SECTION 11

SURVEY PROCEDURES

11.1 Measurement of Gamma-Ray Fields Using a NaI Detector.

Gamma radiation field strengths may be used to indicate contamination by gamma emitters. Elevated count-rate data must be carefully interpreted because uncontaminated areas can demonstrate high readings if they are next to an area contaminated with gamma emitters.

Using this procedure, it is possible to identify area or point sources of gamma-emitting radionuclides and determine whether an observed reading is due to shine from an adjacent source. These techniques are outlined below. It should be noted that these are considered gross screening techniques only, rather than determinate measures.

Count-rate data from a NaI detector can be converted to exposure rate (μR/hr) measurements if the detector has been correlated with a calibrated pressurized ionization chamber (PIC).

11.1.1 Preparatory Activities

(A) Visually inspect the equipment, including the connector cable, for breakage.

(B) Check the battery charge. If necessary, replace the batteries.

(C) Set the threshold to the value given on the calibration sticker.

(D) Set the detector voltage to the value given on the calibration sticker. The operating voltage for an NaI probe is usually 700 to 1000 volts.

(E) Note the response of the detector to the check source.

11.1.2 Field Equipment

* Portable ratemeter/scaler, Ludlum 2220 (or equivalent).

* NaI gamma scintillometer, Ludlum 44-10 (or equivalent).

* D-cell batteries (4).

* Connector cable.

* Hand-held calculator.

* Gamma check source.

11.1.3 Health and Safety. All surveying personnel will be required to wear personnel protective clothes, to include shoe coverings and latex gloves while performing wipe test. Each outdoor site will have a site control area. For details, see the Site Safety Plan.

11.1.4 Specific Protocols

11.1.4.1 Count Rate Measures. Record the gamma count-rate measurements taken with the NaI Detector on the USAEHA Sampling Sheet (Appendix B).

11.1.4.2 Recognizing Area and Point Sources. Walk slowly in the area of interest, holding the NaI detector waist high, and note the count rate. Compare the count rate obtained at waist height with the count rate obtained at ground level. If both count rates are above background and increase rapidly as the detector is held closer to the ground surface, the anomalous area may be an isolated hot spot with an area of only a few square feet. If the HOG is broad in extent and there is little difference in the count rate at ground level and waist height, the anomalous area probably is not highly localized.

11.1.4.3 Recognizing Gamma Shine from Nearby Anomalies. Walk slowly in the area of interest, holding the NaI detector waist high. If the count rate increases while leaving the area of interest, some of the gamma count rate observed at the area of interest may be due to shine from an adjacent gamma source. If the count rate increases (or stays the same) as the height of the detector above the ground increases, some of the gamma count rate at the area of interest may be due to shine.

11.1.4.4 Postoperation

(A) Turn all switches to the off position.

(B) Ensure that all equipment is accounted for, decontaminated, and ready for shipment.

(C) If necessary, make sure all survey or sampling locations are properly staked and the location ID is readily visible on the location stake.

(D) Record any uncompleted work (like additional monitoring) in remarks section of sampling form.

(E) Review Data Collection Forms for completeness.

11.2 Wipe Sampling for Removable Contamination

This procedure provides guidance on using wipe sampling to test for removable contamination of surfaces that may have been contaminated with radioactive material.

Interior surfaces must be radiologically surveyed before the building is released for unrestricted use. The radiological survey includes measuring the total activity with a field instrument and the removable component of the total activity by wipe sampling. The results of the wipe sampling are compared against the limits for removable surface contamination (see Table 11-1).

11.2.1 Preparatory Activities. Complete the USAEHA Instrumentation Sheet (Appendix C).

11.2.2 Field Equipment

* Round swipe pads, 2-inch diameter.
* Sample holders or glassine envelopes.
* Indelible marker.
* Latex gloves.
* Alpha/Beta probe.
* Portable scaler and connecting cable.
* Forceps (for handling contaminated swipes).
* NIST-traceable source.
* Hand-held calculator.

11.2.3 Health and Safety. All surveying personnel will be required to wear personnel protective clothes, to include shoe covers and latex gloves while performing wipe tests. Each outdoor site will have a site control area. For details, see the Site Safety Plan.

Table 11-1

Average Limits for Removable Surface Contamination

Nuclide[a]	Removable[b c]
U-nat, U-235, U-238, and associated decay products	1000 dpm α/100 cm^2
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, and I-129	20 dpm/100 cm^2
Th-nat, Th-232, Sr-90 Ra-223, Ra-224, U-232 I-126, I-131, and I-133	200 dpm/100 cm^2
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above	1000 dpm ß /100 cm^2

[a] Where surface contamination by both alpha- and beta-gamma emitting nuclides exists, the limits established for alpha- and beta-gamma emitting nuclides should apply independently.

[b] As used in this table, disintegrations per minute (dpm) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[c] The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an

appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally. The entire surface should be wiped.

Reference: Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use of Termination of Licenses for Byproducts, Source, or Special Nuclear Material, U.S. Nuclear Regulatory Commission, Nov 1976.

11.2.4 Specific Protocols

11.2.4.1 Swipe Test

(A) Labeling will be done as specified in Appendix B. Make sure a sufficient number of swipes are available for the desired tasks.

(B) If swipes are to be taken in a controlled area, wear appropriate protective clothing. Consult the Health and Safety Plan for the level of protection. Latex gloves will be changed for every sample.

(C) Use sufficient pressure on the swipe to pick up loose contamination without tearing or separating the swipe.

(D) During routine swipe surveys, pay particular attention to areas on equipment where contamination is most likely to occur (for example, handles, footrests, and tires).

(E) Return the swipe to a properly labeled glassine envelope. Maintain the swipe integrity and ensure that the sample material is not dislodged from the swipe.

(F) Counting will be accomplished IAW CECOM SOP.

11.2.4.2 Postoperation. Follow postoperation instructions in section 11.1.4.4. Insure that all forms are completed.

11.3 BETA-GAMMA RADIATION MEASUREMENTS USING A GEIGER-MUELLER (GM) DETECTOR

Portable GM counters have battery-operated power supplies and amplifiers. The sensitive element is a small Geiger tube contained in a probe. The probe is attached to a ratemeter/scaler that has several different scales, a time-response switch, and an audible output.

Two GM probe configurations are described in this procedure: a pancake probe and an energy-compensated tube. The pancake probe consists of a flat, thin windowed GM tube in a shielded housing. It measures radiation coming primarily from in front of the thin window and is used for measuring beta-gamma contamination on surfaces. The energy-compensated probe is typically a thick-walled GM tube measuring 4 to 6 inches long that is covered with a material of sufficient thickness to allow consistent measurement over a broad energy range. The GM tube measures radiation from any direction and absorbed dose rates from beta-gamma radiation fields of energies greater than about 100 kilo-electron volts (keV).

GM counters have several characteristics that can lead to erroneous results, unless the user is aware of them.

* At high radiation levels, the counter will not recover from a count soon enough to measure the next entering particle. This causes a decreased response at higher radiation levels; at extremely high levels, the response may no longer increase with increased radiation. In certain cases, the response may decrease or go to zero at very high levels.

* At extreme temperatures, the instrument may respond erratically or not at all. Under these conditions, a check source is needed to ensure reliable behavior.

* The GM tube is delicate and sensitive to damage if dropped or exposed to significant changes in air pressure. If a rattling sound is heard when the user blows air across the probe face, it is likely that the tube has broken. To avoid a common means of tube breakage, do not ship the probe in an unpressurized airplane.

11.3.1 Preparatory Activities

Take six to ten background counts to ensure that the probe is not contaminated and to determine contamination criteria. For detail instructions (see background study - section 10).

11.3.2 Field Equipment

* GM pancake probe (Ludlum 44-9 or the equivalent).

* Ratemeter/scaler (Ludlum 2220 or the equivalent).

* Energy-compensated GM (Ludlum 44-38 or the equivalent).

* Cable

* Beta source (TC-99, Sr-90 or the equivalent).

11.3.3 Health and Safety. All surveying personnel will be required to wear personnel protective clothes, to include shoe coverings and latex gloves while performing wipe test. Each outdoor site will have a site control area. For details, see the Site Safety Plan.

11.3.4 Specific Protocols

11.3.4.1 Obtaining Measurements

(A) Record beta-gamma measurements with the GM detector on the USAEHA Sampling Sheet in Appendix B.

(B) Place the GM probe at a small distance (1 cm) from the location to be monitored.

NOTE: The thin window of the probe is easily punctured. Care should be taken to protect the surface from sharp objects.

(C) Take a count of predetermined duration (0.5 min to 2 min) and record the count rate.

11.3.4.2 Postoperation. Follow instructions in section 11.1.4.4.

11.4 EXPOSURE RATE MEASUREMENTS USING A PIC

This procedure describes the equipment and proper method to determine the gamma exposure rate at a height of one meter above the soil or other surfaces using a PIC.

The PIC is an extremely accurate instrument for measuring gamma radiation exposure rates in the field. The PIC can be used to field calibrate or standardize portable instruments (like hand-held scintillometer) measuring exposure rates.

11.4.1 Preparatory Activities

Assemble the equipment and supplies listed in subsection 11.4.2. Ensure the proper operation of all field equipment. Follow the steps below to check the PIC:

1. Turn on the display/recorder switch.

2. Turn the electrometer switch to zero.

3. Turn the mode switch to the BATT position.

4. Depress the push-to-read switch (located below the digital display device) and the switch designated 300 volts (V) simultaneously.

5. If the digital display shows less than 85 (as a percent of the charge), replace the 300 V battery according to the operational manual.

6. Check the charge on the -14 V, +14 V, and 12 V lead-acid batteries by depressing the switch immediately below the voltmeter for each battery. If the needle is on or near the shaded area of the meter, recharge these batteries before proceeding.

11.4.2 Field Equipment

* Reuter-Stokes PIC or equivalent PIC and associated equipment.

* Reuter-Stokes PIC operational manual

* Stopwatch

* Hand-held calculator

11.4.3 Health and Safety. All surveying personnel will be required to wear personnel protective clothes, to include shoe coverings and latex gloves while performing wipe test. Each outdoor site will have a site control area. For details, see the Site Safety Plan.

11.4.4 Specific Protocols

11.4.4.1 Exposure Rate Measurements

(A) Place the mode switch in the DC position.

(B) Place the electrometer switch in the zero position and wait 60 sec.

(C) Place the electrometer switch in the read position.

(D) Turn the recorder on (if recorder is included).

(E) Reset the mechanical counter and start the stopwatch simultaneously.

(F) After about 10 min and at the time that the counter indicates the next 1 μR integral, record the elapsed time and exposure.

(G) Determine the exposure rate in μR/hr with the formula shown below.

$$\text{Exposure rate } (\mu\text{R/hr}) = \frac{60 \text{ (min)}}{\text{hr}} * \frac{\text{exposure recorded by PIC } (\mu\text{R})}{\text{count time (min)}}$$

(H) Perform a background measurement. Normal background readings at sites not exhibiting high radionuclide content may range from 5 to 20 μR/hr because of cosmic and terrestrial radiation. Measurements taken in areas of known background exposures that are outside of this range may indicate a mechanical problem in the instrument and should be investigated.

(I) Record the exposure rate and the other information on the USAEHA Sampling Sheet in Appendix B.

11.4.4.2 Postoperation. Follow postoperation instructions covered in subsection 11.1.4.4.

11.5 TOTAL ALPHA SURFACE CONTAMINATION MEASUREMENTS

This procedure provides guidance for determining levels of total surface alpha contamination on surfaces, equipment, and personnel that have been in contact with material that was potentially contaminated with alpha-emitting radionuclides. Procedure 11.2 discusses wipe sampling for the removable portion of alpha contaminants.

Equipment and vehicles must be monitored for contamination before release from radiologically controlled areas for unrestricted use. Levels of total and removable alpha contamination on equipment will be determined and compared to release criteria in "Guideline for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of License for Byproduct, Source, or Special Nuclear Material", by the NRC. The limit for alpha activity applies to natural uranium, U-235, U-238, and associated decay products and is 5000 dpm/100 cm^2

averaged over 1 m^2 or 15,000 dpm/100 cm^2, not to exceed an area of 100 cm^2. Limits for other radionuclides apply to alpha, beta, and gamma radiations, and some are set below the detection limits for portable instruments. As a result, the applicable release criterion for alpha contamination is the minimum detectable activity above background as measured by a direct-reading alpha scintillation detector with a minimum efficiency of 20%. This measurement typically equals about 350 dpm/100 cm^2.

Equipment must be decontaminated to levels that are as low as reasonably achievable and below the applicable release criterion in all cases. Personnel must be monitored for contamination before leaving a controlled area and decontaminated to the lowest reasonably achievable levels.

High-voltage plateau curves and NIST traceable source calibrations must be performed on the detector semiannually to ensure proper operation. Alpha detector counting efficiencies must be determined daily before using the instrument. The counting efficiency is used to convert instrument readings to a measure of activity in units of dpm per 100 cm^2.

11.6.1 Preparatory Activities

(A) Complete the USAEHA Instrumentation Sheet by following instructions in Appendix C.

(B) While counting samples or performing surveys, the alpha probe may be contaminated, causing the background count rate to increase. If this is suspected, repeat the background count. If the background count rate is more than 50% above the average value, the detector should be cleaned.

Calculate the lower limit of detection(LLD) using the formula:

$$\text{LLD (dpm/100 cm}^2\text{)} = \frac{2.71 + 4.66\sqrt{B/T}}{E \times G}$$

B= Background
T= Count time (min)
E= Efficiency (counts/disintegrations)
G= Geometry (probe area cm^2/100)

The actual field count time is used here and is usually 1 minute. Use an average efficiency for the instrument determined with the

lowest activity source. This formula calculates the activity level in dpm/100 cm^2 which can be detected with 95% confidence of having neither a false positive nor a false negative result.

Compare this value to the site guidelines to determine adequate sensitivity of the instrumentation. The LLD should be less than 75% of the applicable criteria.

11.6.2 Field Equipment

Alpha scintillation probe (Ludlum 43-5 or the equivalent)

Ratemeter/scaler (Ludlum Model 3 or the equivalent)

Alpha check source (Am-241 or the equivalent)

Data forms

Voltage meter

Hand-held calculator

Tape measure

11.6.3 Health and safety. All surveying personnel will be required to wear personnel protective clothes, to include shoe coverings and latex gloves while performing wipe tests. Each outdoor site will have a site control area. For details, see the Site Safety Plan.

11.6.4 Specific Protocols

11.6.4.1 Total Alpha Survey. Complete the USAEHA Sampling Sheet by following instructions in Appendix B.

11.6.4.2 Postoperation. Follow postoperation instructions covered in subsection 11.1.4.4.

11.6.4.3 Completion of the USAEHA Instrumentation Sheet, see instructions in Appendix C.