Change History (≤ last 5 Rev-Mods)

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<th>Rev-Mod</th>
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<td>RadCon Request</td>
<td>Modified section 5.2.4.2 and updated Records section.</td>
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<td>C-5</td>
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<td>C-4</td>
<td>06/14/2016</td>
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<td>Changed Record Section to meet Standard</td>
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<td>RadCon Request</td>
<td>Changed note above 5.3.8 &amp; added note to attachment 2.</td>
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<td>Added 4th bullet under 4.2, Add Step 5.2.4 with sub-steps. Struck Notes and changed to Special Instructions prior to Step 5.2.1. Reworded Records Section.</td>
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Table of Contents

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

2.0 INFORMATION ....................................................................................................................4
  2.1 General Information .....................................................................................................4
  2.2 Terms and Definitions .................................................................................................4

3.0 PRECAUTIONS AND LIMITATIONS ................................................................................5
  3.1 Personnel Safety .........................................................................................................5
  3.2 Equipment Safety .........................................................................................................5

4.0 PREREQUISITES ...............................................................................................................6
  4.1 Special Tools, Equipment, and Supplies ....................................................................6
  4.2 Performance Documents .............................................................................................6

5.0 PROCEDURE ....................................................................................................................7
  5.1 Operational Check .......................................................................................................7
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.2</td>
<td>Source Check</td>
<td>9</td>
</tr>
<tr>
<td>5.3</td>
<td>Operating Instructions</td>
<td>12</td>
</tr>
<tr>
<td>5.4</td>
<td>Geometry Correction Factors</td>
<td>16</td>
</tr>
<tr>
<td>5.5</td>
<td>Temperature Correction Factors</td>
<td>17</td>
</tr>
<tr>
<td>5.6</td>
<td>Records</td>
<td>18</td>
</tr>
</tbody>
</table>

Attachment 1 – Temperature Correction Examples ................................................................. 19

Attachment 2 – BW/BB CP Correction Factor Chart ................................................................. 20

Attachment 3 – Example Dose Rate to Alpha Contamination Conversion Chart .......................... 21
1.0 PURPOSE AND SCOPE

1.1 Purpose

This procedure provides specific information regarding the Black Widow and Bumble Bee CP.

1.2 Scope

This procedure provides instruction for operation and performing operational and source checks of the Black Widow and Bumble Bee CP.
2.0 INFORMATION

2.1 General Information

2.1.1 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).

2.2 Terms and Definitions

<table>
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<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>BBCP</td>
<td>Bumble Bee Cutie Pie</td>
</tr>
<tr>
<td>BWCP</td>
<td>Black Widow Cutie Pie</td>
</tr>
<tr>
<td>BW/BB CP</td>
<td>Black Widow/Bumble Bee Cutie Pie</td>
</tr>
</tbody>
</table>
3.0 PRECAUTIONS AND LIMITATIONS

3.1 Personnel Safety

3.1.1 Electrical hazards exist from energized electrical components located inside the instrument. Avoid contact with these components.

3.2 Equipment Safety

3.2.1 Static discharge at any point along instrument signal path may damage the instrument’s integrated circuit.

CAUTION - Failure to protect the thin end window when the beta cap is removed, may result in end window being easily torn or punctured.
4.0 PREREQUISITES

4.1 Special Tools, Equipment, and Supplies

The following supplies may be needed to perform this procedure:
- Linear beta source (LBS) or an ion chamber check source (ICCS) 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:
- A-6002-895, Daily Instrument Source Check Log
- BL-6006-213, Daily Source Check Label
- BT-6002-880, Instrument Service Tag
5.0 PROCEDURE

5.1 Operational Check

NOTE - Calibration expires at midnight of the expiration date on the calibration sticker.

5.1.1 CONFIRM calibration of the instrument is current.

5.1.2 CONFIRM instrument source check is current (Section 5.2).

NOTE - Inspection of the instrument is required before each intermittent use of the BW/BB CP.

5.1.3 INSPECT instrument for the following physical defects:
   • Broken meter glass
   • Loose knobs
   • Punctured/damaged chamber window
   • Loose detector barrel
   • Loose barrel ring
   • Any other observable defects that would affect operation.

NOTE - Missing beta shields can be replaced in the field.

5.1.4 IF beta shield is missing, CONTACT calibration facility for a new beta shield.

5.1.5 TURN selector switch to “BAT 1” AND

CONFIRM meter reading is above the BATT cutoff line.

5.1.6 TURN selector switch to “BAT 2” AND

CONFIRM meter reading is above the BATT cutoff line.

5.1.7 TURN selector switch to “BAT 3” AND

CONFIRM meter reading is above the BATT cutoff line.
5.1 Operational Check (Cont.)

5.1.8 IF any battery on BBCP indicates below the BATT cutoff line, REQUEST an Instrument Technician replace 9-volt alkaline batteries (type NEDA 1604) AND PRIOR to use, PERFORM a daily source check per Section 5.2.

5.1.9 IF battery 2 or battery 3 indicates below the BATT cutoff line for the BWCP, REQUEST an Instrument Technician replace 9-Volt alkaline batteries (type NEDA 1604) AND PRIOR to use, PERFORM a daily source check per Section 5.2.

5.1.10 IF battery 1 indicates below the BATT cutoff line for the BWCP, TAG instrument with a completed Instrument Service Tag (BT-6002-880) AND RETURN to calibration facility for battery replacement.

5.1.11 TURN selector switch to “ZERO” position.

5.1.11.1 USING zero knob, SET instrument to zero.

5.1.12 TURN selector switch to lowest range AND OBSERVE meter needle for erratic behavior.

NOTE - The intent of Step 5.1.13 is to reveal problems associated with loose parts or component stress introduced by holding instrument in various orientations.

5.1.13 ROTATE AND HOLD instrument from one orientation to another AND OBSERVE meter indication.

5.1.14 IF placing instrument in any orientation causes fluctuation or large changes in meter reading, TAG AND RETURN instrument to calibration facility for servicing.

5.1.15 IF BW/BB CP fails any steps other than Steps 5.1.2 and 5.1.5 through 5.1.7, DO NOT USE instrument.

5.1.16 IF BW/BB CP fails any checks, TAG it with a completed Instrument Service Tag, (BT-6002-880) AND RETURN it to calibration facility for servicing.
5.2 Source Check

NOTE - The BW/BB CP is source checked using a linear beta source (LBS) or an ion chamber check source (ICCS) assembly.

- An initial source check is performed when instrument is from the calibration facility.

Initial Source Check

5.2.1 REMOVE beta shield from window AND CENTER BW/BB CP window over source position on check source assembly.

5.2.2 MOVE source to appropriate position for each range of instrument AND ALLOW instrument’s reading to stabilize (about 5 seconds).

5.2.3 OBSERVE instrument’s response on each range.
5.2 Source Check (Cont.)

5.2.4 EVALUATE initial source response as follows:

5.2.4.1 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, GO TO 5.2.5.

5.2.4.2 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 the 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.

5.2.5 MULTIPLY instrument’s response by 0.8 and 1.2 to determine acceptable range for that instrument.

5.2.6 RECORD acceptable range on Daily Instrument Source Check Log (A-6002-895) AND

COMPLETE remainder of form as applicable.
Black Widow and Bumble Bee CP Operation and Source Checks

5.2 Source Check (Cont.)

5.2.7 IF response is acceptable, ATTACH AND COMPLETE a Daily Source Check label (BL-6006-213) to the instrument.

5.2.8 IF BW/BB CP fails Initial source check, TAG with a complete Instrument Service Tag (BT-6002-880) AND RETURN instrument to calibration facility for service.

Daily Source Check

5.2.9 REMOVE beta shield to expose beta window.

5.2.10 CENTER BW/BB CP window over source position on check source assembly.

5.2.11 SELECT range to be tested with range selector switch.

5.2.12 MOVE source to appropriate position for each range of instrument.

5.2.13 ALLOW instrument's reading to stabilize AND OBSERVE reading.

5.2.14 IF instrument response is within the acceptable ranges, COMPLETE the Daily Instrument Source Check Log (A-6002-895).

5.2.15 IF instrument response is within the acceptable ranges, COMPLETE the Daily Source Check Label (BL-6006-213).

5.2.16 IF instrument failed the source check, TAG it with a complete Instrument Service Tag, (BT-6002-880) AND RETURN it to calibration facility.
5.3 Operating Instructions

NOTE - Readings below 0.5 mR/hr (BBCP) or 50 mR/hr (BWCP) are typically considered below the minimum sensitivity of the instrument and are recorded as “<0.5 mR/hr” or “<50 mR/hr” respectively.

- The minimum sensitivity of the BW/BB CP should be considered when choosing the appropriate instrument to perform a survey. (e.g., the BW/BB CP does not have sufficient sensitivity to perform a posting survey to establish the boundary of an RBA, < 100 mRem/yr).

5.3.1 PRIOR to using the BW/BB CP, PERFORM Section 5.1.

NOTE - Typical symptoms of damage due to static discharge include a zero reading with no response to source check, an off-scale high reading with no reduction when moved away from source, and a moderate reading with the inability to zero the instrument.

5.3.2 IF damage to the BW/BB CP 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.

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

5.3.2.2 IF an established field is not available, PERFORM the Daily Source Check per Section 5.2.

NOTE - Under conditions where there is a high potential for static build-up (dry conditions), the BW/BB CP may be grounded frequently (approximately once every hour) and before making a measurement near (within 1 inch) a grounded object.

5.3.3 GROUND the BW/BB CP in order to discharge static in a controlled manner and to prevent instrument damage as follows:

5.3.3.1 TURN instrument to “OFF” or “ZERO” position.

5.3.3.2 TOUCH metal case to any grounded metal surface.
5.3 Operating Instructions (Cont.)

CAUTION

Failure to protect the thin end window when the beta cap is removed, may result in end window being easily torn or punctured.

NOTE - Rapid movement of the instrument can cause momentary measurement inaccuracy due to the effects of 1) inertia on the needle of the meter movement and 2) response time.

- When selecting the most sensitive range, switching noise may cause a temporary meter deflection. This can be avoided by first selecting a higher range, letting the needle settle and then switching to the lowest range.

5.3.4 TURN BW/BB CP’s selector switch to desired range AND

MOVE instrument slowly while observing meter response.

5.3.5 WHEN a measurement is to be performed at a particular location, ALLOW at least one time constant (5 seconds on lowest range) for the reading to stabilize on the final value.

5.3.6 POINT instrument toward all possible sources of radiation.

5.3.7 PERFORM window open (WO) and window closed (WC) radiation measurements.
5.3 Operating Instructions (Cont.)

NOTE - Applying correction factors is required when setting personal dose rates or as directed by Technical Work Documents. If not, the minimum 3 for beta and 1 for gamma is required. Use Attachment 2 to find the correction factors.

- Correction factors for temperature are required when the ambient temperature is less than 0 °C (32 °F).

5.3.8 **CALCULATE** shallow and deep dose rates as follows (include neutron dose contribution as applicable):

**LONG-FORM**

Deep Dose Rate = (WC * CF_{pen})CF_{temp} (see Section 5.4).

Shallow Dose Rate = [(WO-WC)CF_{nonpen} + WC * CF_{pen}]CF_{temp} (see Section 5.4).

Where:

WC = the instrument response with the window closed

WO = the instrument response with the window open

CF_{nonpen} = Nonpenetrating (i.e., beta) correction factor

CF_{pen} = Penetrating (i.e., gamma) correction factor

CF_{temp} = Temperature correction factor (Section 5.4)

5.3.8.1 **IF** WC indication is less than one tenth of the WO indication, **CALCULATE** shallow dose as follows for an estimate of Shallow Dose Rate:

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_{nonpen})CF_{temp}.
5.3 Operating Instructions (Cont.)

5.3.9 IF using BW/BB CP to evaluate contamination that exceeds the range of a Portable Alpha Meter (PAM), PERFORM the following:

5.3.9.1 REMOVE beta and alpha shields.

5.3.9.2 PLACE BW/BB CP window as close as possible to source of contamination, without touching.

5.3.9.3 ADJUST scale selector switch as necessary to obtain an on-scale response.

5.3.9.4 ALLOW meter reading to stabilize AND OBSERVE meter reading and estimated size of contaminated area being evaluated.

5.3.9.5 CONVERT observed reading to activity (dpm) using conversion chart on side of instrument.
5.4 Geometry Correction Factors

NOTE - Small Beam Correction Factors are used when the beam is too narrow to ionize the air in the chamber uniformly (i.e., beam diameter is less than 3 inches).

- Small beam correction factors are calculated as the ratio of the chamber cross sectional area to the beam cross sectional area.

- When measuring beams, the chamber axis should be parallel with the beam (beam must be coaxial with the chamber).

- Though beams are not typically observed with non-penetrating radiation, the beam correction factors are applied to both penetrating, or non-penetrating beam conditions.

Small-Beam Correction Factors

5.4.1 USE the BW/BB CP correction factor chart on the side of the instrument, except when CF_{non-pen} < 3.

5.4.1.1 WHEN CF_{non-pen} < 3, USE a minimum value of 3.

NOTE - Close Geometry Corrections Factors are used when the BW/BB CP measurements are taken with the BW/BB CP window less than 6 inches from the source.

Close Geometry Corrections Factors

5.4.2 IF the BW/BB CP window is less than 1 inch from the source, USE the correction factors provided in MA-562 and on the side of the BW/BB CP.

5.4.3 IF the measurements are for large uniform cylindrical sources (diameter > 18”) and large flat surfaces (diameter > 18”) that have uniform surface dose rate, USE a correction factor of 1 (CF_{pen} = 1) for penetrating radiation.

5.4.4 IF the BW/BB CP window is > 1” and < 6” from the source, USE a CF_{non-pen} = 3 and CF_{pen} = 1.5.

NOTE - Far Field Geometry Correction Factors are used when radiation fields are measured at distances ≥ 6” from the source.

Far Field Geometry Correction Factors

5.4.5 MULTIPLY all non-penetrating exposure rate (WO - WC) readings by 3 (CF_{non-pen} = 3).
5.5 Temperature Correction Factors

NOTE - Temperature Correction Factors are used when the BW/BB CP is used in an environment where the temperature is less than 0 °C (32 °F). The correction factors are given below.

- Temperature Correction examples are given on Attachment 1.

5.5.1 IF Temperature is 0 to 32 °F (-17 to 0 °C), MULTIPLY Instrument Response by 0.90.

5.5.2 IF Temperature is -20 to 0 °F (-29 to -17 °C), MULTIPLY Instrument Response by 0.85.
5.6 Records

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

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

    **OR**

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

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

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

5.6.1.3 **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.

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<td></td>
<td></td>
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</table>

<table>
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<tr>
<th>Signature</th>
<th>Print (First and Last Name)</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Line Manager (or designee)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Attachment 1 – Temperature Correction Examples

1. Determine the shallow dose rate on contact with a 0.5” source. The contact window open and window closed readings are \( W_O = 20 \text{ mR/hr} \) and \( W_C = 10 \text{ mR/hr} \), measured outdoors at a temperature of 5 °F.

   From the correction factor chart on the side of the BW/BB CP, the \( \text{CF}_{\text{non-pen}} = 90 \) and \( \text{CF}_{\text{pen}} = 40 \).

   \[
   \text{Shallow Dose Rate} = [(W_O - W_C) \times \text{CF}_{\text{non-pen}} + W_C \times \text{CF}_{\text{pen}}] \times \text{CF}_{\text{temp}}
   \]

   \[
   = [(20 - 10) \times 90 + (10 \times 40)] \times 0.90
   \]

   \[
   = 1.170 \text{ mRem/hr}
   \]

   \[
   = 1.2 \text{ Rem/hr}
   \]

2. A large drum (36” diameter) is being prepared for shipment. The window closed reading is \( W_C = 25 \text{ mR/hr} \) and is uniform over all exterior surfaces of the drum. The measurement is made indoors at a temperature of 70 °F. Determine the deep dose rate on contact with the drum.

   Because this is a large source (diameter > 18”), the penetrating correction factor is \( \text{CF}_{\text{pen}} = 1 \).

   \[
   \text{Deep Dose Rate} = W_C \times \text{CF}_{\text{pen}} \times \text{CF}_{\text{temp}}
   \]

   \[
   = 25 \times 1 \times 1 \text{ mRem/hr}
   \]

   \[
   = 25 \text{ mRem/hr}
   \]
### Attachment 2 – BW/BB CP Correction Factor Chart

<table>
<thead>
<tr>
<th>Diameter&lt;sup&gt;a&lt;/sup&gt; (in.)</th>
<th>Disc</th>
<th>Disc and Field</th>
<th>Cylinder&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Beam</th>
<th>Cylinder&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>β @ Contact</td>
<td>γ @ Contact</td>
<td>β @ γ ≥ 1 in.</td>
<td>γ @ ≥ 1 in., &lt; 6 in.</td>
<td>γ @ ≥ 6 in&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>&lt; ½</td>
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<td>10</td>
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<td>&gt; 3</td>
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</tbody>
</table>

**NOTE** – Correction factors for beta response for 47mm technical smears are listed on the calibration label.

<sup>a</sup> γ correction for source ≥ 18 in. = 1.0.

<sup>b</sup> Cylinder is on contact w/end of CP barrel; axis of cylinder is perpendicular to axis of CP chamber.

<sup>c</sup> Dimension is the cylinder length.

<sup>d</sup> For measurements at greater than 6 in., measure the distance between centerline of the instrument chamber and source.

**NOTE** – When determining correction factor values on the length of a cylinder that is between available lengths on the table (e.g. between the 4” and 8” choose the smaller length or 4” correction factor). When the diameter of the item is between two available values on the table (e.g. between 3” and 2” choose the smaller diameter or 2” correction factors).
Attachment 3 – Example Dose Rate to Alpha Contamination Conversion Chart