SECTION 7.4

BETA RADIATION MEASUREMENT

1.0 Purpose

To describe the method for measuring total beta radiation levels on equipment and other surfaces.

2.0 Responsibilities

- The site coordinator is responsible for assuring that the procedure is implemented.
- Survey team personnel are responsible for following this procedure.

3.0 Procedure

3.1 Equipment

✔ Portable ratemeter-scaler: Model PRS-1 (Rascal), Eberline Instrument Corporation; Model 2221 or 2223; Ludlum Instrument Corporation; or equivalent.

✔ Beta detector: Model HP-260 (GM "Pancake"), Model 43-68 (proportional) or Model 43-89, Ludlum Instrument Corporation; or equivalent.

✔ Cable: As appropriate (see Section 5).

✔ Alpha shield - The detector face may be covered with a thin layer of tracing paper to provide a total thickness of 7 mg/cm^2 and to increase the degree of protection of the detector face from accidental puncture and contamination, or to intentionally block alpha radiation. A 43-68 detector may be fitted with a 3.8 mg/cm^2 thickness mylar. The detector must be calibrated in the configuration that it will be used in the field.

✔ Record forms.

✔ Check source.

3.2 Operational Check-Out

3.2.1 Assemble detector unit. Purge detector model 43-68 before beginning operational check. Check battery and adjust high voltage and threshold. Follow procedures described in Section 5.

3.2.2 Check the background count rate and the detector response to the check source (if the check source response is outside the established limits, the unit is to be removed from service until the problem can be identified and corrected). Record the values on the daily Instrument Operational Check-Out Form (see Section 5).

NOTE: If the site background is not consistent with the predetermined response range, a new response range shall be established at the specific site and noted on the Instrument Operational Check-out Form, Figure B-1. The daily background count should be consistently measured on a surface in an area deemed appropriate by the site coordinator.

3.2.3 When applicable, calculate the "field action levels" for the instrument combination based on the specific site criteria and background.

Action Level (counts) = [site criteria (dpm/100 cm^2) x ϵ_{tot} x G x T] + B x T

B = background (cpm);

G = geometry = $\frac{\text{physical detector area } cm^2}{100}$;

HP-260 physical detector area = 20 cm^2
43-68 physical detector area = 126 cm^2
43-89 physical detector area = 117 cm^2

T = count time (min);

ϵ_{tot} = total efficency = $\frac{\text{counts}}{\text{disintegration}}$ = $\epsilon_i * \epsilon_s$

ϵ_i = instrument efficiency
ϵ_s = source efficiency; 0.25 for β_{max} < 400 keV or 0.5 for β_{max} > 400 keV

A field count at or above the calculated value indicates that further investigation of the area is necessary.

NOTE: For a particular site, the action level may be established as any activity exceeding background.

3.3 Measurements

3.3.1 Select an appropriate counting time. A counting time is desired which will achieve a minimum detectable concentration value less than 50% of the applicable criteria. For most radionuclides, a 1 minute count is appropriate.

NOTE: If the count must be corrected for alpha contribution, cover the detector face with an alpha shield. If correction for varying ambient gamma backgrounds is required, refer to step 3.4.

3.3.2 Instrument must be switched to beta mode when using 2223/43-89 combination.

3.3.3 Place the detector in contact with the surface being surveyed. Avoid placing the detector on surfaces with sharp projections which may puncture the thin detector face.

3.3.4 Set the meter timer switch, press the count reset button, and accumulate the count events until the meter display indicates that the count cycle is complete.

3.3.5 Record the gross count and time on the appropriate survey form (Figures B-9, B-12, B-13, B-14 or equivalent). Record the location, surface type and condition on Survey Form.

3.3.6 Calculate beta dpm/100 cm^2 by subtracting an appropriate material-specific background to obtain net counts and applying appropriate time, efficiency, and physical detector area factors.

$$\beta \text{ dpm}/100 \text{ cm}^2 = \frac{N}{T \times \epsilon_{tot} \times G \times \text{other modifying factors}}$$

N = net counts (counts);

G = geometry $\frac{\text{physical detector area cm}^2}{100}$;

HP-260 physical detector area = 20 cm^2
43-68 physical detector area = 126 cm^2
43-89 physical detector area = 117 cm^2

T = count time (min);

ϵ_{tot} = total efficiency $\frac{\text{counts}}{\text{disintegration}} = \epsilon_i * \epsilon_s$

ϵ_i = instrument efficiency

ϵ_s = source efficiency; 0.25 for β_{max} < 400 keV or 0.5 for β_{max} > 400 keV
Other modifying factors = corrections for the attenuation effects of overlying materials, surface types, etc. These factors may be incorporated into a revised ϵ_s.

NOTE: If a complete area scan has not been done, the area around the measurement location should be scanned to determine the homogeneity of the measured activity level in the area. Dimensions and activity levels of inhomogeneities should be documented on the appropriate survey forms (Figure B-9 or equivalent).

3.4 Shielded/Unshielded Measurements

NOTE: This procedure is followed when survey unit ambient background gamma radiation levels vary significantly from those in the reference area(s).

3.4.1 Perform steps 3.3.1 through 3.3.5 both with and without a minimum 3/8"-thick plexiglass shield on the detector face.

3.4.2 Record both shielded and unshielded gross counts, count time, location, surface type, and surface condition on the appropriate survey form (Figures B-9, B-12, B-13, B-14 or equivalent).

3.4.3 Perform step 3.3.6 after first calculating the value for N—using the appropriate reference material-specific R_{rm}, determined per Section 5.5, 5.6, or 5.7—as follows:

$$N = (R_{u,\,su} - R_{s,\,su}) - R_{rm}$$

where:

N = net counts
$R_{u,\,su}$ = unshielded survey unit count rate
$R_{s,\,su}$ = shielded survey unit count rate
R_{rm} = reference material count rate