## SECTION 7.7

## BETA MEASUREMENTS USING THE GM-BASED PIPE MONITOR

1.0 Purpose

To describe the method for measuring total beta radiation levels in embedded piping surfaces using the pipe monitor.

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: Four Model 2221s or 2223s; Ludlum Instrument Corporation; or equivalent.
- Pipe Monitor: ESSAP designed with four GM "Pancake"detector tubes.
- Cables: Four 50-foot C-BNC; or other connectors, as applicable.
- Rope (50 to 100 feet) and plumber's snake.
- Record forms.
- Check source.

3.2 Operational Check-Out

3.2.1 Assemble detector array and couple each detector to the appropriate ratemeter-scaler. Check battery and adjust high voltage and threshold. Follow procedures described in Section 5 of the Survey Procedures Manual.

3.2.2 Check the background count rates and the check source response for each detector (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 of the Survey Procedures Manual).

**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-26. 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 $cm^2$) × $,_{tot}$ × G × T] + B × T

B = background (cpm);

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

GM physical detector area = 20 $cm^2$
Pipe monitor array physical area = 336 $cm^2$

T = count time (min);

$,_{tot}$ = total efficency = $\frac{\text{counts}}{\text{disintegration}}$ = $,_i \times ,_s$

$,_i$ = instrument efficiency

$,_s$ = source efficiency; 0.25 for $\$_{max}$ < 400 keV or 0.5 for $\$_{max}$ > 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 Scanning and Measurements

3.3.1 Feed the plumber's snake with attached rope through the down-stream pipe access opening to the up-stream access opening survey start point. Attach the rope clip to the pipe monitor front eye-bolt. Pull the pipe monitor through the piping from the down-stream access point using the rope. As the monitor goes through the pipe, pause the monitor for 5 to 10 seconds at pipe-length intervals specified in the survey plan. A 100 % scan will require pausing the detector at intervals equal to the array length of approximately every 10 cm. Observe both the audio and digital display outputs of each ratemeter-scaler for indications of elevated count rates.

3.3.2 At judgmental, random or systematic locations, perform a measurement of surface activity. 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 faces with an alpha shield.

3.3.3 With the pipe monitor positioned at the measurement location, set each ratemeter-scaler timer switch, press the count reset buttons, and accumulate the count events until the meter displays indicate that the count cycles are complete.

3.3.4 Record the gross counts and times for each detector on the appropriate survey form (Figures B-9, B-12, B-13, B-14 or equivalent). Record the location (distance traveled into the pipe and the type and location of the pipe), surface type and condition on the Survey Form.

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

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

N = net counts (counts);

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

GM physical detector area = 20 $cm^2$

T = count time (min);

$,_{tot}$ = total efficiency $\frac{\text{counts}}{\text{disintegration}} = ,_i \times ,_s$

$,_i$ = instrument efficiency

$,_s$ = source efficiency; 0.25 for $\$_{max}$ < 400 keV or 0.5 for $\$_{max}$ > 400 keV

Other modifying factors = corrections for the attenuation effects of overlying materials, surface types, etc. These factors may be incorporated into a revised $,_s$.

**NOTE**: The surface activity results for the individual detectors are evaluated to determine the homogeneity of the measured activity level in the assessed area. Elevated activity in a single detector is indicative of a hot spot that may require the activity level to be recalculated using an efficiency developed for localized areas of contamination. This determination will be made by the site coordinator.

3.3.6 Calculate the average surface activity for the pipe monitor total assessed area by substituting the following in the surface activity equation: 1) N = the summed net count rate of the four individual detectors 2) $,_{tot}$ = the average total efficiency for the array 3) G = 3.36.