

Approved by:		
	General Manager	Radiation Safety Officer

STANDARD OPERATING PROCEDURE

15.OPS.07

OPERATION OF EXPOSURE RATE / DOSE RATE METERS

1.0 OBJECTIVE

To provide instruction for the operation of exposure rate or dose rate survey meters for the measurement of gamma radiation levels for receiving, free release, routine, and health and safety surveys.

2.0 SCOPE

This standard operating procedure (SOPs) applies to the operation of survey meters with internal probes only, such as the Ludlum Model 19 or 19A microR meter and the Thermo/Bicron MicroRem meter. These instruments may be used to determine ambient gamma radiation levels and worker exposure in facility areas and from packages or vehicles. These instruments may only be used in low radiation environments. Radiation environments which exceed the capabilities of these instruments are not anticipated.

3.0 POLICY

Instruments will be used in accordance with manufacturer's recommendations, SOPs, and site-specific requirements by trained personnel. The use of an instrument outside of its intended capabilities requires approval by the CHDT Radiation Safety Officer (RSO) or designee.

4.0 RESPONSIBILITIES

Responsibilities of the CHDT RSO, management, and staff are defined in the CHDT Radiation Protection Plan (SOP DR 15.RPP.01).

5.0 SURVEY DATA COLLECTION

The collection of survey data is discussed separately for the Ludlum Model 19 and Thermo/Bicron MicroRem below.

5.1 Use of MicroR Meter

5.1.1 Instrument Description

The Ludlum Model 19 microR meter contains a 1" diameter by 1" thick sodium iodide (NaI) detector within a aluminum housing. The instrument measures gamma radiation in units of microrentgens per hour ($\mu\text{R/hr}$). The front panel controls include a rotary switch for selecting the 5 decade range and instrument shut off, an audio on/off switch, a fast/slow response switch, and push buttons for activating the meter lamp, count reset, high voltage display and battery test. The meter scale and scale settings for the Model 19 are shown in Figure 1.



Figure 1. Model 19 Meter Face and Scale Settings

The scale settings and corresponding measurement ranges for the Model 19 are as follows:

- **25** – 0 to 25 $\mu\text{R/hr}$; use the bottom scale with a multiplication factor of 1.
- **50** – 0 to 50 $\mu\text{R/hr}$; use the top scale with a multiplication factor of 1.
- **250** – 0 to 250 $\mu\text{R/hr}$; use the bottom scale with a multiplication factor of 10.
- **500** – 0 to 500 $\mu\text{R/hr}$; use the top scale with a multiplication factor of 10.
- **5000** – 0 to 5,000 $\mu\text{R/hr}$; use the top scale with a multiplication factor of 100.

If the ambient radiation level exceeds 5,000 $\mu\text{R/hr}$ (5 milliroentgens per hour; mR/hr), the CHDT RSO or designee should be notified and work in the area should cease until further direction is received.

The Model 19A is a microR meter that only has a single scale setting, but works in a similar manner to the Model 19. The remainder of Section 5.1 is applicable to both the Model 19 and Model 19A, with the exception of any references to scale settings.

5.1.2 Instrument Setup and Initial Quality Control

Upon receipt of the instrument through purchase, rental, or receipt from annual calibrations, the following steps should be taken to initially setup the instrument and verify that it is in good working order.

- Verify that the instrument calibration is current; confirm that serial number on instrument matches that on the calibration certificate; confirm high voltage (HV) setting on instrument with calibration
- Perform ten (10) initial background quality control (QC) measurements
 - Use location away from radioactive sources
 - Set response to “S” for slow meter response
 - Using the lowest scale (**25**), depress the reset button (“RES”) and allow the needle to come to a rest (approximately 20 to 30 seconds). Record the measurement to the nearest tick mark, and repeat for 10 measurements.
 - Calculate the average plus and minus 20%. Subsequent background QC measurements must fall within this range. Typical background is between 5 and 20 $\mu\text{R/hr}$.
- Perform ten (10) initial source QC measurements
 - Use cesium-137 source in a repeatable geometry (i.e., orientation of the source relative to the meter).
 - Use same location as background measurements
 - Using an appropriate scale, depress the reset button (“RES”) and allow the needle to come to a rest (approximately 20 to 30 seconds). Record the measurement to the nearest tick mark, and repeat for 10 measurements.
 - Calculate the average plus and minus 20%. Subsequent source QC measurements must fall within this range.

5.1.3 Daily Instrument Quality Control

Each day that the instrument is used, the following QC checks and measurements must be performed and recorded.

- Check the battery by depressing the “BAT” button
- Check the HV against the calibrated HV
- Perform background QC measurement
 - Use same location as with initial QC measurements
 - Measurement must be within plus or minus 20% of the initial average
- Perform source QC measurement
 - Use same location and source geometry as with initial QC measurements

- Measurement must be within plus or minus 20% of the initial average

If either measurement does not fall within the required tolerances, turn the unit off, turn it back on, and repeat the measurement(s). If the unit fails a second consecutive time, remove the unit from service and notify the CHDT RSO or designee.

5.1.4 Collection of Survey Measurements

Survey measurements with the Model 19 may be collected as part of equipment or routine surveys. If the ambient radiation level of an area is being measured, the measurement should be collected at waist-level, or at a height of approximately 1 meter. If a package, container, or vehicle is being measured, the instrument should be placed in contact with the surface, provided that doing so does not present a cross-contamination concern.

When collecting a measurement of an unknown radiation field, use the “fast” response on the instrument and start with the highest scale setting, working downward until the lowest setting the measurement falls within is reached. At that point, switch the response to “slow” and read and record the measurement to the nearest tick mark.

5.1.5 Evaluation of Results

The use of Model 19 data in units of $\mu\text{R/hr}$ is acceptable for use in determining worker exposures under most circumstances. To convert $\mu\text{R/hr}$ to a dose rate in units of microrem per hour ($\mu\text{rem/hr}$), divide the Model 19 result by 1.07185. Since the assumption of a 1:1 $\mu\text{rem/hr}$ to $\mu\text{R/hr}$ ratio is conservative, it is generally acceptable to eliminate the conversion.

It should be noted that with the standard calibration using a Cs-137 source, the Model 19 may over-respond to low gamma energies, as shown in Figure 2. Measurements of naturally-occurring radioactive materials or of materials shielded by containers may result in an overly conservative estimate of the true radiation levels. The CHDT RSO or designee should be consulted if this appears to be an issue.

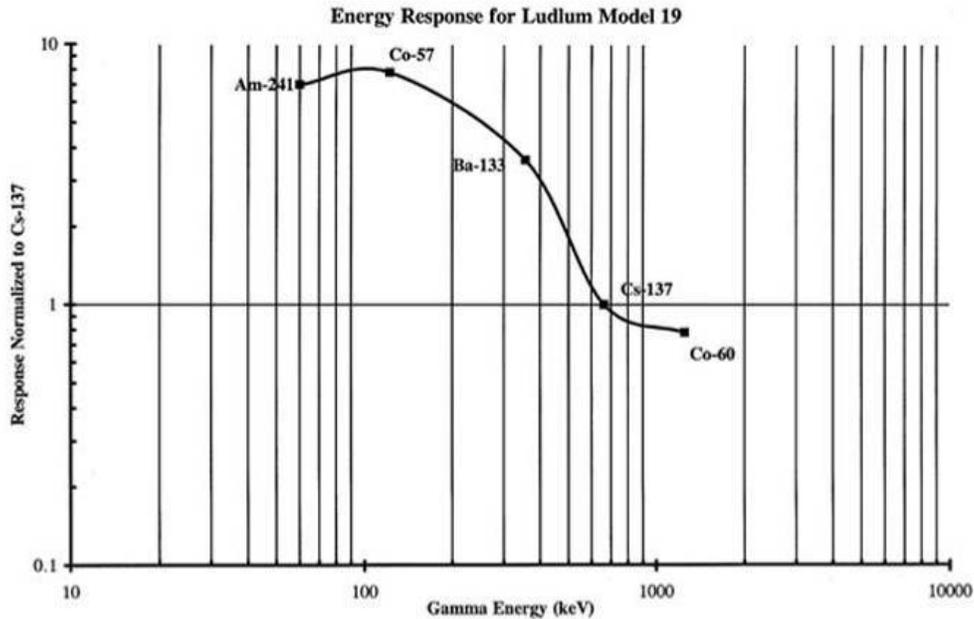


Figure 2. Model 19 Energy Response Curve

5.2 Use of MicroRem Meter

5.2.1 Instrument Description

The Thermo/Bicron MicroRem meter contains a tissue-equivalent organic scintillation detector within a aluminum housing. The instrument measures gamma radiation directly in units of absorbed dose rate (i.e., $\mu\text{rem/hr}$). The front panel controls include a rotary switch for selecting the 5 decade range, instrument shut off, battery test, and HV test; an audio on/off switch; a fast/medium/slow response switch; and a meter reset button.

The scale settings and corresponding measurement ranges for the MicroRem are as follows:

- **X0.1**– 0 to 20 $\mu\text{rem/hr}$
- **X1** – 0 to 200 $\mu\text{rem/hr}$
- **X10** – 0 to 2,000 $\mu\text{rem/hr}$ (0 to 2 millirem per hour [mrem/hr])
- **X100** – 0 to 20,000 $\mu\text{rem/hr}$ (0 to 20 mrem/hr)
- **X1000** – 0 to 200,000 $\mu\text{rem/hr}$ (0 to 200 mrem/hr)

If the ambient radiation level exceeds 2,000 $\mu\text{rem/hr}$ (2 mrem/hr), the CHDT RSO or designee should be notified and work in the area should cease until further direction is received.

5.2.2 Instrument Setup and Initial Quality Control

Upon receipt of the instrument through purchase or rental, the following steps should be taken to initially setup the instrument and verify that it is in good working order.

- Verify that the instrument calibration is current; confirm that serial number on instrument matches that on the calibration certificate; confirm high voltage (HV) setting on instrument with calibration
- Perform ten (10) initial background quality control (QC) measurements
 - Use location away from radioactive sources
 - Set response to “Medium” for slow and use
 - Using the lowest scale (**X0.1**), depress the reset button (“RES”) and allow the needle to come to a rest (approximately 20 to 30 seconds). Record the measurement to the nearest tick mark, and repeat for 10 measurements.
 - Calculate the average plus and minus 20%. Subsequent background QC measurements must fall within this range. Typical background is between 5 and 15 $\mu\text{rem/hr}$.
- Perform ten (10) initial source QC measurements
 - Use cesium-137 source in a repeatable geometry (i.e., orientation of the source relative to the meter).
 - Use same location as background measurements
 - Using the lowest scale (**X0.1**), depress the reset button (“RES”) and allow the needle to come to a rest (approximately 20 to 30 seconds). Record the measurement to the nearest tick mark, and repeat for 10 measurements.
 - Calculate the average plus and minus 20%. Subsequent source QC measurements must fall within this range.

5.2.3 Daily Instrument Quality Control

Each day that the instrument is used, the following QC checks and measurements must be performed and recorded.

- Check the battery by depressing the “BAT” button
- Check the HV against the calibrated HV
- Perform background QC measurement
 - Use same location as with initial QC measurements
 - Measurement must be within plus or minus 20% of the initial average
- Perform source QC measurement
 - Use same location and source geometry as with initial QC measurements
 - Measurement must be within plus or minus 20% of the initial average

If either measurement does not fall within the required tolerances, turn the unit off, turn it back on, and repeat the measurement(s). If the unit fails a second consecutive time, remove the unit from service and notify the CHDT RSO or designee.

5.2.4 Collection of Survey Measurements

Survey measurements with the MicroRem may be collected as part of equipment or routine surveys. If the ambient radiation level of an area is being measured, the measurement should be collected at waist-level, or at a height of approximately 1 meter. If a package, container, or vehicle is being measured, the instrument should be placed in contact with the surface, provided that doing so does not present a cross-contamination concern.

When collecting a measurement of an unknown radiation field, use the “fast” response on the instrument and start with the highest scale setting, working downward until the lowest setting the measurement falls within is reached. At that point, switch the response to “slow” and read and record the measurement to the nearest tick mark.

5.2.5 Evaluation of Results

Data provided by the MicroRem in units of $\mu\text{rem/hr}$ is appropriate for determining worker exposures to gamma radiation sources.

As shown in Figure 2, the Model 19 may over-respond to low gamma energies, resulting in an over-estimate of worker exposure. The response of the MicroRem is essentially energy-independent and therefore will provide a more accurate dose measurement.

6.0 STANDARDS AND CRITERIA

Specific exposure or dose rate limits may be established for the type of survey being performed. The CHDT RSO or designee should be consulted to determine the appropriate limits for any new activity.

An annual instrument calibration must be performed by the instrument manufacturer or other qualified vendor. Copies of the instrument calibration certificates must be maintained for a period of five years. Current calibration certificates should be maintained with the instrument daily QC measurement logs.

7.0 REFERENCES

Ludlum Measurements, Inc., Instruction Manual Model 19 MicroR Meter, Current Version.

Thermo-Electron, Inc., Instruction Manual MicroRem Meter, Current Version.