Table of Contents

1.0 PURPOSE AND SCOPE .................................................................................................................. 3
  1.1 Purpose ........................................................................................................................................ 3
  1.2 Scope ........................................................................................................................................... 3

2.0 INFORMATION ............................................................................................................................. 3
  2.1 Terms and Definitions ................................................................................................................... 3
  2.2 General Information ...................................................................................................................... 3

3.0 PRECAUTIONS AND LIMITATIONS ..................................................................................... 3
  3.1 Equipment Safety ........................................................................................................................ 3

4.0 PREREQUISITES .......................................................................................................................... 4
  4.1 Special Tools, Equipment, and Supplies ....................................................................................... 4
  4.2 Performance Documents ................................................................................................................ 4

5.0 PROCEDURE ............................................................................................................................... 5
  5.1 Operational Check (Low background area) .................................................................................. 5
  5.2 Source Check ............................................................................................................................... 7
  5.3 Operating Instructions .................................................................................................................. 11
5.4 Records ................................................................................................................................. 14
Attachment 1 – Correction Factors .......................................................................................... 15
1.0 PURPOSE AND SCOPE

1.1 Purpose

This procedure provides specific information regarding the Eberline Model RO-7 survey instrument.

1.2 Scope

This procedure provides instruction for operation and testing of the Eberline Model RO-7 survey instrument.

2.0 INFORMATION

2.1 Terms and Definitions

- Ion Chamber Check Source (ICCS)
- Linear Beta Source (LBS)
- Shallow Dose Rate (SDR).

2.2 General Information

Specific information regarding theory of operation, calibration, maintenance and instrument specifications and limitations, including environmental and interfering radiation can be found in MA-562, Radiation Protection Instrument Manual (or equivalent).

3.0 PRECAUTIONS AND LIMITATIONS

3.1 Equipment Safety

CAUTION - When the Beta cap is removed, the thin end window is easily torn or punctured. Do not allow the probe window to touch the surface being surveyed.

CAUTION - Placing mid-range probes in radiation fields > 200 R/hr for extended periods can permanently damage the probe. This effect can occur whether or not the instrument is turned on. This caution is applicable to the entire procedure.
4.0 PREREQUISITES

4.1 Special Tools, Equipment, and Supplies

The following supplies may be needed to perform this procedure:

- ICCS assembly or LBS assembly
- Other tools, equipment, and supplies as identified by Shift Manager/OE/FWS.

4.2 Performance Documents

The following documents may be needed to perform this procedure:

- BT-6002-880, Instrument Service Tag
- A-6002-895, Daily Instrument Source Check Log
- BL-6006-213, Daily Source Check.
5.0 PROCEDURE

5.1 Operational Check (Low background area)

NOTE - Steps within this section may be performed in any logical order.

5.1.1 CONFIRM calibration of the instrument is current (body and probes).

5.1.2 ENSURE probe source check is current.

NOTE - An inspection of the instrument is required before each intermittent use of the RO-7.

5.1.3 INSPECT the instrument for the following physical defects:

- Broken meter glass
- Loose knobs
- Punctured/damaged probe windows
- Defective cables
- Any observable defects which could affect operation.

5.1.4 TURN ON/OFF switch to ON AND CHECK display for a colon.

5.1.4.1 IF colon is displayed, REQUEST an Instrument Technician replace all three 9-volt NEDA 1604 batteries or equivalent (BT2, BT3 and BT4) AND PRIOR to use PERFORM a daily source check per Section 5.2.

5.1.4.2 AFTER battery charge, IF colon is still displayed, PERFORM the following:

a. TAG the instrument body with a completed Instrument Service Tag (BT 6002 880).

b. SEGREGATE the instrument body to prevent inadvertent use.

c. NOTIFY RadCon management.
5.1 Operational Check (Low background area) (Cont.)

NOTE - When using the high range probe, an error of up to ±10 R/hr may be introduced if zero is improperly set.

5.1.5 USE ZERO knob AND ZERO instrument.

5.1.5.1 CONFIRM background area is less than 1/2 of the minimum dose increment for the probe in use.

5.1.6 IF the RO-7 fails any checks, PERFORM the following:

5.1.6.1 TAG the instrument body with a completed Instrument Service Tag (BT 6002 880).

5.1.6.2 SEGREGATE the instrument body to prevent inadvertent use.

5.1.6.3 NOTIFY RadCon management.

5.1.7 IF it is determined an Instrument Service Tag was installed in error, PERFORM the following:

5.1.7.1 CONFIRM the instrument passes all required operational checks.

5.1.7.2 OBTAIN concurrence from the First Line Manager to place instrument back into service.

5.1.7.3 REMOVE the Instrument Service Tag.

5.1.7.4 PLACE the instrument back in service.
5.2 Source Check

NOTE - The RO-7 are source checked using an ICCS assembly.

- The initial source check is done when the instrument (probe) is received from the calibration facility.
- RO-7 bodies and probes may be interchanged with the following exceptions:
  - A modified probe may only be used with a modified body
  - A high range probe may not be used with a modified body.

Initial Source Check

5.2.1 IF detector has a beta end cap, REMOVE Beta end cap.

5.2.2 CENTER end of detector over the source opening on check source assembly AND

DEPRESS source plunger on ICCS to the OS position (500 position for RO-7-BM-M detectors).

5.2.3 ALLOW instrument's reading to stabilize.

5.2.4 RECORD the instrument’s response on the Daily Instrument Source Check Log (A 6002 895).

5.2.5 EVALUATE initial source response.

5.2.5.1 IF response is within +/- 20% of the mean or typical instrument response for that source (3-5 instruments),

OR

IF response is within +/- 20% of source strength as determined for the source by a source calibration provider, proceed to Step 5.2.6
5.2 Source Check (Cont.)

5.2.5.2 IF response is not within +/- 20% of the mean or typical instrument response for that source,

OR

IF response is not within +/- 20% of source strength as determined for the source by a source calibration provider,
PERFORM the following:

a) IF reading is high out-of-range, CONTACT the Instrument FPOC for evaluation for continued use.
b) IF reading is low out-of-range or Instrument FPOC determines not acceptable for continued use, THEN:
   1. TAG the instrument with a completed instrument service tag (BT-6002-880) identifying the problem(s).
   2. SEGREGATE the instrument to prevent inadvertent use.
   3. NOTIFY RadCon management.

5.2.6 MULTIPLY instrument's response by 0.8 and 1.2 to determine acceptable range for that detector AND


5.2.7 COMPLETE the remainder of the Daily Instrument Source Check Log (A-6002-895).

5.2.8 IF initial response is acceptable, ATTACH a Daily Source Check label (BL-6006-213), to the instrument for the probe AND

COMPLETE the label.

5.2.9 IF multiple probes are to be source checked, COMPLETE initial source check activities for each body/probe combination.
5.2 Source Check (Cont.)

Daily Source Check

5.2.10 IF detector has a beta end cap, REMOVE beta end cap.

5.2.11 CENTER end of detector over the source opening on check source assembly AND DEPRESS source plunger on ICCS to the OS position (500 position for RO-7-BM-M detectors).

5.2.12 ALLOW probes’ reading to stabilize.

5.2.13 CONFIRM instrument's response falls within the acceptable ranges on the A-6002-895, Daily Instrument Source Check Log.

5.2.14 IF instrument response is within the acceptable ranges, COMPLETE the following:

- The Daily Instrument Source Check Log (A-6002-895)
- The Daily Source Check label (BL-6006-213).
5.2 Source Check (Cont.)

5.2.15 IF instrument response is not within the acceptable ranges **PERFORM** the following:

5.2.15.1 **TAG** the failed component (probe or body) with a completed Instrument Service Tag (BT 6002 880 or equivalent).

5.2.15.2 **SEGREGATE** the instrument to prevent inadvertent use.

5.2.15.3 **NOTIFY** RadCon management.

5.2.16 IF it is determined an Instrument Service Tag was installed in error, **PERFORM** the following:

5.2.16.1 **CONFIRM** the instrument passes all required operational checks.

5.2.16.2 **OBTAIN** concurrence from the First Line Manager to place instrument back into service.

5.2.16.3 **REMOVE** the Instrument Service Tag.

5.2.16.4 **PLACE** the instrument back in service.

5.2.17 IF multiple probes are to be source checked, **COMPLETE** daily source check activities for each body/probe combination.
5.3 Operating Instructions

5.3.1 IF damage to the instrument is suspected during survey (e.g., instrument is dropped), **PERFORM** either of the following steps:

**NOTE** - An established field value may be a previous reading or a well-known, constant, non-zero field.

5.3.1.1 **IF** an established field is available, **ENSURE** response is within ± 20% of established value.

5.3.1.2 **IF** an established field is not available, **PERFORM** the Daily Source Check portion of Section 5.2.

**NOTE** - Cables or rigid extensions may be used between the probe and the RO-7 up to 500 feet for cables and 60 feet for underwater housing and cable.

5.3.2 **ATTACH** appropriate probe to the body to perform the survey.

**NOTE** - The instrument’s calibration is not affected by using the rigid extensions, cables, or the underwater housing.

5.3.3 **IF** RO-7 will be used in wet or underwater environment, **USE** an underwater housing to protect detector.

5.3.4 **PERFORM** an Operational Check (Section 5.1).
5.3 Operating Instructions (Cont.)

**CAUTION**

When the Beta cap is removed, the thin end window is easily torn or punctured. Do not allow the probe window to touch the surface being surveyed.

**NOTE** - When measuring exposure rates in non-uniform geometries, the displayed value is a conservative estimate of the exposure rate at the center of the detector volume.

- No contact correction factors for general use have been established for this instrument; however, some specific correction factors have been developed (see Attachment 1).

- A measurement taken with the low range probe will be representative of the penetrating dose rate at center of detector, 5 cm (2 in), (1/2 the length of the ion chamber).

- For the mid and high range detectors, the detector dimensions are quite small, 2.5 cm (1 in) in diameter and 1.5 cm (0.6 in) deep. Therefore, a measurement taken with these probes will be representative of the penetrating dose rate at center of the detector, 0.3 cm (0.076 in), (1/2 the depth of the ion chamber).

5.3.5 **PLACE** the detector in the area to be measured.
5.3 Operating Instructions (Cont.)

5.3.6 CALCULATE shallow and deep dose rates by either long-form or short form calculation (include neutron dose contribution, as applicable):

**LONG-FORM**

Deep Dose Rate = WC * CF\text{pen}

Shallow Dose Rate = \[ (WO-WC) \times CF_{\text{non-pen}} + WC \times CF_{\text{pen}} \]

Where:

WC = the instrument response with the window closed

WO = the instrument response with the window open

CF\text{non-pen} = non-penetrating (i.e., beta) correction factor

CF\text{pen} = penetrating (i.e., gamma) correction factor

5.3.6.1 IF WC indication is less than one tenth of the WO indication, CALCULATE shallow dose as follows for an “estimate” of SDR:

NOTE – This equation is for estimation purposes only. The full equation must be used for documentation of radiation surveys.

**SHORT-FORM**

Shallow Dose Rate = WO * CF\text{non-pen}
5.4 Records

5.4.1 PERFORM the following for records identified within this procedure.

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

OR

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

5.4.1.2 ATTACH the completed records to the Records Submittal Checklist AND

SIGN Records Submittal Checklist indicating the package is complete.

5.4.1.3 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>Site Form A-6002-895, Daily Instrument Source Check Log</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

_________________________ / ___________________________ / _____________

Signature                   Print (First and Last Name)                  Date

First Line Manager (or designee)
Attachment 1 – Correction Factors

**Far Field Geometry Correction Factors**

Far Field Geometry Correction Factors are used when making general area dose rate measurements (non-contact geometry). Multiply all non-penetrating exposure rate (WO - WC) readings by 2 (CF<sub>non-pen</sub> = 2). This is based on RO-7 response to 204Tl in a point source geometry at a distance of 30 cm.

All non-contact dose rate measurements of penetration radiation do not require a geometry correction factor (CF<sub>pen</sub> = 1).

**Close Geometry Corrections Factors**

Close Geometry Corrections Factors for small diameter gamma or beta sources have been developed (contact measurements) for the 125 ml grab sample bottle by measurement (Johnson 2000) and for bottles and small containers ranging in size from 50 to 500 mL (TPP-0412-INT-003, by calculation). These correction factors are shown in the table below.

<table>
<thead>
<tr>
<th>Geometry</th>
<th>RO-7 Mid-Range Probe</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Window Open</td>
</tr>
<tr>
<td>Side of 125 ml bottle, detector pointed at center of bottle, in contact</td>
<td>1.4</td>
</tr>
<tr>
<td>Bottom of 125 ml bottle, detector coaxial with bottle</td>
<td>1.7</td>
</tr>
<tr>
<td>Side of 150 to 500 mL bottles and similar small containers, detector pointed at center of bottle, in contact</td>
<td>2.0</td>
</tr>
<tr>
<td>Side of 50 ml bottle, detector pointed at center of bottle, in contact</td>
<td>2.0</td>
</tr>
</tbody>
</table>

“Window open” correction factors correct the instrument’s response to the true shallow dose (dose that would be recorded on a ring dosimeter).
“Window closed” correction factors correct the instrument’s response to the true deep dose (dose that would be recorded on a Hanford Standard TLD).
For conservative measurement and ease of calculation, the “Window open” correction factor of 2.0 may also be used for the 125 mL capacity bottle.