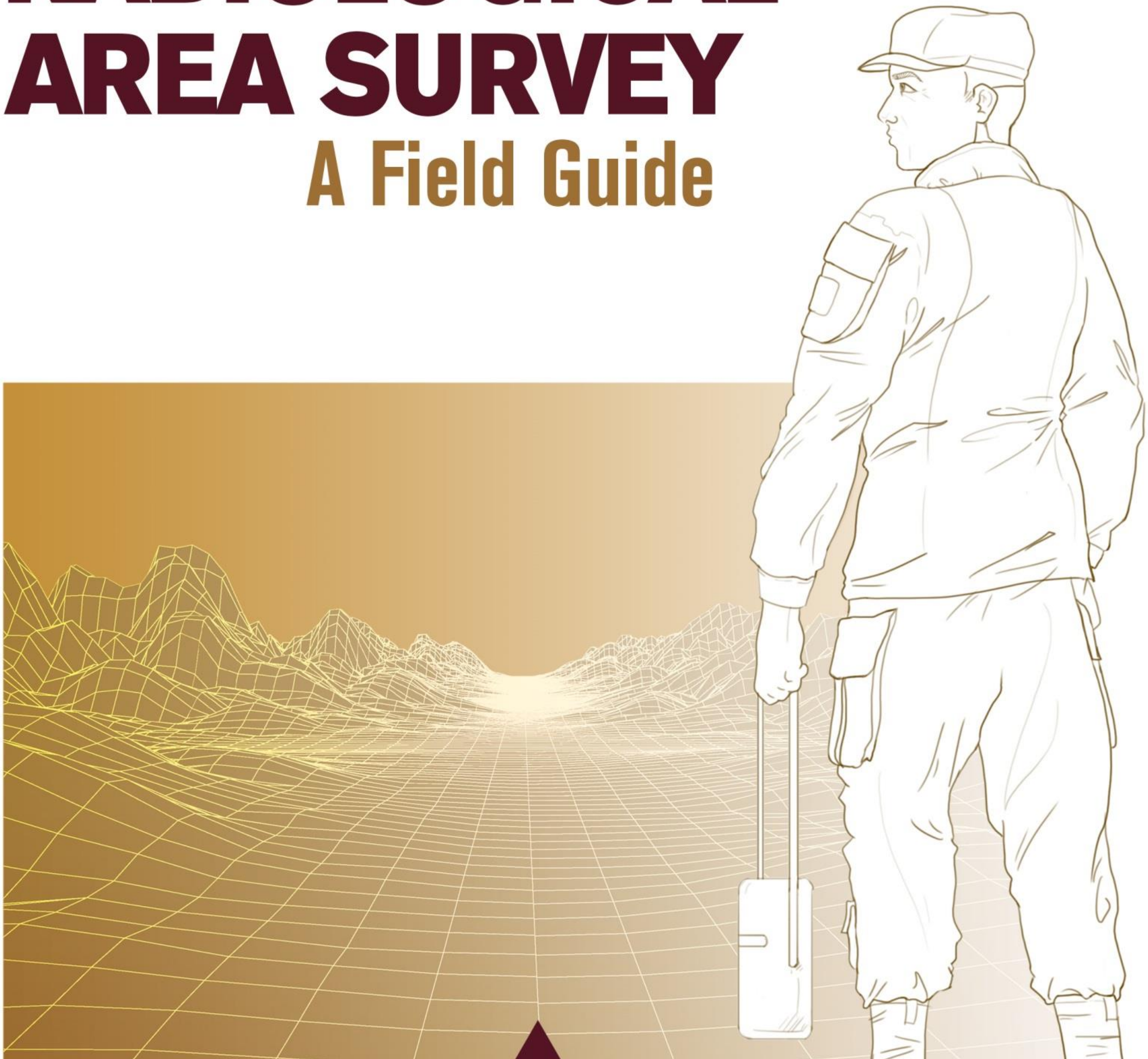
TG 236

RADIOLOGICAL AREA SURVEY

A Field Guide



APHC

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U.S. Army Public Health Center

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Chapter 1. Introduction

1.1. Overview

The following overview presents brief summaries of each chapter to assist in using this technical guide:

- Chapter 1 presents a basic overview of the reasons for creating this technical guide, the intended audience, the scope of the guide, the expected results of an assessment, personnel requirements, and disclaimers or limitations of the entire assessment process.
- Chapter 2 discusses health and safety in relation to performing a radiological assessment. This chapter reminds the user to be aware of all potential hazards in the field, not just radiological hazards.
- Chapter 3 gives guidance for the user experienced in general surveying and sampling. It includes checklists and datasheets for fast review so that the experienced user can start on a radiological assessment.
- Chapter 4 provides general guidance on radiation surveying and sampling for a radiological area survey. The chapter offers information on the basic supplies for sampling and surveying, selecting and setting up the survey unit, background measurements, instrumentation, and quality assurance.
- Chapter 5 has tables, equations (if needed), and guidance aimed to help the user evaluate the field data in a timely manner and communicate the results to the Command staff.
- Chapter 6 covers contamination control procedures, including instructions on setting up a monitoring station, frisking and decontaminating people and equipment.
- Chapter 7 includes the care and use of the AN/PDR-77 and AN/VDR-2 RADIAC meters.
- Chapter 8 provides the user with enough information to collect soil samples, avoid cross-contamination, pack and label samples, establish and maintain chain-of-custody, and prepare the samples to from the survey unit for further handling.

- Chapter 9 includes most of the information required for preparing samples for shipping to a CONUS or an OCONUS laboratory. The user must be aware of the current national, international, Army, DOD, transportation regulations.

- Chapter 10 summarizes NATO guidance on collecting soil samples. It is not a substitute for onsite expertise, but the guidance is useful for the less experienced user.

- Chapter 11 presents an example and a practical guide of the requirements for shipping samples to U.S. Army Public Health Center (APHC). Although written specifically for the laboratory at the APHC, many of the requirements are general enough for use by other laboratories.

- Appendices A through I contains additional information that will be useful to people who use this document. In particular, the removable survey packet in Appendix C can be copied as many times as the user needs. The rest of the appendices contain definitions, points-of-contact, summaries of regulations and other procedures.

1.2. Background

Traditional chemical, biological, radiological, nuclear and high explosive (CBRNE) doctrine was developed to address radiological conditions, such as the use of nuclear weapons, on the battlefield that might lead to degradation of mission performance of soldiers or units. As the United States has become more involved in support and stability operations (SASO), concern regarding the potential long-term health hazards of deployment has risen among the troops and the leadership.

In response to this concern, the medical community has developed ways to detect, assess, and record potential health risks. This guide focuses on estimating the exposure to external ionizing radiation and associated health risk. Complying with the principle of ALARA must be done in the context of managing risk from all sources. Commanders must balance risk management with the requirement of completing the military mission.

A risk management tool to track and limit radiation exposures was developed. Radiation Exposure Status (RES) is used to track unit exposure level, while the Operational Exposure Guidance (OEG) is the commander’s primary administrative control used to limit radiation exposure to personnel for a given mission. The RES is defined as the average exposure of a platoon or larger unit, categorized by levels of performance decrement, or decreasing level of unit mission effectiveness. The OEG is the commander's tool for expressing his willingness to accept risk expressed as a radiation dose equivalent or absorbed dose. The commander has the responsibility of defining the level of exposure that is not be exceeded in performing a given mission (Joint Chiefs of Staff, 2013).

The NATO Standardization Agreement (STANAG) No. 2473, *Commanders Guide on Low Level Radiation (LLR) Exposure in Military Operations* (NATO, 2004), created additional RES categories for use during SASO or operations other than war. RES category 1 was broken down into five subcategories that parallel regulatory and federal guidance, which is founded on minimizing long-term health consequences of exposure to radiation. RES category 1 was broadly defined in doctrine as a level of exposure that would lead to little, if any, loss of combat effectiveness, or immediate short-term effects. The extended RES categories as defined in STANAG 2473 are intended to bridge the gap between peacetime operations and operations conducted during war. STANAG No. 2521 (NATO, 2010) replaced STANAG No. 2473 and uses the same RES categories.

This Technical Guide (TG) is designed to give methods for the public health (PH) community to evaluate radiological dose. The methods presented in this TG require minimal resources and give a quick estimate of the maximum duration of a mission before exceeding the OEG.

1.3. Applicability

The audience for this document is primarily PH personnel. Without assigning tasks, which is beyond the scope of this technical guide, the expected operational roles are Preventive Medicine Science Officers (67C designation), Preventive Medicine Specialists (68S designation), or Nuclear Medical Science Officers (NMSO; 72A designation). These personnel will perform the radiation survey, conduct direct supervision, check the calculations, and make conclusions based on the data. They will then track, document, and communicate the developed information to the command staff as appropriate.

This TG designed for use in situations when a commander wants to temporarily occupy a piece of land or building. Using this guide makes it possible to relate simple measurements to a maximum duration to which land or buildings can be occupied. This procedure has been designed so that two trained personnel equipped with the AN/VDR-2 or AN/PDR-77 have: (1) gross screening capability for acute radiation threats as provided by CBRNE doctrine; and (2) the capability for collection of samples that will be sent back to higher echelon assets for further, more refined analyses. With proper training, personnel will be able to answer the following questions in a timely manner:

- Is there an immediate threat to life and health?

- What are the ambient external gamma radiation levels in the area?
- Is there an indication that a radioactive source or contamination is present?
- What is the estimated personnel radiation dose from external radiation exposure?
- Can the mission be accomplished within the specified OEG, and what is the maximum mission duration given the OEG?

The answers to these questions indicate that a commander may need to consider the following:

- Changing the OEG,
- Canceling the mission,
- Adjusting the mission duration,
- Finding alternate routes or bivouac areas,
- Rotating work schedules, and
- Calling for a higher-level radiation survey and assessment to refine the dose estimate and subsequently the estimate of potential health risks.

Minimum personnel requirements to conduct a radiological area survey are a trained PH noncommission officer or officer and an assistant (from the PH community). This radiological area survey method was designed based on use of the AN/VDR-2 or the AN/PDR-77 (Beta/gamma probe and x-ray probe).

The radiological area survey team is expected to execute the following tasks:

- Using and maintaining the equipment in accordance with the manual;
- Following quality assurance and quality control (QA/QC) procedures appropriate for equipment and procedures;
- Designing and performing radiation surveys as described in this document;
- Planning, coordinating, and executing environmental sampling (soil and water) for shipment to and analysis by higher echelon assets. Prior coordination with the element that will analyze samples will avoid misunderstandings and enhance data quality;
- Comparing results of radiation survey and analyses to pre-set action levels; and
- Communicating results of the radiation survey and analyses as ordered by command staff.

The personnel involved in a radiological area survey may include Preventive Medicine Science Officers (67C), Preventive Medicine Specialists (68S) and APHC personnel (to use the data to offer assistance for a more detailed radiation survey or analysis). Normally, theater level commanders (or higher) make the decision concerning the OEG for a mission and its duration. The radiological area survey should result in data that will estimate either the maximum potential radiation exposure or the mission duration for a specified OEG.

1.4. Disclaimers

The AN/PDR-77 displays exposure rate in multiples of milliroentgen per hour (mR/hr) and the AN/VDR-2 displays absorbed dose rates in multiples of gray per hour (Gy/hr). For simplicity and because only whole body gamma irradiation is considered, the roentgen, rad, rem, and centisievert are considered to be equivalent units of radiation dose.

Thus, 1 R ≈ 1 rad ≈ 1 rem ≈ 0.01 Gy = 1 cGy = 10 mGy ≈ 0.01 Sv = 1 cSv = 10 mSv for the purposes of this TG.

- Further complicating the issue is the fact that the AN/PDR-77 is calibrated to absorbed dose rates in rad/h, despite the units of mR/h on the faceplate.
- This technical guide was designed to be consistent with existing doctrine including NATO STANAG 2521; however, this TG is not an implementation document. It presents a preferred and consistent set of procedures for collecting and performing basic analysis of data.
- Established doctrine prevails over anything in this TG.
- It is the user's responsibility to understand the contents of this technical guide and get help if needed.
- Any mention of a trademarked product name, tradename, commercially available product or service is not an official endorsement.

Chapter 2. Health and Safety Issues

The battlefield is an inherently hazardous place. Be aware of battlefield hazards such as unexploded ordnance (UXO), confined spaces, environmental hazards, poisonous plants, venomous insects and snakes, toxic chemicals, gunfire, and unsanitary conditions before undertaking radiological area surveys. The procedures in this document should not be undertaken if they endanger the health and safety of personnel, unless so ordered by the commander.

Several precautions can help minimize the radiological risk to the radiation surveyors during a radiological area survey. Surveyors must be aware of potential radiological hazards that might not be detectable by their instrumentation; TG 238 is a useful reference to aid in identifying potential hazards (APHC, 1999). For example, if elevated alpha activity is present or is suspected to be present, higher echelon assets must be notified as soon as possible. All radiation surveyors should have an operating $\beta\gamma$-probe and should be watching the dose rate while approaching any potentially contaminated area. The list below outlines health and safety precautions from *NATO Handbook for Sampling and Identification of Biological, Chemical and Radiological Agents (SIBCRA)* (NATO, 2015).

- ALWAYS be aware of the hazards that you may encounter in the field and take the necessary precautions.
- NEVER attempt any field activities without the appropriate safety equipment. Always know how to use it.
- Use the buddy system; do not become separated from the radiation survey team.
- All activities SHALL BE conducted so that exposures are maintained as low as reasonably achievable (ALARA).
- BE AWARE of turn back dose-rates and radiation exposure status.
- BE CAUTIOUS proceeding to areas where the dose-rate is greater than 10% of the OEG/mission duration.
- You SHALL NOT proceed to areas in which the dose-rates exceed OEG divided by mission duration unless commanded otherwise.
- You SHALL EXIT the contaminated area when your dose exceeds 90% of the OEG, unless commanded otherwise.
- USE time, distance, and shielding radiation safety principles to protect personnel.
- DO NOT eat, drink, or smoke in any contaminated areas.
- DO NOT take unnecessary risks; no sample is worth dying for. [*sic*]
- Follow additional command guidance.

The following list is a reminder of things to keep in mind when performing radiological surveys (Lawrence Livermore National Laboratory, 1998).

- **Immediate or serious radiological threats to health and safety**
    - Exposure to high radiation fields from high-level radiation sources; for example, from energized radiation-generating devices, such as an accelerator, an industrial radiography machine, or from nuclear fallout.
    - "Beta burns" from nuclear fallout particles.
    - Ongoing exposure to smoke plume from fire/explosion involving plutonium or spent fuel from a nuclear reactor.
    - Ongoing exposure to a potentially high-concentration fission product released from a nuclear reactor accident.
    - Local intense radiation fields from physically small radiation sources (e.g., industrial radiography and medical cancer therapy sources).

- **Potential threats or near-term concerns**
    - Possibility of nuclear weapon detonation (nuclear yield).
    - Possibility of a nuclear criticality accident (addition of water, change in geometry).
    - Threat of fire or explosion from explosives, fuel sources, or chemical reactions.
    - Resuspended airborne contamination from ground, foliage, clothing, or surfaces. Mechanisms for resuspension include changes in wind direction or speed, human activity such as plowing, excavation, vehicle traffic, or propwash, and forest fire or wildfire.
    - Change in shielding configuration leading to a loss of shield integrity and potentially high radiation fields.
    - Release of volatile radionuclides (examples: iodine and cesium) or gaseous radionuclides (e.g., tritium and krypton).
    - Spread of surface contamination (examples: personnel, vehicles, clothing, or objects).
    - Contamination of hospitals or emergency vehicles (ambulance, fire, etc.) during the transfer of contaminated patients to nearby medical facilities.

- **Interim or long-term concerns**
    - Contaminated run-off from firefighting.
    - Contaminated crops.
    - Contaminated livestock feed.
    - Contaminated drinking water supply.

- Contaminated irrigation water.
- Contaminated fish/shellfish.

- **Miscellaneous concerns**
  - Contaminated wounds (including imbedded fragments of radioactive materials) or breaks in the skin.
  - Contact with contaminated solvents.
  - Increased hazard due to change in chemical state (e.g., oxidation of elemental tritium in a fire).

Chapter 3. A Quick Guide to a Radiological Area Survey

3.1. Introduction

The quick guide assumes that you and your team are already familiar with radiological sampling and radiation surveying techniques. ***You and your team must be aware of all of the health and safety issues involved with your radiation survey. General health and safety are covered in Chapter 2***. Before beginning a radiological radiation survey, make sure that you understand the following flowchart and checklist on the next page. The flowchart in Figure 1 describes the overall process necessary to conduct a radiation survey. The dashed connections in Figure 1 are suggested routes of communication. It is extremely important to contact a health physicist or NMSO early in this process. Whenever possible, contact the Health Physics Division at APHC when starting a survey. See Appendix I for a list of contacts and Chapter 4 for detailed guidance on radiation surveying and sampling.

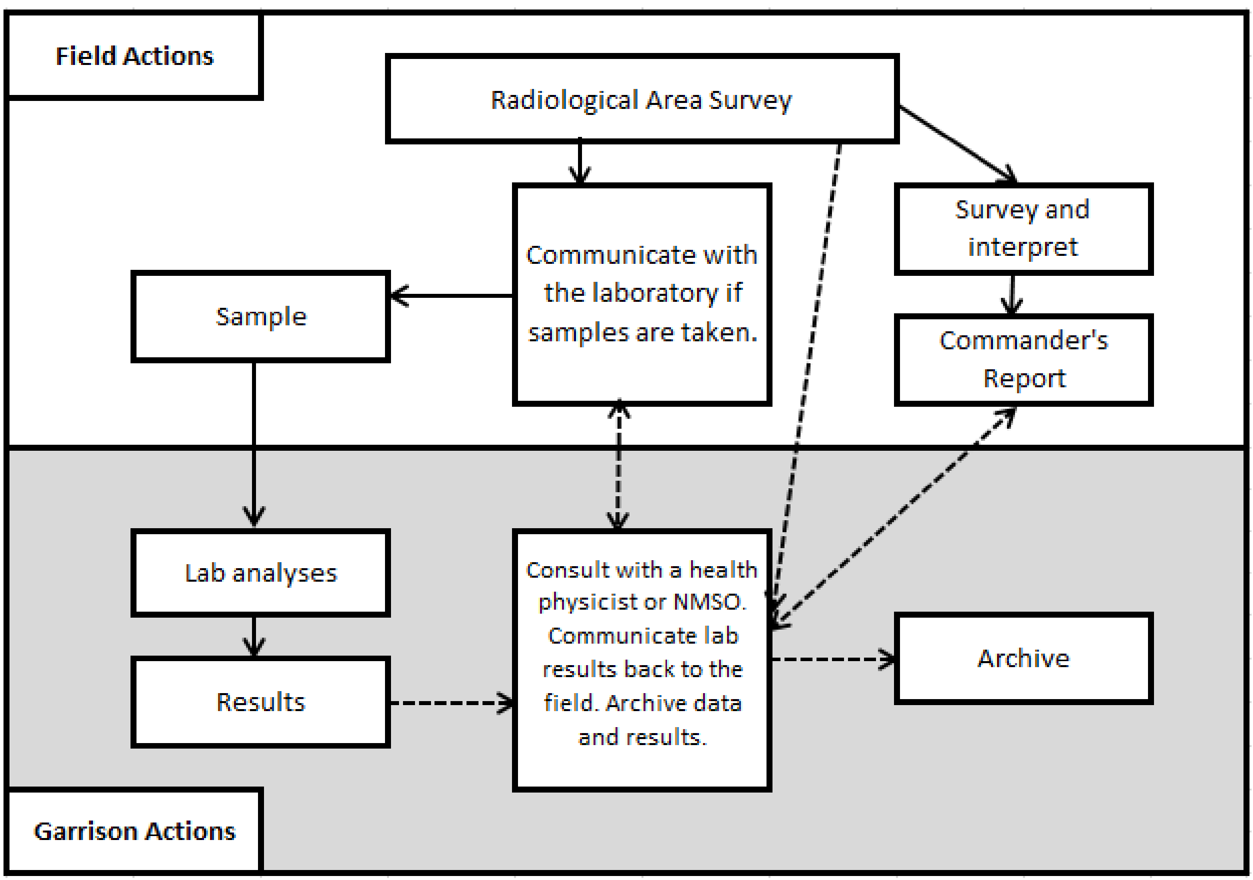

Figure 1. Radiation Survey Process Flowchart

Field actions are those actions that are expected to take place in the area of operations. These actions include sampling, surveying, shipping, communicating, and interpreting the data.

Garrison actions are those actions that are expected to take place CONUS or at laboratories or other facilities OCONUS far from the area of operations. The garrison is where samples are sent for analysis, specialist advisors work, and an intended archive will be established.

A request for an assessment should prompt an alert to a NMSO or health physicist. If collecting samples is anticipated, the laboratory needs to be notified. The laboratory personnel can advise the team on what the sample requirements are for proper analysis. The team should gather preliminary information about the survey unit, do the survey, evaluate the data in accordance with this technical guide, and report the results to the commander or command staff. The NMSO or health physicist will be able to aid in interpreting the data for the command staff. Meanwhile, once the soil sample analyses are complete, the results will be communicated through the advisor to the command staff. Finally, the assessment results, data, and perhaps samples should be archived for future reference.

3.2. Checklist for a Radiological Area Survey

The checklists, instructions, and data sheets in this section are for review only. A removable survey packet is in Appendix C.

- ☐ Review APHC TG 236.
- ☐ Inform APHC or NMSO that you are starting a radiological area survey. If samples are to be collected, inform the laboratory. APHC points of contact are shown in Appendix I, and APHC Laboratory Sciences Directorate (LSD) points of contact are shown in Chapter 11.

CAUTION: If elevated alpha activity is present or suspected to be present, higher echelon assets must be notified as soon as possible.

- ☐ Gather supplies (See Chapter 4, section 4.1.)
- ☐ Review the instructions for using the Radiation Survey Data Table on page 27.
- ☐ Record the check source measurements in section b of the Radiation Survey Data Table. If this reading is within 30% of the value on the calibration sheet, proceed with the radiation survey. If not, see Chapter 4 section 4.8.

☐ Gather and document any information you can about the area to be radiation surveyed.

☐ Fill the Radiological Site Assessment Sheet on page 23 (do not use classified information in an unclassified environment).

☐ Record the meteorological data on the day of the radiation survey.

CAUTION: If anything in this plan endangers the life or health of personnel, the plan should not be undertaken unless so ordered by the commander. See Chapter 2.

☐ Go to a staging area near the area to be radiation surveyed.

CAUTION: Be aware of non-radiological battlefield hazards before undertaking this radiation survey. Examples of these hazards are unexploded ordnance (UXO), confined spaces, tripping hazards, poisonous plants, venomous insects and animals, toxic chemicals, gunfire, and unsanitary conditions. See Chapter 2.

☐ Decide where the specific radiation survey units are (See Chapter 4, section 4.2).

☐ Identify the appropriate background measurement locations (See Chapter 4, section 4.4).

☐ Ensure that the RADIAC instrument is in the proper configuration for static measurements (See Chapter 4, section 4.6).

☐ Take and record the appropriate background measurements (See Chapter 4, section 4.4).

☐ Put on all necessary personal protective equipment.

☐ Set up the radiation survey unit (See Chapter 4, section 4.3).

1. Define the area to be radiation surveyed with a rectangle.
2. If GPS/grid coordinates are available, record the points indicated on the datasheet.
3. Record the length and width of the radiation survey unit on the datasheet.
4. Divide the width into 6 equal blocks.
5. Divide the length into 8 equal blocks.
6. If possible, mark the boundaries of and restrict access to the radiation survey unit. Divide the unit into 48 blocks as shown on the datasheet.

7. Sketch the radiation survey unit, landmarks, structures, and other information on the radiation survey unit schematic.
8. Perform pre-survey checks on all instruments.

☐ Perform a quick scan of the area.

1. Walk at a rate of about 0.5 m/s (roughly one-half step per second).
2. The βγ-probe will be held about 1 meter above the ground (or floor) and the x-ray probe should be held about 10 cm (about 4 in.) above the ground.

☐ Perform the radiation survey.

1. Set up and start air samplers if needed (see Appendix H).
2. Record the external gamma exposure measurements next to the letter G in blocks 1-24 on the Radiation Survey Data Table (Table 3). Take a 2-kilogram soil sample in block 8, split this sample, and label one as a QC sample.
3. Sample the soil from the center of blocks 5-8, 13-16, and 21-24 as laid out on the Radiation Survey Unit. See Chapter 4, section 4.7.
4. If the x-ray probe is available, record the x-ray probe measurements next to the letter X in blocks 5-8, 13-16, and 21-24 on the Radiation Survey Data Table.
5. Take the QC external gamma exposure rate in block 8 on the Radiation Survey Data Table and record the result next to G_{QC} in block 8.
6. If the x-ray probe is available, take the QC x-ray probe measurement in block 2 on the Radiation Survey Data Table and record the result next to X_{QC} in block 7.
7. Record the post-operational check source measurements.

☐ Record any topographical information on the radiation survey unit schematic.

☐ Interpret the data using the tables in Chapter 5 and fill out the Field Results Summary checklist.

☐ Report the results of the assessment to the commander.

☐ Send the samples and a copy of the paperwork to the appropriate laboratory for qualitative gamma spectroscopy.

☐ Send a copy of the paperwork to APHC Health Physics Division (HPD) or other appropriate NMSO.

☐ Decide on the final disposition of the samples with the advice of the command staff, APHC HPD, and the laboratory.

CAUTION: The radiation surveyor should have the βγ -probe operational (window closed) and should be observing the dose rate while approaching any potentially contaminated area (See Chapter 2).

Table 1. Radiological Site Assessment Sheet (Provide as much information as available)

General Survey Information			
Survey Start Date and Time:		Survey End Date and Time:	
Lead Surveyor Name(s):			
Lead Surveyor Title:		Surveyor's Unit:	
Lead Surveyor Phone:		Lead Surveyor Email:	

1. Administrative Data – *Attach the Hard Copy of the OEHSA to this tile in DOEHRS*			
Location Name:			
Location Aliases:			
Geographic location*: Including geo-coordinate (e.g latitude/longitude) of the outside corners of the camp. At a minimum, use the center of the camp. Note: Information may be classified.*			
Coordinate 1:		Coordinate 2:	
Coordinate 3:		Coordinate 4:	
Notes:			
Units and Detachments/Teams/Elements Present: *Note: this information may be classified.*			
Camp Fixed Population: *Note: this information may be classified.*			
Rotation Schedule: *Note: this information may be classified.*			
Number of U.S. Troops, if not U.S. Camp: *Note: this information may be classified.*			

2. Survey Background
Limitations of Assessment: *Physical obstructions, limiting conditions (such as weather), mission restrictions, lack of equipment/supplies.*
General Data Gaps: *Data that was either not obtainable at the time of the survey or that will be received in the future.*
Assumptions / Uncertainties: *Observations and data could be limited due to the inherent challenges of conducting comprehensive public health assessments in an operational environment*
Information Sources / Document Reviewed: *Summaries of environmental sampling and studies, aerial photos, topographic maps, Engineer Environmental Baseline Surveys (EBS, basecamp master plan).*

3. Site Description: *Attach site maps and photographs to the survey. Note: Get pictures of the site, a good rule of thumb is at least one picture per section.*
Physical Setting: *(general geography / topography / urban / rural)*.
Climatic / Weather: *(temperature range / predominate wind direction)*
Soil: (types, permeability, drainage ditches, low lying areas (standing water), unusual/out-of-place mounds, disturbed areas, discolored soil, areas unusually devoid of vegetation, etc)
Groundwater: *(depth, direction of flow)*
Surface Water: *(location, direction of flow)*
Wetlands, Flood Zones, Costal Zone, Vegetation present:

Proposed Site Usage: *What is the proposed usage of the site, especially if assessment is being conducted before usage determination or occupation?*
Current and Past Uses of Property: *What was the past usage of the site; agricultural, industrial, military, etc. For what duration were these uses active?*
Current and Past Uses of Adjacent Property: *(industrial operations, agricultural uses, type of crops grown) Is there knowledge on the use of pesticides (insecticides / herbicides)?*
North of Site:
South of Site:
East of Site:
West of Site:
Notes:

4. Additional Information: *(these inputs are not included in DOEHRS)*
Unit's Existing Radiation Exposure Status (RES): *See chapter 5.*
Water source: *Are the occupants of the land using a ROWPU, bottled water, or other?*
Food Source: *Are the occupants of the land consuming pre-packaged food, local food, CONUS food, or other?*
Laundry Facilities: *Are laundry facilities available? Are they military, local, or other?*
Decontamination Facilities: *Are decontamination facilities available? Describe.*
Prevailing Wind: *What is the wind speed (units) and direction?*
Notes:

Nearby Industrial Facilities. *Are there any nearby industrial facilities*				Present: ☐ Absent: ☐ If Present, list below	
Geo coordinates (MGRS or Lat/Long)*	Name	Type of Industry	Active? (Y/N)	Description	Proximity to Location (in kilometers)
Do the nearby industrial facilities have the potential to affect personnel?				Yes: ☐ No: ☐ If yes, complete the Exposure Pathway form located at the end of this template.	

Physical Hazards – Ionizing Radiation				
Are any ionizing radiation sources present? If known, attach inventory of sources.			Present: ☐ Absent: ☐ If Present, list below	
Storage Area	Sources Contained	Isotope	Activity	Highest does rate observed
8c. Camp Background Dose Rate:				
Notes:				
Do ionizing radiation sources have the potential to affect personnel?			Yes: ☐ No: ☐ If yes, complete the Exposure Pathway form located at the end of this template.	

3.3 Instructions for Using the Radiation Survey Data Table

1 Circle the type of instrument used (AN/PDR-77 or VDR-2). Record the calibration date (Cal. Due Date) and the serial number (SN) of the instrument.

2 Record the Check Source Measurement results (refer to Chapter 4 section 4.8 for the requirements for operational checks).

3 Record the radiological background data and take soil samples at the three background locations. Record the average background readings.

4 Evaluate and record the GPS/grid-A and -B locations.

5 Perform the radiation survey and record the results.

- Record the appropriate instrument reading in the center of each numbered box.
- Collect soil samples. Collect 2 kilograms of soil in block 8-Soil/QC and split the sample. Consider labeling the soil samples sequentially to facilitate the laboratory process. A unique numbering system can be used, see paragraph 8.5.
- Return to block 8 (1-Soil/QC) and repeat the appropriate measurements (βγ-probe and x-ray probe).
- Exclude the G_{QC} measurement in block 8 and take the average of all the βγ-probe measurements. Record the results.

6 Record the personnel information.

7 Record the length and width of the radiation survey unit.

8 Indicate the measurement units used for ***all*** of the measurements. You must be aware of any scale changes and use the same units for all measurements.

9 Indicate north in the Indicate North box.

10 Record topographical information on Radiation Survey Unit Schematic.

11 Answer the Potential Radiological Hazard ID questions to the best of your ability. Use TG 238 and other references, if available (APHC, 1999).

Table 2. Radiation Survey Data Table (Page 1 of 2)

Radiation survey Data Table

a.	**Circle the instrument used.**			**d.**	**GPS/Grid Coordinates (GPS/Grid below.)**		
	AN/PDR-77	Or	VDR-2	A:		B:	
	Cal. Due Date:	SN:		**e.**	**Radiation survey Results**		
b.	**Check Source Measurements**					Gamma	X-ray
		Gamma	X-ray		Average		
	Pre-radiation				Average Background		
	Post-radiation				Net Reading:		
c.	**Radiological Background Information**			**f.**	**Personnel Information**		
	Location	Gamma	X-ray	Radiation surveyors:			
1.							
2.							
3.				Reviewers:			
	Average:						

Radiation Survey Unit Boxes

GPS/Grid-B

	24-Soil X: G:		23-Soil X: G:		22-Soil X: G:		21-Soil X: G:
17 G:		18 G:		19 G:		20 G:	
	16-Soil X: G:		15-Soil X: G:		14-Soil X: G:		13-Soil X: G:
9 G:		10 G:		11 G:		12 G:	
	8-Soil/QC X: G1: G_{QC}:		7-Soil X1: X_{QC}: G:		6-Soil X: G:		5-Soil X: G:
1 G:		2 G:		3 G:		4 G:	

j. North

g. Width

GPS/Grid-A

h. Length

	Soil:	Soil Sampling Location	Unit of Measurement
i.	X:	X-ray Probe Reading	
	G:	βγ-probe or VDR-2 Reading	

Table 3. Radiation Survey Data Table (Page 2 of 2)

k. Radiation Survey Unit Schematic

	24		23		22		21
17		18		19		20	
	16		15		14		13
9		10		11		12	
	8		7		6		5
1		2		3		4	

l. Potential Radiological Hazard ID- Refer to TG 238 for guidance.

Is there evidence or a record of the following?	Circle one	If yes, describe the evidence or attach the record.
The presence, use, storage, or disposal of radioactive materials.	Yes / No / Unknown	
The use of DU or military commodities.	Yes / No / Unknown	
The decontamination, maintenance, or storage of radioactively contaminated equipment.	Yes / No / Unknown	
The presence of enhanced naturally occurring radioactive material.	Yes / No / Unknown	
Radiation generating machines such as accelerators and x ray machines.	Yes / No / Unknown	
Any aircraft accident in the area.	Yes / No / Unknown	
Medical or research facilities in the area.	Yes / No / Unknown	
Coal ash, fertilizer, other mineral processes in the area.	Yes / No / Unknown	
Nuclear power plants in the area.	Yes / No / Unknown	

3.4 Field Results Summary Checklist (Page 1 of 1)

Net Reading: Instrument Used: PDR-77 or VDR-2

Radiation survey Unit ID: Existing RES:

☐ The net gamma reading is less than 0.10 μGy/h (0.010 mR/h). There is no need to proceed with the data interpretation, the radiation survey unit can be considered equivalent to background at this time. Document these results and send them on to the APHC HPD.

Existing RES = 0

☐ The RES at the end of the mission lasting days will be:

☐ For an assigned OEG of the maximum mission duration is about

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days. Existing RES > 0

☐ The RES at the end of the mission lasting days will be:

☐ For an assigned OEG of the maximum mission duration is about days.

This checklist summarizes the results of a particular radiation survey and intended for use in communicating the results.

Chapter 4. Radiation Surveying and Sampling Guidance

4.1. Minimum Supply Requirements

The following is a list of supplies required for a radiological area survey. Reasonable substitutions can be made for the items on this list. A list of additional equipment is in Appendix B.

- ☐ AN/PDR-77 or AN/VDR-2 RADIAC and the corresponding user's manuals
- ☐ Copy of TG 236 and datasheets
- ☐ Extra batteries for the RADIAC meters and other instruments
- ☐ Copies of the removable survey packet from TG 236
- ☐ GPS receiver (optional) and tape measure (optional)
- ☐ Disposable dust masks
- ☐ Pens
- ☐ Indelible marker
- ☐ Soil sampling tool, e.g., trowel or entrenching tool
- ☐ Sample labels
- ☐ Sealing or other strong tape
- ☐ Flags or other land-marking items
- ☐ Rubber gloves
- ☐ Distilled water (at least 4 liters)
- ☐ Calculator
- ☐ Leather or gardener's gloves
- ☐ Fifty (50) 1-gallon plastic bags*

Note: * Other sample containers may be used, when done in coordination with the laboratory

4.2. Selecting a Radiation Survey Unit

The choice of the radiation survey unit depends on the overall military operation. In general, a single radiation survey unit should be limited to an area with uniform environmental characteristics. For example, if the commander wants a radiation survey of an area that includes both farmland and industrial plants, this area should be divided into two radiation survey units. A single room or a group of similar rooms can constitute a single radiation survey unit. However, if you are doing a radiation survey of a warehouse, its parking lot, and an adjacent vacant lot, then consider each area as a single radiation survey unit (three total survey units).

4.3. Setting up the Radiation Survey Unit

The recommended maximum area for each outdoor radiation survey unit is 10,000 m^2.

For each indoor radiation survey unit, the recommended maximum area is 100 m^2 of floor space. The minimum unit area for an outdoor radiation survey is a rectangle 16 meters long and 12 meters wide (192 m^2). If the radiation survey unit is less than 192 m^2 for an outdoor unit or less than 10 m^2 for an indoor unit, then you should initiate an external gamma scan and an x-ray scan.

The radiation survey unit should encompass an area that is suspected to have elevated levels of radiation. If you are surveying near a potentially contaminated item (for example, a tank damaged by a depleted uranium penetrator), the radiation survey unit should be centered around the potentially contaminated item. If you suspect that radioactive materials were released in the air, you may want to conduct additional radiation surveys downwind to determine the spread of the contamination.

The radiation survey unit is a rectangle that delineates the actual area to be surveyed. The width of the rectangle is marked off into six units, and the length is marked off into eight units. Entry to the radiation survey unit may be controlled if desired. After the radiation survey is completed, a decision can be made as to who can enter the area.

Site assessment information can be recorded on the Radiological Site Assessment Sheet. The site assessment sheet contains information about the site conditions, personnel involved, occupation times, site location, and geographical and meteorological information. A recommended radiation survey unit ID is the GPS/Grid coordinates of point GPS/Grid-A from the Radiation Survey Data Table. However, any unique identifier can be used.

The radiation survey unit schematic is included for recording the pertinent geographical features of the site. Following this schematic is a list of questions about the radiological features of the site, such as the presence of depleted uranium, nearby power plants (nuclear, coal, oil, gas, or other fuel), any type of mineral extraction industry, or radioactive material storage locations.

4.4. Background Measurements

4.4.1. Methods

Gather naturally occurring background radiation data at specified locations before beginning the survey. The radiological area survey recommends three background measurement locations. Measurements at the three locations (at the 0°, 120°, and 240° compass directions) should be in a "background-only" area thought to be uncontaminated and at least 10 meters from the central point of the area.

Background Area

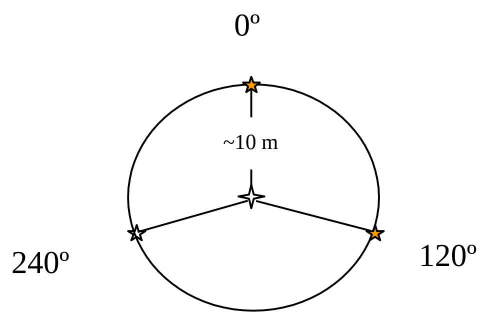


Figure 2. Background Area Radiation Sampling Locations

The outdoor background measurements should be made in an area well outside the radiation survey unit. The background location must have no or, at most, a very small chance of being contaminated; however, it should be similar to the radiation survey unit in all other ways. All background sampling locations must be noted on a field map. A soil sample, a gamma exposure rate measurement taken at about 1 meter (40 inches or waist height) above the ground and an x-ray probe (if the probe is available) measurement at about 10 centimeters (about 4 inches or palm height) above the ground will be taken at each outdoor background location.

Ideally, an indoor background location should be a room of similar design and construction as the radiation survey unit, but well away from it. If possible, avoid choosing an indoor background location that shares ventilation ductwork with the radiation survey unit. A pattern similar to the outdoor pattern used to identify locations may be used to take indoor background measurements, if enough indoor space is available (otherwise, one indoor background measurement will suffice). Indoor locations require measurements for gamma exposure rates and an x-ray probe, if the probe is available.

4.4.2. When is a Measurement Above Background?

As a rule-of-thumb, any gross measurement that exceeds about 3 times the appropriate background measurement (roughly a range of 2 to 5 times background) should be considered as a potential elevated radiation measurement or an action level for further investigation. This rule-of-thumb applies to contamination radiation surveys as well as external radiation surveys. However, the decision whether or not to declare an elevated radiation level or the existence of contamination should be left to those qualified personnel most familiar with the situation.

4.5. Instrumentation Use for a Radiation Survey

Field radiation survey meters should be calibrated every 360 days or in accordance with Technical Bulletin (TB) 43-180 (DA, 2005), whichever is more restrictive. No uncalibrated instrument should be used unless no other option exists. You should use standard procedures to calibrate and maintain equipment and keep the instruments and accessories within their manufacturer specified humidity and temperature requirements. Fill out the Arrival Checklist and Preoperational Test before starting the operational checks. All radiation survey meters should undergo operational checks before and after the radiation survey using an appropriate radioactive check source. The results of these checks must be recorded on the radiation survey datasheets. All instruments should be operated in ratemeter mode with the filter on (see Chapter 7) and should be held in place for 60 seconds before recording any stationary (static) measurement value on the radiation survey sheets.

This procedure has been designed so that two trained personnel equipped with the AN/VDR-2 or AN/PDR-77 will have gross screening capability for acute radiation threats as provided by the CBRNE doctrine. Additional information about the AN/VDR-2 and AN/PDR-77 is in Chapter 7.

If available, a radioisotope identifier can also be used to identify areas with elevated radiation. These detectors are more sensitive than the solid-state detectors included in the AN/PDR-77 kit. Because of this increased sensitivity, these detectors are more likely fluctuate with variations in background radiation levels. Several background readings should be taken and recorded as described in section 4.1.1. These detectors are often able to identify unknown radionuclides. This information should be relayed to APHC, but further swipe or soil sampling should be done to verify the detector's reading. These devices are commercial off-the-shelf and are not available to all Army units, and they should never be used without proper training.

4.6. External Radiation Survey

A 2-second update time and the filtered mode for a 1-minute data collection interval is recommended for the stationary measurements. The window on the $\beta\gamma$-probe should be closed for all measurements. For scanning measurements, an update time of 1 second and the unfiltered mode are recommended because this combination allows a quicker response, which is desirable when scanning for elevated radiation levels.

For stationary measurements, the radiation surveyor will record the external exposure ($\beta\gamma$-probe) rate at about 1 m (about 3 ft) above the ground. If an x-ray probe is available, x-ray probe measurements will be taken about 10 cm (about 4 in.) above the ground. Refer to the Radiation Survey Data Sheet.

For all scanning measurements, the radiation surveyor will walk slowly, at a rate of about 0.5 m/s (roughly one-half step per second). For an external gamma exposure rate scan, the βγ-probe will be held about 1 meter above the ground (or floor) and the x-ray probe should be held about 10 cm (about 4 in.) above the ground.

4.7. Collecting Soil Samples

Soil samples (outdoors only), x-ray, and βγ-probe measurements will be taken in the center of grid blocks 5-8, 13-16, and 21-24.

The list below is a brief set of reminders intended for a radiation surveyor. For a more detailed guidance on sampling and sample management, see Chapter 10.

- Avoid taking soil samples that contain large pieces of organic material (sticks, roots, or plant materials) or pebbles and stones larger than 2.5 cm (1 inch).
- Collect soil samples from the locations laid out on the datasheet.
- Surface soil samples should be collected from the first 15 cm (6 inches) of soil. If other depths are used, they must be noted on the radiation survey sheet.
- Ensure that each soil sample weighs about 1 kg (about 2 lbs). Because of the great variation in soil composition, moisture content, and bulk density, it is impossible to specify a particular volume of soil to collect. You must use some judgment.
- Double bag, seal with tape, and properly label all soil samples.
- If additional soil samples are taken (at the discretion of the radiation surveyor), ensure that they are marked as additional samples and that the location and why they were collected are recorded.

4.8. Quality Assurance and Quality Control (QA/QC)

The intent of QA/QC is to ensure that data is properly collected with respect to the objectives of the radiation survey. The datasheets included in the plan ensure that the data are collected uniformly no matter who the radiation surveyors are or where the radiation survey takes place. Operational checks of the field instrumentation ensure that the instruments are operating acceptably during the radiation survey. One field split soil sample and one additional external exposure rate measurement are required to ensure consistency in the overall measurement process. More extensive QA/QC procedures are not necessary for this survey because the data collected and the interpretation of the data are not intended to be used for a rigorous dose assessment.

Follow these guidelines for quality assurance and quality control.

- Data collection worksheets are provided in the protocols for the radiation surveys.
- Contact a NMSO or health physicist early in the radiation survey process.
- Before deployment to the radiation survey site:
    - Prepare all RADIAC meters for use according to the appropriate user manual.
    - Use the flowchart in Figure 3 on the next page to perform check source measurements on the RADIAC meter with the appropriate radioactive check source. Record the results of these operational checks on the datasheets.

- Ensure that the soil sample from block 8 is about 2 kg (about 4.4 lbs.), homogenize the sample in the field, and split it into two 1 kg samples. Label one of these soil samples as a QC sample.
    - Satisfactory substitutions for one kilogram of soil are a filled coffee can, a half-filled gallon Ziploc® bag, 2 quart Ziploc bags, and anything that is about half a gallon in volume (e.g., a half-gallon ice cream container).

- Repeat an external exposure rate measurement at the end of the radiation survey in block 1 of the radiation survey unit. Record the meter reading as G_{QC} in block 1 of the radiation survey unit.
- If the x-ray probe is available, record a second reading as X_{QC} in block 7 of the radiation survey unit.
- The officer in charge (OIC) or the noncommissioned officer in charge (NCOIC) will review the radiation survey data for anomalies and completeness at the end of each radiation survey.
- Follow the procedures in Chapter 8 for sample management after collection.

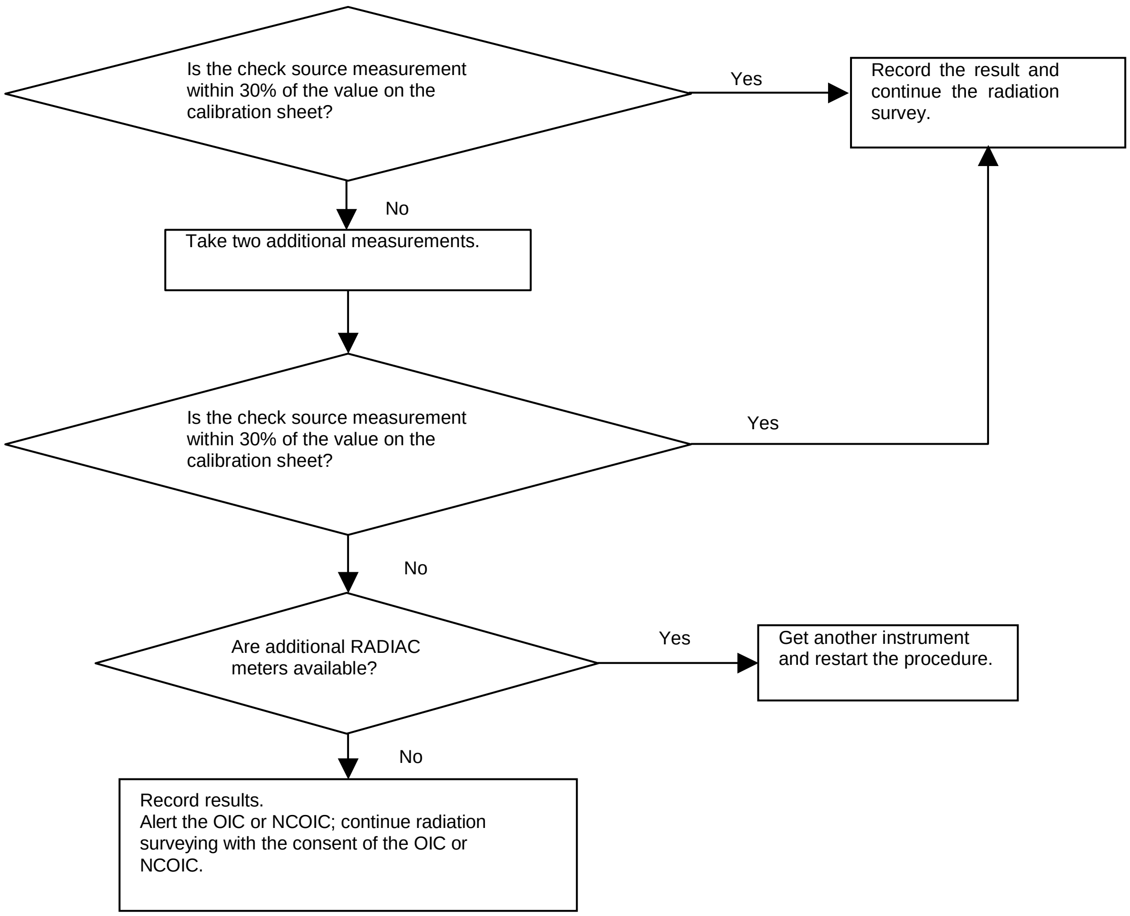


Figure 3. Operational Check Source Flowchart

Chapter 5. Data Interpretation and Archiving

If the net gamma reading is less than 0.10 μGy/h (0.010 mR/h), staying in this area will not affect your RES category. The area surveyed can be considered equivalent to background at this time.

5.1. RES Categories

The field results should be discussed with personnel knowledgeable in radiation protection. APHC HPD can also provide assistance in the final data interpretation and recommendations. The discussions should be made with the primary purpose of relaying the results and recommendations to the commander in a useful manner. Table 4 is a listing of recommended actions for radiation exposures that result in different RES categories. Your commander is responsible for deciding the OEG for the unit. Appendix E contains useful charts for the PH or chemical officer to track the RES of the various units.

5.2. Estimating the Maximum Duration of a Mission Before Exceeding the OEG

The first step in determining the maximum duration of a mission before exceeding the OEG is to determine the maximum total dose for that mission. The maximum total dose for the mission is the OEG minus the unit's current accumulated dose. For example, if the OEG guidance is not to exceed 10 cGy (10 R) (equivalent to RES category 1C) and the unit's current accumulated dose is 1 R, then the maximum total dose allowed for the mission is 10 cGy -1 cGy = 9 cGy. To determine the maximum duration of the mission, simply divide the maximum dose allowed by the average radiation level (the Net Reading from your Data Radiation survey Sheet). Be sure to put the numbers in the proper units. To continue with the above example, if the average radiation level is 5 mGy/hr, then the maximum duration is:

$$\frac{9\ \mathrm{cGy}}{5\ \mathrm{mGy/hr}} * \frac{10\ \mathrm{mGy}}{\mathrm{cGy}} * \frac{1\ \mathrm{day}}{24\ \mathrm{hr}} = 0.75\ \mathrm{days}$$

If you know the unit's current RES category but do not know the unit's accumulated dose, then use Table 5 through Table 9. These tables assume the RES category average value as the unit's accumulated dose. To use the tables, first find the table of your present RES. If your unit has not been exposed to radiation above background, then use Table 5 (RES of 0). Then find the average radiation level (the Net Reading from your Data Radiation survey Sheet) in the left column. Then find your assigned OEG in the top row. The maximum number of days that can be spent in that area without exceeding the OEG is the intersection of that row and column.

Table 4. Recommended Actions for RES Categories (Joint Chiefs of Staff, 2013)

RES Category	**Total Cumulative Dose (See notes 1 and 2.)**	Recommended Actions (Continue Actions from the previous RES Categories as RES increases)
0	0 to 0.05 cGy (0 to 50 mR)	• Routine monitoring for early warning of hazard
1A	0.05 cGy to 0.5 cGy (50 mR to 500)	• Record individual/unit dose readings
1B	0.5 cGy to 5 cGy (500 mR to 5 R)	• Initiate radiation survey and continue monitoring
1C	5 cGy to 10 cGy (5 R to 10 R)	• Update survey and continue monitoring • Continue dose control measures • Execute PRIORITY tasks only (see note 3)
1D	10 cGy to 25 cGy (10 R to 25 R)	• Execute CRITICAL tasks only (see note 4)
1E	25 cGy to 75 cGy (25 R to 75 R)	• Monitor for acute radiation syndrome symptoms

NOTES:

1. Due to the fact that the military may only have the capability to measure centigray (cGy) or milligray (mGy), the radiation guidance tables are presented in units of cGy for convenience. For whole body gamma irradiation, 10 mGy = 1 cGy = 1 cSv = 10 mSv. However, radiation measurement in either centisievert (cSv) or millisievert (mSv) is preferred in all cases as different types of radiation have a much higher radiation weight factor – for example, for alpha particles 10 mGy = 200 mSv.
2. All doses should be kept ALARA. This will reduce individual personnel risk as well as retain maximum operational flexibility for future employment of exposed personnel.
3. Examples of priority tasks are those that contain the hazard, avert danger to persons, or allow the mission to continue; however, with consideration toward the mission, radiological risk, and overall risk.
4. Examples of critical tasks are those that save lives or allow continued support that is deemed essential by the operational commander to conduct the mission after a complete risk analysis has been carried out.
5. Although an upper bound for RES 1E is provided in the table, it is conceivable that doses to personnel could exceed this amount. Radiation induced health effects such as nausea, loss of appetite, fatigue can commence with doses as low as 50 cGy with acute radiation sickness commencing as whole body doses start to exceed 75 cGy. Personnel exceeding the RES 1E upper bound should be considered for prompt medical evaluation with serious consideration for removal from further exposure.

When an operational mission duration spans more than one calendar year and it does not exceed the annual occupational dose limit, the RES category will be reset to RES 0 on 1 January. All radiation exposure data records are still required to be maintained by the service dosimetry centers.

The net readings on Table 5 through Table 10 are instrument-specific because of the display differences between the AN/VDR-2 and the AN/PDR-77 when using the βγ-probe. To avoid confusion, the units have been omitted from the net reading column in Table 5 through Table 10; however, there is a place on the Radiation Survey Data Table to record the measurement units. See Chapter 7 for additional information.

Table 5. Estimating the Maximum Duration of a Mission in Days for Units with No Previous Radiation Exposure (RES of 0)

Net Reading		Assigned OEG					
PDR-77	VDR-2	0	1A	1B	1C	1D	1E
0.01	0.1	> 180	> 180	> 180	> 180	> 180	> 180
0.02	0.2	100	> 180	> 180	> 180	> 180	> 180
0.03	0.3	69	> 180	> 180	> 180	> 180	> 180
0.04	0.4	52	> 180	> 180	> 180	> 180	> 180
0.05	0.5	41	> 180	> 180	> 180	> 180	> 180
0.06	0.6	34	> 180	> 180	> 180	> 180	> 180
0.07	0.7	29	> 180	> 180	> 180	> 180	> 180
0.08	0.8	26	> 180	> 180	> 180	> 180	> 180
0.09	0.9	23	> 180	> 180	> 180	> 180	> 180
0.10	1.0	20	> 180	> 180	> 180	> 180	> 180
0.15	1.5	13	120	> 180	> 180	> 180	> 180
0.20	2.0	10	93	> 180	> 180	> 180	> 180
0.30	3.0	6	62	> 180	> 180	> 180	> 180
0.40	4.0	5	46	> 180	> 180	> 180	> 180
0.50	5.0	4	37	> 180	> 180	> 180	> 180
1.00	10.0	2	18	> 180	> 180	> 180	> 180
1.50	15.0	1	12	130	> 180	> 180	> 180
2.00	20.0	1	9	100	> 180	> 180	> 180
3.00	30.0	0	6	68	130	> 180	> 180
4.00	40.0	0	4	51	100	> 180	> 180
5.00	50.0	0	3	41	82	> 180	> 180
10.00	100.0	0	1	20	41	100	> 180
15.00	150.0	0	1	13	27	69	> 180
20.00	200.0	0	0	10	20	51	150

Table 6. Estimating the Maximum Duration of a Mission in Days for Units with Existing RES of 1A

Net Reading		Assigned OEG			
PDR-77	VDR-2	1B	1C	1D	1E
< 1.00	< 10.0	> 180	> 180	> 180	> 180
1.50	15.0	120	> 180	> 180	> 180
2.00	20.0	93	> 180	> 180	> 180
3.00	30.0	62	130	> 180	> 180
4.00	40.0	46	98	> 180	> 180
5.00	50.0	37	79	> 180	> 180
10.00	100.0	18	39	100	> 180
15.00	150.0	12	26	68	> 180
20.00	200.0	9	19	51	150

Table 7. Estimating the Maximum Duration of a Mission in Days for Units with Existing RES of 1B

Net Reading		Assigned OEG		
PDR-77	VDR-2	1C	1D	1E
< 1.50	< 15.0	130	> 180	> 180
2.00	20.0	100	> 180	> 180
3.00	30.0	69	> 180	> 180
4.00	40.0	52	> 180	> 180
5.00	50.0	41	160	> 180
10.00	100.0	20	83	> 180
15.00	150.0	13	55	> 180
20.00	200.0	10	41	140

Table 8. Estimating the Maximum Duration of a Mission in Days for Units with Existing RES of 1C

Net Reading		Assigned OEG	
PDR-77	VDR-2	1D	1E
< 4.00	< 40.0	150	> 180
5.00	50.0	120	> 180
10.00	100.0	62	> 180
15.00	150.0	41	> 180
20.00	200.0	31	130

Table 9. Estimating the Maximum Duration of a Mission in Days for Units with Existing RES of 1D

Net Reading		Assigned OEG
PDR-77	VDR-2	1E
<	<	> 180
15.00	150.0	130
20.00	200.0	100

5.3. Estimating the RES at the End of a Mission

The RES of a unit at the end of a mission depends on the RES of the unit at the beginning of the mission, the mission duration, and the net exposure rate. The next exposure rate is reflected as the net reading on the tables and data sheets. If your unit had not previously received radiation (RES of 0), then Table 7 should be used to determine the new RES for the unit. To use this table, first find the average radiation level (the Net Reading from your Data Radiation survey Sheet) in the left column. Then find the duration of the mission (the time spent in the area with net radiation levels greater than 0.10 μGy/h (0.010 mR/h)) in the top row. The new RES of the unit is the intersection of that row and column.

Table 10. Estimating the Net RES for a Mission

Net Reading		Duration (days)												
PDR-	VDR-2	1	7	14	21	30	35	40	45	50	60	90	120	180
0.01	0.10	0	0	0	0	0	0	0	0	0	0	0	0	0
0.02	0.20	0	0	0	0	0	0	0	0	0	0	0	1A	1A
0.03	0.30	0	0	0	0	0	0	0	0	0	0	1A	1A	1A
0.04	0.40	0	0	0	0	0	0	0	0	0	1A	1A	1A	1A
0.05	0.50	0	0	0	0	0	0	0	1A	1A	1A	1A	1A	1A
0.10	1.00	0	0	0	1A	1A	1A	1A	1A	1A	1A	1A	1A	1A
0.15	1.50	0	0	1A	1A	1A	1A	1A	1A	1A	1A	1A	1A	1B
0.20	2.00	0	0	1A	1A	1A	1A	1A	1A	1A	1A	1A	1B	1B
0.30	3.00	0	1A	1A	1A	1A	1A	1A	1A	1A	1A	1B	1B	1B
0.40	4.00	0	1A	1A	1A	1A	1A	1A	1A	1A	1B	1B	1B	1B
0.50	5.00	0	1A	1A	1A	1A	1A	1A	1B	1B	1B	1B	1B	1B
0.60	6.00	0	1A	1A	1A	1A	1B	1B	1B	1B	1B	1B	1B	1B
0.70	7.00	0	1A	1A	1A	1B	1B	1B	1B	1B	1B	1B	1B	1B
0.80	8.00	0	1A	1A	1A	1B	1B	1B	1B	1B	1B	1B	1B	1B
0.90	9.00	0	1A	1A	1A	1B	1B	1B	1B	1B	1B	1B	1B	1B
1.00	10.00	0	1A	1A	1B	1B	1B	1B	1B	1B	1B	1B	1B	1B
1.50	15.00	0	1A	1B	1B	1B	1B	1B	1B	1B	1B	1B	1B	1C
2.00	20.00	0	1A	1B	1B	1B	1B	1B	1B	1B	1B	1B	1C	1C
3.00	30.00	1A	1B	1B	1B	1B	1B	1B	1B	1B	1B	1C	1C	1D
4.00	40.00	1A	1B	1B	1B	1B	1B	1B	1B	1B	1C	1C	1D	1D
5.00	50.00	1A	1B	1B	1B	1B	1B	1B	1C	1C	1C	1D	1D	1D
10.00	100.00	1A	1B	1B	1C	1C	1C	1C	1D	1D	1D	1D	1E	1E
15.00	150.00	1A	1B	1C	1C	1D	1D	1D	1D	1D	1D	1E	1E	1E
20.00	200.00	1A	1B	1C	1D	1D	1D	1D	1D	1D	1E	1E	1E	>1E

If your unit had a RES greater than zero at the beginning of the mission and you know the accumulated dose for the unit, then add the total dose for the mission to the unit's accumulated dose. To determine the total dose for the mission, multiply the average radiation level (the Net Reading from your Data Radiation survey Sheet) by the duration of the mission. Then add this number to the unit's accumulated dose of the unit to find the new accumulated dose. Be sure to put the numbers in the proper units. Once you find your new accumulated dose, refer to Table 1 to determine the RES category.

Example: at the beginning of a 10-day mission, your unit was in RES category 1B with an accumulated dose of 0.6 cGy. The average radiation level (the Net Reading from your Data Radiation survey Sheet) is 0.01 cGy/hr. The total dose for the mission is:

$$0.01\,\frac{\text{cGy}}{\text{hr}} * \frac{24\text{ hr}}{1\text{ d}} * 10\text{ d} = 2.4\text{ cGy}$$

Adding the total dose for the mission to the previously accumulated dose, you get 3.0

cGy (3.0 R) for the current accumulated dose. Referring to Table 4, you see that your unit is still RES category 1B with an accumulated dose of 3 cGy (3 R).

If your unit had a RES greater than zero at the beginning of the mission and you do not know the accumulated dose for the unit, then you use the RES category average value as the unit's accumulated dose. The average value for RES 1A is 0.275 cGy, for 1B it is 2.75 cGy, for 1C it is 7.5 cGy, for 1D it is 17.5 cGy, and for 1E it is 50 cGy. Add this average value to the total dose for the mission to determine the new accumulated dose for the unit. The total dose for the mission is the average radiation level (the Net Reading from your Data Radiation survey Sheet) times the duration of the mission. Be sure to put the numbers in the proper units. Once you find your new accumulated dose, refer to Table 4 to determine the RES category.

5.4. Estimating Numerical Values for a Mission Duration

Equation 1 below can be used to estimate a mission duration. The parameter R_N is the net reading from block e on the Radiation Survey Data Table of the datasheet.

Equation 1. Estimating the duration of a mission

$$\text{Mission Duration} = \left(\frac{\text{OEG} - (\text{Existing Exposure})}{\text{R}_\text{N}}\right)$$

If the existing exposure is not known but the unit's RES is known, then use midpoint of the RES category as the value for "Existing Exposure" in Equation 1. The units of the numerator in Equation 1 are radiological dose units (e.g., mR or cGy), and the units of the denominator are radiological dose rate units (e.g., mR/h or cGy/h).

Example calculations:

Example 1
A unit with no previous radiation exposure is directed to occupy an area where the net reading on the AN/PDR-77 is 2.3 μGy (0.23 mR/h). How long can the unit remain in the area and not exceed an OEG of 1A?

Answer 1
The upper limit of RES category 1A is 0.5 cGy and R_N = 2.3 μGy /h. These numbers are entered into the Equation 1 above to get:

$$\text{Mission Duration} = \left(\frac{0.5\ \text{cGy}}{2.3\ \frac{\mu\text{Gy}}{\text{hr}}}\right)\left(\frac{10000\ \mu\text{Gy}}{1\ \text{cGy}}\right) = 2174\ \text{hours} = 90.6\ \text{days}$$

This value is rounded down to 90 days.

<u>Example 2</u>
Another unit is going to occupy the same area as above. The new unit has a RES of 1A before beginning this mission. How long can they stay there and not exceed an OEG of 1B?

<u>Answer 2</u>
Note that the existing exposure is unknown but the RES category is known. Therefore, the existing exposure value is 0.275 cGy (275 mR), which is the midpoint of RES category 1A. The OEG if 1B corresponds to an exposure of 5 cGy (5,000 mR).

$$\text{Mission Duration} = \left(\frac{5 - 0.275}{0.23}\right) = \left(\frac{4.725\ \text{cGy}}{2.3\ \mu\text{Gy/hr}}\right)\left(\frac{10000\ \mu\text{Gy}}{1\ \text{cGy}}\right) = 20543\ \text{hours} = 855.9\ \text{days}$$

This would be rounded down to 855 days.

<u>Example 3</u>
You've been tasked to determine how long a unit can operate in an area where you've recently performed a radiological area survey with an AN/VDR-2. The commander's OEG is given as 4.5 cGy, and the unit has had no previous radiation exposure. The results of the radiation survey yielded a net dose rate of 95 μGy/h.

<u>Answer 3</u>

$$\text{Mission Duration} = \left(\frac{4.5\ \text{cGy}}{95\ \mu\text{Gy/hr}}\right) = \left(\frac{45000\ \mu\text{Gy}}{95\ \mu\text{Gy/hr}}\right) = 474\ \text{hours} = 19.7\ \text{days}$$

This would be rounded down to 19 days.

Because the AN/VDR-2 automatically changes units on its display, you must be very careful to record and use the proper units in any calculation.

5.5. Archiving

When the data interpretation and communication is completed, all the associated paperwork should be preserved and archived. To archive the data, fill out the Field Results Summary Checklist and attach copies of all paperwork with the samples. The documentation should be kept by the command. Send an additional copy of all documentation to APHC HPD.

All data collected using this technical guide is required to be entered into DOEHRS. For information on getting access and training for DOEHRS, contact the Directorate of Environmental Health Sciences and Engineering at APHC. See Appendix G for more details.

Chapter 6. Contamination Control Procedures

Except for nuclear war, radiological contamination is a minor concern in most instances. In *Medical Management of Radiological Casualties*, *Fourth Edition* (Armed Forces Radiobiology Research Institute, 2013) it states, “It is impossible for a living patient (a radiation surveyor in our case) to be so contaminated as to pose a threat to medical providers.” Do not panic if you discover that you might be contaminated; take the appropriate steps for decontamination. Remember that despite your best efforts, some degree of contamination may remain.

This chapter includes procedures for setting up decontamination and monitoring station, personnel and equipment monitoring procedures, and decontamination procedures to be followed in the event of radiological contamination. Table 12 at the end of this chapter is a comprehensive list of Army documents that contain decontamination and other related procedures. Although the documents listed are concerned with operations in war with nuclear weapons, they contain a much greater level of detail than in this chapter.

6.1. Monitoring and Decontamination Station

In this technical guide, the phrase decontamination station includes the personnel monitoring station. A decontamination station can vary greatly in complexity, from a simple step-off pad and monitoring (frisker) station, to a complete contamination control station detailed in the *Nuclear Weapon Accident Response Procedures* (NARP) (Defense Threat Reduction Agency, 2013) manual] for a weapons accident.

Figure 4 below shows the basic components of a simple step-off pad. A decontamination station should be placed in a low background area free of contamination, upwind of the radiation survey area or far enough away from areas of elevated contamination to minimize chance of airborne material reaching the location, and in an area that is flat and easy to work in. If necessary, a preliminary decontamination station can be set up near or in the radiation survey area. This preliminary station can be used as a transfer point for items that may be contaminated or for the removal of the outermost layer of protective clothing.

At this station, personnel and commodities are cleansed of radiological contaminants. Contaminated items may be brought into the clean area if they are bagged and sealed or radiation surveyed and found to be clean.

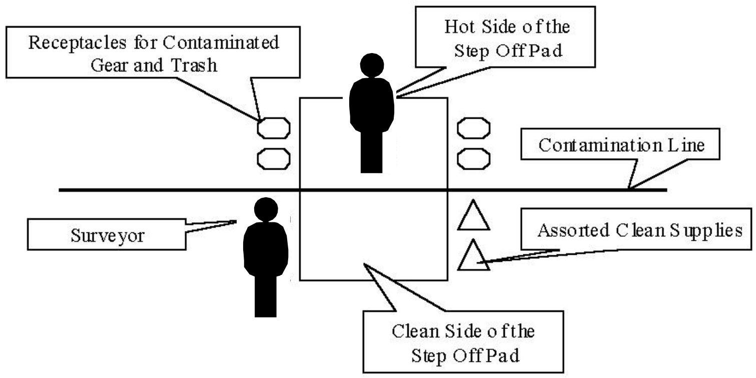


Figure 4. Decontamination Step-Off Pad Schematic

Personnel monitoring (frisking) is often required for people who have been in an area with elevated radiation measurements. RADIAC radiation surveys are used to determine with reasonable certainty whether that person is contaminated. In the event that a person is contaminated, the level of contamination should be estimated so that a decision whether or not to decontaminate can be made.

The following are guidelines for personnel monitoring:

- Try to find an area with low background radiation (roughly ≤0.02 mR/hr or ≤0.2 μGy/hr) and little to no radiological contamination.
- The pancake probe or the βγ–probe with the end window open is the best choice for personnel monitoring.
- Use the headphones or other audio capabilities of the radiation survey meter. It is easier to detect audible than visual changes in counting rate, and audio monitoring will allow you to concentrate on the radiation survey, not just the meter.
- Note the background on the meter.
- The person being monitored should stand straight, with feet spread apart, arms extended with the palms flat, and the fingers straight out (see Figure 5).
- Keep the probe window within 2.5 cm (1 in.) from the surface of the body. To avoid contaminating the probe, do not to touch the person with the probe.
- Move the probe over the person at a rate of about 2.5 cm/s (1 in/s). Start at the head and radiation survey the front of the person, including the inseam, crotch, and armpits.

- Survey the outline of the body with special attention to the fingertips. Repeat with the arms and hands turned over, and repeat the radiation survey on the back of the person.

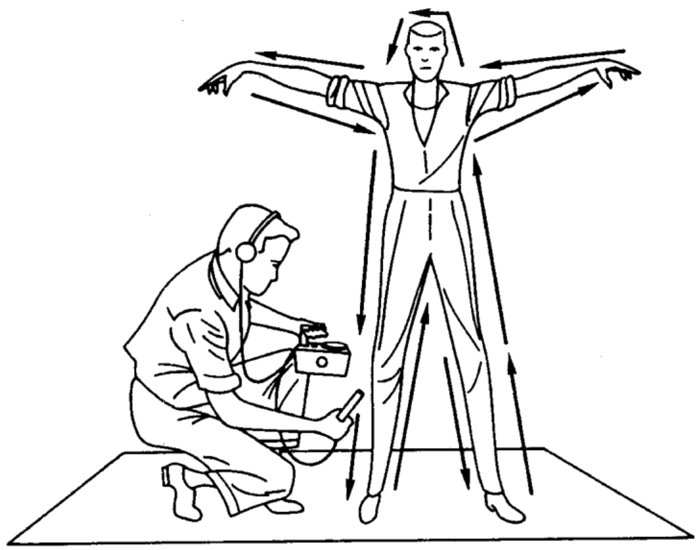


Figure 5. Individual Personnel Monitoring With a Portable Radiation Survey Meter (FDA, 1983)

Take another background measurement after the personnel radiation survey is completed. If the second background reading is significantly different from the first: check to see if the probe is contaminated; if not, resurvey the person.

6.2. Surveys of Items or Commodities

An equipment radiation survey is required for an item that may have been in an area with elevated radiation measurements, may have been damaged by a depleted uranium penetrator, or may contain a broken radioactive commodity. Because of the complexity and range of sizes of equipment that might be encountered in the field, a single generic approach to an equipment radiation survey would be ineffective and incomplete. Techniques similar to those described in Section 6.1 can be used for an equipment radiation survey.

- For relatively small pieces of equipment, a surface scan can cover the entire surface of the equipment.

- Measure the ambient background reading about 1 m from the equipment to be radiation surveyed.
- Bag (for example, Ziploc bags) and label small, contaminated items, if possible.

6.3. Personnel Decontamination

Personnel suspected of being contaminated should be monitored with a radiation survey meter to identify contaminated areas. Special emphasis should be placed on the location of any contaminated areas on the individual.

If contamination is suspected, resurvey the person carefully, noting areas that are contaminated. Then remove clothing that is contaminated. Removing clothes removes about 90% of the residual contamination if it is present. Clothing that is significantly contaminated should be removed and stored in plastic bags until the activity has decayed to an acceptable level. If the radionuclide can be identified, then it may be possible to calculate the time until the activity will reach a level acceptable for reuse or disposal.

If skin contamination occurs, start with the mildest decontamination measures and move to stronger measures if the contamination is difficult to remove. Washing with soap and water is the best initial decontamination approach for unbroken skin. If simple washing fails, then you can try harsher methods such as abrasive soap or a complexing agent. Take care not to break the person's skin or cause abrasion, which could introduce contamination into the bloodstream. Clipping the fingernails may remove a significant amount of contamination that remains on the fingers after washing. Wounds suspected of being contaminated should be irrigated profusely with tepid water and cleaned with a swab. Skin cleansing methods, in order of harshness, are listed in Table 11.

Table 11. List of Cleansing Methods in Order of Harshness to the Skin

Order	Method
1	Lifting off dry contamination with sticky tape. (CAUTION: Some individuals are allergic to certain adhesives. Strong adhesives can also disturb the skin barrier, enabling internal uptake of the contamination.)
2	Flushing with water.
3	Cleansing with soap and warm water, commercial skin cleaner.
4	Cleansing with mild abrasive soap, soft brush, and water.
5	Cleansing with skin cleaner with a mild abrasive.

Order	Method
6	Cleansing with a complexing solution. (CAUTION: Any agents not designed and approved for use on the human skin should have medical approval before use.)
7	Cleansing with a mild organic acid (e.g., citric acid). (CAUTION: Any agents not designed and approved for use on the human skin should have medical approval before use.)

After each decontamination attempt, radiation survey the surrounding area to ensure that contamination is removed and not being spread. Wear gloves and coveralls, if needed, and work from the edges of the contaminated area of the person s body toward the center.

6.4. Item and Commodity Decontamination

Equipment decontamination proceeds in essentially the same way as personnel decontamination, except that there are a few more options with equipment decontamination. Rougher mechanical means such as vacuuming with a filtered vacuum system and using abrasives are available. There is no concern about breaking the skin.

Five general methods to reduce surface contamination from equipment are:

1. Brushing and vacuum cleaning.
2. Washing, soaking, or scrubbing with hot or cold water. Soaps, detergents, or chelating agents may be used.
3. Steam cleaning.
4. Cleaning with solvents, such as bleach or gasoline.
5. Removing the contaminated surface by using chemicals, abrasives, or by sandblasting or electrolysis.

Note that radioactive airborne material can be generated if the vacuum cleaners are not used properly. As with personnel decontamination, the milder methods to reduce contamination should be tried first, and equipment should be monitored after each decontamination attempt. If additional decontamination is needed, a milder method can be repeated or a more aggressive method can be tried until acceptable levels are reached.

Showering, washing, or hosing them prior to their removal can generally decontaminate moisture-proof protective clothing, rubber boots, and similar items.

Personnel may decontaminate canvas, rope, and similar coarse materials by dry brushing or shaking them. When items are soaked, washed, or scrubbed with liquids other than water, soap, or solvents, clear water should be used as a final rinse. Regardless of the decontamination method used, an adequate drainage system must be provided to ensure control of contaminated wastewater.

If an item or commodity cannot be decontaminated, then request advice from the command staff regarding the disposition of the materiel.

6.5. Care of RADIAC Equipment During Monitoring and Decontamination

Care should be taken to avoid contaminating the RADIAC meter or its probes while monitoring. If an instrument is contaminated, it can be decontaminated just like any other piece of equipment. It is important not to damage the meter or probes while cleaning them. Gently pouring water over the contaminated surface may be sufficient to decontaminate the surface. It is best to put a bag or glove over the end of the probe, since the bag can be easily removed if it becomes contaminated.

Table 12. Army Publications Containing Decontamination Protocols

Publication type	Document	Title
Army Techniques Publications (ATP)	ATP 4-02.7	Multi-Service Tactics, Techniques, and Procedures for Health Service Support in a CBRN Environment (DA, 2016)
	ATP 4-02.83	Multi-Service Tactics, Techniques, and Procedures for Treatment of Nuclear and Radiological Casualties (DA, 2014)
	ATP 3-11.32	Multi-Service Tactics, Techniques, and Procedures for Chemical, Biological, Radiological, and Nuclear Passive Defense (DA, 2016)
Department of the Army Regulations (AR)	AR 50-7	Army Reactor Program (DA, 2016)
	AR 700-48	Management of Equipment Contaminated with Depleted Uranium or Radioactive Commodities (DA, 2002)
	AR MEDCOM 40-42	Army MEDCOM Radiation Safety Program (DA, 2012)
Technical Bulletins (TB)	TB 43-0197	Instructions for Safe Handling, Maintenance, Storage and Disposal of Radioactive Materials (DA, 2006)
Technical Guides (TG)	TG 244	The Medical NBC Battlebook (APHC, 2008)
Department of the Army Pamphlets (DA PAM)	DA PAM 385-24	Army Radiation Safety Program (DA, 2015)
	DA PAM 50-5	Nuclear Accident or Incident Response and Assistance (NAIRA) Operations (DA, 2002)
	DA PAM 700-48	Handling Procedures for Equipment Contaminated with Depleted Uranium or Radioactive Commodities (DA, 2002)

Chapter 7. AN/PDR-77 and AN/VDR-2

The AN/PDR-77 RADIAC Set is a set of portable radiation detection equipment for detecting alpha, beta, x-ray, and gamma radiation. The set includes a scaler/ratemeter, an alpha scintillator (ZnS), an energy-compensated pair of Geiger-Mueller (GM) tubes, and an x-ray detector (thin NaI detector). The Radiation Protection Officer (RPO) kit contains a pancake GM tube and a “microR meter” (1" x 1.5" NaI) detector. The AN/PDR-77 faceplate displays units of milli Roentgen per hour (mR/h), but the instrument is calibrated in units of absorbed dose rate, rads per hour (rad/h).

The AN/VDR-2 is the standard Army RADIAC instrument, issued to every deployable unit. The AN/VDR-2 includes a pair of energy-compensated GM tubes identical to that found with the AN/VDR-77. The AN/VDR-2 is normally used to measure dose rates and accumulated doses.

The scaler/ratemeter can detect the type of probe attached and automatically set the correct operating characteristics. Because each probe is calibrated with a particular unit, only under extreme circumstances may a probe be used with a unit other than the one with which it was calibrated. If circumstances require using a mismatched probe and scaler, the results must be considered suspect until they are confirmed with a calibrated system.

Both the AN/PDR-77 and the AN/VDR-2 use three 9V batteries as a power source. The minimum lifetime of the batteries in the AN/PDR-77 is about 50 hours, and in the AN/VDR-2 the minimum lifetime is about 100 hours of constant use. After the low-battery warning is triggered, there are about 10 operational hours left on the AN/VDR-2 and about 5 operational hours left on the AN/PDR-77. Figure 6 is a picture of the digital readout meter resting on the β/γ-probe. Table 13 and Table 14 list the front panel components of the AN/VDR-2 and AN/PDR-77 and their respective functions. Figure 7 through Figure 12 show the major components, controls, and indicators of the AN/VDR-2 and the AN/PDR-77 including switches, buttons, and display lights (DA, 2003).

Routine external radiation surveys can be taken with the β/γ probe (Model DT-616), which is to be used for external dose rate measurements and for locating sources of radiation. According to the draft User's Guide for β/γ probe Model DT-616, for routine radiation surveying, the best accuracy in the ratemeter mode is obtained in the filtered mode with a 2-second update time (DA, 1997). Filtered and unfiltered modes refer to smoothed or raw data, respectively. The filter takes the count rate from the current update time and averages it over the previous 32-update periods. In the unfiltered mode, the counting rate determined over the current update period is displayed, with no averaging over previous update periods.

In effect, filtered data displays a running average of the past 32 measurements (64 seconds). This averaging smoothes out the statistical fluctuations in the dose rate data, but it also smooths out real fluctuations. The effect of filtered data is similar to that of choosing a longer time constant on an analog meter. For routine gamma ray radiation surveys, it is recommended that the filter is turned on, but it is more likely to miss a small hot spot of radioactive material when operating in the filtered mode when moving the meter too quickly. With proper training, either mode can be used well.

The β/γ-probe has an end shield that can be lifted for beta dose measurements, but this capability is not always accurate. If needed, however, the end shield can be lifted for beta surface contamination radiation surveys to detect beta radiation but not measure it. If more sensitivity is required, the thick end-window (under the moveable shield) can be removed for contamination radiation surveys. If the thick end-window is removed, the user must be extremely careful not to break the very thin window of the GM tube. The β/γ probe and its components are shown in Figure 11 and Figure 12.

The AN/VDR-2 displays units of the Gy/h and automatically changes ranges when necessary. There are three ranges for the autoscaling function of the AN/VDR-2, μGy/h, cGy/h, and Gy/h. At environmental radiation levels and the levels expected to be encountered for this technical guide to be most useful, the AN/VDR-2 will most likely display μGy/h.

The AN/PDR-77 displays units mR/h (with the mR/h symbol engraved on the faceplate) but does not change ranges. What the AN/PDR-77 does is append a k to the displayed value to give "kilo-milliroentgen per h" when the dose rate exceeds 1 R/h. For example, 1.33 cGy/h (1.33 R/h) is displayed as 1.33 k. As a further complication, the AN/PDR-77 is calibrated to display absorbed dose, mrad/h.

Figure 6. Picture of the AN/PDR-77 with the Beta/Gamma Probe

Table 13. Front Panel Controls of the AN/VDR-2

Panel controls from left to right	Function
PWR (switch)	Toggle switch turns power on (up) and off (down).
CLR/TEST (push button)	If depressed and held, CLR/TEST activates the preoperational self-test. It changes settings when used with other buttons.
DOSE PER HR	Used with other buttons to set the dose rate alarm, display the dose rate alarm set point, and clear the accumulated dose.
ACCUM DOSE	When pressed, the accumulated dose is displayed. This button is used with other buttons to perform various other functions.
ATTEN	When the VDR-2 is mounted in a vehicle, pressing this button displays the dose external to a vehicle. Used with the CLR/TEST button to display the attenuation factor.
LIGHT (switch)	On/off toggle switch that turns display light on or off. The light intensity is not very bright, and in daylight conditions the light may not be visible. The light should only be left on when needed as it drastically increases the battery use.
ALARM (3-position switch)	Used to change audible settings for the instrument. In the AUD position (up/top), an alarm will sound when either alarm set point is exceeded. In the OFF position (center), ***no*** alarm will sound. In the VIS position (bottom), the RATE or DOSE light illuminates when either set point is exceeded.
DOSE and RATE lights	Illuminate when the dose rate or accumulated dose alarm set points are exceeded and the alarm is set to VIS.

Table 14. Front Panel Controls of the AN/PDR-77

Panel controls from left to right	Function
PWR (switch)	Toggle switch turns power on (up) and off (down).
CLR/TEST (push button)	If depressed and held, it activates the operating self-test. It changes settings when used with other buttons.
SCALER	Accumulates the total counts for a predetermined time. To access the scaler mode, press this button while turning the instrument on. This mode allows for count time from 0.1 to 20.9 minutes or will allow for a continuous count until it is manually terminated. To clear the previous reading and begin a new count sequence, press and hold the CLR/TESTbutton. To view the preset count time, press and hold the ALARMbutton. To change the preset count time (minute value), press and release the CLR/TESTbutton while depressing the SCALER button. To adjust the tenths of a minute value, press and release the UPDATE TIMEbutton while depressing the SCALERbutton. By setting the time to 0.0, the instrument will set a continuous count time that must be stopped manually. To display the preset count time, press the SCALERbutton during a scaler count. To display the elapsed count time, press the SCALERbutton while depressing the UPDATE TIMEbutton.
FILTER (push button)	Converts indicated readings to average readings. To display the filter status, press this button while the instrument is on. A display of 1indicates that the filter is active, and a display of 2 indicates the filter is off. To display average readings, set the filter in the activeposition. To display raw readings, set the filter in the offposition. For all probes except the alpha probe, a filter in the active position is recommended. To change the filter status, depress and release the CLR/TESTbutton while holding down the FILTERbutton.
SETor AGE	Only used with the x-ray probe in the 1Ci/m^2 mode. To view and change the weapon agedata, press this button and hold it while turning the instrument on. After the instrument is turned on, 01is displayed, followed by a flashing digit (tens place of the weapons age). Successively pressing the AGE button will change the digit from 0 to 6. Pressing the CLR/TESTbutton will display a 02, and a flashing digit represents the ones place of the weapons age. Pressing the CLR/TESTbutton again will display a 03and a flashing digit that represents the tenths place of the weapons age. The only

Panel controls from left to right	Function
	acceptable choices here are a 0 or a 5. All ages should be rounded to the nearest half of a year. To place the instrument back into the ratemeter mode once age is set, press the CLR/TESTbutton.
LIGHT (switch)	On/off toggle switch that turns display light on or off. The light intensity is not very bright, and in daylight conditions the light may not be visible. The light should only be left on when needed as it drastically increases the battery use.
CHIRP/ALARM (switch)	Used to change audible settings for the instrument. In the CHIRP(up/top) position, the instrument will make a "chirping" sound indicative of the count rate. In the VIS(center) position, all meter functions must be visualized on the front panel. Both CHIRPand Audible alarm are disabled. In the AUD/VIS (down/bottom) position, the trend lights are illuminated and the audible and visual indicator alarms operate when alarm set point is exceeded. This signal will automatically shut off when the reading drops below the alarm value.
TREND (lights)	Dual-purpose trend lights located on each side of the word TREND. They illuminate when a statistically significant change in the count rate has occurred. The light on the left will illuminate if the trend is downward, and the light on the right will illuminate if the trend is upward. Both trend lights are illuminated when alarm set point is exceeded.

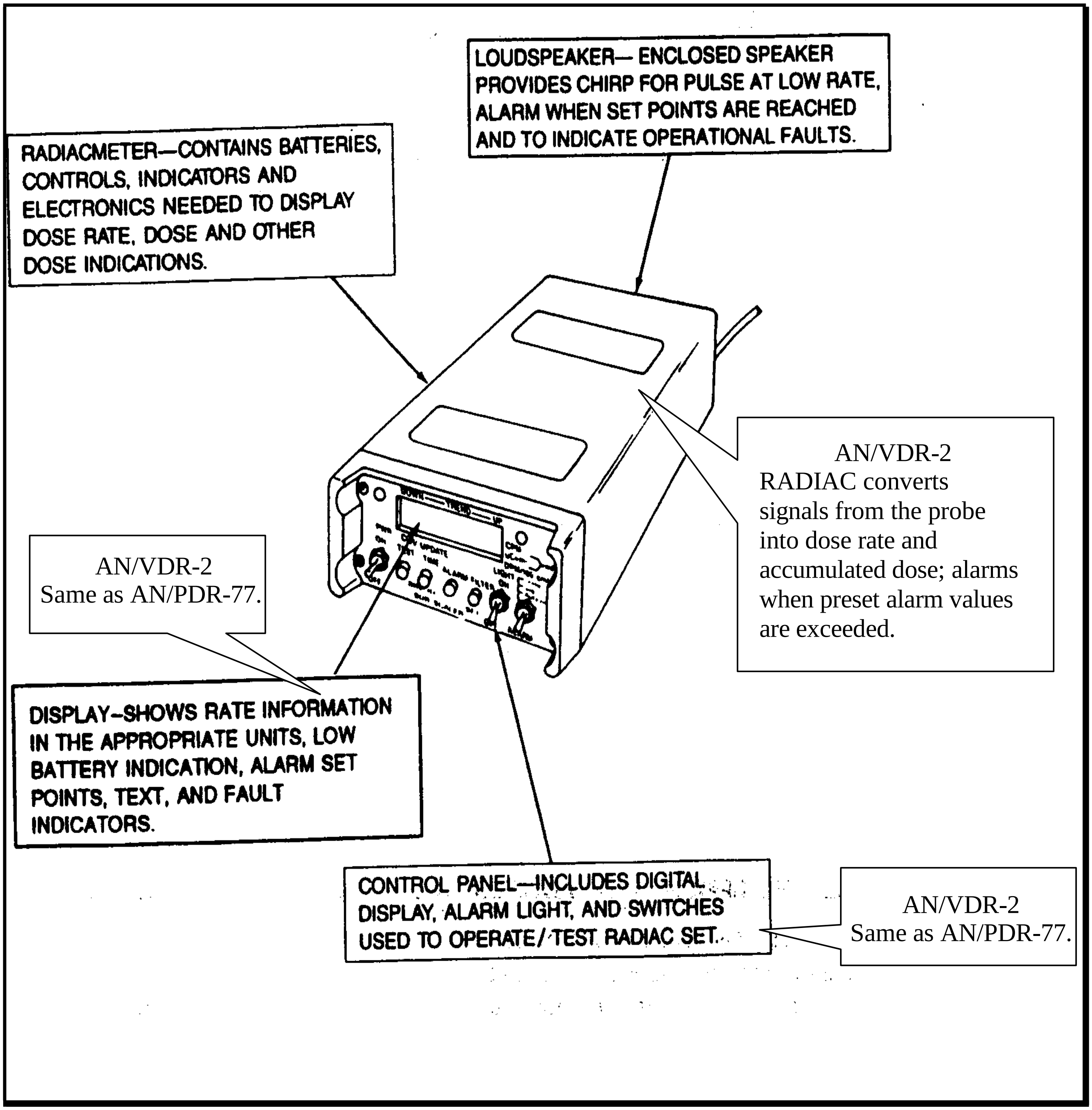


Figure 7. Major Components of the AN/PDR-77 Ratemeter with Annotations for the AN/VDR-2

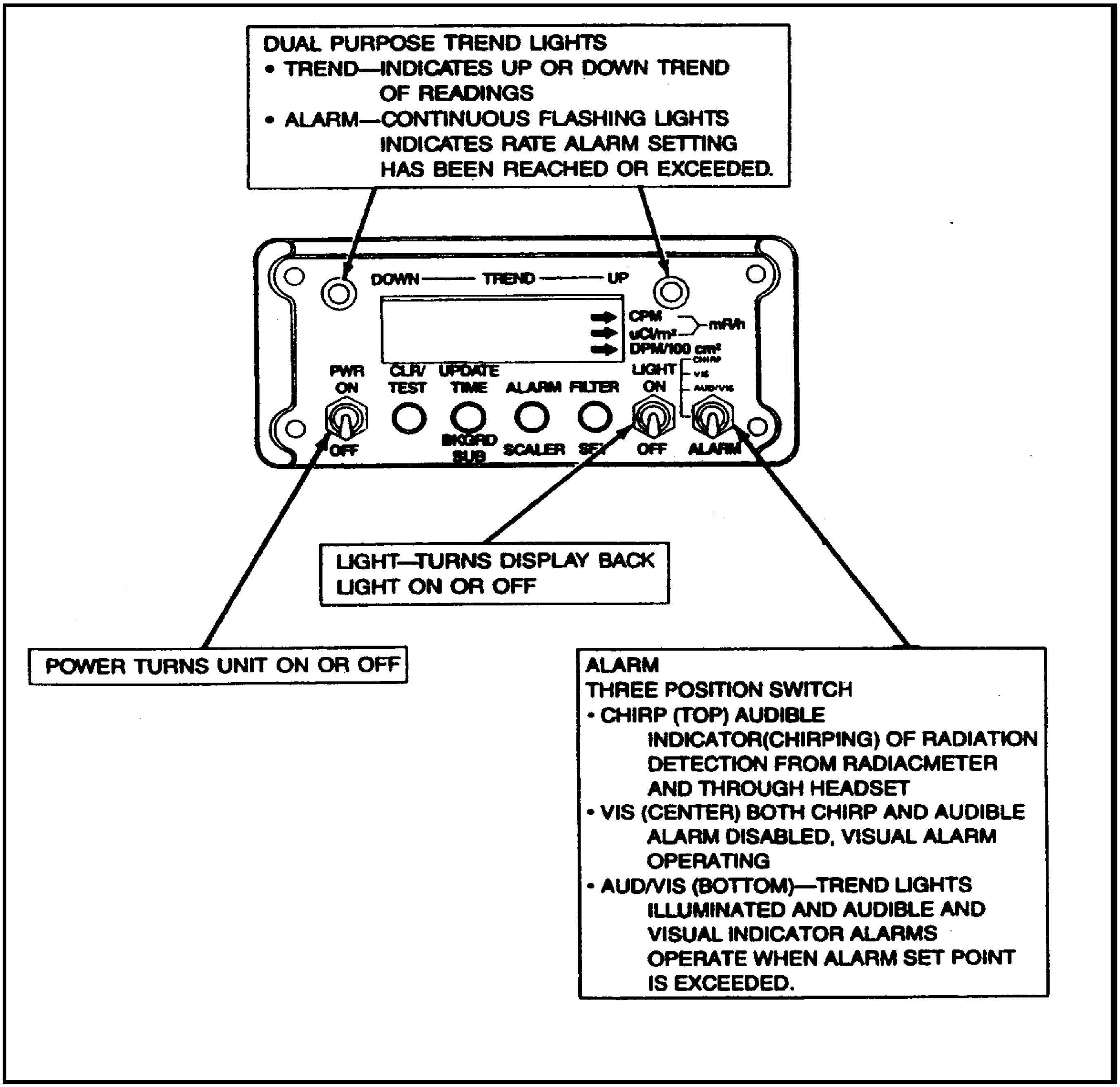


Figure 8. Toggle Switches and Alarm Settings in the AN/PDR-77 Ratemeter

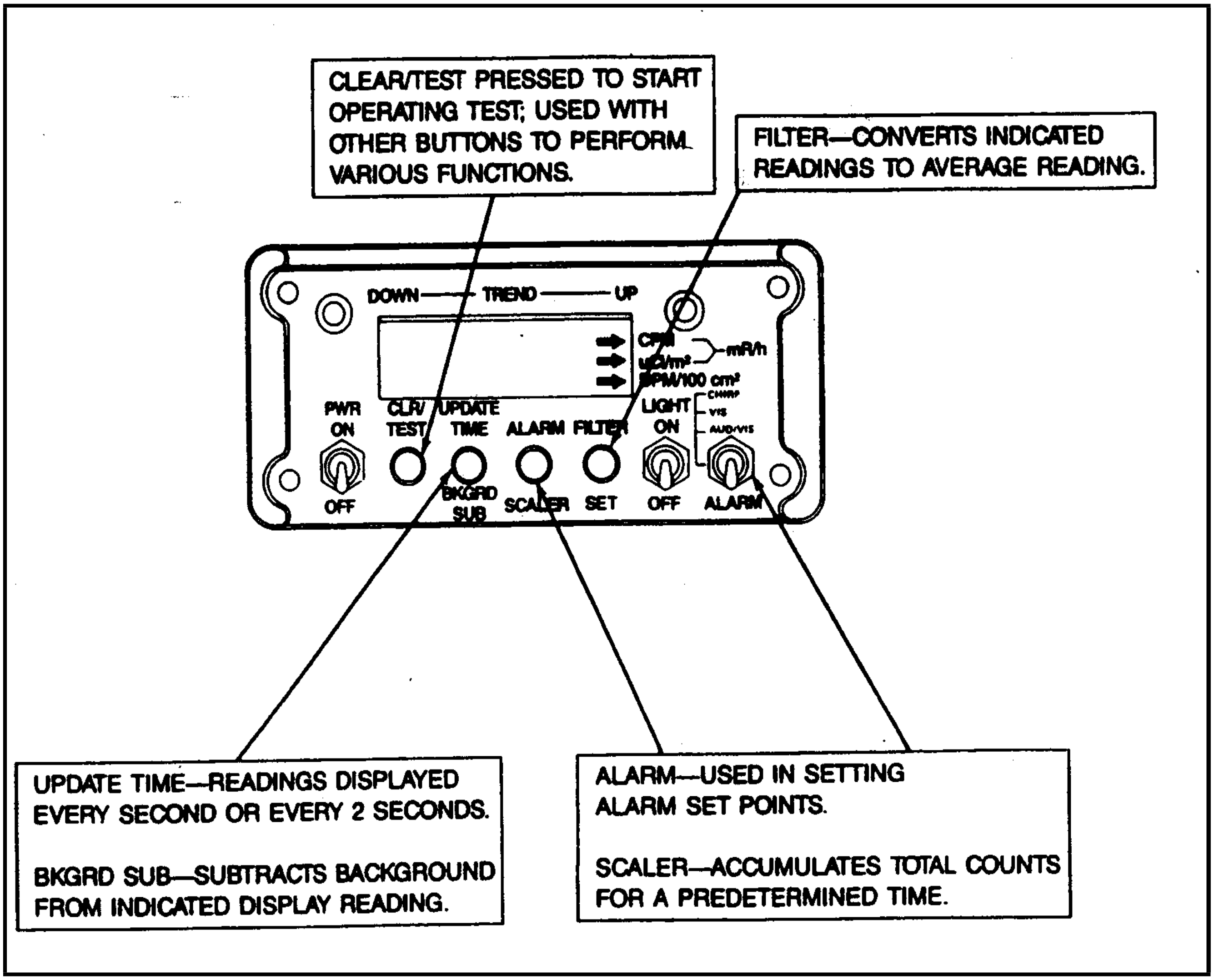


Figure 9. Pushbuttons on the AN/PDR-77 Ratemeter

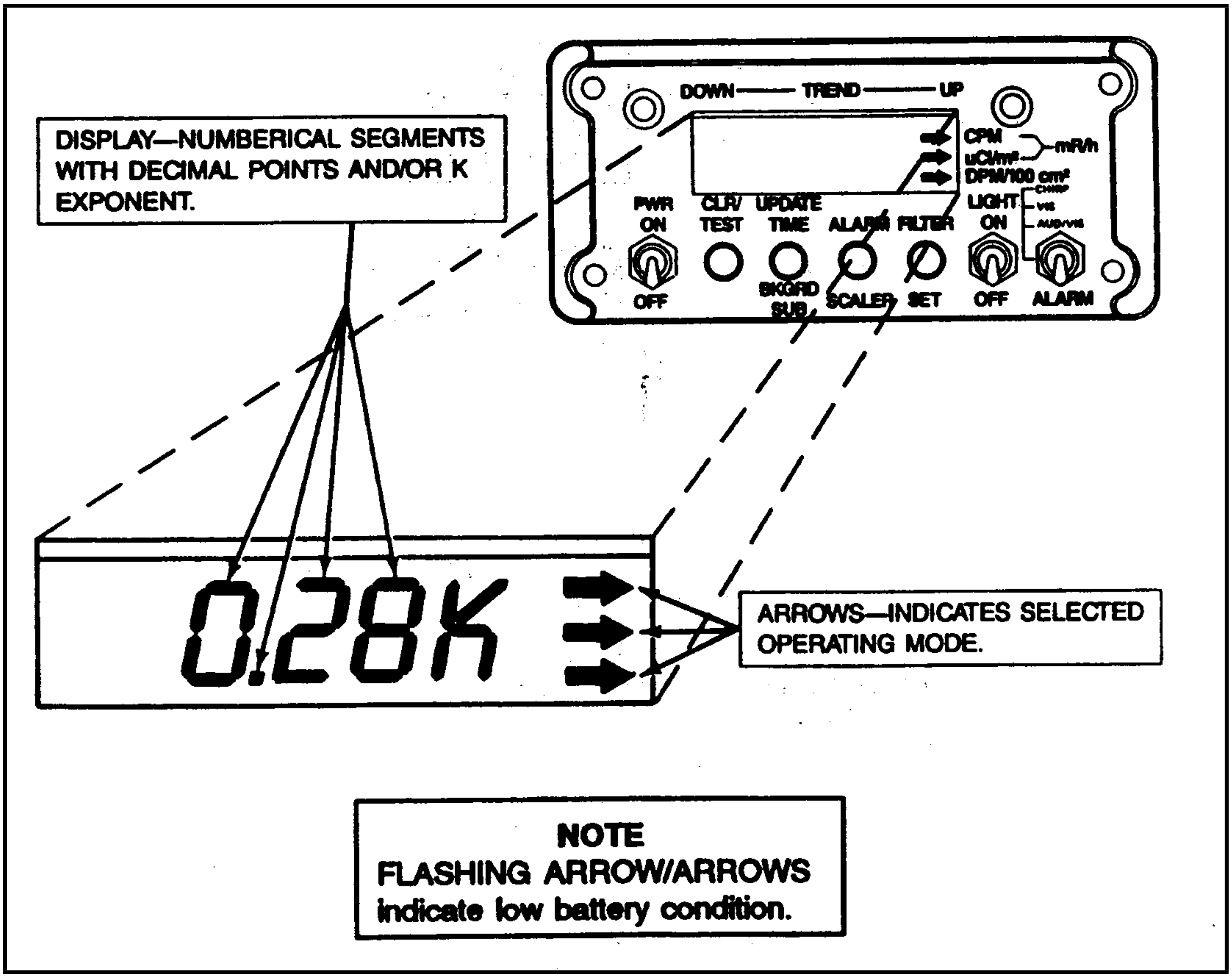


Figure 10. Digital Display from the AN/PDR-77 Ratemeter. This Figure is an Exact Copy from Reference 9

Figure 11. Picture of the Beta/Gamma Probe

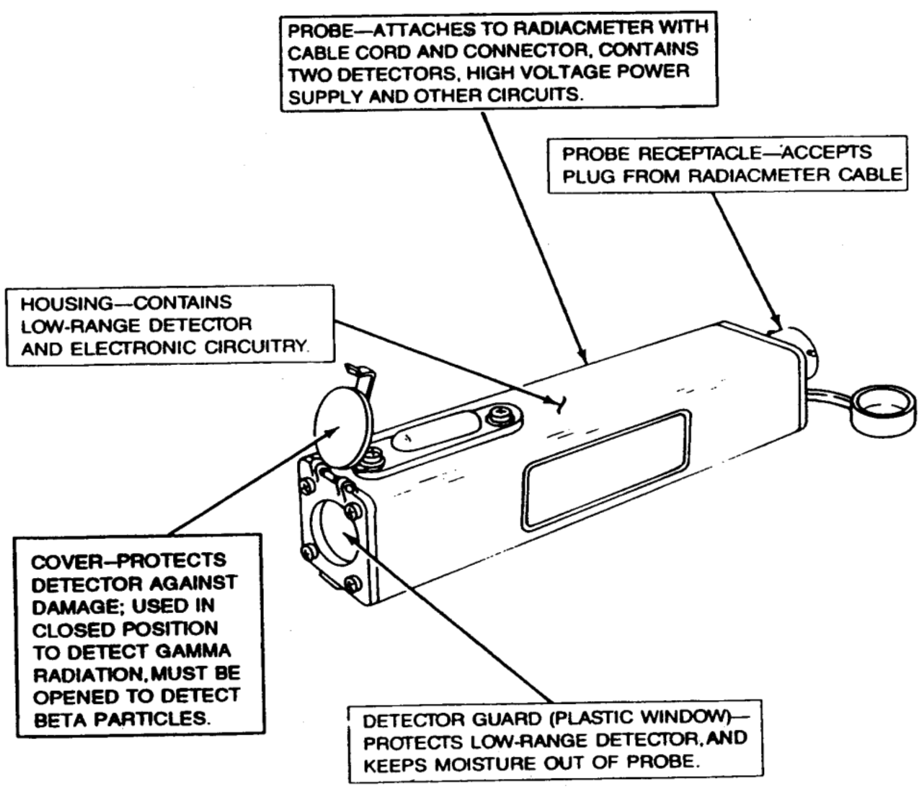


Figure 12. The Beta/Gamma Probe and its Components

Table 15. RADIAC Checklist and Preoperational Test

Instrument Type (Circle one.): PDR-77 or VDR-2 Date: ______________

Beta/ Gamma Probe SN: ______________________________ Time: ______________

X-ray Probe SN (PDR-77 only): ______________________________

Alpha Probe SN (PDR-77 only): ______________________________ Radiation survey Unit ID ______________________

AN/PDR SN: ______________________________

Checkout performed by: ______________________________

PDR-77 Yes	PDR-77 No	VDR-2 Yes	VDR-2 No	
				Carrying Case Inspection: Is the case free of obvious damage and is the case in proper working order?
				All probes present?
				RADIAC Meter Inspection: Is the meter free of obvious damage?
				Beta/Gamma Probe Inspection: Is the probe free of obvious damage?
				Alpha Probe Inspection: Is the probe free of obvious damage, especially the Mylar®§ window?
				X-ray Probe Inspection: Is the probe free of obvious damage?

RPO Kit

Pancake Probe SN: ______________________________

"micro R" Probe SN: ______________________________

Yes	No	
		Are the pancake probe and "micro R" probe present?
		Pancake Probe Inspection: Is the probe free of obvious damage?
		"micro R" Probe Inspection: Is the probe free of obvious damage?

Preoperational Test

If the unit passes the preoperational test in the Technical Manual, the unit is ready for the operational check source test. See the flowchart page 36.
If the instrument fails the test twice, then notify your supervisor.

Note: § Mylar is a registered trademark of E.I. du Pont de Nemours and Company, Inc., 1007 Market Street, Wilmington, Delaware, USA 19899.

Chapter 8. Sampling and Sample Management

The majority of this chapter was adapted from the *NATO Handbook for Sampling and Identification of Biological, Chemical, and Radiological Agents (SIBCRA)* (NATO, 2015).

The principal objective of sampling is to provide reliable estimates of radionuclide concentrations in environmental media, food, and bioassay media. The level of accuracy of such measurements is not only dependent on the analytical method used by a laboratory, but also by protocols employed in collecting, handling, storing, and transporting of the samples by field personnel. This section provides guidance on the collection, preparation, and preservation of samples subject to radioanalysis.

8.1. Common Sample Collection Practices

The following sample collection practices are common to all sampling procedures to assure sample quality:

- Use properly sized and prepared containers with an airtight seal
- Keep empty containers in a clean bag or box
- Only open the sample container to add the sample
- Use proper tools to collect samples
- Ideally, sampling equipment should be either disposable or enough spares should be available to allow single-use during a sampling mission
- Properly decontaminate sampling equipment between sample locations (See Section 6.4 for guidance.)
- Collect sufficient amount and number of samples for accurate lab analysis; generally collect as much of a sample as the container will safely allow
- Mark and record sample locations for quality control and if additional samples must be taken
- Number and label sample containers and sample collection forms sequentially
- Complete the sampling form during the sample collection
- Tape the container cap or seal after closing
- Double-bag samples

8.2. General Site Selection Considerations

When selecting a sampling site, the following general considerations should be included:

- As a rule, sampling sites are open undisturbed areas that are unaffected by water runoff, or unusual local wind patterns (e.g., away from buildings, trees, and so forth).

- Sampling and measurements in support of military operations will be at the direction of the Commander, and potentially include field hospitals, staging areas, and logistical support areas. Local officials will likely have a list of high-priority sampling locations that, under the Commander's discretion, may be sampled.
- It is quite possible that a pattern of hot particles could be superimposed on a contamination gradient. These might be particles of fuel from a power reactor damaged by a conventional weapon, spread over a wide area and generating pockets of high dose- rates. These particles would be easily detected with even simple GM detectors and could be sampled into shielded containers for further measurement, subject to handling dose- rate considerations.

8.3. Proper Selection of Sample Containers

Several physical and chemical characteristics must be considered when selecting a suitable container for shipping and sampling. Important characteristics include the container material and its size, shape, and method of sealing. Generally, containers should be made of a material that is chemically non-reactive with the sample. Similarly, it should maintain physical integrity during normal handling and shipment. The container must have a volume sufficient to contain enough samples for all analyses required of the sample, as well for several repeat analyses. It should have an opening that allows for easy filling and emptying of the container with the media of interest, and minimizes external contamination of the container. Finally, all containers should be new and unused. Table 16 recommends sample containers based on accepted analytical practices and typical media sampled.

Table 16. Characteristics of Typical Soil Sample Containers

Container	Advantages
High density polyethylene, wide mouth containers	Economical Disposable Resistant to chemicals Break resistant
Sealable plastic bags	Transparent Disposable Inexpensive

It is important to ensure that sufficient quantities of the correct type of sample containers will be available. Sample kits should be pre-assembled with sufficient containers to collect all required media, as well as sufficient quality control samples for each media.

8.4. Avoiding Cross-Contamination

Critical to accurate analysis is ensuring that a sample is not contaminated during the process of collection and transport. To avoid cross-contamination, it is necessary to take the following precautions:

- When sampling, work from the site you expect to be least contaminated towards the site you expect to be most contaminated (without exceeding specified radiation exposure guidance).
- Wear disposable gloves when collecting samples and change gloves after taking each group of samples at one site (e.g., discard your gloves after collecting all soil samples).
- Keep equipment out of dirt, dust, soil and surfaces that are likely to be contaminated. Use a clean plastic sheet to put your equipment on.
- Double-bag samples immediately after they are collected.
- Clean sampling equipment after taking each group of samples and check for residual contamination, or use only disposable sampling equipment.

Sampling tools must be adequately cleaned or decontaminated in between the collection of the replicate samples to minimize cross-contamination. Loose soil or vegetation should be scraped off and then suitable agents used (e.g., alcohol followed by wiping with paper tissues). A contamination meter should be used to determine if the tool is sufficiently clean to take the next sample. If the tool is not clean, (i.e., it is either physically dirty or contaminated above background) then it should not be used for sampling. Using disposable tools (e.g., plastic scoops for soil, funnels for liquids, brushes for dust sampling, and scalpels to cut vegetation) is the easiest way to eliminate cross-contamination of samples.

8.5. Sample ID, Sample Labels, and Field Sampling Forms

8.5.1. Sample ID and Labeling

Each sample can only be identified over the life of the incident response if permanent identification is written-on or affixed-to the sample container. Generally, writing directly on the sample container with permanent marker is the simplest and safest way to label a sample.

If tags or adhesive labels (bar codes for example) are used, they should be affixed to each sample container immediately after a sample is collected. Labeling should not contaminate the sample and should be sufficiently resistant to degradation, fading, or tampering (i.e., difficult to remove once affixed to the container). The sample number or ID should be clearly printed on the label, and clearly recorded on the accompanying sample data sheet, film, or video that documents the nature and circumstances of collection.

A unique identifier can combine a sample descriptor, a 6-digit sampling site location, and the NATO Date-Time Group for collection. The following method is recommended:

ALATLOGDDTTTTZMMMYYYYXX, where:

A is the media
descriptor:
A - Air
S - Soil
H - Hydrological samples (Water)
V - Vegetation
D - Dairy (Milk)
G - Grain
M - Meat
O - Other Foodstuffs
B - Breathing Zone Air
U - Urine
F - Feces
W - Wipes (Smears and Swipes)

LATLOG is the six digit latitude-longitude GPS or grid coordinate

DDTTTTZMMMYYYY is the NATO Date-Time Group,
where DD - day of the month (e.g., 09 = 9th day of month) TTTT - time of day (e.g., 1600 hours)
Z - time zone (e.g., A for alpha and Z for zulu time)
MMM - month, alphabetically abbreviated (e.g., April is APR)
YYYY - year (e.g., 2001)

XX - A sequential number used to identify field replicate or split samples, or for sampling methods that generate more than one sample (e.g., simultaneous particulate and iodine sampling).

Warning

If the sample is sufficiently radioactive to trigger a response from hand-held instruments, the sample containers must be labeled w a yellow and/or magenta colored radiation symbol.

8.5.2. Sample Collection Forms

A sample data sheet must accompany each sample when forwarded for analysis. All information relevant to field sampling may be subject to audit, and therefore must be recorded on the appropriate sampling forms. Critical information that must be documented regardless of sample type includes:

- Identification of operation or incident, and its date and time
- Date and time of sampling
- Grid and GPS location of the sampling point
- Sampled medium
- Sample specific identification number
- Sampling method and equipment used
- Sample preparation and preservation
- Name of persons collecting the sample, or identification of sampling team
- Physical and meteorological conditions at time of sampling
- Special handling or safety precautions
- Results of field expedient assays using hand-held instruments
- Signatures

Additional information may be required, depending on the media sampled and the intent of sampling. Figure 13 is an example of a soil sample collection form.

Soil Sample Collection

APHC - Health Physics Division – TG 236

Sampling Location:	
Radiation survey Unit ID:	

Team Leader:		Sample Types: Grab and Soil Analyses Desired: γ-spectroscopy
Samples packed by:		
POC:		

APHC Project number if applicable:

List the **Field ID** and **NATO Date-Time Group.**	
Field ID	**NATO Date-Time Group (DDTTTTZMMMYYYY)**

Tamper Resistant Seals Used?	Yes	No

Chain of Custody Information			
Sign and Print Name			
Released By	Received By	Date	Purpose of Transfer

Notes and Comments

Figure 13. An Example of a Soil Collection Form

8.6. Chain-of-Custody

Documentation of changes in the custody of a sample(s) is very important. In such cases, there should be sufficient evidence to demonstrate that the integrity of the sample was not compromised from the time it is collected to the time the sample is analyzed. During this time, the sample should either be under the positive control of a responsible individual or secured and protected from any activity that could change the true value of the results. Samples of particular concern should be closed with tamper indicating seals after field processing and preservation steps have been completed. The seals will show if a sample has been disturbed.

8.6.1. Field Custody Considerations

The person collecting samples is responsible for the care and custody of the samples until they are properly transferred or dispatched. This means that samples in their possession are under constant observation, or secured. Samples may be secured in a sealed container, locked vehicle, locked room, etc.

8.6.2. Transfer of Custody

A chain-of-custody record should accompany all samples with medical or legal significance. This record documents sample custody transfer from the sampler, often through several persons, to the analyst in the laboratory. The individuals relinquishing and the individual receiving the samples should sign, date, and note the time on the record. Upon receipt of the sample, the new custodian should inspect the condition of the sample container and tamper seals, if used, and record observations on the record. Any problems with the individual samples, such as a broken container, should also be noted. The method of shipment and courier name can also be listed in the chain-of-custody record.

For samples shipped from the field to a fixed laboratory, the original chain-of-custody record should accompany the samples. The individual relinquishing the samples should retain a copy of the record. The custody objectives should be discussed with the shipper to ensure that the required shipping conditions are met. For example, if the samples are sent by mail and the originator of the sample requires a record that the shipment was delivered, the package should be registered with return receipt requested. If, on the other hand, the objective is to provide a written record of the shipment, a certificate of mailing may be a less expensive appropriate alternative.

8.6.3. Instructions for Fulfilling Chain-of-Custody Requirements

Decisions on what level of security needs to be applied should be made in consultation with command staff, the analytical laboratory, and the Health Physics Division at APHC. An adequate chain-of-custody record allows tracing of custody and handling of individual samples from the time of field collection through laboratory analysis. The chain-of-custody record should be included in the shipment of each sample and should contain the following information, at a minimum:

- Sample number
- Signature of collector
- Date and time of collection
- Sample station location
- Number of containers
- Signatures of people involved in the chain of possession
- Inclusive dates of possession.

When transferring samples, the individuals releasing and receiving them should sign, date, and note the time on the form. The original chain-of-custody form accompanies the sample shipment, while the sampling team retains the copies. When samples are split, the event should be noted in the "Notes and Comments" section of the chain-of-custody record. The team should complete a separate chain-of-custody record for custody and shipment of the split samples. Figure 14 shows a sample chain-of-custody form.

8.6.3.1. Chain-of-Custody for Samples Requiring Strict Custody

Most of section 8.6.3.1 through section 8.6.3.3 was adapted from *Groundwater Field Sampling Manual* (Wisconsin Department of Natural Resources, 1996).

To be admissible as evidence, sample results must be traceable back through their collection, storage, handling, shipment, and analysis so that the court is satisfied how the sample results submitted as evidence were collected, transferred and claimed. This is accomplished by following chain-of-custody procedures from sample collection to introduction as evidence.

Field records identifying sampling personnel, equipment, collection, storage and transfer techniques, and field conditions are required. The sample collector is responsible for maintaining sample custody and integrity until the samples are transferred via a dated and signed chain-of-custody form to a carrier or are personally delivered and transferred directly to the laboratory.

A sample is in custody if it is:

- In physical possession, or
- In view, after being in physical possession, or
- Secured so that no one can tamper with it.

The courts have accepted two degrees of chain-of-custody. The first involves physical possession of the sample from collection to laboratory possession. With this chain-of-custody method, the sample collector or other person to whom sample possession was transferred delivers the samples to the laboratory. The second chain-of-custody method is by shipping the samples through a mail carrier. Mail carriers may not assume any liability or responsibility for compromised sample integrity during shipping (e.g., broken samples and/or containers, ice melting in cooler, etc.).

In both cases, a written record must be transferred with the samples. However, when using the second method described above, the sample collector fills out a chain of custody record, seals it in a shipping container, and uses a carrier to deliver the samples to the laboratory. Upon arrival, a pre-determined laboratory custodian receives the samples, notes the shipping container's condition (whether sealed or unsealed), notes each sample container's condition (broken samples, ice present in cooler, etc.), and assumes custody of the samples by signing and dating the chain-of-custody record. The laboratory maintains possession of the chain-of-custody record until the sample analysis is complete and then sends the analytical results, along with the chain-of-custody record, to the sample collector or other pre-designated receiver of the analytical results and chain-of-custody records.

For routine surveillance samples, the second chain-of -custody method should suffice. If enforcement action may occur based on the type of samples and/or regulatory programs or agencies involved, the first chain-of-custody method involving the sample collector physically delivering and transferring possession of the samples to the laboratory is recommended.

8.6.3.2. Field Chain-of-Custody Guidance

- Limit sample collection and handling to as few people as possible. If sample transfers are necessary, use signed receipts of possession. The chain- of-custody record must accompany the samples. Keep a copy of the chain- of-custody record for your own records.
- Check with the mail carrier for restrictions and procedures.
- Record field measurements and other important data in a bound field notebook or on the data sheets provided in this technical guide. For legal purposes,

indelible ink should be used for recording all data and errors in field records should be crossed out with one line and initialed.

- When required or applicable, document with photographs the sample locations, pollution sources, violations, etc. If possible, use cameras that print the date the photos were taken.
- Maintain physical possession and sample integrity of the collected samples until they are properly transferred to the laboratory custodian or the mail carrier.
- Obtain a sample possession transfer receipt (a copy of the dated and signed chain- of- custody record) after transferring possession of the samples to the laboratory custodian or the mail carrier.

8.6.3.3. Sample Security when Strict Custody is Necessary

Use the following procedures when securing and transferring possession of strict custody samples:

- Use sample seals. Tape the sample container so that the tape must be cut or ripped to open the container. Use nylon-reinforced tape or other tape that cannot be tampered with without being noticed upon receipt. Sign and date the tape across the top.
- Using an indelible permanent marker or ink, write the following information on the security tape, writing across the overlapping ends:
  - Name of the sample collector(s), date, time, well number, facility name, etc., where the samples were collected.
  - Write the words **"Strict Custody Requirement**s," or similar language indicating that sample security is critical.
  - Write, "To be opened by________**"** In the blank write the appropriate person or organizational representative.

By overlapping and writing over the edges of the security tape, it will be possible to detect if someone has tampered with the sample container. If someone were to remove the tape and then reseal it, it would be difficult to realign the writing seamlessly.

Do not use sealing wax to seal the tape. Sealing wax is brittle and will chip and break during normal use. This gives the appearance of tampering even when none has occurred.

Sample containers labeled "Strict Custody Requirements," or with similar language, must be locked up by the laboratory upon receipt and not removed from the locked refrigerator until ready to be analyzed. The laboratory will hold all strict custody samples until notified otherwise. When the case is resolved, by either trial or stipulation, the enforcement specialist should notify the laboratory that the samples associated with the case may be discarded or destroyed.

Field Chain-of-Custody Sheet

APHC - Health Physics Division – TG 236

Sampling Location:	Date of Collection:	Page 1of 2
	Radiation survey Unit ID:	

Team Leader: Samples packed by: POC:	Sample Types: Grab and Soil Analyses Desired: γ-spectroscopy

APHC Project number if applicable:

List the **Field ID** and **time of collection** of each sample.

	Time		Time		
1.		11.			
2.		12.			
3.		QC.			
4.		Additional Samples	Time	Sample Type	Desired Analyse
5.					
6.		BKG 1.			
7.		BKG 2.			
8.		BKG 3.			
9.		13.			
10.		14.			

Method of Shipping and Carrier Used:	Tamper Resistant Seals
	On the container? O Yes O No
Shipping Date:	On each sample? O Yes O No

Chain- of- Custody				
Sample or Samples Transferred	Sign and Print Name			
	Released By	Received By	Date	Purpose of Transfer

Field Chain-of-Custody Sheet
APHC - Health Physics Division – TG 236

Chain-of-Custody				Page 2 of 2
Sample or Samples Transferred	Sign and Print Name			
	Released By	Received By	Date	Purpose of Transfer

<u>Notes and Comments</u>

Figure 14. A Sample Chain-of-Custody Sheet

8.7. Field Processing, Preservation, and Transport of Samples from the Survey Unit

8.7.1. General

Initial steps, taken in the field, are frequently critical to the quality of the laboratory analysis performed hours or days after sample collection. Various steps of preparing raw sampling materials for field or fixed laboratory processing may be required depending on sample matrix, the nature of the contaminant, and the analytical method to be used. Field processing ensures the sample is (1) homogeneously distributed, (2) free from material that is not considered part of the sample matrix, and (3) chemically and physically preserved. In this case, the field does not mean the sample collection location. The field essentially is any location that is not the CONUS or OCONUS destination for the samples. Examples of field processing include:

- Separating and separately bagging biological matter removed from soil samples.
- Excluding oversized material, including rocks and gravel, not representative of soil.

8.7.2. Sample Transport

The final responsibility of field sampling teams is, properly and as quickly as possible, transport samples from the collection site to a sample control site or field laboratory. For sampling performed in a known contaminated region, transport will include contamination control precautions (Chapter 6). Sample forms must be maintained with the samples through the contamination control area, and transfers of possession must be documented on the chain-of-custody record. The following issues should be considered when moving samples:

- Transfer to sample control should be expedited in order to minimize decay of short half-life radionuclides and surface plating before analysis.
- Samples should be segregated from contaminated sampling equipment.
- Low activity and background samples should be segregated from high activity samples.
- Samples should be transported securely and safely.

At this point in the process, the samples have been packed and transported out of the survey unit and must be made ready to be shipped to their CONUS or OCONUS destination. This aspect of shipping is discussed in Chapter 9.

8.8. Liaison Between Sampling Team and Sample Control

All laboratories will have unique requirements and procedures with respect to analyzing a given media for a given analyte. To assure sampling protocols are consistent with analytical protocols of the laboratory, field teams should communicate with either the field deployed laboratory or the field sample control station to determine any special requirements for sample collection or quality control.

Chapter 9. Shipping Samples to Laboratory - Sample Receipt, Inspection, Tracking, and Shipment

The majority of this chapter was adapted from the *NATO Handbook for Sampling and Identification of Biological, Chemical and Radiological Agents (SIBCRA)* (NATO, 2015).

9.1. Overview

After a sample is collected, it is passed to a sample control site or field laboratory. Successful acceptance of the sample by either entity terminates the sampling team's role in sample handling. Figure 15 demonstrates the typical flow of activities for sample receipt and inspection at a sample control site, which in turn will forward the sample, if necessary, to a field laboratory or rear echelon fixed radioanalytical laboratory.

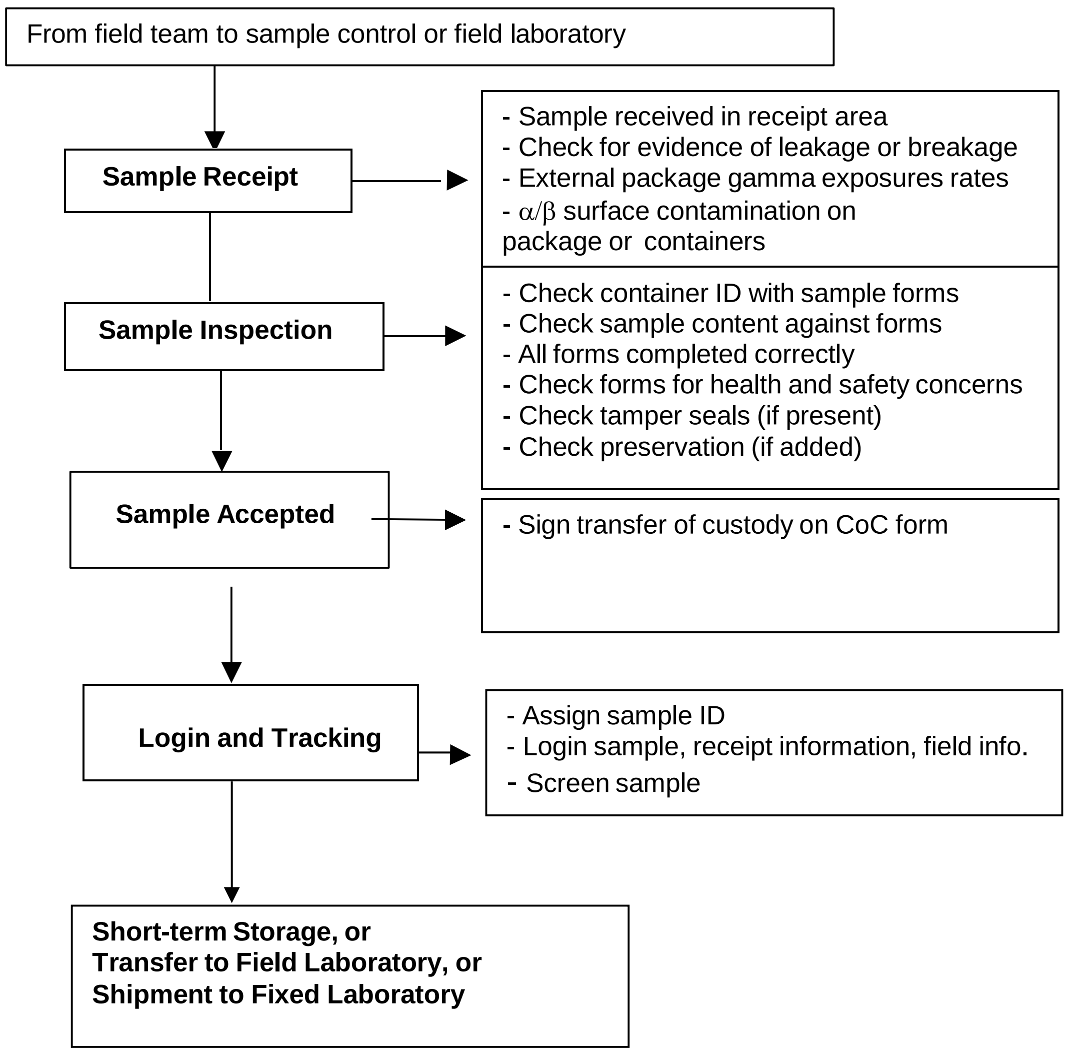


Figure 15. Flow Chart for Sample Receipt

9.2. Shipment of Samples to Analytical Laboratories

9.2.1. Sample Packing

All samples being sent off-site for analysis should be properly packaged before shipment. Some examples of sample packaging techniques include:

- Visually inspecting each sample container for indications of leaks or defects in the sample container.
- Wiping individual sample containers with a damp cloth or absorbent paper to remove any exterior contamination.
- Placing sample containers inside individual plastic bags to reduce the chance of cross-contamination, and to contain the sample in case of leakage or breakage.
- Grouping samples for shipment in terms of overall activity or surface contamination levels.
- Including sufficient absorbent material to contain the samples in case of leakage or breakage if there are liquid samples in the package.
- Packaging sample containers to prevent breakage by immobilizing and isolating each sample container using packing material-this is especially important in cold weather when plastic containers become brittle and water samples may freeze. A minimum 2.5-cm cushion between samples is recommended.
- Including the original, signed chain-of-custody form that lists the samples that are included in each package (e.g., if possible avoid having multiple packages covered by a single chain-of-custody form).
- Sealing the package to deter tampering with the samples-the seal should indicate if the sample has been opened or tampered with during shipment.
- Enclosing the paperwork (the chain-of-custody and sample forms) in a plastic sealable bag. The sealable bag serves to protect the sampling forms from inadvertent sample leakage. The bag should be securely attached to the sample container.

9.2.2. Sample Inspection, Administration, ID Confirmation

Verifying the identity of a sample is a simple process where the appearance, sample container label, chain-of-custody form, and sample collection form are inspected. Nonconformance between labels, ID numbers, forms, and chain-of-custody forms must be resolved immediately before final packaging and shipping. Visual inspection allows one to:

- Verify the identity of samples by matching container IDs and sample form IDs.
- Verify that the samples are as described by matrix (and quantity).
- Check the tamper seal.

- Verify field preparation, if appropriate, including removal of extraneous materials.
- Note any change in sample since collection (e.g., from chemical reactions).

If these problems cannot be resolved upon receipt, or by coordination with the sampling team, the sample must be rejected for nonconformance.

9.2.3. Sample Shipping

Samples should be delivered to the analysts within a reasonable amount of time. For some contamination scenarios, short-lived radionuclides (fission or activation products) could be present and unnecessary delays in transport or analysis could result in the loss of this information. The time requirements for shipping should be made in consultation with the analytical lab, PH community, command, national and international regulators, and other appropriate personnel.

Packages and sample containers are screened for external exposure rates and surface contamination before shipping. Radiological screening of shipping and sample containers should be performed with a dose-rate meter and a beta/gamma and alpha contamination radiation survey meter.

9.2.3.1. OCONUS Shipping

If OCONUS samples are sent off-site for analysis via commercial carrier, the consignor is responsible for complying with all applicable international regulations, which requires more training than is provided by this Tech Guide. Requirements will include use of a proper container or packaging dependent on the total activity of the shipment, and the dose-equivalent rates measured at the exterior of the package. Additional requirements include package marking and labeling, and completion of proper shipping papers. Specific guidance for the shipment of radioactive material is found in the International Atomic Energy Agencies (IAEA) Safety Series Report 6 "Regulations for the Safe Transport of Radioactive Materials" (IAEA, 2012).

It is not possible to specify what the requirements would be for military transport without a detailed knowledge of the exemptions that might apply, particularly following a conflict. However, IAEA regulations are generally conservative, and when complied with, there should be no possibility of exceeding either civil or military restrictions on the transport of radioactive materials.

9.2.3.2. CONUS Shipping

Shipping samples within the United States must conform to all federal and state regulations. Detailed information about CONUS shipping is in Appendix F.

9.3. Communication Between Sample Control and Laboratory

Laboratory personnel conducting sample analysis are generally not involved with sample collection. This separation of tasks can potentially lead to problems based on the lack of communication between the two groups. Fixed and field laboratories may need to pass special requirements on to the sampling teams. For this reason, unhindered communications between command personnel, the sampling personnel, and the laboratory is vital.

Any unique conditions of the sample and any special requirements for sample analysis should be communicated to the laboratory. Sampling teams generally make this communication by thorough documentation on the sample form. However, the laboratory can be prepared for receiving special samples. For example, a sample may contain combustible materials or high levels of chemically or biologically hazardous materials. This is particularly important for samples posing health and safety issues for laboratory personnel. The carrier/shipper should also be made aware of what types of hazardous materials are in the package.

9.4. Short-term Sample Storage

If necessary, samples should be stored with samples of comparable activities, in designated storage areas, to await forwarding to a fixed laboratory. Storage areas must meet chain-of-custody requirements, and be designated and posted as a radioactive material storage area (other hazards, such as chemical or biological, may require posting as well).

9.5. Final Sample Disposition

After the samples are analyzed, it is up to the requester of the analyses to decide on how to dispose of the samples and any residuals. Archiving the samples is strongly recommended. At the time of this technical guide’s publication, an archive location has not been established; however, it is very important to communicate with APHC HPD about the final disposition of samples.

Chapter 10. Surface Soil Sampling

This chapter provides guidance on surface soil sampling according to the *NATO SIBCRA* (NATO, 2015) from which most of this information was adapted. This chapter is intended to expand on the information in Chapter 4 and provides more detail for specific soil sampling situations.

Precautions/Limitations

- Ground contamination may vary significantly from place to place (hot spots); local dose rate averages are helpful in choosing a representative sampling location.
- Soil sampling is to be done after a release has ended and after plume passage; exposure to external radiation is possible but inhalation hazards may only be due to re-suspended materials.
- Team members should be aware of commanders' dose and turn back dose-rate guidance.
- No sample is worth life or limb. Always be aware of the hazards that you may encounter in the field and take the necessary precautions. Never attempt any field activities without the appropriate safety equipment. Always know how to use it.
- All monitoring activities shall be conducted so that exposures are maintained as low as reasonably achievable. Team members shall be aware of turn back levels.
- Monitoring teams must refrain from eating, drinking, or smoking in any contaminated areas or where monitoring activities are being conducted.

10.1. Prior to Being Dispatched

Step 1: Receive an initial briefing and initial assignments from Command

- Obtain appropriate equipment.
- Check instrument performance.
- Conduct the radio check when leaving for the assignment.
- Conduct a GPS check when leaving for the assignment.

Step 2: According to instructions from Command

- Wrap the instruments in plastic to prevent contamination (except for the detector window if there is any).
- Sample collection equipment should be pre-cleaned and bagged or wrapped.
- Set alarm levels of direct-reading dosimeters and dose rate meters.

- Wear appropriate protective equipment.
- Disposable latex or vinyl gloves should be worn and changed between sample locations.

NOTE

Command will decide on the implementation of the use of agent blocking drugs, protective clothing, respirators, or other protective equipment.

10.2. At the Site (Survey Unit)

Step 3:

- Sampling sites should be selected to permit easy resampling at a later date, should it become necessary. Upon identifying the sampling site, document the position using GPS reading, local landmarks, stakes, or other markers.
- Both hot spots, background sites, and sites more representative of local count rates should be selected for sampling. Upwind and uncontaminated sites should be selected for the background samples. If only hot spots are selected for sampling, record the ratio of hot spot dose rate to average dose rates for future risk assessments.
- Select an area that is relatively unvegetated and undisturbed since the radioactive release and well away from structures (e.g., approximately twice the height of the nearby structure) to minimize the effects of wind currents on deposition.
- Populated Area: Select an open, level, grassy area that has been undisturbed, if possible. These areas should be away from normal walkways and roadways, and located in open, level, grassy areas that are mowed at reasonable intervals (e.g., lawns, parks, etc.).
- Agricultural Area: Select an open, level, grassy area that has been undisturbed, if possible. Such an area should be free of excessive rocks and vegetation and there should be little or no run-off during heavy rains causing excessive erosion. Such sites are frequently found on smooth ridge crests and level virgin lands. If possible, do not select areas that have been fertilized heavily since fertilizing adds naturally occurring radioactive materials to the soils.

NOTE

Place tools, instruments and collected samples on a ground tarp to help prevent contamination of sampling equipment.

Step 4:

At each sampling location, record the environmental conditions at the time of sample collection. These include the weather conditions and ambient gamma dose rate.

Step 5:

Collect the soil samples based on the procedures in accordance with guidance in Chapter 4, Chapter 8, and this chapter.

Step 6:

Seal the bags with tape. With an indelible ink pen, write on the sampling container and the sample control form the sample ID, GPS location, date, and time of sample collection, and the collector s initials. Begin a chain- of- custody form if necessary.

Step 7:

Clean the sampling tools in clean (distilled) water and dry before proceeding to the next sample collection point. Assess the tool for residual contamination using alpha/beta instruments.

Step 8:

Repeat the above steps for all necessary duplicates, background samples, and other sampling locations.

Step 9:

Visually inspect the sampling equipment and replace or clean if necessary. Use alpha/beta instruments to determine if the sampler remains contaminated.

Step 10:

For each soil sample collected, complete a soil sampling form. Place the original forms in a separate sealed plastic bag to be shipped with the sample.

Step 11:

Periodically perform radiation surveys on vehicles and personnel used during sampling.

Step 12:

Throughout the mission perform personnel and equipment monitoring (contamination check) using the guidance in Chapter 6.

10.3. Sampling Guidance for Specific Soil Types

This section provides guidance for sampling specific soil types. This guidance is very general and is not required for sampling. It is best to perform the sampling after consulting with specialist advisors in environmental or radiological sampling. Use the information in this section as a starting point if there is difficulty in collecting samples.

10.3.1. Sampling in Dry, Loose, and Sandy Soils

After selecting the location of sampling and the sampling pattern to be used, don rubber gloves, remove all vegetation to a height of 1 - 2 cm above the soil, and save for vegetation analysis if desired.

10.3.1.1. Stamp Method

- Press the 10x10x1 cm "stamp" into the desired location. (A rubber mallet may be used if necessary to assist.)
- Use the matching scoop to slide beneath stamp, trapping the sample within the stamped area.
- Carefully transfer the sample to a clean, unused sample container.

10.3.1.2. Template Method

- Measure a 30x30 cm area for sampling.
- Next to the desired area, dig away from the sampling area to create a sloping trench with a perpendicular wall along one side of and slightly larger than the sampling area.
- Collect the top 15 cm (6 inches) of soil from the desired area of the surface at the edge of the wall. If the sample location has a cover of vegetation, collect it as a separate sample. Place the sample into a new container.

10.3.2. Sampling in Moist or Loamy Soil

- After selecting the location of sampling and the sampling pattern to be used, don rubber gloves, remove all vegetation to a height of 1 - 2 cm above the soil, and save for vegetation analysis if desired.

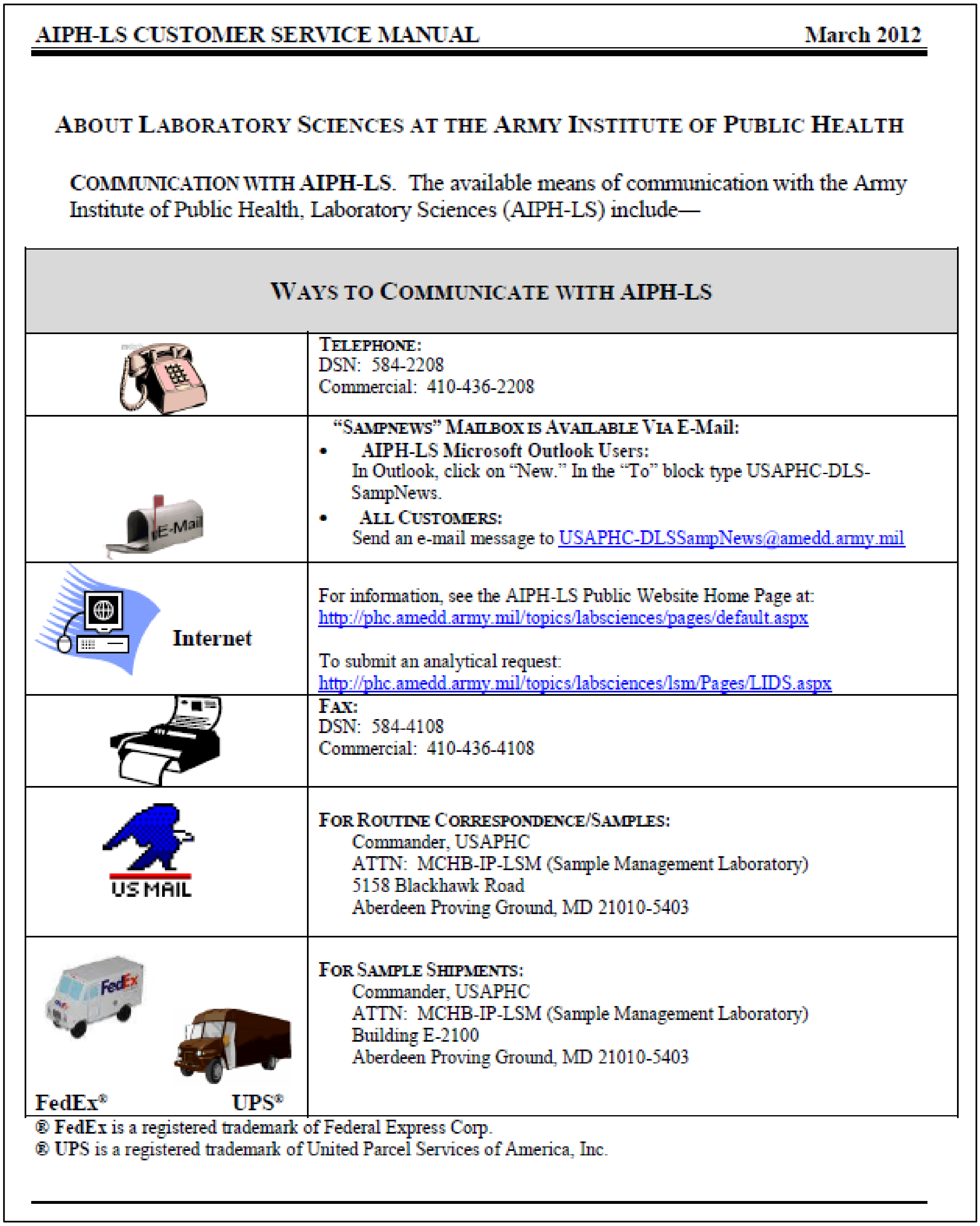
- Using an indelible ink pen, measure and mark the outside of the sampling tool to the desired depth.
- Press the sampling tool into the ground to the desired depth without twisting or disturbing the grass cover or surface soil. Force may be required to get the sampling tool into the ground. This may be accomplished by stepping on the top of the sampling tool or using a rubber mallet.
- After the sampling tool is at the appropriate depth, gently twist it cleanly removing the topsoil plug intact. If the plug cannot be removed intact, another method of sampling must be used.
- Place the plug in a new sample collection container. If the plug does not easily come out of the sampling tool, take a long, flat blade knife or picker to remove it from the tool.

10.3.3. Other Types of Soil Conditions

- Extremely Wet Areas: If possible, avoid areas where soil is extremely wet. If this is impossible, it may be difficult to follow the above procedures. A modified area sample may be appropriate in this situation. Any changes in the location of the survey unit must be made with concurrence from Command and advice from specialist advisors. Use a shovel or trowel to remove the upper layer off the desired area. Put the sample in a container and label it as appropriate.
- Frozen Soils: Lightly frozen soil can be sampled by taking a square bladed spade and driving it into the ground to a known depth. The soil can be easily removed in one quick movement. Hard frozen soils must be sampled using a chisel to "chip" the soil. This process is extremely difficult to use to obtain a representative sample.
- Clay Soils: These should be avoided if possible. Because clays tend to be "sticky," there may be a handling to get a representative sample. Wearing double gloves may be warranted. The long flat blade knife or picker can be used to assist removal of a core from the sampler.

Chapter 11. Using the Laboratory at APHC

If you choose to use the laboratory at APHC, coordinate all laboratory analyses with APHC, LSD, Laboratory Analytical Division-Inorganic Division. All samples submitted to the Laboratory Sciences Directorate (LSD) must be submitted in accordance with a chain-of-custody protocol. The samples will be analyzed in accordance with APHC LSD protocols and procedures to meet the radiation survey plan data quality objectives. Normally the initial analyses of the soil samples will be a qualitative gamma spectroscopy measurement. Figure 16 details contact information with LSD and can be found in APHC TG 214, *Customer Service Manual* (APHC, 2012).



AIPH-LS CUSTOMER SERVICE MANUAL March 2012

ABOUT LABORATORY SCIENCES AT THE ARMY INSTITUTE OF PUBLIC HEALTH

COMMUNICATION WITH AIPH-LS. The available means of communication with the Army Institute of Public Health, Laboratory Sciences (AIPH-LS) include—

WAYS TO COMMUNICATE WITH AIPH-LS	
	TELEPHONE: DSN: 584-2208 Commercial: 410-436-2208
E-Mail	**"SAMPNEWS" MAILBOX IS AVAILABLE VIA E-MAIL:** • **AIPH-LS Microsoft Outlook Users:** In Outlook, click on "New." In the "To" block type USAPHC-DLS-SampNews. • **ALL CUSTOMERS:** Send an e-mail message to USAPHC-DLSSampNews@amedd.army.mil
Internet	For information, see the AIPH-LS Public Website Home Page at: http://phc.amedd.army.mil/topics/labsciences/pages/default.aspx To submit an analytical request: http://phc.amedd.army.mil/topics/labsciences/lsm/Pages/LIDS.aspx
	FAX: DSN: 584-4108 Commercial: 410-436-4108
US MAIL	**FOR ROUTINE CORRESPONDENCE/SAMPLES:** Commander, USAPHC ATTN: MCHB-IP-LSM (Sample Management Laboratory) 5158 Blackhawk Road Aberdeen Proving Ground, MD 21010-5403
FedEx® UPS®	**FOR SAMPLE SHIPMENTS:** Commander, USAPHC ATTN: MCHB-IP-LSM (Sample Management Laboratory) Building E-2100 Aberdeen Proving Ground, MD 21010-5403

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Figure 16. Communication Details with Laboratory Sciences

INTRODUCTION

1-1. PURPOSE

The Army Institute of Public Health (AIPH), Laboratory Sciences (LS) of the U.S. Army Public Health Command (USAPHC) is committed to excellent customer service. Every effort is made to give the customer what is needed, when it is needed. This Customer Service Manual reflects this commitment by giving AIPH-LS customers information and guidance on how to—

- Communicate with AIPH-LS.
- Select the Best Test Method and Analytical Test Code (Acode).
- Complete an AIPH-LS LIDS 330 (Request for Laboratory Services).
- Submit samples to AIPH-LS.

1-2. REFERENCES

Appendix A contains references that provide information about other areas of interest to AIPH-LS customers, such as regulatory requirements and sample collection techniques. These references include, but are not limited to, other USAPHC technical guides (TGs) and pertinent regulatory documents.

1-3. AIPH-LS FORMS

Appendix B provides copies of AIPH-LS Laboratory Information Documentation System (LIDS) referenced in this manual. Reproduction of these documents is permitted and encouraged.

1-4. ABBREVIATIONS AND TERMS

Appendix C contains the glossary which explains the abbreviations and terms used in this manual.

Figure 16. Communication Details with Laboratory Sciences

AIPH-LS CUSTOMER SERVICE MANUAL March 2012

1-5. COMMUNICATION WITH AIPH-LS

> Communication and interaction with LS should begin in the earliest stages of project planning and continue throughout the entire life of the project.

a. **Means of Communication.** Communication with customers offers AIPH-LS the ability to respond to the customers' needs. The "WAYS TO COMMUNICATE WITH AIPH-LS" chart, located in the front of this manual, describes the available means of communication with AIPH-LS. Chapter 3 provides additional information on communicating and interacting with AIPH-LS.

b. **AIPH-LS Service Hours.**

(1) Technical Information and Routine Sample Receipt. Routine service hours are from 0800 to 1630 hours Eastern Standard Time, Monday through Friday, except for Federal holidays.

(2) Sample Receipt Outside of Normal Service Hours. Special arrangements must be made prior to the shipment of any samples that will arrive outside of AIPH-LS routine service hours. These arrangements are necessary to ensure appropriate AIPH-LS personnel will be available to receive, process, and preserve the samples.

c. **"Sampnews": The E-Mail Mailbox.**

(1) "Sampnews" is an electronic mail (e-mail) mailbox. This mailbox was established to offer AIPH-LS customers a convenient, effective, and efficient way to exchange information with AIPH-LS using e-mail. In AIPH-LS, the site is monitored on a regular basis by the laboratory consultants, section chiefs, and other parties, as appropriate, and can be accessed simultaneously by the AIPH-LS staff.

(2) Advantages of using the mailbox include the following:

- Eliminates the time spent on the telephone trying to track down the appropriate person.
- More than one person can access your message simultaneously, thereby speeding up responses.
- Not restricted to worldwide time zones.

1-2

Figure 16. Communication Details with Laboratory Sciences

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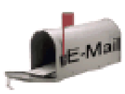
- Messages can be sent 24 hours a day.
- Questions about the status of samples and laboratory reports can be answered quickly.
- Convenient route for submitting requests for laboratory services, LIDS 330. See Chapter 6 for more information about this form.

(3) To be an effective communication tool, messages sent to "Sampnews" need to be easy to understand, complete, and with a header that clearly summarizes the content. See Chapter 6, Figure 6-2, for a sample message.

HOW TO SEND A MESSAGE TO "SAMPNEWS"	
	• **AIPH-LS Microsoft Outlook Users:** In Outlook, click on "New." In the "To" block type USAPHC-DLS-SampNews. • **ALL CUSTOMERS:** Send an e-mail message to USAPHC-DLSSampNews@amedd.army.mil

d. **Customer Support Service.** Table 1-1 describes the customer's potential needs and the available AIPH-LS customer support services.

TABLE 1-1. AIPH-LS CUSTOMER SUPPORT SERVICES

CUSTOMER'S NEED	TECHNICAL CONSULTANT	SAMPNEWS MAILBOX
Selection of the proper **Acode**	X	
Choice of the most appropriate **SAMPLE ANALYSIS PRIORITY**	X	
Interpretation of regulatory procedures and documents	X	
Technical information on analyses	X	
Review of laboratory data and reports	X	
Coordination of priority, complex, or special projects	X	
Submission of **PROJECT MODIFICATIONS** to a processed LIDS 330		X
Cost quotes for sampling projects		X
Guidance pertaining to requirements for sample collection, shipping, or submission		X

1-3

Figure 16. Communication Details with Laboratory Sciences

AIPH-LS CUSTOMER SERVICE MANUAL March 2012

TABLE 1-1. AIPH-LS CUSTOMER SUPPORT SERVICES (CONTINUED)

CUSTOMER'S NEED	TECHNICAL CONSULTANT	SAMPNEWS MAILBOX
Details about Sample Collection Kits		X
Details concerning sample processing		X
Project status reports	X	

Figure 16. Communication Details with Laboratory Sciences

Figure 17 shows a copy of LIDS Form 330, Request For Laboratory Services. This is the preferred form to use when arranging to have samples analyzed at APHC.

Request For Laboratory Services

(For use of this form, see USAPHC TG 214; the proponent is MCHB-IP-LOD)

SECTION A: PROJECT INFORMATION

1. **Request submitted by (name):**

2. **Program number, PHC ONLY:** 3. **JONO:** 4. **SUBJONO:**

5. **Other fund source (if applicable):**

Customer information:

6. **Project officer name:**

7. **Address:**

8. **Voice phone number:**

9. **Cell phone:**

10. **E-mail address:**

11. **Was project coordinated w/LS?** Y (Yes) or N (No):

12. **LS Technical Consultant:**

13. **Date range that samples are expected to arrive at LS (dd/mmm/yyyy):** **To**

14. **Project name:**

15. **Project installation:**

16. **Installation State:** 17. **Installation country:**

18. **Special project criteria that need to be met:**

☐ a. Regulatory ☐ b. Is there a project QAPP (please provide to Client Services Division POC)

☐ c. Other special conditions:

19. **Project description / objective:**

20. **Sample or site history** (High concentrations, etc.):

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Figure 17. LIDS Form 330

SECTION B: PROJECT COORDINATION INFORMATION

21. Are sampling kits/ supplies needed? ○ No ○ Yes   22. Date the kit/supplies are requested by (dd/mmm/yyyy): [ ]

23. Kit handling preference: ○ Pick-Up ○ Ship

Kit shipping address Information:

24. Name: [ ]

25. Address: [ ]
[ ]
[ ]

26. Voice phone number: [ ]

27. Number of coolers requested: [ ]

28. Expected number of shipments: [ ]

Special Project Requirements:

29. ☐ Chain-Of-Custody

30. ☐ Safety considerations Specify: [ ]

31. ☐ Analyses with short holding times

List specific analyses: [ ]

32. Will samples contain residual chlorine? ☐ All ☐ None
☐ Some Explain: [ ]

33. Number of VOC trip blanks required: [ ]

34. Other special handling requirements: [ ]

SECTION C: REPORT DELIVERY

35. **All results will be delivered by e-mail.** The e-mail will contain the final report and associated electronic data deliverables (EDDs).

36. Additional e-mail addresses (if different than e-mail address in item 10):

Note: The report will be addressed to the project officer. If any others are to receive the report via e-mail, please list their contact information here (at least e-mail, name and address). [ ]

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Figure 17. LIDS Form 330

SECTION D: TURN AROUND TIME REQUESTED

37. Priority Requested: O Standard – (28 calendar days) O High – (14 calendar days) O Top – (7 calendar days)

Or Requested Due Date (dd/mmm/yyyy):

SECTION E: ANALYSIS REQUESTED

38. a. LS Acode (Optional)	b. Analyte/Parameter	c. Method	d. Matrix	e. Quantity	f. Comments

Additional comments:

Phone number to contact the LS Client Services Division: 410-436-2208

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Figure 17. LIDS Form 330

SECTION F: INSTRUCTIONS FOR COMPLETING A REQUEST FOR LABORATORY SERVICES
(IF CLARIFICATION NEEDED)

Section 2. Program number: Internal PHC-AIPH customers should list the program number with which the project is associated. External PHC-AIPH customers list program number as 00.

Section 3. JONO: An internal PHC-AIPH Accounting Number. For internal PHC-AIPH customers, indicate the SUBJONO assigned to your project. PHC-AIPH external customers use X7G003.

Section 4. SUBJONO: An internal PHC-AIPH Project Job Number. For internal PHC-AIPH customers, indicate the SubJono assigned to your project for laboratory analysis. PHC-AIPH external customers use 1236.

Section 5. Other fund source: (If not identified in JONO, SUBJONO).

Section 13. Date range that samples are expected to arrive At LS: List the date (dd/mmm/yyyy - 12 Dec 2000) you expect LS to receive your samples. Note: Prior arrangements must be made with LS-SML for sample delivery outside of the routine (M-F, 0730-1600hrs) duty hours. This requirement includes weekend and holiday deliveries.

Section 14. Project name: List the name of project as referred to in your project plan.

Section 15. Project installation: The installation or site where sampling is occurring.

Section 19. Project description/objective: Write a brief description of the primary project objective. Indicate whether the samples are being analyzed for screening, monitoring, regulatory compliance, or health concern purposes.

Section 20. Sample or site history: Write a brief statement indicating any pertinent sample or site histories that LS staff members should be aware of when analyzing the samples.

Section 23. Kit handling preference: Indicate whether the sample containers will be picked-up or request that LS ship sample containers to a specific location. If selecting the shipping option provide address (no P.O. Boxes) and a telephone number at the shipping destination.

Section 27. Number of coolers requested: Indicate the number of cooler(s) that need to be shipped by LS to the project site.

Section 28. Expected number of shipments: Indicate the number of sample shipments planned to the laboratory (include direct shipment to LS contract labs).

Section 29. Chain-of-Custody (COC): Check here if project requires COC. COC is legal documentation of the possession and handling of a sample from the time of collection until final disposition.

Section 30. Safety considerations: Briefly list the known associated hazardous and safety requirements for the samples. If available, provide LS with an MSDS on the samples (e.g., see MSDS, use Personal Protective Equipment (PPE) when handling samples, etc.).

Section 31. Analyses with short holding times: List the analysis(es) that have less than 7 days holding times (e.g., BOD, Conductivity, pH; Encore Samples, Coliform, etc.). Holding time is the elapsed time from the date of sample collection until the initiation of the analytical procedure.

Section 32. Will samples contain residual chlorine? Drinking water samples, for example, usually contain residual chlorine. Please specify.

Section 33. Note: Volatile organic compound analyses require that trip blanks be included in the sample kit. If applicable, list the number required.

Section 34. Other special handling requirements: In addition to those described above.

Section 36. Additional e-mail addresses: (If different than, or in addition to e-mail address in item 10)**.** Note that the report will be sent to the project officer. If any others are to receive the report via e-mail, please list their e-mail information here.

Section 37. Priority requested: Select the priority you would like for your project. Note: Turn-around-time is calculated using calendar days from date of sample receipt at the laboratory. Samples are routinely processed as Standard Priority. High-Priority and Top Priority requests require coordination with LS and are subject to surcharges. Requesting a nonstandard due date requires pre-approval, and a surcharge may be applied.

Section 38. Analytical request table: List in the table the analysis(es) requested for the project. If more than 25 analyses will be requested, reuse page 3.

a. LS Acode (optional) - LS analytical procedure code (if known).
b. Analyte/Parameter - Analysis name or abbreviation (e.g., Turbidity, VOCs, Lead, etc.).
c. Method - List the standard method number (e.g., NIOSH 1501, EPA 200.7, ASTM 1613, etc.).
d. Matrix - The predominant material of which the sample to be analyzed (e.g., Drinking Water (D), Water (W), Waste Water (WW), Soil/Sediment/Sludge (S), Air (A), Bulk (B), Wipe (WI), Biological Liquid (BL), Biological Solid (BS), Paint Chip (P), Oil (O), Metal Fragment (F), etc.).
e. Quantity - The number of samples to be analyzed for each method and matrix.
f. Comments - List any specific special comments or special supplies needed for each method and matrix (e.g., blanks, extra containers, preservatives forms etc.). List individual metals here.

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Figure 17. LIDS Form 330

Appendix A. References

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Appendix B. Equipment Common to Sampling and Radiation Surveying

This section was adapted from *NATO Handbook for Sampling and Identification of Biological, Chemical, and Radiological Agents (SIBCRA)* (NATO, 2015) and lists additional equipment that could help in radiation surveying and sampling.

B.1. Supplies

- ☐ Rucksack
- ☐ Binoculars (wide depth of field)
- ☐ Camera (with time and date display facility), films and spare batteries
- ☐ Video camera, video tapes and spare batteries, charger
- ☐ Sample position markers: flags, spray paint, etc.
- ☐ Flashlight (torch) with spare batteries, whistle
- ☐ Ladder (collapsible)
- ☐ Stop-watch
- ☐ Measuring tape (50 m) or laser range finder
- ☐ Indelible ink pens / writing pad
- ☐ Log book
- ☐ Small tool kit containing hammer, knife, screwdrivers, pliers
- ☐ Bar code labels
- ☐ Radioactive hazard labels
- ☐ Disposable plastic sheeting
- ☐ Tissues/paper roll (for cleaning purposes)
- ☐ Solvent, alcohol, distilled water or de-ionized water (for cleaning/decontamination purposes)
- ☐ Groundsheet

B.2. Radiation Protection Equipment

- ☐ Individual direct reading dosimeter
- ☐ Individual passive (permanent) dosimetry, this should be the national (for record) or best available dosimetry.
- ☐ First aid kit

- □ Vinyl and heavy duty gloves
- □ Protective clothing (anti-Cs, overshoes, gloves)
- □ Respiratory protection

B.3. Instrumentation

- □ Alpha/beta contamination monitor, calibrated with spare batteries
- □ Dose-rate meter and spare batteries
- □ Portable balance/weighing machine (to gauge weight of collected sample)
- □ Check source for instruments

B.4. Communication/Location Equipment

- □ Mobile (cellular) phone
- □ 2-way Radio
- □ Global Positioning System
- □ Compass

B.5. Supporting Documentation

- □ Maps
- □ Sample forms
- □ Equipment operations manuals
- □ Sample collection procedures
- □ Field monitoring procedures
- □ Radiation protection instructions

B.6. Sample transport

- □ Packing/Transport containers (e.g., 30 gallon drums)
- □ Absorbent packing material
- □ Seals for transport containers
- □ Boxes/crates (for temporary storage of samples prior to transportation)

Appendix C. A Removable Packet for a Radiological Area Survey

This packet is intended for a knowledgeable radiation surveyor or radiation survey team and includes the following items:

- Minimum supply requirements
- RADIAC preoperational test and check source procedures.
- Checklist for a Radiological Area Survey.
- Radiological Site Assessment Sheet.
- Instructions for using the Radiation Survey Data Table.
- Radiation Survey Data Table.
- Chain-of-custody form.
- Field results summary checklist.

This packet consolidates the necessary information to perform the radiation surveying and sampling parts of an assessment. Make as many copies of this packet as you need or use it as a basis for recording data if you cannot make copies.

C-1. Minimum Supply Requirements

The following is a list of supplies required for a radiological area survey. Reasonable substitutions can be made for the items on this list. A list of additional equipment is in Appendix C.

- ☐ AN/PDR-77 or AN/VDR-2 RADIAC and the corresponding user's manuals
- ☐ Copy of TG 236 and datasheets
- ☐ Extra batteries for the RADIAC meters and other instruments
- ☐ Copies of the removable survey packet from TG 236
- ☐ GPS receiver (optional) and tape measure (optional)
- ☐ Disposable dust masks
- ☐ Pens
- ☐ Indelible marker
- ☐ Soil sampling tool, e.g., trowel or entrenching tool
- ☐ Sample labels
- ☐ Sealing or other strong tape
- ☐ Flags or other land-marking items
- ☐ Rubber gloves
- ☐ Distilled water (at least 4 liters)
- ☐ Calculator
- ☐ Leather or gardener's gloves
- ☐ Fifty (50) 1-gallon plastic bags*

* Other sample containers may be used when done in coordination with the laboratory

RADIAC checklist and preoperational test

Instrument Type (Circle one.): PDR-77 or VDR-2 Date:______

Beta/ Gamma Probe SN:______________________________Time:______

X-ray Probe SN (PDR-77 only): ______________________

Alpha Probe SN (PDR-77 only): ______________________

Radiation survey Unit ID______________________

AN/PDR SN:______________________

Checkout performed by:______________________

PDR-77 Yes	PDR-77 No	VDR-2 Yes	VDR-2 No	
				Carrying Case Inspection: Is the case free of obvious damage and is the case in proper working order?
				All probes present?
				RADIAC Meter Inspection: Is the meter free of obvious damage?
				Beta/Gamma Probe Inspection: Is the probe free of obvious damage?
				Alpha Probe Inspection: Is the probe free of obvious damage?
				X-ray Probe Inspection: Is the probe free of obvious damage?

RPO Kit

Pancake Probe SN: ______________________

"micro R" Probe SN: ______________________

Yes	No	
		Are the pancake probe and "micro R" probe present?
		Pancake Probe Inspection: Is the probe free of obvious damage?
		"micro R" Probe Inspection: Is the probe free of obvious damage?

Preoperational Test

If the unit passes the preoperational test in the Technical Manual, the unit is ready for the operational check source test. See the flowchart on the following page.
If the unit fails the test twice, then notify your supervisor.

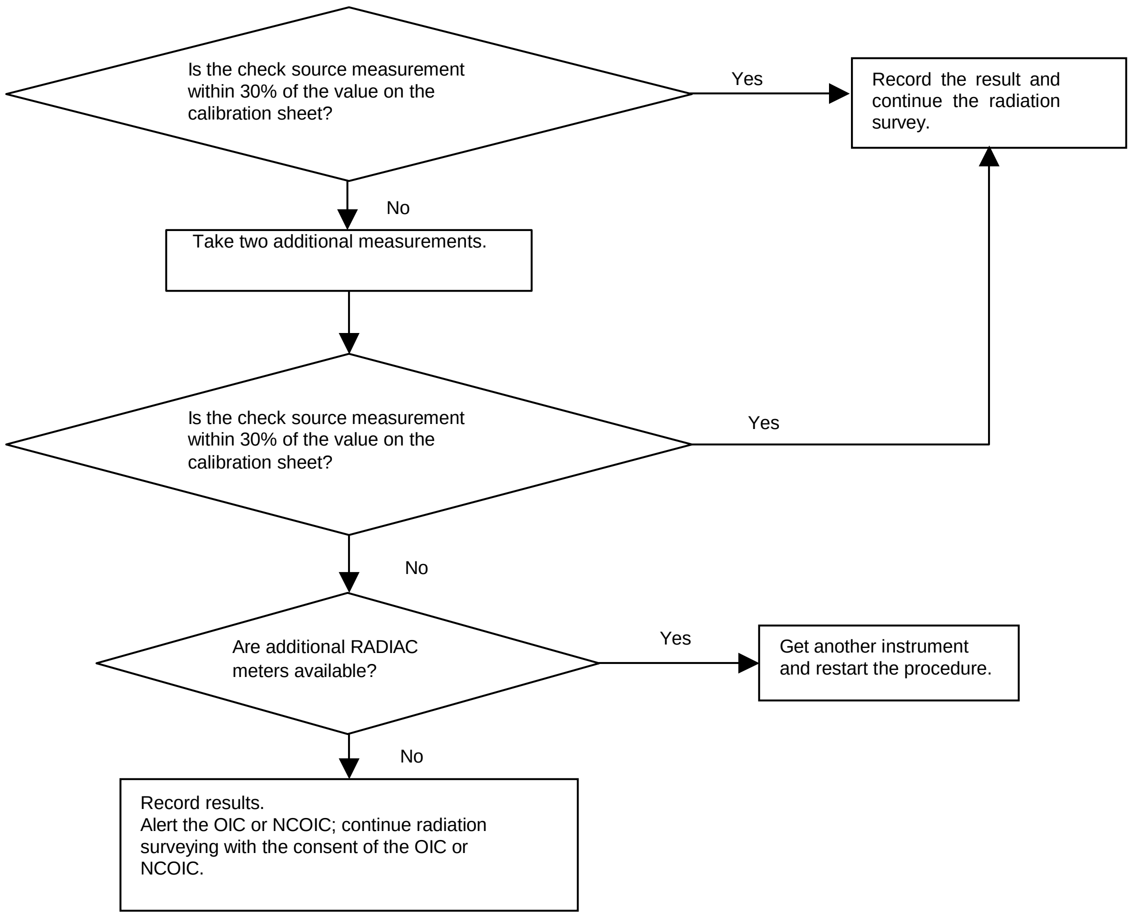


Figure C-1. Operational Check Source Flowchart

C-2. Checklist for a Radiological Area Survey

☐ Review APHC TG 236.

☐ Inform APHC or a NMSO that you are starting a radiological area survey. If samples are collected, inform the laboratory. APHC points of contact are shown in Appendix J, and APHC Laboratory Sciences Directorate (LSD) points of contact are shown in Chapter 11.

CAUTION: If elevated alpha activity is present or suspected to be present, higher echelon assets must be notified as soon as possible.

☐ Gather supplies (See Chapter 4, section 4.1.)

☐ Review the instructions for using the Radiation Survey Data Table on page 27.

☐ Record the check source measurements in section b of the Radiation Survey Data Table. If this reading is within 30% of the value on the calibration sheet, proceed with the radiation survey. If not, see Chapter 4 section 4.8.

☐ Gather and document any information you can about the area to be radiation surveyed.

☐ Answer the site assessment questions on the Radiological Site Assessment Sheet on page 23.

☐ Record the meteorological data on the day of the radiation survey.

CAUTION: If anything in this plan endangers the life or health of personnel, the plan should not be undertaken unless so ordered by the commander. See Chapter 2.

☐ Go to a staging area near the area to be radiation surveyed.

CAUTION: Be aware of non-radiological battlefield hazards before undertaking this radiation survey. Examples of these hazards are unexploded ordnance (UXO), confined spaces, tripping hazards, poisonous plants, venomous insects and animals, toxic chemicals, gunfire, and unsanitary conditions. See Chapter 2.

☐ Decide where the specific radiation survey units are (See Chapter 4, section 4.2.).

☐ Identify the appropriate background measurement locations (See Chapter 4, section 4.4.).

☐ Ensure that the RADIAC instrument is in the proper configuration for static measurements. (See Chapter 4, section 4.6)

☐ Take and record the appropriate background measurements (See Chapter 4, section 4.4.).

☐ Put on all necessary personal protective equipment.

☐ Set up the radiation survey unit (See Chapter 4, section 4.3.).

1. Define the area to be radiation surveyed with a rectangle.
2. If GPS/grid coordinates are available, record the points indicated on the datasheet.
3. Record the length and width of the radiation survey unit on the datasheet.
4. Divide the width into 6 equal blocks.
5. Divide the length into 8 equal blocks.
6. If possible, mark the boundaries of and restrict access to the radiation survey unit. Divide the unit into 48 blocks as shown on the datasheet.
7. Sketch the radiation survey unit, landmarks, structures, and other information on the radiation survey unit schematic.
8. Perform pre-survey checks on all instruments.

☐ Perform a quick scan of the area.

1. Walk at a rate of about 0.5 m/s (roughly one-half step per second).
2. The βγ-probe will be held about 1 meter above the ground (or floor) and the x-ray probe should be held about 10 cm (about 4 in.) above the ground.

☐ Perform the radiation survey. The preferred order of steps is below.

1. Set up and start air samplers, if needed (see Appendix I).
2. Record the external gamma exposure measurements next to the letter G in blocks 1-24 on the Radiation Survey Data Table. Take a 2-kilogram soil sample in block 8, split this sample, and label one as a QC sample.
3. Sample the soil from the center of blocks 5-8. 13-16, and 21-24 as laid out on the Radiation Survey Unit. See Chapter 4, section 4.7.

4. If the x-ray probe is available, record the x-ray probe measurements next to the letter X in blocks 5-8, 13-16, and 21-24 on the Radiation Survey Data Table.

5. Take the QC external gamma exposure rate in block 8 on the Radiation Survey Data Table and record the result next to G_{QC} in block 8.

6. If the x-ray probe is available, the QC x-ray probe measurement in block 2 on the Radiation Survey Data Table and record the result next to X_{QC} in block 7.

7. Record the post-operational check source measurements.

☐ Record any topographical information on the radiation survey unit schematic.

☐ Interpret the data using the tables in Chapter 5 and fill out the Field Results Summary checklist.

☐ Report the results of the assessment to the commander.

☐ Send the samples and a copy of the paperwork to the appropriate laboratory for qualitative gamma spectroscopy.

☐ Send a copy of the paperwork to APHC Health Physics Division (HPD) or other appropriate NMSO.

☐ Decide on the final disposition of the samples with the advice of the command staff, APHC HPD, and the laboratory.

CAUTION: The radiation surveyor should have the βγ –probe operational (window closed) and should be observing the dose rate while approaching any potentially contaminated area. (See Chapter 2.)

Table C-1. Radiological Site Assessment Sheet

Provide as much information as available.

General Survey Information			
Survey Start Date and Time:		Survey End Date and Time:	
Lead Surveyor Name(s):			
Lead Surveyor Title:		Surveyor's Unit:	
Lead Surveyor Phone:		Lead Surveyor Email:	

1. Administrative Data – *Attach the Hard Copy of the OEHSA to this tile in DOEHRS*			
Location Name:			
Location Aliases:			
Geographic location*: Including geo-coordinate (e.g latitude/longitude) of the outside corners of the camp. At a minimum, use the center of the camp. <u>Note: Information may be classified.</u>*			
Coordinate 1:		Coordinate 2:	
Coordinate 3:		Coordinate 4:	
Notes:			
Units and Detachments/Teams/Elements Present: *<u>Note: this information may be classified.</u>*			
Camp Fixed Population: *<u>Note: this information may be classified.</u>*			
Rotation Schedule: *<u>Note: this information may be classified.</u>*			
Number of U.S. Troops, if not U.S. Camp: *<u>Note: this information may be classified.</u>*			

2. Survey Background
Limitations of Assessment: *Physical obstructions, limiting conditions (such as weather), mission restrictions, lack of equipment/supplies.*
General Data Gaps: *Data that was either not obtainable at the time of the survey or that will be received in the future.*
Assumptions / Uncertainties: *Observations and data could be limited due to the inherent challenges of conducting comprehensive public health assessments in an operational environment*
Information Sources / Document Reviewed: *Summaries of environmental sampling and studies, aerial photos, topographic maps, Engineer Environmental Baseline Surveys (EBS, basecamp master plan).*

3. Site Description: *Attach site maps and photographs to the survey. Note: Get pictures of the site, a good rule of thumb is at least one picture per section.*
Physical Setting: *(general geography / topography / urban / rural)*.
Climatic / Weather: *(temperature range / predominate wind direction)*
Soil: (types, permeability, drainage ditches, low lying areas (standing water), unusual/out-of-place mounds, disturbed areas, discolored soil, areas unusually devoid of vegetation, etc)
Groundwater: *(depth, direction of flow)*
Surface Water: *(location, direction of flow)*
Wetlands, Flood Zones, Costal Zone, Vegetation present:

Proposed Site Usage: *What is the proposed usage of the site, especially if assessment is being conducted before usage determination or occupation?*
Current and Past Uses of Property: *What was the past usage of the site; agricultural, industrial, military, etc. For what duration were these uses active?*
Current and Past Uses of Adjacent Property: *(industrial operations, agricultural uses, type of crops grown) Is there knowledge on the use of pesticides (insecticides / herbicides)?*
North of Site:
South of Site:
East of Site:
West of Site:
Notes:

4. Additional Information: *(these inputs are not included in DOEHRS)*
Unit's Existing Radiation Exposure Status (RES): *See chapter 5.*
Water source: *Are the occupants of the land using a ROWPU, bottled water, or other?*
Food Source: *Are the occupants of the land consuming pre-packaged food, local food, CONUS food, or other?*
Laundry Facilities: *Are laundry facilities available? Are they military, local, or other?*
Decontamination Facilities: *Are decontamination facilities available? Describe.*
Prevailing Wind: *What is the wind speed (units) and direction?*
Notes:

Nearby Industrial Facilities. *Are there any nearby industrial facilities*				Present: ☐ Absent: ☐ If Present, list below	
Geo coordinates (MGRS or Lat/Long)*	Name	Type of Industry	Active? (Y/N)	Description	Proximity to Location (in kilometers)
Do the nearby industrial facilities have the potential to affect personnel?				Yes: ☐ No: ☐ If yes, complete the Exposure Pathway form located at the end of this template.	

Physical Hazards – Ionizing Radiation				
Are any ionizing radiation sources present? If known, attach inventory of sources.			Present: ☐ Absent: ☐ If Present, list below	
Storage Area	Sources Contained	Isotope	Activity	Highest does rate observed
8c. Camp Background Dose Rate:				
Notes:				
Do ionizing radiation sources have the potential to affect personnel?			Yes: ☐ No: ☐ If yes, complete the Exposure Pathway form located at the end of this template.	

C-3. Instructions for Using the Radiation Survey Data Table

1) Circle the type of instrument used (AN/PDR-77 or VDR-2). Record the calibration date (Cal. Due Date) and the serial number (SN) of the instrument.

2) Record the check source measurement results (refer to Chapter 4 section 4.8 for the requirements for operational checks).

3) Record the radiological background data and take soil samples at the three background locations. Record the average background readings.

4) Evaluate and record the GPS/grid-A and -B locations.

5) Perform the radiation survey and record the results.

   - Record the appropriate instrument reading in the center of each numbered box.
   - Collect soil samples. Collect two kilograms of soil in block 8-Soil/QC and split the sample.
   - Return to block 8 (1-Soil/QC) and repeat the appropriate measurements (βγ-probe and x-ray probe).
   - Exclude the G_{QC} measurement in block 8 and take the average of all the βγ-probe measurements. Record the results.

6) Record the personnel information.

7) Record the length and width of the radiation survey unit.

8) Indicate the measurement units used for all of the measurements. You must be aware of any scale changes and use the same units for all measurements.

9) Indicate north in the Indicate North box.

10) Record topographical information on Radiation Survey Unit Schematic.

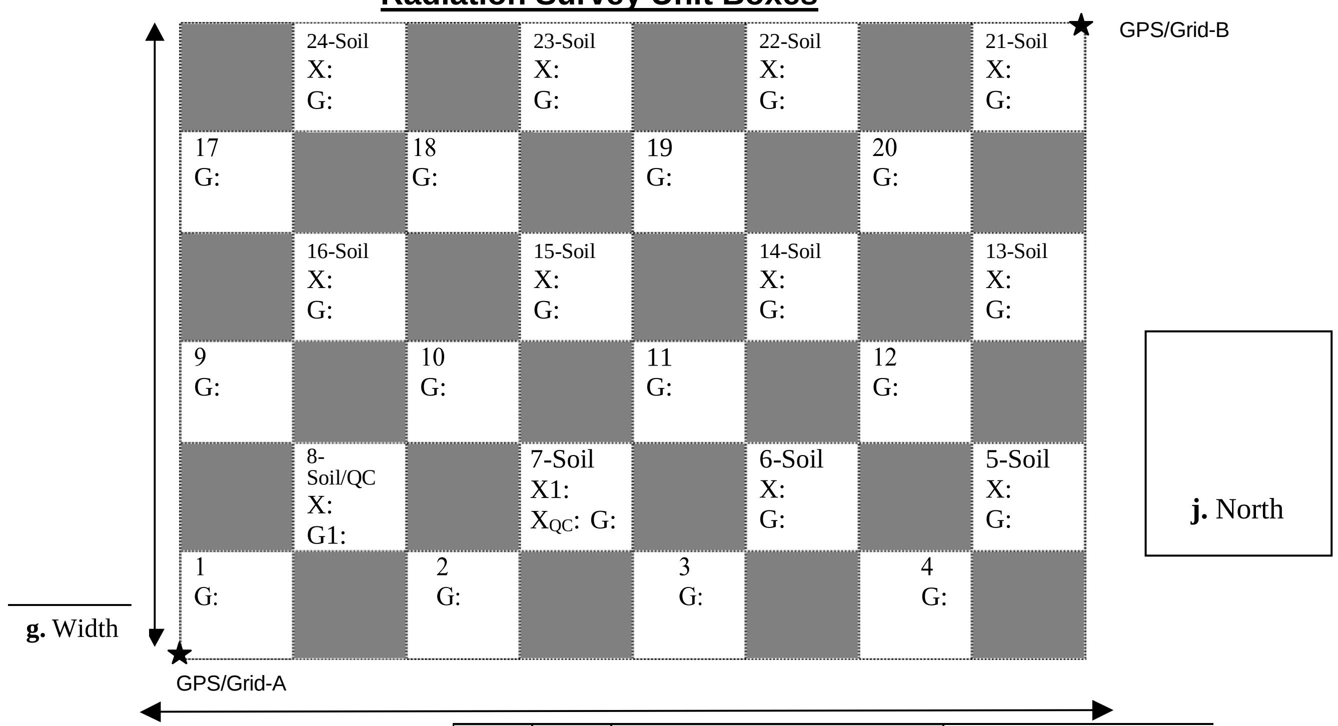
11) Answer the Potential Radiological Hazard ID questions to the best of your ability. Use TG 238 and other references, if available. (APHC, 1999)

Table C-2. Radiation Survey Data Table (Page 1 of 2)

Radiation survey Data Table

a.	**Circle the instrument used.**			**d.**	**GPS/Grid Coordinates (GPS/Grid below.)**		
	AN/PDR-77 Or	VDR-2		A:		B:	
	Cal. Due Date:	SN:		**e.**	**Radiation survey Results**		
b.	**Check Source Measurements**					Gamma	X-ray
		Gamma	X-ray		Average Reading:		
	Pre-radiation survey:				Average Background Reading:		
	Post-radiation survey:				Net Reading:		
c.	**Radiological Background Information**			**f.**	**Personnel Information**		
	Location	Gamma	X-ray	Radiation surveyors			
1.							
2.							
3.				Reviewers:			
	Average:						

Radiation Survey Unit Boxes



h. Length

	Soil:	Soil Sampling Location	Unit of Measurement
i.	X:	X-ray Probe Reading	
	G:	βγ-probe or VDR-2 Reading	

TG 236
Radiological Health Risk Planning and Projection
U.S. Army Public Health Center
United States Army Medical Command

Table C-3. Radiation Survey Data Table (Page 2 of 2)

k.. Radiation Survey Unit Schematic

	24		23		22		21
17		18		19		20	
	16		15		14		13
9		10		11		12	
	8		7		6		5
1		2		3		4	

l. Potential Radiological Hazard ID- Refer to TG 238 for guidance.

Is there evidence or a record of the following?	Circle one	If yes, describe the evidence or attach the record.
The presence, use, storage, or disposal of radioactive materials.	Yes / No / Unknown	
The use of DU or military commodities.	Yes / No / Unknown	
The decontamination, maintenance, or storage of radioactively contaminated equipment.	Yes / No / Unknown	
The presence of enhanced naturally occurring radioactive material.	Yes / No / Unknown	
Radiation generating machines such as accelerators and x ray machines.	Yes / No / Unknown	
Any aircraft accident in the area.	Yes / No / Unknown	
Medical or research facilities in the area.	Yes / No / Unknown	
Coal ash, fertilizer, other mineral processes in the area.	Yes / No / Unknown	
Nuclear power plants in the area.	Yes / No / Unknown	

Table C-4. Soil Sample Collection

Soil Sample Collection

APHC - Health Physics Division – TG 236

Sampling Location:	
Radiation survey Unit ID:	
Team Leader:	Sample Types: Grab and Soil Analyses Desired: γ-spectroscopy
Samples packed by:	
POC:	
APHC Project number if applicable:	

List the **Field ID** and **NATO Date-Time Group.**

Field ID	**NATO Date-Time Group (DDTTTTZMMMYYYY)**

Tamper Resistant Seals Used?	Yes	No

Chain of Custody Information

Sign and Print Name

Released By	Received By	Date	Purpose of Transfer

Notes and Comments

Table C-5. Field Chain- of- Custody Sheet

Field Chain- of- Custody Sheet **APHC - Health Physics Program - TG236**			
Sampling Location:	Date of Collection:		Page 1of 2
		Radiation survey Unit ID:	
Team Leader: Samples packed by: POC:		Sample Types: Grab and Soil Analyses Desired: γ-spectroscopy	
APHC Project number if applicable:			

List the **Field ID** and **time of collection** of each sample.

	Time		Time		
11.		21.			
12.		22.			
13.		QC.			
		Additional Samples	**Time**	**Sample Type**	**Desired Analyses**
14.					
15.					
16.		BKG 1.			
17.		BKG 2.			
18.		BKG 3.			
19.		15.			
20.		16.			

Method of Shipping and Carrier Used:		Tamper Resistant Seals
		On the container? O Yes O No
	Shipping Date:	On each sample? O Yes O No

Chain- of- Custody				
Sample or Samples Transferred	Sign and Print Name			
	Released By	Received By	Date	Purpose of Transfer

Field Chain- of- Custody Sheet APHC - Health Physics Program - TG236				
Chain- of- Custody				Page 2 of 2
Sample or Samples Transferred	Sign and Print Name			
	Released By	Received By	Date	Purpose of Transfer
Notes and Comments				

Appendix D. Field Results Summary Checklist

Net Reading: Instrument Used: PDR-77 or VDR-2

Radiation survey Unit ID: Existing RES:

☐ **The net gamma reading is less than 0.10 μGy/h (0.010 mR/h). There is no need to proceed with the data interpretation, the radiation survey unit can be considered equivalent to background at this time. Document these results and send them on to the Health Physics Division at APHC.**

Existing RES = 0

☐ The RES at the end of the mission lasting days will be:

☐ For an assigned OEG of ____________ the maximum mission duration is about ___ days.

Existing RES > 0

☐ The RES at the end of the mission lasting______days will be:

☐ For an assigned OEG of ______ the maximum mission duration is about_____days.

Appendix E. Public Health Officer's Information for Dose Tracking

The following are based on radiation exposure charts In Joint Publication 3-11. Note the highest recommended OEG for these sampling missions is 75 R or cGy (750 mGy), consistent with the highest recommendation for non-combat operations.

Date: ____

Unit: ____

Total Accumulated Dose		**RES Category**	**RES-Equivalent Value**
<50 mR	<500 μGy	0	0
50 mR to 500 mR	500 μGy to 5 mGy	1A	1
500 mR to 5 R	5 mGy to 50 mGy	1B	2
5 R to 10 R	50 mGy to 100 mGy	1C	3
10 R to 25 R	100 mGy to 250 mGy	1D	4
25 R to 75 R	250 mGy to 750 mGy	1E	5

RES of Company or Battalion	**Number of Platoons in Company or Companies in Battalion**					
	2	3	4	5	6	7
	Sum of all the RES-equivalent Values from the radiation exposure chart					
0	0	0-1	0-1	0-2	0-2	0-3
1A	1-2	2-4	2-5	3-7	3-8	4-10
1B	3-4	5-7	6-9	8-12	9-14	11-17
1C	5-6	8-10	10-13	13-17	15-20	18-24
1D	7-8	11-13	14-17	18-22	21-26	25-31
1E	9-10	14-15	18-20	23-25	27-30	32-35

Radiation Exposure Chart					
Element	Previous Exposure	New Exposure	Total Exposure	RES Category	RES-equivalents

RES-equivalent total (Equivalent to "Category Total" from FM 3-3-	
Overall Status (Use the previous table):	

Definitions

Site Location:	Where the exposure occurred. At a minimum, the Site ID from the Site Assessment Sheet must be included here.
Dates of Exposure:	Time over which the exposure occurred. "Dates" can be a single day; for example, a unit is exposed for 10 hours on 5 JUN 17. The "Dates of Exposure" would be 5 JUN 17.
Duration:	Actual time interval during which the unit was exposed, in hours.
Dose Rate:	Net dose rate if it is greater than 0.1 μGy/h (0.010 mR/h).
Total Dose:	Total dose received by the unit from a single location. The product of the dose rate and duration.
Accumulated Dose:	Running total of the doses received by the unit.
RES:	Radiation exposure status of the unit, based on the accumulated dose.
RES-equivalent:	A conversion factor that allows the RES categories between 0 and 1E to be used in place of the standard categories 0 to 5.
Recorder:	Preventive medicine person responsible for recording and maintaining this record.

Table E-1. Unit Dose Tracking Sheet

Unit ID: Page of

Location (Site ID)	Dates of Exposure		Duration (hours)	Dose Rate[if]	Total Dose (Duration x Dose rate)	Accumulated Dose	RES	Recorder
	From	To						
Example Site	5 Jun 17 1350	5 Jun 17 1850	5	0.060 mR/hr	0.3 mR	0.3 mR	0	

[if] The units for dose rate are mR/h for the AN/PDR-77 and μGy/h (be aware of automatic scale changes) for the AN/VDR-2.

Appendix F. CONUS Transportation Regulations and Procedures

<u>REFERENCES:</u>

Title 49 Code of Federal Regulations (DOT, 2017)

Army Pamphlet 385-24, Army Radiation Safety Program (DA, 2015)

Technical Bulletin 43-0116, Identification of Radioactive Items in the Army (DA, 2017)

A. Regulations Governing Radioactive Materials Use and Shipment

1. Title 10 Code of Federal Regulations

    a. Governs the use of byproduct material

    b. Nuclear Regulatory Commission (NRC) is proponent

    c. Part 71 "Packaging and Shipment of Radioactive Material"

2. Title 49 Code of Federal Regulations

    a. Governs the transportation of all materials

    b. Department of Transportation is proponent

    c. Primary reference for the shipment of radioactive materials

3. Technical Bulletin 43-0116, Identification of Radioactive Items in the Army

    a. Identifies, by part number and national stock number (NSN), items in the Department of the Army that contain radioactive materials

    b. U.S. Army Communications-Electronics Command (CECOM) is proponent

    c. Identifies radioactive material and activity in Becquerels

    d. Online resource – access requires a Common Access Card (CAC) (https://cecom.aep.army.mil/cecom/home/Safety/RSO/SitePages/TB430116.aspx)

B. Terms and Definitions

1. Special Form Radioactive Material - materials which, by nature of their physical form or encapsulation, if released from a package, might present some direct radiation hazard but would present little hazard from the possibility of contamination.

   a. Single solid piece or contained in a sealed capsule

   b. At least one dimension not less than 5mm (0.2in)

   c. Meets requirements of test specified in 49CFR 173.469

2. Normal Form Radioactive Material - materials which if released from a package might present a contamination hazard.

3. Instrument and Articles - any manufactured instrument and article such as an instrument, clock, electronic tube or apparatus, or similar instrument and article having Class 7 (radioactive) material in gaseous or non-dispersible solid form as a component part.

4. Package - the packaging together with its radioactive contents as presented for shipment.

5. Transport Index (TI) - dimensionless number (rounded up to the next tenth) placed on a label of a package to designate the degree of control to be exercised by the carrier during transportation. For non-fissile materials, TI is the radiation level in mR/hr measured one meter from the external surface of the package.

C. Preparing Proper Shipment - once an item containing radioactive material is identified for shipment, a shipping packet should be started in which all information pertaining to the shipment will be maintained. It is the responsibility of the shipper to ensure that all shipping requirements are met.

1. Identity and activity of radioactive material(s).

   NOTE: Just knowing that an item is radioactive or has radioactive material as a component part is not enough to satisfy shipping requirements. The exact isotope and activity are required to determine the proper shipping method.

   a. Look on item to be shipped. Many items will contain a label that identifies the isotope and activity.

b. For military commodities, the radioactive items may be identified using either the end item or individual part NSN and the TB 43-0116. Items are listed giving the radioactive isotope and the activity in Bq.

c. For other items in the military supply system, the Army Master Data File has a Special Control Item Code. This code can be used to identify which items are radioactive or have radioactive materials. These codes may not give you the specific information needed for shipment.

NOTE: Regardless of the method used to identify the radioactive material and activity, ensure that the information gathered is transferred accurately (i.e., units and isotope identifications).

2. Construction Form - maximum activity allowed in a shipping sub-type is determined by the radioactive materials construction form (Special or Normal)

a. *Special form* material is constructed such that the radioactive material will not be dispersed if the shipping package is destroyed. For a material to be considered special form, the radioactive material must have been constructed and tested in accordance with Department of Transportation (DOT) specifications.

- Special form requirement allow for more activity in the same shipping sub-type.
- Without documentation specifying special form, the source **must** be shipped as normal form.
- Specified as A_1 values.

b. *Normal form* radioactive material is any form that is not certified to be special form.

- May be in any physical form (gas, solid, liquid), in any type of container (glass, plastic, ceramic).
- When in doubt or without a specific document certifying special form, ship radioactive material as normal form.
- Specified as A_2 values.

3. Shipping Sub-type - there are 6 sub-types for the shipment of radioactive material (RAM); "Limited Quantity," "Instrument and Article," "Type A Quantities," "Type B Quantities," "Low Specific Activity (LSA)," and "Surface Contaminated Object (SCO)." The shipment of military items can usually be accomplished under the specifications for Limited Quantity, Instrument and Article, or Type A Quantity.

a. *Limited Quantities* - a quantity of radioactive material not exceeding the limits specified in § 173.425.

- Package requirements specified in § 173.410. Essentially a strong tight package that is easy to handle and will contain the material during incident normal to transportation.
- Radiation levels at any point on the external surface of the package does not exceed 5 μSv/hr (0.5 mrem/hr).
- Removable contamination on the external surface does not exceed limits specified in Table 11 of § 173.443(a).
- Outside of inner packaging, or outer packaging if no inner packaging, must bear the marking "Radioactive."
- Material prepared as specified in § 173.422.

b. *Instruments and Articles* - may be excepted from the specification for packaging, shipping paper and certification, marking and labeling requirements provided:

- Package requirements of § 173.410 are met.
- The activity of the instrument or article or the entire package contents do not exceed the limits in Table 7 in § 173.425.
- Radiation levels at any point external to the instrument or article when measured at 10 centimeters (4 in) does not exceed 5 μSv/hr (0.5mrem/hr).
- Radiation levels at any point on the external surface of a package does not exceed 5 μSv/hr (0.5 mrem/hr).
- Removable contamination on the external surface does not exceed limits specified in Table 11 of § 173.443(a).
- The instrument or article is otherwise prepared as specified in § 173.422.

c. *Type A Quantity* - when the requirements for limited quantity or instrument and articles cannot be met and provided the activity of the radioactive material does not exceed the limits for A_1 Special form or A_2 Normal form as specified in § 173.435, you have a Type A quantity.

NOTE: Due to the high cost of shipping materials and control measures, the lowest sub-type for which a radioactive material would qualify should be used for shipping.

4. Packaging Requirements - the cost of different shipping containers can be very drastic. The lowest package type that meets specifications should be used.

a. If restrictions require the shipment to be sub-typed as Type A, the shipping container must be certified as meeting the specifications in § 173.410, 173.412, 173.415, such as the DOT specification 7A.

b. No certification is required for the shipment of Limited Quantity or Instruments and Articles.

5. Special Restrictions - packages may include special instruction if the package weighs more than 110 pounds and/or contains materials being shipped as fissile or containing an additional hazard other than the radioactive hazard.

6. Package Assembly - Each package type must have the appropriate certification statement prepared to enclose in the package, included with the packing list, or otherwise forwarded with the package.

a. *Limited Quantity* - Inner package must be marked "Radioactive" along with statement; "This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, expected package-limited quantity of material, UN2910."

b. *Instruments or Articles* - No requirement for the marking "Radioactive." Certification statement must read; "This package conforms to the conditions and limitations specified in 49 CFR 173.424 for radioactive material, expected package-instruments or articles, UN2910."

c. *Type A* - This package has DOT specification labels, or is identified by the DOT specification number. Must be shipped in the same configuration, as it was when the specification testing was performed.

7. Radiation Surveys - must be performed to determine the radiation dose rates and removable contamination levels.

a. *Dose Rate Measurements* - taken on all six sides and is the determining factor for the type of label used for a type A package.

- LQ or IA dose rates must be less than 5 μSv/hr at the package surface
- Type A Packages label is dose rate specific

(1) White I - is used on packages with radiation levels measured at the surface of the package which do not exceed 5 μSv/hr (0.5 mrem/hr); and do not exceed the background level when measured at a distance of 1 meter from the package.

(2) Yellow II - is used on all Type A packages with radiation levels measured at the surface of the package which exceed 5 μSv/hr (0.5 mrem/hr) but do not exceed 500 μSv/hr (50 mrem/hr); or with a radiation level measured at 1 meter which is greater than background but less than 10 μSv/hr (1 mrem/hr).

(3) Yellow III - is used on all Type A packages with radiation levels measured at the surface of the package which exceed 500 μSv/hr (50 mrem/hr) but do not exceed 2,000 μSv/hr (200 mrem/hr); or with a radiation level measured at 1 meter which is greater than 10 μSv/hr (1 mrem/hr) but less than 100 μSv/hr.

(4) Yellow III whose surface radiation levels exceed 2,000 μSv/hr (200 mrem/hr) but do not exceed 10,000 μSv/hr (1,000 mrem/hr); or with a radiation level measured at 1 meter which exceeds 100 μSv/hr (10 mrem/hr) may be shipped only in a vehicle under exclusive use provisions.

b. *Removable (non-fixed) Radioactive Contamination* - must be kept as low as practicable.

- May be determined by wiping 300 cm^2 of package surface with a smear or wipe using moderate pressure and measuring the activity on the wiping material.
- Sufficient number of wipes will be taken to yield a representative assessment of the contamination present.
- When performing the wipes records of the true area wiped must be recorded to calculate the activity per area.
- Use the proper swipe medium for the isotope of concern (i.e., most beta/gamma emitter can be sampled using NUCON hard wipes; where isotopes like H-3 or Ni-63 need to be sampled using a medium which can be analyzed in a liquid scintillation counter).

8. Communications - includes the written, verbal, and symbolic instructions that will ensure the package is transported according to the specifications required by DOT.

a. *Basic Description* - the Proper Shipping Name, Hazard Class, and ID Number as specified in 49CFR172.101.

b. *Additional Requirements for Radioactive Materials* -

- Name of Radionuclide
- Physical Form
- Quantity

- Total Weight
- Transport Index
- Activity per Package
- Highway Route Controlled Quantity (if appropriate)
- "Fissile Excepted" (if appropriate)
- "Warning - Fissile Material Controlled Shipment" (if appropriate)
- Package Identification Markings (if DOE/NRC approved)
- Shipper Certification found in 172.204(a)(1)
- "RQ" before basic description if Hazardous Substance
- 24 hour Emergency phone number for all labeled shipments

9. U.S. Postal Regulations - may be used when shipping small quantities of radioactive material (limited to 1/10 of Table II values below). See <http://pe.usps.com/text/pub52> for more information.

D. Summary - Organization and care are key to the shipping of radioactive material safely and in compliance with the federal regulations. To ensure that all packages are shipped in compliance with federal, army, and state regulations it is imperative that all items are completed to the fullest extent.

1. Identify and activity of radioactive material(s): Isotope and activity to be shipped

2. Construction Form: Determine normal vs special as well as physical form

3. Shipping Sub-Type: Verify A_1 Special form or A_2 Normal Limits and Limited Quantities from Table 7.

4. Package Requirements: Choose proper package for class of shipment.

5. Special Restrictions: Research special restrictions if the item is fissile, weighs more than 110 pounds, or contains hazardous material other than radioactive material.

6. Communicate: Applicable paperwork, labeling and marking, shipping papers, package and source certifications, etc.

7. Surveys: Dose rate levels and removable contamination

8. Records: Maintain records for time specified by regulations.

Table F-1. General U.S. DOT Requirements for Shipping Radioactive Materials

Package Type	Limited Quantity §173.421	Instruments/Articles §173.424	Type A §173.431
Activity Limit	Table 7, §173.425	Table 7, §173.425	≤ A_1 or A_2 Value
Packaging Material	General Design	General Design	Type A §173.465
Special Restrictions	≤ 15 grams fissile	≤ 15 grams fissile	§ 173.418, 173.419
Package Requirements	§173.421	§173.424	DOT Type A
Radiation Levels @ Surface @ 10 cm for I&A @ 1 meter	≤ 0.005 mSv/hr	≤ 0.005 mSv/hr ≤ 0.1 mSv/hr	Determines Label §173.441
Contamination Level	≤ Table 11, §173.443	≤ Table 11, §173.443	§173.443
Communications	None	None	All of Part 172
Special Requirements	"Radioactive" & Statement §173.422	Statement form §173,422	§173.448 and §173.451

Because of changes to the Code of Federal Regulations, values and requirements should be verified prior to each shipment.

* Fissile radionuclides are Plutonium-239, Plutonium-241, Uranium-233, and Uranium-235

TABLE F-2. Table of DOT Activity Limits Common to Military Shipments

Limited Quantities, Instruments & Articles and Type A package activity limits for common isotopes in military commodities in Bq						
Isotope	Instruments and Articles				Limited Quantity	
	Individual		Type A Package		Package	
	Special Form	Normal Form	Special Form	Normal Form	Special Form	Normal Form
Cs-137	2.0E+10	6.0E+09	2.0E+12	6.0E+11	2.0E+09	6.0E+08
Co-60	4.0E+09	4.0E+09	4.0E+11	4.0E+11	4.0E+08	4.0E+08
Pu-239	1.0E+11	1.0E+07	1.0E+13	1.0E+09	1.0E+10	1.0E+06
Am-241	1.0E+11	1.0E+07	1.0E+13	1.0E+09	1.0E+10	1.0E+06
Ni-63	4.0E+11	3.0E+11	4.0E+13	3.0E+13	4.0E+10	3.0E+10
Pm-147	4.0E+11	2.0E+10	4.0E+13	2.0E+12	4.0E+10	2.0E+09
Ra-226	2.0E+09	3.0E+07	2.0E+11	3.0E+09	2.0E+08	3.0E+06
Sr-90	3.0E+09	3.0E+09	3.0E+11	3.0E+11	3.0E+08	3.0E+08
Kr-85	1.0E+11	1.0E+11	1.0E+13	1.0E+13	1.0E+10	1.0E+10
H-3	4.0E+11	4.0E+11	4.0E+13	4.0E+13	4.0E+10	4.0E+10

Limited Quantities, Instruments & Articles and Type A package activity limits for common isotopes in military commodities in Ci						
Isotope	Instruments and Articles				Limited Quantity	
	Individual		Type A Package		Package	
	Special Form	Normal Form	Special Form	Normal Form	Special Form	Normal Form
Cs-137	0.54	0.16	54	16	0.054	0.016
Co-60	0.11	0.11	11	11	0.011	0.011
Pu-239	2.7	0.00027	270	0.027	0.27	0.000027
Am-241	2.7	0.00027	270	0.027	0.27	0.000027
Ni-63	11	8.1	1100	810	1.1	0.81
Pm-147	11	0.54	1100	54	1.1	0.054
Ra-226	0.054	0.00081	5.4	0.081	0.0054	0.000081
Sr-90	0.081	0.081	8.1	8.1	0.0081	0.0081
Kr-85	2.7	2.7	270	270	0.27	0.27
H-3	11	11	1100	1100	1.1	1.1

Note: Shipping limits for the US Postal Service are one tenth of the above tables.

Appendix G. Defense Occupational and Environmental Health Readiness System (DOEHRS)

DOEHRS is a Defense Health Agency system managed by the Defense Health Services Systems for entering, assessing, managing and reporting occupational and environmental exposures. DOEHRS consists of multiple business areas: industrial hygiene, environmental health, radiation and incident reporting. It is used for both garrison and deployed operations, is mandated by various DoD policies and public laws and is the system of record for the DoD individual longitudinal exposure record.

All data collected using this technical guide is required to be entered into DOEHRS. For information on getting access and training for DOEHRS, the Directorate of Environmental Health Sciences and Engineering at APHC should be contacted.

The worksheets below are from the "Occupational and Environmental Health Site Assessment – Stage 1 Template" (May 2014). This document can be referenced for instructions on how to fill out these worksheets.

General Survey Information			
Survey Start Date and Time:		Survey End Date and Time:	
Lead Surveyor Name(s):			
Lead Surveyor Title:		Surveyor's Unit:	
Lead Surveyor Phone:		Lead Surveyor Email:	

<table>
<tr><td colspan="4">Note: This information may be classified, if the information is classified, enter “Geographic Location Classified” in the Notes field and capture classified data at the end of the template and marked accordingly. It should also be sent to <u>usarmy.apg.medcom-phc.mbx.oehs@mail.smil.mil</u>
1. Administrative Data – Attach the Hard Copy of the OEHSA to this tile in DOEHRS</td></tr>
<tr><td>Location Name:</td><td colspan="3"></td></tr>
<tr><td>Location Aliases:</td><td colspan="3"></td></tr>
<tr><td colspan="4">Geographic location: Including geo-coordinate (e.g latitude/longitude) of the outside corners of the camp. At a minimum, use the center of the camp. <u>This information may be extracted from the Engineer EBS. Note: Information may be classified.</u></td></tr>
<tr><td>Coordinate 1:</td><td></td><td>Coordinate 2:</td><td></td></tr>
<tr><td>Coordinate 3:</td><td></td><td>Coordinate 4:</td><td></td></tr>
<tr><td colspan="4">Notes:</td></tr>
<tr><td colspan="4">Units and Detachments/Teams/Elements Present: <u>Note: this information may be classified.</u></td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="3">Camp Fixed Population: <u>Note: this information may be classified.</u></td><td></td></tr>
<tr><td colspan="3">Rotation Schedule: <u>Note: this information may be classified.</u></td><td></td></tr>
<tr><td colspan="3">Number of U.S. Troops, if not U.S. Camp: <u>Note: this information may be classified.</u></td><td></td></tr>
</table>

2. Survey Background
Limitations of Assessment: *Physical obstructions, limiting conditions (such as weather), mission restrictions, lack of equipment/supplies.*
General Data Gaps: *Data that was either not obtainable at the time of the survey or that will be received in the future.*
Assumptions / Uncertainties: *Observations and data could be limited due to the inherent challenges of conducting comprehensive public health assessments in an operational environment*
Information Sources / Document Reviewed: *Summaries of environmental sampling and studies, aerial photos, topographic maps, Engineer Environmental Baseline Surveys (EBS, basecamp master plan).*

3. Site Description: <u>*This information may be extracted from the Engineer EBS.*</u> *Attach site maps and photographs to the survey. Note: Get pictures of the site, a good rule of thumb is at least one picture per section (if applicable).*
Physical Setting: *(general geography / topography / urban / rural)*.
Climatic / Weather: *(temperature range / predominate wind direction)*
Soil: (types, permeability, drainage ditches, low lying areas (standing water), unusual/out-of-place mounds, disturbed areas, discolored soil, areas unusually devoid of vegetation, etc)
Groundwater: *(depth, direction of flow)*
Surface Water: *(location, direction of flow)*
Wetlands, Flood Zones, Costal Zone, Vegetation present:

3. Site Description *(continued)*
Proposed Site Usage: *What is the proposed usage of the site, especially if assessment is being conducted before usage determination or occupation?*
Current and Past Uses of Property: *What was the past usage of the site; agricultural, industrial, military, etc. For what duration were these uses active?*
Current and Past Uses of Adjacent Property: *(industrial operations, agricultural uses, type of crops grown) Is there knowledge on the use of pesticides (insecticides / herbicides)?*
North of Site:
South of Site:
East of Site:
West of Site:
Notes:

3. Site Description *(continued)*					
Nearby Industrial Facilities. *Are there any nearby industrial facilities*				Present: ☐ Absent: ☐ If Present, list below	
Geo coordinates (MGRS or Lat/Long)*	Name	Type of Industry	Active? (Y/N)	Description	Proximity to Location (in kilometers)
Do the nearby industrial facilities have the potential to affect personnel?				Yes: ☐ No: ☐ If yes, complete the Exposure Pathway form located at the end of this template.	

Note: * *(If geo-coordinates are classified please place in the appropriate table at the end of the template)*

Physical Hazards Instructions - *Ionizing Radiation Sources*

8b. Physical Hazards – Ionizing Radiation				
Are any ionizing radiation sources present? If known, attach inventory of sources.			Present: ☐ Absent: ☐ If Present, list below	
Storage Area	Sources Contained	Isotope	Activity	Highest does rate observed
8c. Camp Background Dose Rate:				
Notes:				
Do ionizing radiation sources have the potential to affect personnel?			Yes: ☐ No: ☐ If yes, complete the Exposure Pathway form located at the end of this template.	

IF AN EXPOSURE PATHWAY (EP) ALREADY EXISTS IN DOEHRS ENTER THE EP ID # IN THE EXPOSURE NOTES OF THE FDS AND DO NOT SUBMIT THIS FORM.

Exposure Pathway Form

Name (Unique Name Descriptor)		
Applicable OEHSA Section	OEHSA Section	OEHSA Sub-section (SELECT ONE)
	Site Description	Nearby Industrial Facilities________________
	Site Infrastructure	Onsite Industrial Operations Descriptions of Structures Description of Roads/Hardstand Description of Power Generation
	Hazardous Materials	Petroleum Distribution Points Hazardous Materials Storage/Unidentified Substances
	Waste Management	Solid Waste Landfills Incinerators/Burn Pits Waste Water
	Entomology	Vectors Present Pests Present
	Physical Hazards	Non-Ionizing Radiation Sources Ionizing Radiation Sources Environmental Noise Sources
	Air Quality	Ambient (Outside) Air Quality Indoor Air Quality (IAQ)
	Water	Natural Water Sources Municipal Water Sources Bottled Water Sources Water Treatment Systems
	Other Environmental	Other__________________
Source		
Environmental Media (select one)		○ Air ○ Water ○ Soil ○ Other
Health Threat (Potential Hazard)		
Route of Exposure (multiple routes will require multiple entries in DOEHRS)		☐ Ingestion ☐ Inhalation ☐ Physical ☐ Skin Absorption ☐ Skin Contact ☐ Other
Description of Affected Population	Fill out roster the Affected Roster for each person affected if known	Number of Affected Personnel:
Existing Controls		
Assessment		
Exposure Duration (Fill out time and select increment)		________ Minute Hour Day Week Month Year Other ________
Exposure Frequency (Fill out time and select increment)		________ *(times per)* Day Week Month Quarter Half-Year Year Other________
Start Date (yyyy/mm/dd)		
Hazard Priority (select one)		LOW / MODERATE / HIGH / EXTREMELY HIGH

Note: Make as many copies as needed for each Exposure Pathway(s) and Affected Roster(s)

Appendix H. Air Sampling for Radioactive Material

H-1. Introduction

Air sampling is conducted to demonstrate the presence or absence of airborne radioactive material in the environment during normal operations as in the case of a military base camp assessment, or during a nuclear/radiological accident or incident. Air sampling serves as an additional tool to help estimate the radiation dose to people who may or might have received the exposure in the absence of respiratory protection. Before sampling for environmental analysis and during normal operations, review historical data and find out which contaminants have been there in the past. For nuclear/radiological incidents or accidents, sampling will be performed based on military intelligence and information from Federal, state and local authorities. Figure H-1 shows a typical air sampler arrangement. The commercial air sampler is usually preassembled (See Figure H-2) and the only assembly required is the placement of the proper sampling head with an appropriate sampling medium (filter) specific to the job been performed.

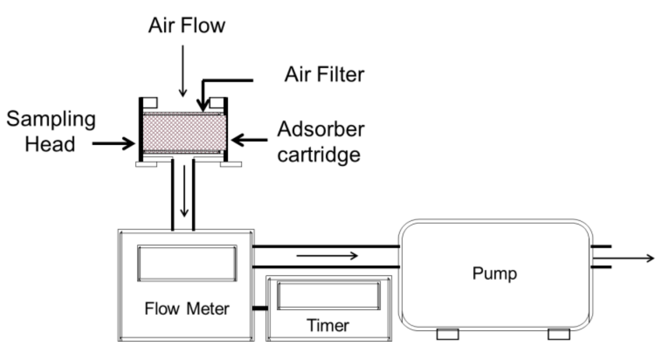


Figure H-1. Air Sampler Layout

Figure H-2. Commercial Air Sampler

H-2. Equipment Requirements for Air Sampling:

- A high-volume air sampler (18 to 40 cubic feet per minute (cfm)) with a 4-inch round flange is recommended for base camp assessments or for incidents/accidents. An 8 x 10-inch rectangular filter flange is also available.
- A tripod to support the air sampler.
- Metal plate (Some samplers require the metal plate.)
- Four-inch filters that retain 0.3 micrometer diameter particles.

- Tweezers to handle the filter.
- Disposable gloves.
- Quart-sized sealable bag in order to place the filter.
- Security seal.
- Sample Control & Chain of Custody form.
- Extension cord.
- Generator.
- An instrument to directly measure contamination on the filter. A Geiger-Mueller will work for a presence/absence measurement. Filters can be sent to a lab for more in-depth analysis; the lab will work with you for the best analytical method to meet your needs.

H-3. Preparation of Air Samplers:

Assemble the air sampler on top of the tripod and the metal plate (if required). Place the 4" filter within the sampling head and then attach the sampling head on the air sampler as shown in Figure H-3.

Figure H-3. (From left) Air Sample Head, Paper, and Filter; Assembled Sample Head; Attaching Sample Head to Pump

H-4. Placement of Air Samplers

For base camp assessments or environmental sampling two air samplers with their tripods would be ideal. The first air sampler should be placed upwind from the entrance/exit into the area where residual radiation might be present; this position has priority if only one air sampler is available. The second air sampler should be positioned upwind from the first air sampler for background measurements. For nuclear or radiological incidents/accidents, it is beneficial to use three air samplers: one upwind of the potential hazard to determine any potential change of wind or ground resuspension of radiological materials within the cold zone (outside the contaminated area), a second air sampler for background readings, and the third downwind of the potential contamination (see Table H-1). Disrupting the soil around the air samplers causes resuspension of particles. Contaminated particles can enter a person's breathing zone for inhalation or ingestion.

Table H-1. Air Sampler Downwind Distance (Reference 2)

Wind Speed		Approximate Downwind Distance	
Miles Per Hour (MPH)	(Knots)	(Meters)	(Feet)
6 to 10	4 to 9	1,000	3,300
11 to 15	10 to 13	1,500	5,100
16 to 20	14 to 17	2,000	6,600
Above 20	Above 17	2,500	8,200

Air samplers should be placed at the breathing zone height and away from any obstacles. Connect the air sampler to a power outlet or to a portable electric generator (upwind from the air sampler) with an extension cord (see Figure H-4).

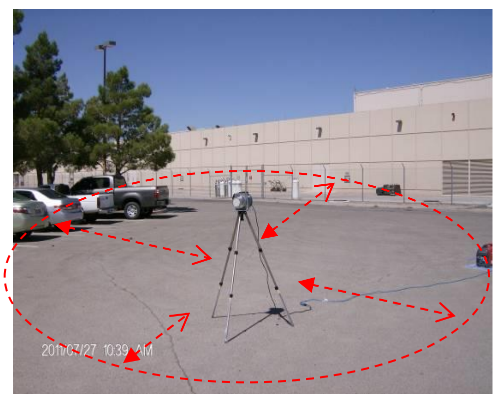


Figure H-4. Air Sampler Placement at Breathing Zone Height and Away from Any Potential Obstruction

H-5. Sampling

Set the timer function (or other timing device) to 1 hour. Typically, about 1,000 cubic feet of air needs to be collected for an accurate sample. The normal average flow rate is about 18 cubic feet per minute (cfm) so at 1 hour of sampling so the total amount of air volume collected at the end of air sampling is 1080 cubic feet.

Turn on the air sampler and immediately record the flow rate of the air sampler and record the filter identification number on the quart-sized sealable bag where the filter will be placed. Take a background reading of the area with a radiological survey meter and record the data on the respective survey form. Right before sampling ends, once again record the flow rate. Ensure to also record the location, date and time of both beginning and final flow rates (See paragraph below on how to correct collected flow rate).

Additional information must also be recorded on a survey form for each sample taken:

- Type and serial number of sampler.
- Location of sampler, including identification of field marking (stake) used to mark location.
- Start and stop time of sample.
- Flow rate during collection.
- Wind direction, temperature, pressure and weather conditions.
- Type of filter.
- Field readings on filter and time recorded
- Radiation detection instrument type and serial number, as well as designation of attached probe used to monitor the filter.
- Laboratory facility to which the filter will be sent for processing.

H-6. Corrected Flow Rate

For air sampling it is important to correct the flow given at the beginning and at the end of the sampling period. The corrected flow rate is given by the following equation:

Equation 1. Flow Rate Equation

$$Q_a = Q_0 \sqrt{\frac{p_0}{p_a} \times \frac{T_a}{T_0}}$$

The Q_o is the measured flow rate during sampling; Q_a is the actual flow rate. The actual flow rate is corrected for the difference in temperature and pressure under which the flow rate meter was calibrated. While the p_o and T_o are the pressure and temperature where the device was calibrated, p_a and T_a are the pressure and temperature where the measurement is being taken. The corrected average flow rate (in cubic feet per minute) multiplied by the number of minutes is approximately equal to the total volume of air sampled.

H-7. Field Data Collection

At the end of sampling, turn off the air sampler (if it does not turn off automatically) before removing the sample head. Using a survey meter, a measurement can be made directly from the filter on the air sampler prior to removing it from the sampling head. Remove the filter from the sampling head with a pair of tweezers to avoid cross contamination and place the filter on a protected flat surface where you can take an initial direct reading from the filter with a survey meter. The survey meter used must be appropriate for the type of radiation of interest (e.g., using an alpha scintillator to look for alpha-emitting radionuclides). Place the probe close to the outward facing side of the air filter while avoiding contact. Record this value in counts per minute (cpm). Wait 4 hours for the radon progeny to decay and measure again. If required, wait another 3 days for the thoron progeny to decay and measure the filter a third time. After measurements are done, use the tweezers to place the filter within the respective plastic sealable bag. Properly seal the plastic bag.

H-8. Shipment of Filters

Prior to shipping, ensure proper forms are filled out to include chain of custody. If not specified, all filter samples can be shipped to the APHC Laboratory Sciences Directorate, Analytical Division, Inorganic Radiochemistry Section at Aberdeen Proving Ground, MD (see Chapter 11).

H-9. Additional Sources of Information

- Nuclear Accidents Response Plan Internet Supplement
- NARP Internet Supplement: Environmental Sampling
- The Los Alamos Radiation Monitoring Notebook (Radiation Data 2015). (http://www.nrrpt.org/file/Los%20Alamos%20Radiation%20Monitoring%20Notebook%202015.pdf)
- Bioenvironmental Engineers (BEEs) Guide to Ionizing Radiation (http://www.dtic.mil/dtic/tr/fulltext/u2/a439547.pdf)
- Environmental Protection Agency; Representative Sampling: Air, August 1992
- NUREG 1400 (http://pbadupws.nrc.gov/docs/ML1305/ML13051A671.pdf)

Appendix I. Points of Contact

U.S. Army Public Health Center

phc.amedd.army.mil

Commander's Office	DSN
Director	584-2307
Deputy Director	584-4311
Staff Duty Officer	584-4375*
Laboratory Operations Division	584-2208
Public Affairs	584-2937
Secure FAX	584-7301
DSN FAX	584-8513

Health Physics Division	DSN
Division Manager	584-8396
Secretary	584-3502
DSN FAX	584-8263

* The Staff Duty Officer line is staffed 24 hours a day.

Commercial	410 - 436 - (the four digit extension)
International calling	(Int l access #) + 1 - 410 - 436 - (the four digit extension)

Public Health Command - Europe

Commander's Office	DSN
Commander	590-9839
Scientific Advisor	486-8371
Sergeant Major	590-9734
Detachment Commander	590-9873
Detachment Sergeant	590-4874
FAX Access-Military DSN	486-8549
FAX Access-German Civilian	(Area Code) 06371+86-8549
FAX Access-International	(Int l access)+49+ 6371+86-8549

Radiation Protection Personnel	DSN
Chief, Radiation Protection	486-8800
Chief, Radiation Protection Division	486-8800
NCOIC, Radiation Protection	596-4913

International DSN Area Code: 314

Public Health Command - Pacific

Commander's Office (Tripler, Hawaii)	**DSN**
Commander	315-433-6623
Sergeant Major	315-433-6623
Secretary	315-433-6623
Staff Duty Officer	+81 901-839-1494
Public Health Activity Japan (PHA-J) Health Physics (Camp Zama, Japan)	**DSN**
Chief	315-263-3564
NCOIC	315-263-3202
Public Health Activity Korea (PHA-K) Health Physics (Camp Humphreys, South Korea)	**DSN**
Chief	315-737-5727

Glossary

Abbreviations and Definitions

Section I.
Abbreviations

ALARA
As low as reasonably achievable

APHC
U.S. Army Public Health Center

AR
Army Regulation

CAC
Common Access Card

CBRNE
Chemical, Biological, Radiological, Nuclear, and Explosive

CECOM
Communications-Electronics Command

CFR
Code of Federal Regulations

CONUS
Continental United States

DA
Department of the Army

DA PAM
Department of the Army Pamphlet

DOD
Department of Defense

DOEHRS
Defense Occupational and Environmental Health Readiness System

DOT
Department of Transportation

FDA
Food and Drug Administration

FM
Field manual

GM
Geiger-Mueller (counter)

GPS
Global positioning system

HPD
Health Physics Division (APHC)

HQ
Headquarters

IAEA
International Atomic Energy Agency

LLR
Low-level radiation

LSA
Low specific activity

LSD
Laboratory Sciences Directorate (APHC)

NATO
North Atlantic Treaty Organization

NCOIC
Noncommissioned officer in charge

NMSO
Nuclear Medical Science Officer

NRC
Nuclear Regulatory Commission

NSN
National stock number

OCONUS
Outside the continental United States

OEG
Operational exposure guidance

OIC
Officer in charge

PH
Public Health

QA/QC
Quality control/quality assurance

RADIAC
Radiation detection, identification, and computation

RES
Radiation exposure status (see Glossary)

ROWPU
Reverse osmosis water purification unit

RPO
Radiation Protection Officer

RSSO
Radiation Safety Staff Officer

SASO
Stability and support operations

SI
International System (*Systeme International*)

SIBCRA
Sampling and Identification of Biological, Chemical and Radiological Agents

SN
Serial number

STANAG
Standardization Agreement (NATO)

TB
Technical bulletin

TG
Technical guide

TI
Transportation Index

TM
Technical manual

UXO
Unexploded ordnance

Section II.
Definitions

Absorbed dose
The ionizing radiation energy absorbed by a material measured in energy per unit mass of irradiated material. The units of absorbed dose are the gray (Gy) (the traditional unit is the rad)

Activity
The mean number of nuclear transformations occurring in a given quantity of radioactive material per unit time. The International System (SI) unit of activity is the Becquerel (Bq). The traditional unit is the curie (Ci).

Assessment
In this TG, an assessment is the entire process of evaluating the radiological characteristics of a given area, not just hazards. Contrast this with Risk assessment: The identification and assessment of hazards (first two steps of the risk management process). (DA, 2015)

Background radiation
Radiation from cosmic sources; naturally occurring radioactive material, including radon (except as a decay product of source or special nuclear material); and global fallout as it exists in the environment from the testing of nuclear explosive devices or from past nuclear accidents such as Chernobyl that contribute to background radiation. Background radiation does not include radiation from source, by-product, or special nuclear materials that the NRC regulates or from naturally occurring radioactive material that the Army regulates.

Becquerel
The International System (SI) unit of activity equal to one nuclear transformation (disintegration) per second. 1 Bq = 2.7×10^{-11} Curies (Ci) = 27.03 picocuries (pCi).

Bioassay
The determination of kinds, quantities or concentrations and, in some cases, the locations of radioactive material in the human body, whether by direct measurement (in vivo counting) or by analysis and evaluation of materials excreted or removed from the human body (in vitro counting).

Complexing agent
A chemical that will bind with a metal atom to form a molecule that can be easily removed from a system. Chelating agents are a subset of complexing agents.

Contamination
Radioactive material where it is not wanted.

Curie
The traditional unit of activity. One curie (Ci) is equal to 37 billion disintegrations per second (3.7×10^{10} dps = 3.7×10^{10} Bq).

Data quality objectives
Data quality objectives are those qualitative and quantitative statements that clarify a study's technical and quality objectives, define the appropriate type of data, and specify the tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions.

Dose equivalent
The product of absorbed dose in tissue, quality factor and all other necessary modifying factors at the location of interest in tissue. The units of dose equivalent are the rem and sievert (Sv). This quantity is also called equivalent dose in international guidance.

Gray (Gy)
The SI unit of absorbed dose. One gray is equal to an absorbed dose of 1 joule/kilogram (100 rad).

Grid
In this technical guide, grid refers exclusively to map reference points.

Half-life
The time required for one-half of the atoms present in a particular radionuclide to decay. Every radionuclide has a different half-life, ranging from fractions of seconds to billions of years. As an example, if we start with 100 atoms of a radionuclide with a 5-year half-life, in 5 years only 50 atoms will be left, and in another 5 years, only half of those atoms (25 atoms) will be left.

Hazard
Any real or potential condition that can cause injury, illness, death of personnel, damage to or loss of equipment or property, or mission degradation.

Health risk assessment
In this TG, a health risk assessment means the process that identifies and evaluates the risk to human health of exposures to radiation or radioactive materials.

Intake
The amount of a radionuclide taken into the body by inhalation, ingestion, or absorption through the skin.

Ionizing radiation
Charged subatomic particles and ionized atoms with kinetic energies greater than 12.4 eV, electromagnetic radiation with photon energies greater than 12.4 eV, and all free neutrons and other uncharged subatomic particles (except neutrinos and antineutrinos).

Measurement
The term measurement encompasses both sampling and radiation surveying.

Operational checks
Those procedures to verify that an instrument is acceptable for use.

Operational exposure guidance (OEG)
The maximum amount of nuclear/external ionizing radiation that the commander considers a unit may be permitted to receive while performing a particular mission or missions. This decision is made in consultation with appropriate staff specialists as defined in JP 3-11.

Qualified expert
A person who, by virtue of training and experience, can provide competent authoritative guidance about certain aspects of radiation safety. Being a qualified expert in one aspect of radiation safety does not necessarily mean that a person is a qualified expert in a different aspect. Forward requests for determination of whether a certain individual is a qualified expert through command channels to the MACOM RSSO as necessary. Forward these requests to HQDA (DACS-SF), WASH DC 20310-0200, for further evaluation as necessary.

Quality factor
The modifying factor (listed in 10 CFR 20.1004, tables 1004(b).1 and 1004(b).2) that is used to derive dose equivalent from absorbed dose.

Rad
A unit of absorbed dose. One rad is equal to an absorbed dose of 0.01 joule/kilogram (0.01 gray).

Radiation
In this TG, radiation refers to *ionizing radiation* only.

Radioactive commodity
An item of Government property made up in whole or in part of radioactive material. A national stock number (NSN) or part number is assigned to commodities containing radioactive material greater than 0.01 Ci.

Radioactive decay
The spontaneous transformation of an unstable atom into one or more different nuclides accompanied by either the emission of energy and/or particles from the nucleus, nuclear capture or ejection of orbital electrons, or fission. Unstable atoms decay into a more stable state, eventually reaching a form that does not decay further or has a very long *half-life.*

Radiation exposure status (RES)
The radiation exposure status is the current cumulative radiation dose for a given unit of soldiers or the cumulative radiation dose at the end of a given mission, including any radiation dose acquired before the mission.

Radionuclide
An unstable nuclide that undergoes *radioactive deca*y.

Reference (standard) man
A hypothetical aggregation of human physical and physiological characteristics arrived at by international consensus that is used by researchers to standardize results of experiments and relate them to human biology.

Rem
A unit of any of the quantities expressed as dose equivalent. The dose equivalent in rems is equal to the absorbed dose in rad multiplied by the quality factor (1 rem = 0.01 sievert).

Resuspension
The process whereby materials deposited on surfaces can become airborne.

Risk
Chance of encountering a hazard or bad consequences; exposure or chance of injury or loss. Risk level is expressed in terms of hazard probability and severity.

Roentgen
A unit of exposure; a measure of the charge produced in air by photons. One roentgen equals 2.58 x 10^{-4} coulombs per kilogram of air. The symbol for roentgen is R.

Sievert (Sv)
The SI unit of any of the quantities expressed as dose equivalent. The dose equivalent in sieverts is equal to the absorbed dose in grays multiplied by the quality factor (1 Sv = 100 rem).

Sampling
Sampling is the act of collecting material (such as air or soil) in the field for additional analysis.

Scan or scanning
Scans or scanning measurements are specific radiation surveying techniques where a RADIAC meter is operating constantly in ratemeter mode while the radiation surveyor moves about a given area or moves the probe over a surface. Sometimes the term *scanning radiation survey* is used as a synonym for scan or scanning.

Radiation survey
A radiation survey is the process of using an instrument to determine radiation or contamination levels in a given area, on a person (personnel radiation survey), or on equipment.

Radiation survey unit
A radiation survey unit is an area assumed to be homogeneous with respect to radiological parameters in which a radiation survey will be done. In this plan, a recommended radiation survey unit can be an outdoor area of less than 10,000 m^2 or an indoor area with a floor space of less than 100 m^2. There can be more than one radiation survey unit for each radiation survey site.

Uptake
The amount of a radionuclide that was taken into the body that makes it to the blood. Contrast this with an intake; for example, the amount of material inhaled would be an intake, but the amount of material that passes through the lung and enters the blood is an uptake. Technically, a contaminated wound would result in an uptake with no intake because the radioactive material enters the blood directly. It is possible to have an intake without having an uptake.

Wipes
Wipes are a subset of samples. They are used to estimate the removable amount of surface contamination on a given area, usually 100 cm^2 (an area of about 4 inches by 4 inches or the size of the palm of your hand.