.3 ENTER the number of unknown samples in each batch.

5.6.4 SELECT desired matrix from matrix pull down box (filter or smear).

5.6.5 SELECT the counting procedure to be used AND CHECK that box.

NOTE - Count time is based on Attachment 2.

5.6.6 ENTER sample volume AND
SELECT desired units from the pull-down box.

5.6.7 LEFT CLICK “next” on the bottom right of the page.

5.6.8 LEFT CLICK on the first unknown to highlight the section.

5.6.9 LEFT CLICK on the “Edit” button.

5.6.10 COMPLETE the blank fields with the information pertaining to the sample.

5.6.11 IF the sample is an air sample, LEFT CLICK the correction factors button.

5.6.12 ENTER a value in the generic divisor (1/x) block for the appropriate sample media from the list below:
- Flouropore = 0.9999
- Versapore = 0.9584
- AKI Steel Planchet = 0.6396.

5.6.13 LEFT CLICK “ok” to close the correction factor window.
5.6 Sample Counting (Cont.)

5.6.14 CONFIRM that “Queue Batch” is checked at the bottom of the page.

5.6.15 LEFT CLICK “Update Sample” button.

5.6.16 IF more than one was selected for the batch, REPEAT data entry for other samples.

5.6.17 LEFT CLICK the “save” button.

5.6.18 LEFT CLICK the “Sample Assigner” on the main taskbar.

5.6.19 LEFT CLICK on the available alpha chamber.

5.6.20 LEFT CLICK “Expand All” button.

5.6.21 LEFT CLICK on the queued sample.

5.6.22 DRAG AND DROP each queued sample to the appropriate detector.

5.6.23 AFTER all samples have been assigned, LEFT CLICK “Load Samples” button on top right.

5.6.24 LEFT CLICK “yes” to vent chambers.

5.6.25 OPEN the chamber door AND LOAD the sample planchet on the tray.

5.6.26 CLOSE the chamber door.

5.6.27 LEFT CLICK “OK” to begin counting.

5.6.28 WHEN counting is complete, RIGHT CLICK on the chamber used.

5.6.29 LEFT CLICK “Vent” in the menu.

5.6.30 OPEN the chamber door AND REMOVE the sample.

5.6.31 CLOSE the chamber door.

5.6.32 AFTER each sample count, PERFORM sample background check per Section 5.3.

5.6.33 REVIEW AND SIGN the printer reports.
5.7 Counting Sample to Down Post Airborne Radioactivity Area

5.7.1 **ENSURE** all analyses listed below are complete:
- gross Alpha Only
- Beta
- Alpha Spectroscopy.

5.7.2 **REVIEW AND RECORD** data on Attachment 1 as follows:

5.7.2.1 **REVIEW** Tennelec Beta analysis data.

5.7.2.2 **CONFIRM** results are:
- < 20% DAC for Sr-Y90
- MDC is < 20% DAC Sr-Y90.

5.7.2.3 **RECORD** results from Step 5.7.2.2 in Sections B, and D, respectively, on Attachment 1.

5.7.2.4 **RECORD** Beta sample error in section F of Attachment 1.

5.7.2.5 **RECORD** ROI No. 1 Alpha Spec Counts in (G).

5.7.2.6 **RECORD** ROI No. 2 Alpha Spec Counts in (H).

5.7.2.7 **ADD** counts in ROI No. 1 and ROI No. 2. (G+H=I)

5.7.2.8 **DIVIDE** ROI No. 1 counts by sum of counts in ROI No. 1 and ROI No. 2 to determine ROI fraction **AND**

**RECORD** to three significant digits in (J). (G/I=J)

5.7.2.9 **REVIEW** Tennelec Alpha Only concentration, MDC, and alpha sample error **AND**

**RECORD** in (C), (A) and (E) respectively.
5.7 Counting Sample to Down Post Airborne Radioactivity Area (Cont.)

5.7.2.10 ADD Alpha Only air concentration (C) and alpha sample error (E) AND

RECORD in (K). (C+E=K)

5.7.2.11 MULTIPLY Alpha Spec Ratio (J) and Alpha Concentration corrected for error (K) AND

RECORD Corrected Alpha Concentration for RIO in (L). (JxK=L)

5.7.2.12 FORWARD complete worksheet to CRFLM or designee.
5.8 Records

5.8.1 **PERFORM** the following for records identified within this procedure.

5.8.1.1 On the Records Submittal Checklist, **RECORD** the number of pages that were completed

**OR**

**PLACE** a check mark (✔) in the N/A column.

5.8.1.2 **ATTACH** the completed records to the Records Submittal Checklist **AND**

**SIGN** Records Submittal Checklist indicating the package is complete.

5.8.1.3 **SUBMIT** the completed records to an approved RadCon Record Storage Area for retention.

The record custodian identified in the Company Level Records Inventory and Disposition Schedule (RIDS), is responsible for record retention in accordance with TFC-BSM-IRM_DC-C-02.

<table>
<thead>
<tr>
<th>Records Submittal Checklist</th>
<th>Number of pages completed</th>
<th>N/A (✔)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WRPS Radiological Count Room-Alpha Spectrum Analysis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Airborne Radioactivity Area Worksheet</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

_________________________ / _________________________ / _______________
Signature                  Print (First and Last Name)                   Date

First Line Manager (or designee)
## Attachment 1 – Airborne Radioactivity Area Worksheet

<table>
<thead>
<tr>
<th>Sample No.: _______</th>
<th>Date: ______________</th>
<th>Volume: _________</th>
<th>Location: _________</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>(A) Alpha MDC:</th>
<th>(B) Beta MDC:</th>
</tr>
</thead>
<tbody>
<tr>
<td>___________________ (μCi/mL)</td>
<td>___________________ (μCi/mL)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(C) Alpha Concentration:</th>
<th>(D) Beta Concentration:</th>
</tr>
</thead>
<tbody>
<tr>
<td>___________________ (μCi/mL)</td>
<td>___________________ (μCi/mL)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(E) Alpha Sample Error (1.645 x σ):</th>
<th>(F) Beta Sample Error (1.645 x σ):</th>
</tr>
</thead>
<tbody>
<tr>
<td>___________________ (μCi/mL)</td>
<td>___________________ (μCi/mL)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(G) Alpha Spec ROI No. 1:</th>
<th>(H) Alpha Spec ROI No. 2:</th>
</tr>
</thead>
<tbody>
<tr>
<td>___________________ Counts</td>
<td>___________________ Counts</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(I) Sum of ROI No. 1 and ROI No. 2</th>
<th>(J) Alpha Spec Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>(G + H): ___________________ Counts</td>
<td>(G / I): ___________________</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(K) Alpha Conc. Corrected for error</th>
<th>(L) Corrected Alpha Conc. for ROI</th>
</tr>
</thead>
<tbody>
<tr>
<td>(C + E): ___________________ (μCi/mL)</td>
<td>(J x K): ___________________ (μCi/mL)</td>
</tr>
</tbody>
</table>

If corrected alpha concentration (L) is < 20% DAC, the area can be down-posted from airborne controls. Sample should be retained and analyzed until concentration is verified < 20% DAC.

| RCT Print/Signature: ____________________________/___________________________ |
|---------------------------|---------------------------|
| Date: ______________ | |

| CRFLM/Analyst Print/Signature: ____________________________/___________________________ |
|---------------------------|---------------------------|
| Date: ______________ | |
### Attachment 2 – Acceptable Background Values

**Note:** MDC (µCi/ml) for given sample volume ($V_a$), media (Fluoropore and AKI) and count time ($T_g$) with 60 minute background count time ($T_b$) and a minimum detector efficiency of 6% ($E_c$).

<table>
<thead>
<tr>
<th>Sample Volume (ft&lt;sup&gt;3&lt;/sup&gt;)</th>
<th>250</th>
<th>300</th>
<th>350</th>
<th>400</th>
<th>450</th>
<th>500</th>
<th>600</th>
</tr>
</thead>
<tbody>
<tr>
<td>$N_b$ Fluoropore</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>$T_g$ Fluoropore</td>
<td>16</td>
<td>13</td>
<td>10</td>
<td>9</td>
<td>8</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>$N_b$ Fluoropore</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>$T_g$ Fluoropore</td>
<td>14</td>
<td>11</td>
<td>9</td>
<td>8</td>
<td>7</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>$N_b$ Fluoropore</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>$T_g$ Fluoropore</td>
<td>12</td>
<td>10</td>
<td>8</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>$N_b$ Fluoropore</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>$T_g$ Fluoropore</td>
<td>8</td>
<td>6</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>$N_b$ AKI</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>$T_g$ AKI</td>
<td>12</td>
<td>10</td>
<td>9</td>
<td>8</td>
<td>7</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>$N_b$ AKI</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>$T_g$ AKI</td>
<td>21</td>
<td>16</td>
<td>14</td>
<td>11</td>
<td>10</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>$N_b$ AKI</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>$T_g$ AKI</td>
<td>27</td>
<td>21</td>
<td>17</td>
<td>14</td>
<td>12</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>$N_b$ AKI</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>$T_g$ AKI</td>
<td>34</td>
<td>25</td>
<td>19</td>
<td>16</td>
<td>13</td>
<td>12</td>
<td>9</td>
</tr>
</tbody>
</table>
Attachment 2 – Acceptable Background Values (Cont.)

\[
MDC (\mu Ci/mL) = \frac{2.71 + 3.29 \sqrt{R_b T_g \left(1 + \frac{T_g}{T_b}\right)}}{k E_c T_g E_f V_a E_a}
\]

Where:

- \(E_a\) = Self absorption factor (%/100) for oil-coated AKI planchet = 0.82 for alpha activity and 1.0 for beta activity
- \(E_c\) = Instrument Counting Efficiency (%/100) identified on the calibration sticker
- \(E_f\) = Collection efficiency (% Eff)/100; for oil coated AKI planchet = 0.78, Versapore = 0.9584, Fluoropore = 0.9999, LB = 0.9997
- \(V_a\) = Sample volume (ft\(^3\))
- \(R_b\) = Background count rate (cpm)
- \(T_g\) = Gross count time (min)
- \(T_b\) = Background count time (min)
- \(N_b\) = Number of counts in 60 minutes
- \(k\) = 6.29 E+10

\[
MDC (\mu Ci/mL) \approx 3.29 + 2.71 + \frac{R_b T_g (1 + \frac{T_g}{T_b})}{k E_c T_g E_f V_a E_a}
\]