FEDERAL RADIOLOGICAL
MONITORING AND ASSESSMENT CENTER

Monitoring and Sampling Manual
Volume II, Revision 3
Radiation Monitoring and Sampling

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FEDERAL RADIOLOGICAL
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Radiation Monitoring and Sampling

January 2021

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ACRONYMS AND UNITS OF MEASURE

A	
ALARA	As Low As Reasonably Achievable
AMS	Aerial Measuring System
B	
Bq	Becquerel
C	
cfm	cubic feet per minute
Ci	curie
cm	centimeter
CM	Consequence Management
CMRT	Consequence Management Response Team
CMweb	Consequence Management website
cpm	counts per minute
cps	counts per second
D	
DFM	Digital Field Monitoring program
DoD	U.S. Department of Defense
DOE	Department of Energy
dpm	disintegrations per minute
dpm/100 cm^2	disintegrations per minute per 100 square centimeters
E	
ECAM	Environmental Continuous Air Monitor
eFRMAC	Electronic FRMAC Enterprise
EOC	Emergency Operations Center
EOF	Emergency Operations Facility
EPA	Environmental Protection Agency
F	
FEMA	Federal Emergency Management Agency
FIDLER	Field Instruments for Detection of Low-Energy Radiation
FAL	Fly Away Laboratory
FMS	Field Monitoring Specialist
FRMAC	Federal Radiological Monitoring and Assessment Center
ft	feet
FTS	Field Team Supervisor

G

g	gram
GIS	Geographic Information System
GM	Geiger-Mueller
GPS	Global Positioning System
Gy	Gray

H

HPGe	High Purity Germanium
hr	hour
H&S	Health and Safety

I

IC/UC	Incident Command/Unified Command
ICRP	International Commission on Radiological Protection
ICS	Incident Command System
in	inches

K

keV	kiloelectron Volt
kg	kilogram

L

LAM	Local Area Monitor
lb	pound
lpm	liters per minute

M

m	meter
MDA	Minimum Detectable Activity
MeV	mega electron volt
mGy	milliGray
MPCD	Multipath Communication Device
mph	miles per hour
mR	milliRoentgen
mrad	millirad
mrem	millirem
MSL	Mean Sea Level
mSv	millisievert
$\mu Ci/m^2$	microcuries per square meter

N

NaI	Sodium Iodide
NARAC	National Atmospheric Release Advisory Center
NCRP	National Council on Radiation Protection
NNSA	National Nuclear Security Administration
NRC	Nuclear Regulatory Commission
NRP	National Response Plan

P

PAG	Protective Action Guide
PIO	Public Information Officer
PPE	Personal Protective Equipment
PRND	Preventative Radiological Nuclear Detection

Q

QA	Quality Assurance
QC	Quality Control

R

R	Roentgen
rad	radiation absorbed dose
RAMS	Radiological Assessment and Monitoring System
RAP	Radiological Assistance Program
rem	Roentgen equivalent man
RSL	Remote Sensing Laboratory

S

SCF	Sample Control Form
SOP	Standard Operating Procedure
Sv	sievert

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1 INTRODUCTION

1.1 Purpose

The Federal Radiological Monitoring and Assessment Center (FRMAC) Monitoring and Sampling Manual, Volume 2 provides standard operating procedures (SOPs) for field radiation monitoring and sample collection activities that are performed by the FRMAC Monitoring and Sampling Division (known as the Monitoring Division throughout this document) during a FRMAC response to a radiological emergency.

For more information on FRMAC Monitoring Division operations, please see the *Federal Radiological Monitoring and Assessment Center Monitoring and Sampling Manual, Volume 1, Monitoring Division Operations.*

1.2 The Monitoring Division Role in the FRMAC

The Monitoring Division is primarily responsible for the coordination and direction of:

- Aerial measurements to delineate the footprint of radioactive contaminants after they have been released into the environment.
- Monitoring radiation levels in the environment.
- Sampling to determine the extent of contaminant deposition in soil, water, air, and vegetation.
- Preliminary field analyses to quantify soil concentrations or depositions.

Monitoring and sampling techniques used during Consequence Management (CM)/FRMAC operations are specifically selected for radiological emergencies where large numbers of measurements and samples must be acquired, analyzed, and interpreted in the shortest amount of time possible. Also, techniques and procedures are flexible so that they can be used during a variety of scenarios; e.g., accidents involving releases from nuclear reactors, nuclear weapon accidents, nuclear detonations, space vehicle reentries, or contamination from a radiological dispersal device.

1.3 FRMAC and Monitoring Division Organizational Structures

The Consequence Management Response Team (CMRT) is deployed and the FRMAC is established following the guidance provided in the *FRMAC Operations Manual*. The CMRT is expected to integrate deployed Radiological Assistance Program (RAP) team members into any applicable Monitoring Division role.

Figure 1 illustrates the organizational structure of a FRMAC and how the Monitoring Division fits into the overall FRMAC organization. Figure 2 illustrates the organizational structure of the Monitoring Division. This organizational structure is the preferred, default structure to use for all responses. However, this structure may change depending on the needs of Incident Command/Unified Command (IC/UC).

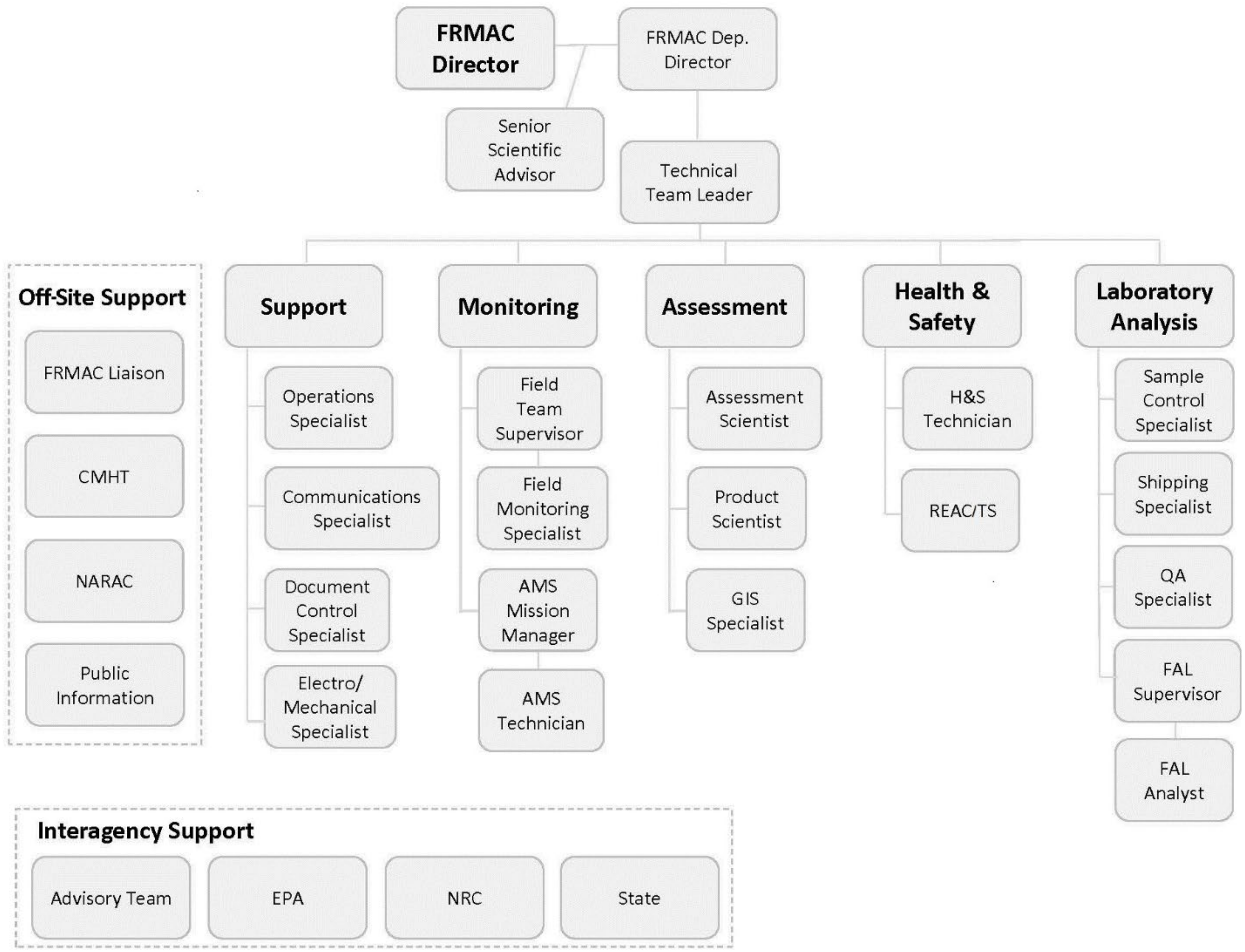

Figure 1. FRMAC Organizational Structure

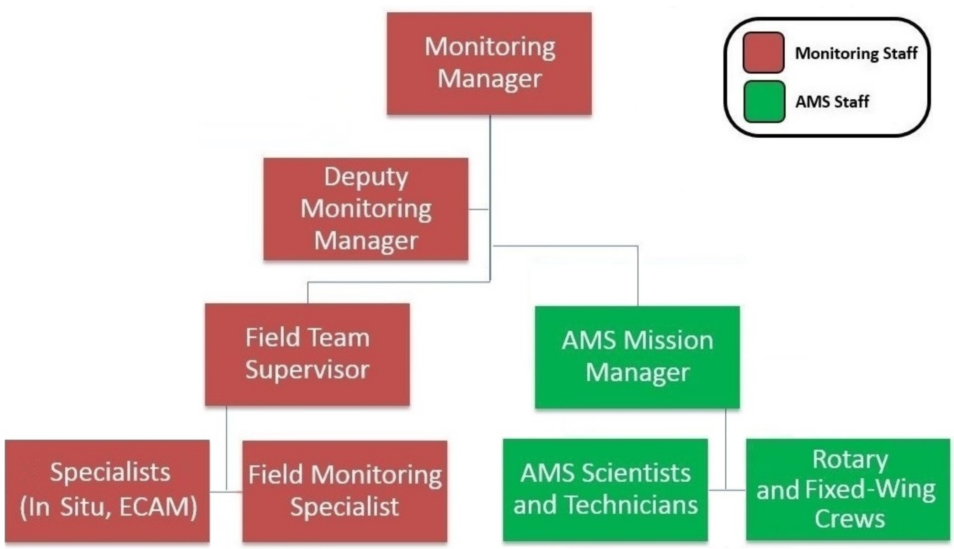

Figure 2. Monitoring Division Organizational Structure

1.4 Guidance and Orientation for Field Personnel

It is important for the Monitoring Division to follow the chain of command. Field team activities involve input from various FRMAC divisions, which implement tactics to fulfill objectives from IC/UC. Field team instructions are documented on an Incident Command System (ICS) form known as the ICS 204FRMAC, "Assignment List, Adapted for FRMAC Field Monitoring Teams" form (otherwise known as the ICS 204FRMAC form in this document). The ICS 204FRMAC form should be adhered to as closely as possible.

While in the field, personal safety is of utmost importance. A field team briefing is provided before field team deployment and should include a safety briefing developed by the Health and Safety (H&S) Division. Field monitoring teams are also provided with a list of contacts, including one for the Public Information Officer in case the public has questions about field team activities.

1.4.1 General Instructions

- All monitoring and sampling activities must be conducted so that exposures are maintained as low as reasonably achievable (ALARA). However, radiological emergency responders should know that receiving non-zero exposures is a possibility.
- Teams are under the direction of the FRMAC Monitoring Manager and FRMAC Field Team Supervisor, who provide instructions and locations for radiological monitoring and collection of environmental samples. These instructions are documented in the ICS 204FRMAC form and should be followed as best as possible.
- For large operations, and as necessary, the FRMAC Field Team Supervisor could assign one or more experienced Field Monitoring Specialists to act as the Field Team Contact. The role of the Field Team Contact is to support communication between the Field Team Supervisor and the field teams. See Appendix A for more information on the Field Team Contact.
- Teams must, to the best of their ability, identify, record, and transmit all field information in a precise, accurate, and timely manner.
- Teams must document all sampling and measurement activities on the appropriate forms (digital or paper) and report to the Field Team Supervisor, as directed.
- If possible, teams should determine in advance if special access or special hazards may be encountered at the time of sample collection. They must obtain access permission from landowners or their agents, or from federal or local government jurisdictions. Arrangements must be made prior to entering a property. If assistance is required, help can be provided from the Monitoring Manager, Field Team Supervisor, or local contact.

1.4.2 Safety

The H&S Division must provide information to the Monitoring Division for safe field operations as documented in the Health and Safety briefing. This should include such topics as: turn-back levels, use of personal protective clothing, respirators and other radiological protective equipment, use of prophylaxis drugs including thyroid-blocking drugs, contamination control instructions, etc.

Team Members must be aware of administrative control levels, hold points, turn-back levels, and accepted organization limits for emergency workers as established by the H&S Division.

- Team members are responsible for their own safety. No sample or measurement is worth compromising personal safety. Field sample collection can be dangerous. Always be aware of the hazards that may be encountered in the field and take the necessary precautions. Never attempt any field activities without the appropriate equipment.
- Teams should make all reasonable efforts to comply with turn-back guidance.
- Teams may generate waste material in collecting a sample. Place all waste items such as disposable gloves, tape, absorbent towels, etc., in a separate plastic bag and label it “contaminated waste.” Turn the bag in at the Contamination Control Line.

1.4.3 Public Affairs

The public has a right to know the facts about the incident and response operations. The media has a legitimate interest in telling the public about these facts. It is important that a clear and consistent message is presented to the public. The Public Information Officer (PIO) has that responsibility. Therefore, Field Monitoring Teams, and others who may come into contact with the general public, will be provided specific guidance on responding to their queries.

Field Teams:

- May explain what they are doing and why
- May not provide data directly to the public
- May provide contact information for the PIO.

2 FIELD MONITORING

Following a radionuclide release, Field Monitoring Teams use portable instruments to rapidly locate contamination and measure the level of radioactivity. Immediate results are then transmitted to supervisors who recommend precautionary actions to protect the responders. Additionally, teams collect environmental samples such as soil and water for definitive radioisotope analyses to confirm field measurements.

2.1 Field Team Structure

It is important during an emergency response to use Field Monitoring Specialists (FMS) who are skilled, experienced, and familiar with the monitoring equipment, sample collection, and preparation procedures. Responders performing routine monitoring and sampling should also receive specific training for non-routine and emergency monitoring and sampling in which higher than background readings may be expected. Greater care in sample handling techniques may be needed. Also, novel methods such as screening large numbers of samples using less sophisticated techniques may be required. If enough trained responders are not available, then firefighters, police, or other local emergency response personnel may provide this type of support with the provision that they receive applicable training and are equipped with appropriate monitoring equipment.

Large responses involving multiple agencies have responders with diverse training, experience, and knowledge. To balance this diversity, it is suggested that teams are built by integrating responders from various agencies and joining experienced responders with those with less experience. This type of team building could result in some loss of cohesion but will result in a more capable team. Each team should be comprised of at least two members (three members are preferable). One member should be designated as a Field Team Leader.

Recommended technical skills of a Field Team Leader include:

- Radiation dose rate and surface contamination measurement techniques
- Contamination control techniques
- Experience with personal protective equipment
- Emergency response scenarios training
- Sampling techniques
- Sample management

Other desired skills include:

- Experience with emergency communication equipment such as two-way radio
- Map reading and experience with global positioning system (GPS) equipment

On-the-Job training will be developed and given to all field teams on site as required, to ensure there is an acceptable minimum capability for the event. This training will also ensure that FRMAC methods, or other designated methods, are used to maintain consistency in radiological monitoring and sampling.

2.2 Field Team Briefing

Field teams are briefed daily prior to the start of work and departure into the field. A representative of the H&S Division conducts part of the briefing, focusing on the current Health and Safety plan requirements. The Monitoring Manager or the Field Team Supervisor (FTS) completes the briefing with the monitoring objectives and priorities for the operational period. All field team personnel for each shift are required to attend. The following subsections address some of the main contents of a field team briefing.

2.2.1 Condition of the Incident

Short update on the current condition of the incident:

- Status of evacuations and shelter-in-place
- Arrival of additional responders
- Locations of fuel, food, and barricades

2.2.2 Scope of Work to be Performed

Monitoring needs vary depending on the emergency, the responding organization(s), and local emergency responders. The staff of the responding organization(s) may be required to operate in a wide variety of settings (in vehicles, in public facilities) and perform various functions, such as:

- Defining the plume or deposition footprint (area monitoring)
- Sample collection
- *In situ* measurements
- Personnel surveys
- Monitoring of critical facilities
- Monitoring of vehicles
- Decontamination of personnel and equipment

2.2.3 Conditions of the Deployment Location

Personnel should be aware of local surroundings. Weather conditions should be presented to personnel at regular intervals and as changing conditions warrant.

Existing radiological, chemical, biological or other hazards need to be communicated to monitoring teams. It enables them to prepare for a variety of circumstances such as:

- Climate (weather)
- Biohazards (snakes, ticks, etc.)
- Expected radiological contaminants/levels
- Expected chemical contaminants/levels
- Possibility of terrorist activity and use of weapons of mass destruction
- Traffic expected (Is the area to be evacuated?)

- Response of local population
- Any known checkpoints or barricades
- Locations of available decontamination/hotline facilities

2.2.4 Personal Protective Equipment

Field teams are briefed on personal protective equipment (PPE) requirements. The teams are briefed on the PPE to be used for each hazard, as well as when to don and doff PPE, such as anti-contamination clothing and respiratory protection. The FRMAC deploys with PPE that meets level D or C requirements typical for entry into radioactive contaminated areas (coveralls, shoe covers, gloves, and respirators). Entries into impacted areas that require level A or B PPE require interagency coordination.

2.2.5 Dosimetry

Field teams are briefed on the dosimetry requirements prior to any potential exposure and an H&S representative must ensure personnel have the appropriate dosimetry, such as:

- Whole body dosimeter
- Personal air sampler
- Supplemental dosimeter

Field teams will also receive instructions on entry into a bioassay program.

2.2.6 Communications

- Types of communication to be used
- Contact phone numbers
- Call signs, radio protocols
- Call in times/frequency
- What information to call in
- Contingencies for communications failure

2.2.7 Turn-Back Limits and Hold Points

Turn-back limits and hold points are established when the hazard exceeds the level of the prescribed protection. If a field team exceeds the turn-back limits, they should immediately exit the area, notify the FTS, and return to the hotline (or other designated return location).

Hold points should be established for field teams where additional controls are required to continue work. If the field teams encounter a hold point, then the team must check in with the FTS to receive further instructions. Possible instructions may be to don additional PPE (such as gloves/boots, coveralls, or respiratory protection) and continue work, enact stay-time restrictions, or turn back at these levels.

Initially, the use of default hold points and turn-back limits (found in the *FRMAC Monitoring and Sampling Manual Volume I*) is sufficient if no specific guidance is provided during the early phase of the response. The H&S Manager must update and refine turn-back guidance as additional information and data on actual conditions become available.

2.2.8 Return Briefing

On return to FRMAC, each field team leader reports to the Field Team Supervisor controlling the team. The Field Team Leaders should turn in the team's paper work, including digital or paper Field Monitoring Logs, and be debriefed by the Field Team Supervisor.

2.3 Instrumentation

Portable survey equipment for the FRMAC is maintained and calibrated by the Department of Energy (DOE) Management and Operating contractor to the Nevada National Security Site. It is acknowledged that there are many instruments with similar capabilities that are deployed for a FRMAC response by other agencies. Those that meet the quality control (QC) requirements and have the capability to measure with the appropriate sensitivity may be used upon approval of the FRMAC Monitoring Division.

2.3.1 FRMAC Common Instrumentation

FRMAC uses multiple types of radiation detectors. The main instruments used for radiological emergency response by FRMAC field teams are portable instruments in the health physics kit. The kit consists of an ion chamber (for dose rate measurements), alpha/beta scintillator probes attached to scalers (for ground deposition and contamination surveys), and Geiger-Mueller (GM) detectors (for contamination surveys). High Purity Germanium (HPGe) detectors are used to quantify radionuclides deposited on the ground. Proportional counters (single sample readers) are used to evaluate swipes, smears, and air samples. Tripod-mounted pressurized ion chambers are used to collect accurate dose rates and to help characterize the area for Aerial Measuring System (AMS) personnel.

FRMAC also maintains other equipment that are used for particular incident scenarios. SpecFIDLERs (for alpha ground deposition) are used only for alpha emitting scenarios. Handheld sodium iodide (NaI) probes attached to scalers are used for surveys of gamma emitters. Environmental Continuous Air Monitor (ECAM) systems contain an air sampler and an exposure rate detector that telemeters data in real time. The ECAM system is usually brought to support known events in which real time air sampling is important.

2.3.2 Calibration Records

Calibration records are required to meet ANSI N323AB-2013 standards for all radiation detection instruments used by the FRMAC.

Field teams need to confirm that a calibration sticker is affixed to each instrument and that the instrument is not being used after the calibration due date. If the instrument is out of calibration or performance tolerance then it cannot be used. Tag the instrument “Out of Service” and mark the tag with:

- Name
- Date
- Reason for placing unit out of service.

2.3.3 Post-Calibration Performance Test

To assure proper operation, each instrument must be tested with a check source at the beginning of each shift or before use. An end of shift operational check may be performed as directed. Two types of checks are performed on each instrument:

- Operability checks in the field (see Section 2.5.1 “Operability Check Instructions” for more information).
- QC source checks when the appropriate sources are available (see Section 2.5.2 “Quality Control Check Instructions” for more information).

Each instrument must be periodically checked to ensure proper response to radiation. These QC checks should be performed during shift change and during routine maintenance.

2.4 Digital Collection Systems

FRMAC field teams record data using a digital collection method (primary) or paper forms (secondary). As of the publication date, FRMAC utilizes Electronic FRMAC Enterprise (eFRMAC) capabilities to collect data (see Appendix B for more information on eFRMAC) and the Radiological Assessment and Monitoring System (RAMS) database to store radiological data.

The RadResponder Network (https://www.radresponder.net) is another solution for the management of radiological data. It is a product of collaboration between Federal Emergency Management Agency (FEMA), DOE/National Nuclear Security Administration (NNSA), and the Environmental Protection Agency (EPA), and is provided free of charge to all Federal, state, local, tribal, and territorial response organizations. RadResponder enables organizations to rapidly and securely record, share, and aggregate large quantities of data while managing their equipment, personnel, interagency partnerships, and multijurisdictional event space. RadResponder can be accessed on smartphone/tablet applications and via the web.

FRMAC field team tablets are equipped with eFRMAC software and the RadResponder application. This allows a combined field team the flexibility to use whatever system they are most comfortable with or are instructed to use. To utilize the RAMS database or RadResponder effectively, detailed information about the instrument meter and probe is needed. Some of the information captured in both systems are:

- Meter Name
- Meter Model Number
- Meter Serial Number
- Displayed Units
- Probe Name
- Probe Type

- Probe Serial Number
- Reported Units
- Probe Surface Area
- Probe Efficiency based on energy correction factors.

The assessment of data is more efficient if the appropriate information on meters and probes is provided.

2.5 Field Team Pre-Deployment Duties

There are certain tasks that need to be accomplished before a team deploys to the field to perform monitoring and sampling activities. The field team must receive a daily briefing, gather necessary instruments and equipment to accomplish their tasks, check instruments for operability, and prepare the vehicle, instruments, and personnel for field conditions. Generally, to prepare for activities, field teams would need to:

- Receive the initial briefing and assignments from the Field Team Supervisor and H&S representative.
- Obtain monitoring and sampling equipment to fulfill the tasks indicated by the ICS 204FRMAC. Refer to Appendix C for sample forms and Appendix D for FRMAC operator aids.
- Obtain a pocket dosimeter and/or self-reading dosimeter, Breathing Zone Air Sample Pump and Bioassay instructions from H&S Division, if required.
- Record initial dosimeter reading on a digital or paper Pocket Dosimeter Log, or equivalent, before deploying to the field.
- Perform quality control (QC) checks on survey instruments, including battery check at the beginning of shift or before use. Perform quality control (QC) checks at the end of each shift if instructed.

2.5.1 Operability Check Instructions

Operability checks of radiation survey instruments should be performed periodically and after doing any minor maintenance such as changing batteries or fixing a loose cable.

1. Check instrument for:
   - Completeness (i.e., all the needed probes and parts are present)
   - Physical damage
   - Unusual and unexpected response or behavior.
2. Check batteries
   - Spare batteries are located in emergency response kits and can be obtained from the Instrument Staging Area, Field Team Supervisor or designee.
3. Zero instruments having manual electronic ZERO function.

2.5.2 Quality Control Check Instructions

Perform Quality Control (QC) checks daily or prior to deploying the instrument into the field. Perform the proceeding steps for each instrument and probe to be used in the field.

1. Perform an operability check.
2. Ensure the calibration is current and has not expired.
3. Look for a normal background response.
4. Perform a response check with radioactive material, if the correct QC source is unavailable.
5. Perform a QC source check for the instrument.
    a. Use the appropriate QC source with the desired radiation type for each instrument.
    b. Perform the QC source check in the predetermined geometry to yield a consistent exposure or count rate.
    c. Ensure that the instrument reading is within the acceptable range.
    d. Perform preceding step on each scale calibrated for use, if possible.
6. Complete a “Daily Instrument QC Checks” form (see Appendix C) and give the form to the Field Team Supervisor or designee.
7. Complete a “Team, Instrument, & Equipment Information” form and submit the form to the Field Team Supervisor before departing for the field.

2.5.3 Preparing Field Team for Field Activities

The FRMAC Monitoring Manager is responsible for creating field team instructions as documented on the ICS 204FRMAC form. The form is completed daily, or for each operational period, and describes in greater detail the techniques used to obtain sample and measurement data to characterize the incident. The form addresses how each field team must collect data to support the priorities listed. As part of this process, field teams have specific monitoring and sampling locations. Field teams receive directions on where to go and the best route to take to avoid unnecessary dose and contamination. CMRT/FRMAC uses DOE developed software named Consequence Management Center (CMC), to plan, document, and track field team activities.

The level of field team preparation may be different for varying scenarios and as the response progresses. The level of preparation should be documented for the field teams in the H&S briefing and the ICS 204FRMAC form. The following preparation steps should be taken:

1. Attend the field team briefing for the health and safety information and to receive field team assignments.
2. Ensure that all necessary monitoring and sampling equipment and supplies are obtained to accomplish the tasks indicated by the ICS 204FRMAC from.
    a. Prepare to either wipe down or rinse the sampling equipment, or bag the equipment to decontaminate later at the hotline.
    b. If the field team is unable to decontaminate equipment and supplies in the field, ensure that extra monitoring and sampling equipment and supplies are obtained to accomplish the tasks as outlined in the ICS 204FRMAC form.

3. Assemble sampling equipment (air sampler filter/cassettes, etc.) to reduce the time spent in the field.
4. Bag instruments if instructed by the Field Team Supervisor, or as required for surveys in contaminated areas.
5. Prepare the vehicle for contamination (as instructed).
    a. Tape a plastic sheet in the back of the response vehicle to create a clean work area for Contamination Control measures.
    b. Tape plastic sheets on the floor boards and seats.
6. Ensure a Multi-Path Communications Device (MPCD) with a FRMAC tablet has been installed in the response vehicle and is communicating properly.
7. Take a background survey, if possible in an area that will be representative of the field sampling area, at the FRMAC location with each survey instrument assigned to the team.
    a. Record the results on a digital or paper Field Monitoring Log. These background readings will be used by the Assessment Division as a reference background.
    b. If using an *in-situ* gamma spectrometer, in addition to the background spectrum, collect a spectrum of a known radioisotope. Save the background and known radioisotope spectra files with a unique name (as well as an indicator if the spectrum is background or a known nuclide).
8. Don protective clothing and respiratory equipment, if necessary, as instructed by the Field Team Supervisor and Health & Safety.
9. Conduct communications checks prior to leaving the FRMAC.

3 MONITORING SURVEYS

Monitoring surveys are performed by field teams throughout the entire response. During the early phase of a response these surveys are used to protect the health and safety of both the public and responders. This section covers the common surveys performed during a response, with general survey instructions. These general survey instructions are guidelines and can be updated in the field to best meet the needs of the response.

3.1 Ten-Point Monitoring Strategy

The Ten-Point Monitoring Strategy is a standardized methodology for quickly gathering required radiological monitoring information after a potential release. The strategy is intended to be used during the early post-incident phase (typically completed by the RAP team or first responders). This strategy will allow a quick comparison of real-world data to plume projections and allow responding personnel to provide effective recommendations on protection of responders and the local population. The strategy is not intended to guide selection of monitoring activities for follow-on cleanup and site restoration tasks.

Figure 3 depicts the locations of the 10 points. The distance between the downwind arcs is 1 kilometer (km) and the arc is 22.5 degrees (°) azimuth on either side of the centerline. Grid Point 1 is 500 meters (m) (~1,600 feet [ft]) from the point of release. Grid points 2, 3, 4, 5, and 6 are spaced 1 km (~0.6 miles) apart on the assumed centerline of the plume based on the prevailing wind direction. Grid points 7, 8, 9, and 10 are located at 3 km (~2 miles) and 5 km (~3 miles) at ±22.5° azimuth on either side of the centerline. The exact location of each point is not critical, but attempts should be made to be reasonably accurate. The strategy includes six points directly downwind and four points on the outer edges, with two on each edge.

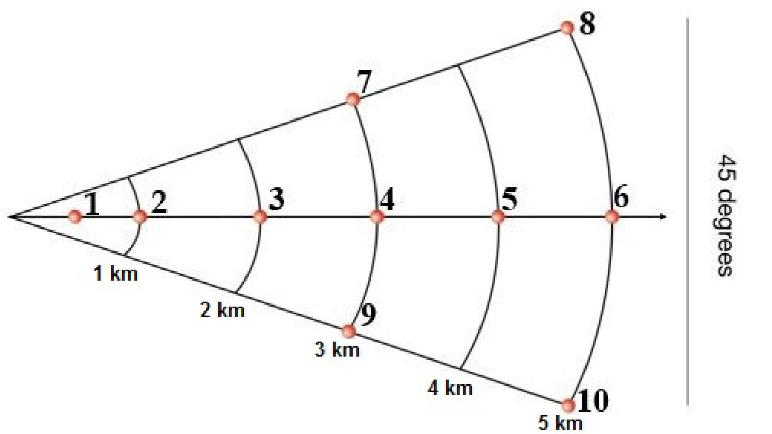

Figure 3. Ten-Point Monitoring Strategy

To execute the Ten-Point Monitoring Strategy, responders should gather radiological monitoring data for the 10 points depicted in Figure 3. Conditions or local terrain may prevent access to some of the 10 points. If that occurs, responders should collect as many of the 10 points as possible.

Initially design surveys to determine the presence of alpha, beta, and gamma radiations. Even in a known incident, there may be surprises, especially in the early phase of an event. It is better to document some negative data than to rush into an unexpected hazard. Note that many first responders have been issued gamma exposure rate instruments only and may not be capable of surveying for alpha/beta contamination. Although every incident is different, data from the same kinds of measurements may be used to resolve issues; e.g., dose and exposure rates.

The Ten-Point Monitoring Strategy was designed to determine the direction of ground deposition. It is not required to be performed before other measurements are collected. This strategy should only be used in the early phase of the incident.

3.1.1 Procedure

> **NOTE:** The required PPE, turn-back levels, survey points, types of surveys, and number of samples vary depending on the incident and should be determined on a case-by-case basis. Depending on the situation, field teams could start at point 1 or start at the farthest edges of the 10 point and work towards the release point.

1. Periodically check personal dosimeters.
2. If readings exceed any turn-back levels, hold points, or administrative control limits, proceed to a safe area and notify the Field Team Supervisor.
3. Take surveys at point #1.
   a. If the survey result is equivalent to background radiation levels, perform surveys in a circular pattern around the release point until elevated readings are acquired. Report this information to FRMAC as the Ten-Point Monitoring grid may need adjusting which will result in new locations for the 10 monitoring location points.
4. Perform surveys at each of the 10 points.
   a. Perform, at a minimum, an exposure rate survey at each point.
   b. Surveys and environmental sampling should be performed in undisturbed, relatively level, open areas away from vehicles, buildings, roads, heavy traffic areas (paths), excavated areas, and piled rocks, gravel, or soil. If possible, perform surveys at least 10 feet from the side of the road.
5. Record all data on a digital platform or a paper Field Monitoring Log.

3.2 FRMAC Survey Strategy during Operations

After the initial actions of the response, a more systematic way of planning field team activities should occur. Field team activities must be based upon IC/UC command objectives. FRMAC will capture the field team instructions on an ICS 204FRMAC, "Assignment List, Adapted for FRMAC Field Monitoring Teams" form (otherwise known as the ICS 204FRMAC form, see Appendix C, in this document). These forms contain specific instructions on where to perform monitoring, which samples to collect, and which surveys to perform. Section 3 subsections contain general survey guidance, but should never replace actual field team instructions documented on the ICS 204FRMAC form.

3.2.1 General Field Team Survey Instructions

1. Prepare for field deployment as mentioned in Section 2.5.3 “Preparing Field Team for Field Activities.”
2. Proceed to designated monitoring locations as specified in the ICS 204FRMAC form.
3. During transit through an active plume, close all vehicle windows and vents and either use the recirculation switch on the heat or air conditioning system or shut off the heat or air conditioning system, as directed.
4. Use the most sensitive instrument to provide a first indication of encountering radiation from plume or contaminated area.
5. Place the probe of the exposure rate instrument on the dashboard next to the window to monitor any changes while in transit.
6. If turn-back levels (as indicated on ICS 204FRMAC) are reached, proceed to a safe location and notify the Field Team Supervisor of the location and readings.

> **NOTE:** FRMAC has default turn-back limits for different scenarios listed in the Monitoring and Sampling Manual, Volume I. These turn-back limits assume that responders are not in an active plume. The general exposure rate turn-back limits are 500 milliRoentgens per hour (mR/hr). The general dose turn-back limits are 500 millirem (mrem) in a shift.

7. Periodically check dosimeter readings during operations.
8. Upon arrival at the monitoring location, conduct requested surveys and sampling and report the results on a digital platform or a paper Field Monitoring Log.

> **NOTE:** Step 8 assumes that all appropriate metadata was collected and recorded for all surveys and samples such as: GPS location, instrument used, date and time of survey, measurement value, proper units, name of person or team performing surveys, etc.

9. Conduct further plume traverse/tracking only as directed on the ICS 204FRMAC or by instructions from the Field Team Supervisor.
10. Return to the contamination control hotline for personnel and equipment contamination surveys and sample drop-off.

3.3 Exposure or Dose Rate Surveys

Gamma exposure or dose rate surveys may be the most common radiological survey performed during a response. These surveys are useful during the totality of the response and especially for comparing field data with derived response levels for public protective actions. Gamma exposure or dose rate surveys may be collected using standard health physics instrumentation and even some Preventative Radiological Nuclear Detection (PRND) equipment that is utilized by first responders.

3.3.1 Exposure or Dose Rate General Survey Procedure

1. Wrap the instrument(s) in plastic cling wrap to prevent contamination, as directed.
2. Choose an undisturbed, relatively level, open area away from vehicles, buildings, roads, heavy traffic areas (paths), tree canopies, excavated areas, and piled rocks, gravel, or soil. If possible perform surveys at least 10 feet from the side of the road.
3. Take an exposure or dose rate survey at 1 meter above the ground.
4. Allow the instrument to stabilize for a minute before recording data.
5. Record all data on a digital platform or a paper Field Monitoring Log.
6. Inform the Field Team Supervisor if any readings exceed the hold points or turn-back levels.
7. Periodically check personal dosimeters and notify Field Team Supervisor if readings exceed any administrative control limits.

3.4 Beta/Gamma Ground Deposition Surveys

After the release of radioactive material, the affected area should have ground deposition monitoring surveys performed to determine radiation levels from materials deposited on the ground. This is to identify if resuspension of the radioactive material is present and to determine the migration of material. Sometimes these surveys are referred to as ground contamination surveys. These types of surveys, along with exposure rate surveys, are the most common surveys performed during a radiological response.

Beta/gamma-emitting radionuclides can be found in reactor material, fission and activation products such as cobalt-60, cesium-137, uranium, thorium, and many radiopharmaceuticals. Use a pancake Geiger-Mueller (GM), or similar detector, with the window pointed towards the surface of interest. These monitoring surveys will yield results of total beta/gamma activity.

Beta/gamma ground deposition surveys should not be confused with an *in-situ* ground deposition measurements as mentioned in Section 4.10 "*In Situ* Gamma Spectroscopy Measurements." If performing beta/gamma surveys to determine if an object or person is contaminated, refer to Section 8.1.2 "General Beta/Gamma Contamination Survey Procedure."

3.4.1 Beta/Gamma Ground Deposition General Survey Procedure

1. Use an instrument appropriate for the target radionuclide(s).
   a. Wrap the instrument(s) in plastic cling wrap to prevent contamination, as directed. The active area of the detectors should not be covered.
   b. Begin on the lowest scale, switching scales as necessary.
2. Monitor instruments during travel between survey points, along roadways in and around the contaminated area to ensure the team is aware of changes in the exposure rate.
3. Make initial gamma measurements from inside a slowly moving vehicle with the vehicle windows closed.

   a. Position the detector, as close to the outside window of the response vehicle, while affording the ability to watch the instrument display.
   b. Use the audio on the instrument if it is available as the meter audio will respond faster than the display.
4. At the survey location, as you depart the vehicle, closely monitor the instrument's response for exposure rate and/or contamination levels to determine a measurement location that has a consistent level of radioactivity (i.e., not surveying in a hot spot).
5. For ground deposition surveys, choose an undisturbed, relatively level, open area away from vehicles, buildings, roads, heavy traffic areas (paths), tree canopies, excavated areas, and piled rocks, gravel, or soil. If possible perform surveys at least 10 feet from the side of the road.
6. Hold the probe ~ 1/2 inch above the ground surface and start the survey. The FRMAC default collection time is 1 minute.
7. Record all data on a digital platform or a paper Field Monitoring Log.
8. Inform the Field Team Supervisor if any readings exceed the hold points or turn-back levels.
9. Periodically check personal dosimeters and notify Field Team Supervisor if readings exceed any administrative control limits.

3.5 Alpha Ground Deposition Surveys

After the release of radioactive material, the affected area should have ground deposition monitoring surveys performed to determine radiation levels from materials deposited on the ground. This is to identify if resuspension of the radioactive material is present and to determine the migration of material. Sometimes these surveys are referred to as ground contamination surveys. These types of surveys, along with exposure rate surveys, are the most common surveys performed during a radiological response.

If performing alpha surveys to determine if an object or person is contaminated, refer to Section 8.1.3 "General Alpha Contamination Survey Procedure."

Alpha-emitting radioactive materials include uranium, plutonium, americium, and other actinides. A zinc sulfide scintillator or proportional counter is used as the measuring device. Alpha ground deposition surveys will yield results of total alpha activity. Alpha radiation has a very short range. Any dew or snow overburden on the contamination may reduce or block the alpha radiation. Because of geometry and environmental factors, alpha contamination survey meters are useful for identifying but are not optimal for quantifying alpha contamination. Refer to Section 3.6, "X-ray/Low-Energy Gamma Material Surveys" for the preferred method to quantify alpha ground deposition.

Choose a surface that is relatively flat. A cloth or paper large-area wipe can be surveyed with a portable instrument to test for removable contamination on irregular surfaces. Take measurements as close as possible to the surface using caution not to contaminate or puncture the probe.

3.5.1 Alpha Ground Deposition General Survey Procedure

1. Use an instrument appropriate for the target radionuclide(s).

a. Wrap the instrument(s) in plastic cling wrap to prevent contamination, as directed. The active area of the detectors will not be covered.

CAUTION:
Never "wrap" an alpha probe face with plastic. Alpha radiation cannot be measured through plastic.

2. Begin surveying on the lowest scale, switching scales as necessary.
3. For deposition surveys, choose an undisturbed, relatively level, open area away from vehicles, buildings, roads, heavy traffic areas (paths), tree drop lines, excavated areas, and piled rocks, gravel, or soil. If possible, perform surveys at least 10 feet from the side of the road.
4. Perform surveys at no more than ¼ inch from the ground surface. The FRMAC default collection time is 1 minute.
5. An air sample may be needed to verify airborne radioactive material (see Section 4.4 "Air Samples").
6. Record all data on a digital platform or a paper Field Monitoring Log.
7. Inform the Field Team Supervisor if any readings exceed the hold points or turn-back levels.
8. Periodically check personal dosimeters and notify Field Team Supervisor if readings exceed any administrative control limits.

3.6 X-ray/Low-Energy Gamma Material Surveys

The preferred instrument to quantify alpha ground deposition is a Field Instrument for Detecting Low Energy Radiation (FIDLER). The FIDLER is a thin windowed NaI crystal used to measure the low energy photons from actinide sources. This is done by the detection of the low energy gamma rays from americium-241 or the very low energy x-rays from plutonium-239. It is expected that americium-241 will be the surrogate for the total plutonium deposition. Because photons are not affected as much as alpha particles by geometry or shielding, FIDLERs may be used in environments where standard alpha contamination meters would not perform.

A FIDLER detector, when attached to a count rate meter, will give gross counts. During instrument calibration, the meter is set to read either 17 kiloelectron Volt (keV) region of interest and/or 60 keV region of interest.

A FIDLER detector attached to a multi-channel analyzer has the ability to collect and save spectra and report the results as estimated activity for both americium and plutonium. An example of this type of instrument would be the SpecFIDLER used by CMRT.

There are two types of surveys when using FIDLER systems: static measurements and scan surveys. Static measurements are used to characterize a single location. Depending on the type of FIDLER detector, the result may be in counts per minute or an estimate of the radionuclide deposition in $\mu Ci/m^2$. Scan surveys are used to characterize the deposition area.

Ideally, scan surveys would record data every second as the field teams traverse the impacted area. The goal of the scan surveys would be to show the extent of the contamination.

3.6.1 X-ray/Low-Energy Gamma Material General Survey Procedure

1. Along with the FIDLER, bring standard alpha contamination meters to help identify survey locations and to check for personnel and equipment contamination.
2. Follow the recommendations for personal protective equipment on the ICS 204FRMAC form. Depending on the incident and field team assignment, field teams may need to wear respirators or breathing zone air samplers, or both to protect them from inhalation hazards and to estimate internal doses.
3. If using a SpecFIDLER and prior to field team deployment:
    a. Review the "Operator Aid: FRMAC SpecFIDLER" in Appendix D.
    b. Collect a background spectrum and a spectrum of a known radioisotope. Save the background and known radioisotope spectra files with a unique name (as well as an indicator if the spectrum is background or a known nuclide).
4. To perform static measurements:
    a. Hold the FIDLER detector about 30 cm (1 foot) above the ground.
    b. Wait at least 30 seconds at the survey location to allow time for the FIDLER to respond before recording the data.
    c. Perform the static count (preferably for at least one minute).
    d. Record all data in accordance with Field Team Supervisor instructions on a digital platform or a paper Field Monitoring Log.

> **NOTE:** Recording FIDLER data on digital platforms is not intuitive. Whether to enter count rate from the 17 keV channel, the 60 keV channel, or both as either a gamma or alpha survey is dependent on the equipment used and the response scenario. If using a SpecFIDLER, this may also include saving and uploading a spectrum file to the digital collection platform.

    e. Inform the Field Team Supervisor if any readings exceed the hold points or turn-back levels.
    f. Periodically check personal dosimeters and notify Field Team Supervisor if readings exceed any administrative control limits.
5. To perform scan surveys:

> **NOTE:** In order to effectively record data during a scan, additional equipment would be necessary such as a GPS antenna and a data logger.

    a. Hold the FIDLER detector about 30 cm (1 foot) above the ground.

b. Walk throughout the survey area, preferably in a parallel line pattern.
c. If FIDLERs are mounted to a vehicle, then perform the scan as slow as possible and with the detector about 30 cm (1 foot) above the ground.
d. If automatic data recording is not available, then periodically record data on a digital platform or a paper Field Monitoring Log.
e. Inform the Field Team Supervisor if any readings exceed the hold points or turn-back levels.
f. Periodically check personal dosimeters and notify Field Team Supervisor if readings exceed any administrative control limits.

6. Check for personnel contamination upon exit from the area with an alpha contamination meter.

3.7 Airborne Radioactive Material Surveys

Airborne radioactive material surveys are performed to identify the air concentration of radioactive materials, inhalation exposure to the plume, and external doses from the plume. A "plume" typically refers to an active airborne release. The term "plume" is sometimes used to reference the pattern in which materials are deposited on the ground, however the correct term would be "ground deposition."

> **NOTE:** The airborne plume phase of an incident typically occurs within the first few hours of an incident. FRMAC may not arrive in time to perform plume surveys at the incident location.

For a contaminated plume boundary default value, use 5 times the background level until more specific direction is given to the team. With specific isotopic mix and instrument detection limits, the number can be as low as 2 times background.

> **CAUTION:**
>
> All field teams need to be cautious when working within a plume. Minimize operations in an active plume. The external radiation dose recorded by radiation surveys or dosimeters does not include the internal dose received while working in a plume.

3.7.1 Active Plume Survey Procedure

Fission products, including radioiodines and noble gasses, are beta/gamma emitters. Since beta radiation has a limited range, compared to gamma radiation, higher open window measurements are used to indicate the location of the radioactive material.

1. Take a gamma (closed window) and beta plus gamma (open window) measurements at waist level (approx. 3 feet or 1 meter) **AND** at 1 inch (2.5 cm) above the surface.

2. Record all data (be sure to include the height and whether the window was open/closed) on a digital platform or a paper Field Monitoring Log.
    a. Recording the data may be optional, if the survey is solely to determine whether the team is in an active plume in order to take further actions.
3. Interpret the results of the survey.
    - If the beta/gamma (open window) waist high measurement is significantly higher (normally 20%) than the closed window waist high measurement, this is an indication of immersion in an active plume. An air sample may be needed to accurately characterize the composition of the radioactive material in the plume (see Section 4.4 “Air Samples”).
    - If the beta/gamma (open window) measurement near the surface is significantly higher than the open window measurement at waist level, this indicates deposition of radioactive material on the ground. Because of an infinite plane geometry and extensive range of gamma radiation, it is possible that ground level and waist high gamma (closed window) measurements will be similar.
4. Periodically check personal dosimeters and notify Field Team Supervisor if readings exceed any hold points or turn-back levels.

3.7.2 Continuous Air Sampling Survey Guidance

The most effective method to determine if Airborne Radioactive Material is present is to collect an air sample and then analyze the filter for radioactivity. Air samples should be accompanied with exposure rate surveys and ground deposition surveys. Collecting these surveys in conjunction with an air sample could help in determining radionuclide resuspension values.

High volume air samples are generally collected for a grab sample of air that is typically used to determine responder or public safety at that moment in time. The FRMAC default air sample collection time for high volume air samplers is 10 minutes.

Low volume air samples are generally collected for longer periods of time and are typically used to determine radioactive material concentrations in air for public safety. A 24-hour collection time is typical, but depending on the event and radionuclide of interest, the collection time could vary.

See Section 4.4 “Air Samples” for the procedure for collecting air samples.

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4 SAMPLE COLLECTION

4.1 General Guidance

These are general guidelines for field sample collection. Sample collection procedures and sample sizes may be modified to address the specific needs of a mission. The procedures described in this section are intended to provide instructions regarding the collection of environmental samples to be analyzed for radiological contaminants following a contamination incident or emergency. These procedures are intended to address the sample collection needs during the initial response. Detailed sampling procedures must be developed as the incident moves from the initial response. The FRMAC Monitoring Manager provides directions on the maximum accepted activity on a sample that FRMAC Laboratory Analysis can process. This decision will be based on input from the FRMAC Assessment and Laboratory Analysis Divisions and from State and Local partners.

4.1.1 General Sample Collection Procedure

1. Prepare for field deployment as mentioned in Section 2.5.3 "Preparing Field Team for Field Activities."
2. Proceed to designated sampling locations as identified in the ICS 204FRMAC form.
3. Only bring the equipment necessary to complete sampling activities at the sample location. Leave other non-essential equipment in the vehicle.
4. At the sampling location, take ground measurements (i.e., exposure rate and contamination surveys), as directed.
5. At the sampling location, take a picture of the sample area, if possible, and upload the picture with the sample information on a digital platform.
6. Ensure disposable gloves are worn for sample collection, changed, and disposed of between samples.
7. After sample collection, perform an exposure rate survey on the sample container.
    a. It may be necessary to collect field samples and then move, to a low background area away from the plume, to conduct the exposure rate surveys on the sample containers.
8. Record all data on a digital platform or a paper Field Monitoring Log. Document any deviations from sampling protocol due to unforeseen problems or equipment failures incurred during the sample collection.

> **NOTE:** This step assumes that all appropriate metadata was collected and recorded for all surveys/samples such as: GPS location, instrument used, date and time of survey/sample, measurement value, proper units, name of person or team performing surveys and samples, etc.

9. Complete the applicable portions of the Sample Control Form and chain of custody.

> **NOTE:** A Sample Control Form and chain of custody accompanies each sample matrix. An Air Sample paper filter and cartridge are considered 2 samples. Samples must be uniquely identified and labeled.

10. Report status to Field Team Supervisor as directed.
11. Package and label the samples according to Section 6 "Sample Packaging and Labeling."

4.2 Equipment and Supplies

Equipment needed for sampling will vary with the mission. This is a suggested list of general equipment and supplies for a sample collection duffel bag and does not reflect all the material that may be needed. Certain Section 4 subsections will contain additional equipment needed to perform sampling.

Table 1. Suggested Sample Collection Tools

Soil Sampling Frame (Soil)	Plastic Bucket (Water)
Hammer, Claw (Soil)	Funnel (Water)
Spoon (Soil)	Nylon Rope (45 Ft) (Water)
Camp Shovel (Soil)	Clippers (Vegetation)
Pruning Shears (Vegetation)	Scissors (Vegetation)
Survey Instruments	GPS Unit
FRMAC tablet or paper Field Monitoring Log	Clipboard with sample control forms

Table 2. Suggested Supplies

Absorbent Towels (Maslin Cloths)	Pens, Ink, Marker, Pencil
Bags, Quart Sealable	Plastic Cling Wrap (Roll)
Bags, Gallon Sealable	Plastic Sheet / Drop Cloth
Bags, 36 x 54 Clear	Security Seals
Bags, 16 x 24 (Boot)	Tape, Duct
Cleaning Wipes or Decon Bottle	Tape, 2in Masking
Kimwipes	Tape, marked: Contaminated Material
Multi-Tool (Leatherman)	Plastic Containers 1 Gallon (3.5 Liter) or 1 Quart (1 Liter) (Milk/Water)*
Pre-printed barcode labels	Tape measure

* Sufficient volume is needed for laboratory analysis.

4.3 Duplicate Samples

A duplicate sample is a second sample which is approximately equal in mass or volume to the original sample and is collected in the same manner, location, and time, and analyzed for the same parameters. A split sample is a sample that is separated into two equal parts and placed in two separate containers. Duplicate samples are preferable to splitting the sample to ensure enough sample is available for analysis. Duplicate and Split samples are typically collected to document the overall precision of the sampling and analysis process. Collecting these samples is of secondary importance to limiting exposure of field teams to ionizing radiation and other safety considerations.

Field teams collect duplicate samples by direction of the Field Team Supervisor or Monitoring Manager. Each duplicate sample is collected, handled, packaged, and documented in the same manner as the original sample. Remarks on the Sample Control Form identify the sample as a duplicate and reference the original sample control number.

4.4 Air Samples

It is critical that the proper air sampling method and equipment is selected because the data obtained must be meaningful and accurate to assign radiological control measures adequately. Improper selection and use may incorrectly indicate a safe environment where an airborne radiological hazard exists or lead to unneeded actions where no hazard exists. To provide a representative background air concentration, Field Monitoring Teams should take air samples from normal, uncontaminated sampling locations in addition to other samples located in impacted and suspect areas.

There are several factors to consider when selecting an air sampling method.

- The environmental conditions in the area where the sample is to be obtained.
  - Humid conditions may preclude the use of some methods, such as paper filtration devices or charcoal canisters, because water vapor loading of the medium will change the collection efficiency and flow rate.
  - High temperature environments may cause some samplers to overheat if run for a long time.
  - Explosive gases may be present which could present an explosion hazard for samplers with electric motors not designed for such environments.
  - Dusty areas could cause excessive sample loading, which will reduce sampler flow rates and potentially overheat the sampler.
  - Corrosive environments may lead to the deterioration of the sampling device.
- The expected concentration level:
  - This will determine the sampling time and type of sampler required. Low-level concentrations will require large volumes to reduce statistical errors and meet minimum sensitivity levels of the analysis equipment. When large volume samples must be taken over a long time it is best to use samplers designed to run for long periods.
  - If immediate readout of information is needed, an initial screening can be performed in the field. If not, then samples may be taken and removed to a central analysis location.

- The physical state of the airborne contaminant:
  - The sampler and sample medium required is dependent upon whether the contaminant is gas, vapor, or aerosol.

4.4.1 General precautions

Weather conditions, such as dust, wind, rain and snow, can have a major impact on whether an air sample is representative of the actual environmental contamination levels. Filters can become completely clogged by dust, snow, or ice.

Assemble sampling equipment (air sampler filter/cassettes, etc.) before field team deployment to reduce the time spent in the field. Consider assembling extra sampling heads in case some sampling heads in the field need to be totally removed.

Be aware of weather conditions when retrieving a filter from an air sampler. If there is rain, snow, or wind consider removing the filter in a sheltered area to prevent dropping or losing the filter.

4.4.2 High Volume Air Samples

High Volume Air Samplers are generally considered to have a flow greater than 10 cubic feet per minute. High Volume Air Samplers will typically use either a filter paper or impactor. FRMAC will use a glass fiber filter paper unless otherwise directed.

Table 3. Special Equipment for High Volume Air Sampling

High Volume Air Sample Pump	Tripod
Glass Fiber Filter paper	Sampling head
Forceps	Bags, Gallon Sealable
Bags, Quart Sealable	Glassine Envelopes (if available)
Gloves, Disposable	Extension cord
AC generator and Fuel (only if A/C power is unavailable)	Fire Extinguisher (Required when using generator)

4.4.3 Low Volume Air Samples

Low Volume Air Samplers are considered to have a flow less than 10 cubic feet per minute. Low Volume samples can consist of filter paper alone or filter paper with a cartridge. Standard air sampling cartridges used by FRMAC are either charcoal (preferred) or silver impregnated zeolite. Charcoal is a TEDA (triethylene di-amine) impregnated carbon-filter media. It has a high affinity for the adsorption and retention of the various species of iodine. Silver impregnated zeolite cartridges contain a highly efficient inorganic adsorbent for the collection and removal of elemental and organic forms of radioactive iodine and have a low affinity for noble gases. Do not use a silver zeolite cartridge in an explosive environment.

Table 4. Special Equipment for Low Volume Air Sampling

Low-volume air sampler	Sampling head
Tripod or Connector hoses with Stake (to get air sampler to breathing height)	Forceps
Filter Paper	Cartridge*
Glassine Envelopes (if available)	Bags, Gallon Sealable
Bags, Quart Sealable	Gloves, Disposable
Fire Extinguisher (Required when using generator)	AC generator and Fuel (only if A/C power is unavailable)
Extension cord	

* Because of the high cost of silver zeolite cartridges, use charcoal cartridges for drills and exercises. Use silver zeolite cartridges (when directed) during actual radiological emergencies, as they retain fewer noble gases than charcoal cartridges.

4.4.4 Air Sampling Collection Procedure

1. Review the "Operator Aid FRMAC Air Sample Pump Staplex High Vol" and the "Operator Aid FRMAC Air Sample Pump F&J Low Volume" in Appendix D for an example of setup and use of the air samplers.
2. Inspect all equipment for:
   - Apparent physical damage.
   - Contamination, if equipment has been previously used.
3. If possible, assemble the equipment before field team deployment.
   a. Prepare sample heads in advance and place them in protective plastic bags.
4. Make sure the pump switch is in the off position.
5. Choose a location that is in an open area to collect a representative air sample.
   a. Do **NOT** sample under trees, bushes, or other overhanging objects.
   b. Avoid areas next to roads.
6. Perform an exposure or dose rate survey at a height of approximately 1 meter (3 feet) and a ground contamination survey at 2.5 cm (1 inch) above the ground. See sections 3.3.1, 3.4.1, and 3.5.1 for applicable survey instructions.
   a. Record the readings on a digital or paper Field Monitoring Log.
7. Install a filter paper into the sampling head assembly.
   a. Obtain a new, unused filter.
      i. Inspect the filter for physical damage. If damaged, then obtain a new filter.
      ii. If you are unable to identify front and back of filter paper, write an "X" in the edge of the filter paper under the retaining ring. The "X" indicates the front of the filter (the rough inlet side). Be sure to specify this on the sample information.
   b. Remove the particulate filter retaining ring. Using forceps, center the new filter in the holder.

   i. Touch the filter as little as possible.
   ii. Glass fiber filters should be installed "rough side out" for air sample collection.

c. Reinstall the retaining ring, tightening it finger-tight to produce a proper seal.
   i. Ensure that the filter remains centered in assembly.

> **NOTE:** Over-tightening the retaining ring may tear the filter.

8. If a cartridge is to be used, obtain a new, unused cartridge.

> **NOTE:** Silver zeolite is used for radioiodine sampling to support a Nuclear Power Plant incident. A charcoal cartridge is used for any other sampling conditions including exercises, or as otherwise specified.

   a. Remove the cartridge retaining assembly.
   b. Ensure that the airflow direction indicated on the cartridge and the sampler airflow match.
      i. Note the direction of flow indicated on the cartridge in assembly. The arrow on the cartridge should point toward the sampler.
   c. Reinstall the retaining ring, tightening it finger-tight to produce the proper seal.
9. Setup the Tripod and position the sampler considering the following:
   a. Locate the Sample Head off the ground, approximately 1.5 meters (5 feet). This is to sample at a height of a standard breathing zone.
   b. If the pump is too heavy or does not have a tripod, then place the pump on a clean flat surface away from the generator or vehicle exhaust gases, dust, dirt, and known surface contaminants.
   c. Locate the air sampler in an area with unrestricted airflow.
10. Connect the sample head assembly to the sampler.
    a. Tighten finger-tight to produce proper seal.
11. Start one Sample Control Form for the filter paper and a separate Sample Control Form for the cartridge.
    a. Record the sample location, sampler number and other information on a Sample Control Form. Start the Air Sample Pump.
    b. Determine the initial flow rate on the rotameter and record the start date, start time and flow rate on the Sample Control Form for the filter paper and one for the cartridge.
12. Run the sampler for the time directed by the ICS 204FRMAC form.
13. If the sampler is left unattended for an extended time, place all forms in a sealed plastic bag and attach or secure the bag to the sampler.
14. Prior to turning the sampler off, determine the ending flow rate.
15. Stop the Air Sampler Pump.

16. Record the ending flow rate, stop date, stop time and note abnormalities such as the condition of the filter paper or local weather conditions on the Sample Control Form or digital sample record.
17. Perform a survey of the filter paper, if required.

> **NOTE:** Field personnel may be instructed to survey immediately and report. This step is best performed in a low background area.

    a. Take the contact dose rate of the filter.
    b. Take a measurement of the gross total activity (cpm) of the filter or the gross alpha and gross beta activity (cpm) if possible.
    c. Record all data on a digital or paper Field Monitoring Log.
    d. Report all results to Field Team Supervisor, as instructed.
18. To remove the filter paper:
    a. Put on disposable gloves.
    b. Use the bar code label or write the sample control number on sealable plastic bag using an indelible ink pen.
    c. Remove the filter paper carefully using forceps.
        i. If excessive dust or snow is on the filter paper, fold upwards in half with the collection side in.
        ii. If unable to remove the filter paper, then bag the sampling head and seek help to remove the filter paper at the hotline.
    d. Place the filter paper in a glassine envelope if available.
    e. Place the filter paper in a sealable plastic bag. Seal the bag. Do not tear or cut the filter paper.
19. To remove the cartridge:
    a. Put on disposable gloves.
    b. Use the bar code label or write the sample control number on a sealable plastic bag using an indelible ink pen.
    c. Remove the cartridge carefully.
    d. Place the cartridge in a sealable plastic bag and then seal the bag.
20. Complete the Sample Control Form or digital sample record.
21. Prepare the sample for transport to Sample Control in accordance with Section 6 "Sample Packaging and Labeling."

4.4.5 Air Sample Pump Power Considerations and Precautions

Air Sample Pumps can be powered from a variety of power sources, and each has its pros and cons. When selecting the sample pump, consider what power is available at the sample collection locations. Consider the following when choosing the sample pump and sample location. An electrical outlet may not be available or close, and a battery-powered sampler or portable generator may be required. Close spaces or passages may preclude the use of movable ECAMs (Environmental Continuous Air Monitor) or heavy samplers.

4.4.5.1 AC Line Power

- AC power Air Sample pumps, powered by fixed line, can run almost indefinitely without the need for constant monitoring of energy source as in battery and electric generator powered samplers. AC powered fixed line pumps can also collect at a higher flow rate.
- The problem is finding an available outlet in the location you would like to collect your sample is often difficult.

If AC line power is unavailable then consider a generator.

4.4.5.2 AC powered Air Sample Pumps

- AC powered Air Sample Pumps are the most durable and easiest to operate.
- Use a GFI Surge protector between the pump and the outlet if the outlet does not have a built-in GFI feature.
- When possible, locate the Air Sampler at a Police or Fire Station as this is more secure if the sample runs for an extended period.
    - When extension cords are used:
    - Care should be taken not to exceed the load capacity of the cord and circuit panel.
    - Ensure plugs stay dry.
    - Ensure the power cord does not create a tripping hazard.
    - Run the power cord to avoid vehicle traffic.

4.4.5.3 Generator Supplied AC Power

Before departure, learn how to setup and operate the generator and use all the generator controls, output receptacles, and connections. Ask questions if needed. When checking out a generator, keep a fire extinguisher close by in case of emergency.

- Generators are not to be used indoors, in partially enclosed locations, or at outdoor locations close to doors, windows, or vents (to prevent exhaust from entering buildings).

CAUTION:
Exhaust contains poisonous carbon monoxide, a colorless and odorless gas. Breathing exhaust can cause loss of consciousness and may lead to death.

- When using a generator or electrical appliance in wet conditions such as rain or snow, or near a pool or sprinkler system, keep the generator dry. This can be done by placing it under a canopy.

CAUTION:

Do NOT cover the generator with a tarp (fire hazard).

- Allow the generator to cool before moving into a vehicle or indoors.

CAUTION:

The exhaust system gets hot enough to ignite some material. Keep flammable and combustible material away from the generator.

- If a generator and gas can need to be transported inside a vehicle, ensure that the generator has cooled down and is isolated from flammable and combustible materials within the vehicle. Ensure the windows are open for ventilation.
- For generators placed in outdoor areas, use a GFI Surge protector between the pump and generator when possible, to prevent shock/fires.
- If the generator is stored outdoors, unprotected from the weather, check all electrical components on the control panel before each use.
- Position the generator far enough away from the sampler and downwind so that exhaust fumes are not picked up by the sampler.

4.4.5.4 Internal DC Battery

Some types of Air Sampler Pumps have an internal DC battery. This type of pump gives you the flexibility to collect the sample where you would like, without the (AC) power line restrictions.

Drawbacks:

- Limited battery run time (depends on battery life)
- Lower flow rate
- Battery will need to recharge after long collection times
- Weight of the unit is typically heavier than other samplers.

4.4.5.5 Battery Power from the Vehicle

CAUTION:

Batteries pose an electrocution hazard.

Automotive batteries produce explosive hydrogen gas. Use caution when attaching cable clamps to the battery to avoid sparks. Make sure the operating switch on the sampler is in the off position while attaching cables to the battery.

- Air Sample pumps that connect to the vehicle DC power outlet or DC jumper cables attached to a vehicle battery are suitable for quick grab samples.
- Keep the engine running during this procedure to ensure even voltage to the sampler and to avoid running down the car battery.
- Ensure the exhaust is downwind of the Air Sample pump.
- First, attach the ground cable to a metal object in the engine compartment, not directly to the negative terminal.
- Then connect the positive (hot) cable to the positive (hot) terminal on the battery.

4.5 Soil Samples

This section addresses the collection of different types of soil under varying conditions. The three types of soil samples discussed in this section are: ground deposition samples, standard soil samples, and core soil samples.

4.5.1 General Guidance

During the early phase of the response, ground deposition samples should be collected. During the intermediate and late phase of the response, standard soil samples should be collected with a provision to collect core soil samples to determine a contamination depth profile. Soil sampling in conjunction with *in situ* HPGe measurements assist in data assessment.

It is important to carefully control the surface area and depth of the ground deposition sample. FRMAC field teams use a soil sampling frame when collecting ground deposition and standard soil samples. This sampling frame ensures that each soil sample has a consistent surface area (10 x 10 cm) and depth (2 cm). When the contamination has weathered into the soil at a depth greater than 2 cm, then consider using a modified method to obtain soil samples with the sampling frame or implement core soil sampling. The soil sampling procedure should be reviewed and modified, as necessary, to fit the needs of the response.

4.5.1.1 Sample Selection

To collect a representative soil sample, choose soil that is relatively dry and is in a flat, open area. Do not sample under trees, bushes, or other overhanging objects. Avoid wind rows or areas next to roads.

Table 5. Special Equipment for Soil Sampling

Sampling frame, 10 x 10 x 2 cm	Flat Trowel
Hammer, (if soil is compacted)	Spoon, (if sandy or wet)
Gallon Size sealable bags	Work gloves
Sample Control form	Shovel
Scissors/shears	

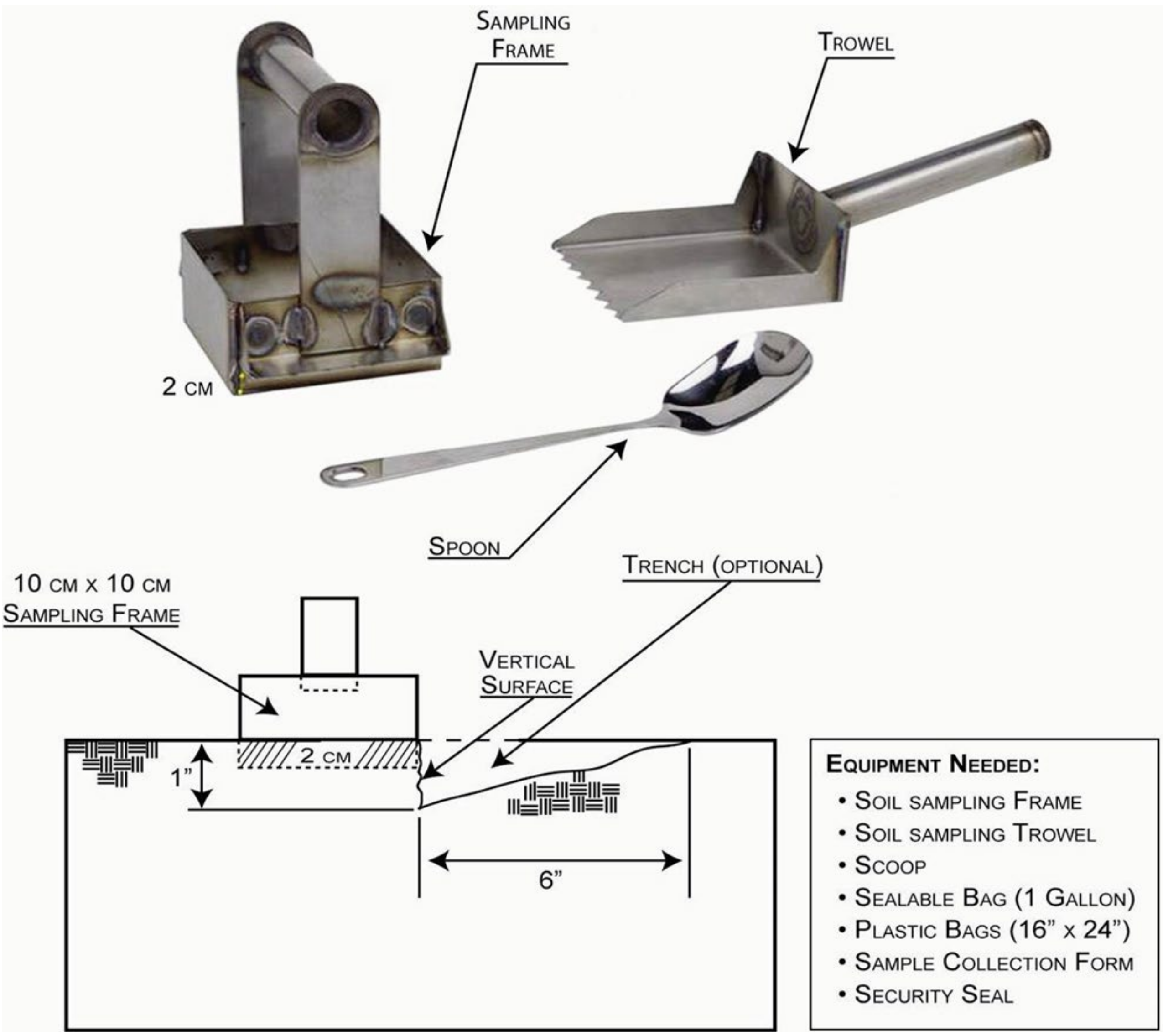

Figure 4. Sample Frame

4.5.2 Ground Deposition Sample

In the early phase, ground deposition samples are collected to estimate total surface deposition (radioactivity per unit area). Ground deposition samples are taken during the initial stage of the response with the assumption that the contamination resides primarily on the ground surface and has had no or very minimal weathering or leaching into the soil. This type of soil sample includes soil, any vegetation, rocks, sticks, and other vegetative debris located directly above the soil.

Refer to Section 4.5.1 "General Guidance" for an equipment list and soil sampling information.

4.5.2.1 Procedure

1. Review the "Operator Aid FRMAC Ground Deposition Sample" in Appendix D for an example of the process.
2. Go to the sample location as indicated on the ICS 204FRMAC.
3. Choose an undisturbed, relatively level, open area away from vehicles, buildings, roads, heavy traffic areas (paths), tree canopies, excavated areas, and piled rocks, gravel, or soil. If possible collect the sample at least 10 feet from the side of the road.
4. Because vegetation, rocks, sticks, and other debris on top of the soil are collected with the soil, choose a location that has a vegetation height less than 6 inches, if possible.
5. Prepare to take the sample.
   a. Place all sampling tools and the Sample Control Form into a plastic bag to carry to sample location.
   b. To avoid contamination, place plastic sheeting on the ground; lay the clipboard, instruments, and tools on the sheeting.
   c. On the Sample Control Form, record the GPS reading, location, time, date, and other descriptive information.
   d. Put on work gloves over disposable gloves.
   e. Perform an exposure or dose rate survey at a height of approximately 1 meter (3 feet) and a ground contamination survey at 2.5 cm (1 inch) above the ground. See sections 3.3.1, 3.4.1, and 3.5.1 for applicable survey instructions.
   f. Record the survey results on a digital or paper Field Monitoring Log.
   g. Use a bar code label or indelible ink pen to record the sample control number on the gallon size sealable bag.
6. Place the open end of the sampling frame (see Figure 4) in the center of the sample area to form a 10 x 10-cm (4 x 4-in) square sample area. Press or tap the cutter edge into the soil to the stops (2 cm deep).
7. Using a trowel, dig a trench large enough to slide the trowel under the sample.
   a. Be careful not to disturb the sample collection area while digging the trench.
   b. Use the claw part of the hammer or shovel to loosen the soil as needed.
   c. Dig a trench about 30 cm long x 15 cm wide x 4 cm deep (12 x 6 x 1.5 in).
   d. Fashion a vertical surface that is as straight as possible, as seen in Figure 4.
8. Slide the flat trowel under the sampling frame.

   a. If needed, tap the handle of the trowel to push the trowel under the frame.

9. Lift the trowel, frame, and sample and then slowly deposit the soil and associated vegetation into a sealable bag.
10. Record the applicable data on the Sample Control Form.
11. Record all pertinent data on a digital platform or paper Field Monitoring Log.
12. Clean the sampling equipment with cleaning wipes or water. If unable to clean the equipment in the field, place the equipment in a plastic bag and deliver to the hotline for decontamination.
13. Package and label the sample in accordance with Section 6 "Sample Packaging and Labeling."

4.5.3 Standard Soil Sample

Standard soil samples can be collected at any time during the response to assess the radioactive concentration in the soil (radioactivity per unit mass). These soil samples are the traditional soil samples that laboratories are accustomed to receiving and analyzing. Typically, these soil samples are void (as much as possible) of vegetation, debris, and rocks. If the area to be sampled is covered with vegetation, leaves, etc., a decision must be made by FRMAC management on whether the debris will be removed and discarded or to treat that portion as a separate vegetation sample.

4.5.3.1 Procedure

1. Review the "Operator Aid FRMAC Standard Soil Sample" in Appendix D for an example of the process.
2. Go to the sample location as indicated on the ICS 204FRMAC.
3. Choose an undisturbed, relatively level, open area away from vehicles, buildings, roads, heavy traffic areas (paths), tree canopies, excavated areas, and piled rocks, gravel, or soil. If possible collect the sample at least 10 feet from the side of the road.
4. Prepare to take the sample.
   a. Place all sampling tools and the Sample Control Form into a plastic bag to carry to sample location.
   b. To avoid contamination, place plastic sheeting on the ground; lay the clipboard, instruments, and tools on the sheeting.
   c. On the Sample Control Form, record the GPS reading, location, time, date, and other descriptive information.
   d. Put on work gloves over disposable gloves.
   e. Perform an exposure or dose rate survey at a height of approximately 1 meter (3 feet) and a ground contamination survey at 2.5 cm (1 inch) above the ground. See sections 3.3.1, 3.4.1, and 3.5.1 for applicable survey instructions.
   f. Record the survey results on a digital or paper Field Monitoring Log.
   g. Use a bar code label or indelible ink pen to record the sample control number on the gallon size sealable bag.
5. If it is determined that the vegetation was not necessary to be collected, then:

   a. Remove the vegetation from the surface, cutting vegetation as closely as possible to the soil layer, being careful not to scrape or sweep the soil surface.
   b. Discard the vegetation away from the soil sampling area.
6. If it is determined that the vegetation is necessary to be collected, then collect the vegetation according to Section 4.7 “Vegetation Samples.”
   a. Remove and collect all ground cover vegetation, cutting vegetation as closely as possible to the soil layer, minimizing disturbance of soil.
   b. Do not scrape or sweep the surface of the ground when collecting vegetation.
   c. On the Sample Control Form, check the box saying Vegetation was collected with the soil sample, and cross-reference sample control numbers of these co-collected samples.
7. Place the open end of the sampling frame (Figure 4) in the center of the vegetation free sample area to form a 10 x 10-cm (4 x 4-in) square sample area. Press or tap the cutter edge into the soil to the stops (2 cm deep).
8. Using a trowel, dig a trench large enough to slide the trowel under the sample.
   a. Be careful not to disturb the sample collection area while digging the trench.
   b. Use the claw part of the hammer or shovel to loosen the soil as needed.
   c. Dig a trench about 30 cm long x 15 cm wide x 4 cm deep (12 x 6 x 1.5 in).
   d. Fashion a vertical surface that is as straight as possible, as seen in Figure 4.
9. Slide the flat trowel under the sampling frame.
   a. If needed, tap the handle of the trowel to push the trowel under the frame.
10. Lift the trowel, frame, and sample and then slowly deposit the soil into a sealable bag.
11. Record the applicable data on the Sample Control Form.
12. Record all pertinent data on a digital platform or paper Field Monitoring Log.
13. Clean the sampling equipment with cleaning wipes or water. If unable to clean the equipment in the field, place the equipment in a plastic bag and deliver to the hotline for decontamination.
14. Package and label the sample(s) in accordance with Section 6 "Sample Packaging and Labeling.”

4.5.4 Soil Sample Variations

Conditions in the field are not always ideal to collect soil samples. If a field team encounters non-ideal conditions while collecting a ground deposition sample or standard soil sample, here are some examples of soil sampling variations that could be implemented.

- Dry or Sandy Soil
  - Unconsolidated or sandy soil (that is extremely dry and not cohesive) should be sampled carefully without digging a trench next to the area. Collect the soil by carefully lifting the surface area off the measured plot using a spoon.
- Wet Soil
  - If rain and water saturation make it impossible to dig next to the collection area, attempt to remove the surface layer of the collection area with a spoon.

- Soil Sampling under Snow
  - If snow has fallen after the suspected time of deposition, gently remove as much snow as possible from the collection area and take the sample.
  - If snow fell before deposition occurred, collect the snow (see Section 4.6.5 “Snow Collection”) then take a soil sample. Record the sample control number of the co-collected sample on the Sample Control Form.

4.5.5 Core Soil Sample

Core soil samples are soil samples taken at various depths to create a contamination depth profile. The depth of sampling will be dependent on the elapsed time since deposition, the porosity of the soil and any potential interaction with precipitation or run off. Depths of 5-8 cm typically provide good data for determination of a contamination profile with depth, however soils with high porosity can facilitate a pathway for contamination at deeper depths. FRMAC does not deploy with core soil sampling equipment, however, coordinating agencies could provide equipment. Selection of sampling equipment depend on the soil type, moisture content, compaction, groundcover, and the size of the required sample. Equipment used to perform core soil samples may include an auger or shovel for bulk samples, and open trenching or split barrel sampler for discreet samples at depth. There is not currently a standard FRMAC method for obtaining core soil samples. As core soil samples could be useful in the latter part of the intermediate phase and the late phase, FRMAC will coordinate with states and local agencies and other applicable agencies on proper core sampling methodologies based on existing field conditions.

4.5.6 Sediment

Radioactive material from an incident can be deposited in the sediment on the bottom of a river, lake, pond or other body of water. Physical samples of these sediments can provide information on contaminant levels within these environments. Sediment sampling techniques utilized will depend on the type of fluvial environment of interest; turbulent or laminar flow, depth of water body, salinity gradients and sediment characteristics.

Grab sampling using a scoop or dredge is a common technique used to examine the surface sediment (approximately 10-15 cm deep). Commonly the first 15 cm of sediment are utilized to determine extent of contamination. Different grab samples are collected depending upon the type of substrate being sampled (soft or hard) and the size of the sample required.

Sediment corers are another method for obtaining sediment samples. Cores provide a vertical cross-section of the sediment column but can also function as a grab sampler. There are several different techniques for sediment coring including piston corers, hand corers, gravity corers, vibracorers, and freeze corers. Depending on the coring technique that is used, cores can vary in length from 10 cm - 6 m. The type of corer used will depend on the radionuclides present on substrate material, depth of interest, and volume of material required.

FRMAC does not deploy with sophisticated sediment sampling equipment. There is not currently a standard FRMAC method for obtaining sediment samples. Detailed sediment sampling procedures specific to each body of water will need to be developed with input from the state and local agencies for each incident.

4.6 Water Samples

This section addresses the collection of different types of water samples. The types of water samples discussed in this section are: well water, surface water, rain water, snow, and water treatment plant.

4.6.1 General Guidance

During the early phase of the response, water sampling should be focused on potable water to determine possible doses to the public from ingestion. As the response progresses, other water samples may be collected to determine the possible doses from indirect ingestion (example: eating meat from a cow that drinks contaminated water).

Table 6. Special Equipment for Water Sampling

Absorbent towels	Plastic funnel
Bucket/Collection container	Rope
Plastic Bags	Disposable gloves
Clean drinking water, distilled, or deionized water (for rinsing equipment)	Electrical Tape
Plastic Containers 1 Gallon (3.5 Liter) or 1 Quart (1 Liter)*	

* Sufficient volume is needed for laboratory analysis

4.6.1.1 Sample Selection

Water samples must be representative of the body of water the FRMAC is trying to analyze. When sampling in strong rain, wind, hail, etc., the body of water may become churned up to a point where material from the sedimentary layers becomes suspended in large quantities. This material can bias the "true" activity concentrations of the various radionuclides dissolved or suspended in the sample. Choose a location with minimal turbidity and little or no vegetative debris.

4.6.2 Well Water for Public Drinking

Use this procedure for both potable and non-potable wells that bring water to the surface using either submersible or surface pumps.

4.6.2.1 Sample Site Selection

Obtain water directly from manned wells, pumped wells, or abandoned wells and inlet/outlet areas of water treatment plants.

4.6.2.2 Procedure

1. Review the “Operator Aid FRMAC Early Phase Water Sample (Tap)” in Appendix D for an example of the process.
2. Prepare to take a sample.
   a. Place all sampling tools and the Sample Control Form into a plastic bag to carry to sample location.
   b. To avoid contamination, place plastic sheeting on the ground; lay the clipboard, instruments, and tools on the sheeting.
   c. Perform an exposure or dose rate survey at a height of approximately 1 meter (3 feet) and a ground contamination survey at 2.5 cm (1 inch) above the ground at a land location near the water sample collection area. See sections 3.3.1, 3.4.1, and 3.5.1 for applicable survey instructions.
   d. Record the survey results on a digital or paper Field Monitoring Log.
   e. On a Sample Control Form, record the GPS reading, location, time, date, and other information. Include a description of the well depth, if known, and other pertinent information such as “capped”, etc.
   f. Use a bar code label or indelible ink pen to record the sample control number on the collection container.
3. Locate the tap nearest the pump.
4. Turn on the pump and/or open the tap. Allow the water to purge for one minute (40-foot well) or longer to allow for collection of a representative sample.

> **NOTE:** EPA requires a minimum 3 x displacement for well purging.

5. Use the funnel, if necessary, to put small amounts of deionized or distilled water into the sample container, rinse, and discard water. Rinse the cap also. Dry the outside of the container if it becomes wet.

> **NOTE:** This is to remove any contaminants left in the container during manufacturing.

6. Fill the sample container. Approximately 3.5 liters (1 gallon) is usually needed for gamma analysis, so the sample container should be nearly full. Remove the funnel and cap all containers.
7. Turn off the faucet and/or well.
8. Decontaminate the funnel with cleaning wipes or clean water and place in a plastic bag. Decontaminate the exterior of the sample container with disinfectant wipes or clean water. Dry the exterior of the sample container with an absorbent towel.
9. Seal the cap of the water container with three turns of electrical tape across the lid and container itself to prevent leaks. Wrap tape around the cap and leave a tab at the end of the tape for easy removal in the future.

10. Complete the Sample Control Form or complete the digital sample record.
11. Package and label the sample in accordance with Section 6 "Sample Packaging and Labeling."

4.6.3 Surface Water for Public Drinking

Surface water refers to lakes, ponds, streams, rivers, etc. This procedure only applies to the Early Phase and when the contamination is on the surface of the water. Water sampling at depths and in sediments require specific procedures to be developed.

> **SAFETY:** Use proper safety equipment around bodies of water such as a personal flotation devices or rope and harness, etc.

4.6.3.1 Sample Site Selection

Consider the purpose of sampling when selecting a location; i.e., intake for drinking water, areas of access for farm animals or wildlife drinking water supplies. Operating from bridges, docks, or boats is the ideal method to facilitate open-water collections.

- Choose an area that is open, not sheltered by trees or high brush, if possible.
- When a lake or reservoir is sampled, the sample should represent water that makes up the largest portion of reservoir.
- Inlet and outlet areas of water treatment plants may both need to be sampled. Samples from still water areas may also be required.
- Take samples from midstream, if possible.

A goal in water sampling is to avoid stirring up sediment and other debris so it is not included in the sample.

- Avoid areas where surface debris could inhibit sampling. Avoid areas of high turbidity or high sediment, if possible.
- Take sample as close to the surface as possible.
- Sampling buckets should not be allowed to sink to the bottom to avoid collecting sediment.

4.6.3.2 Procedure

1. Review the "Operator Aid FRMAC Early Phase Water Sample" in Appendix D for an example of the process.
2. Prepare to take a sample.
    a. Place all sampling tools and the Sample Control Form into a plastic bag to carry to the sample location.
    b. To avoid contamination, place plastic sheeting on the ground; lay the clipboard, instruments, and tools on the sheeting.
    c. Perform an exposure or dose rate survey at a height of approximately 1 meter (3 feet) and a ground contamination survey at 2.5 cm (1 inch) above the ground at a land

location near the water sample collection area. See sections 3.3.1, 3.4.1, and 3.5.1 for applicable survey instructions.

   d. Record the survey results on a digital or paper Field Monitoring Log.
   e. On a Sample Control Form, record the GPS reading, location, time, date, and other descriptive information.
   f. Use a bar code label or indelible ink pen to record the sample control number on the collection container.

3. If the funnel and bucket have been previously used, they should be as clean as reasonably achievable.
4. Use the funnel, if necessary, to put small amounts of deionized or distilled water into the sample container, rinse, and discard water. Rinse the cap also. Dry the outside of the container if it becomes wet.

> **NOTE:** This is to remove any contaminants left in the container during manufacturing.

5. Set the sample container in a stable location on the ground with the funnel inserted in the opening. Stand downstream of bridges or structures.
6. Don work gloves over disposable gloves.
7. Lower the bucket into the main channel of stream, using care not to disturb sediments and aquatic vegetation.
8. Collect a bucket of water and pour it into the sample container until the water in container is within 2 cm (1 in) from the top.
9. Decontaminate the funnel with cleaning wipes or clean water and place in a plastic bag. Decontaminate the exterior of the sample container with cleaning wipes or clean water. Dry the exterior of the sample container with an absorbent towel.
10. Seal the cap of the water container with three turns of electrical tape across the lid and container itself to prevent leaks. Wrap tape around the cap and leave a tab at the end of the tape for easy removal in the future.
11. Complete the Sample Control Form or complete the digital sample record.
12. Package and label the sample in accordance with Section 6 “Sample Packaging and Labeling.”

4.6.4 Rain Collection System

This procedure is for placement and use of a rain collection system, not for the collection of rainwater from puddles or standing on rooftops.

Rainwater sampling can be complicated by freezing or strong snowstorms, which tend to clog the rainwater collection apparatus. If snow is present on the collector, collect it along with the water sample and try to melt some of the snow before pouring the water into a collection container. Keep in mind that snow has a very low water density (so take a large sample which may be required for laboratory analysis).

Table 7. Special Equipment for Rain Collection

Sheet of plastic	4 stakes
Bucket, 5 gallons (~20 liters)	String
Graduated cylinder (at least 1 Liter [1 Quart])	Plastic bags
a weight	Ruler/Tape Measure
Funnel	
Plastic Containers 1 Gallon (3.5 Liter) or 1 Quart (1 Liter)*	

* Sufficient volume is needed for laboratory analysis

4.6.4.1 Building a Makeshift Rain Collection System

This system will not stand up well to heavy rain, wind, or snow, but in an emergency, it is simple to set up and move.

1. It is necessary to know the finished surface area of the plastic.
2. Cut a plastic sheet to the predetermined size. Tie each corner to a stake that will hold it 5-8 cm (2-3 inches) above the 5-gallon bucket when the stakes are driven in the ground and the plastic is stretched out like a canopy.
3. Cut a small slit in the center of the plastic and center the bucket under the hole.
4. Place the weight over the slit. Ensure the weight does not cover the slit. The weight provides a slight downward slant to the plastic. The rainwater will run into the bucket in this depressed area of the plastic.

4.6.4.2 Procedure

1. Choose an area that is open, not sheltered by buildings, trees, or high brush, when possible.
2. Assemble the rain collection system at the desired location. Find a location where leaves or other debris cannot blow into it and clog the drain. In addition, make sure the collection system is anchored securely so high winds will not overturn it. Be aware that samples may have to be collected in freezing or near-freezing conditions.
3. Note on the Sample Control Form the date and time when the rain collection system was set up.
4. When returning to collect the rain sample, survey with a beta/gamma survey instrument, if applicable.
5. Prepare to take a sample.
   a. On the Sample Control Form, record the GPS reading, location, start time, stop time, start date, stop date and other descriptive information.
   b. Use a bar code label or indelible ink pen to record the sample control number on the collection container.
6. Measure the precipitation.
   a. Transfer the rainwater to a graduated cylinder directly, if possible.

b. Measure the amount of water with a graduated cylinder. Record the volume on the Sample Control Form.

7. Collect the sample.
   a. To pre-rinse the sample container, use a funnel, if necessary, and put a small amount of deionized or distilled water into the sample container, swirl it around, and discard it. Be sure to rinse cap. Try not to wet the outside of the sample container.

> **NOTE:** This is to remove any contaminants left in the container during manufacturing.

   b. Carefully fill the sample container. Sufficient volume is needed for laboratory analysis, so the sample container should be nearly filled, where possible. If the sample is not large enough to fill the container, record the total volume as a comment.
   c. Remove funnel and cap all containers.
8. Rinse and decontaminate rainwater collection system with cleaning wipes or clean water before leaving. Include both the catch basin (plastic sheeting) and the rain collection jug (bucket).
9. Decontaminate the funnel with cleaning wipes or clean water and place in a plastic bag. Decontaminate the exterior of the sample container with cleaning wipes or clean water. Dry the exterior of the sample container with an absorbent towel.
10. Seal the cap of the water container with three turns of electrical tape across the lid and container itself to prevent leaks. Wrap tape around the cap and leave a tab at the end of the tape for easy removal in the future.
11. Complete the Sample Control Form or complete the digital sample record. Record all special rainwater information (collection area, start time, stop time) in the comment field on the form.
12. Package and label the sample in accordance with Section 6 “Sample Packaging and Labeling.”

4.6.5 Snow Collection

During an incident, if the plume passed over an area covered in snow, then water samples collected from the snow may be needed.

4.6.5.1 Sample Site Selection

Snow samples should be collected in an area free from disturbance (trees, shrubs, buildings, etc.). When taking a snow sample, try to collect a sample from pre-incident depths. Document the surface area. Avoid areas of drifting and scouring.

Table 8. Special Equipment for Snow Collection

Ruler / Tape Measure	Trowel
One-gallon plastic bucket with lid	Graduated Cylinder
Plastic bags for bucket	Funnel
Sample Collection Forms	Absorbent Towel
Plastic Containers 1 Gallon (3.5 Liter) or 1 Quart (1 Liter)*	

* Sufficient volume is needed for laboratory analysis

4.6.5.2 Procedure

1. Prepare to take a sample.
    a. Place all sampling tools and the Sample Control Form into a plastic bag to carry to sample location.
    b. To avoid contamination, place plastic sheeting on the ground; lay the clipboard, instruments, and tools on the sheeting.
    c. Perform an exposure or dose rate survey at a height of approximately 1 meter (3 feet) and a ground contamination survey at 2.5 cm (1 inch) above the ground at the sample collection location. See sections 3.3.1, 3.4.1, and 3.5.1 for applicable survey instructions.
    d. Record the survey results on a digital or paper Field Monitoring Log.
    e. On a Sample Control Form, record the GPS reading, location, time, date, and other descriptive information.
    f. Use a bar code label or indelible ink pen to record the sample control number on the collection container.
2. Using a ruler or tape measure and trowel, outline an area one foot by one foot by 2 inches deep (one square foot). This will give you approximately one gallon of snow.
3. Using a trowel, scoop snow approximately two inches deep from the one-foot grid into a plastic bucket.
4. Complete Sample Control Form and affix label and Security Seal to plastic bucket.
5. Decontaminate the bucket with cleaning wipes or clean water. Dry the exterior of the sample container with an absorbent towel.
6. Place the bucket and the copy of the Sample Control Form inside plastic bag and seal.
7. Rinse and dry any equipment used to collect the sample (e.g., trowel).
8. Transfer the melted snow into a graduated cylinder.
9. As the snow melts, pour the water into a graduated cylinder using the funnel to determine the volume.

NOTE: The laboratory may require the sample to be transferred from a bucket to a smaller container. This may occur at the hotline by Sample Control personnel.

10. Using a funnel, if necessary, put a small amount of deionized or distilled water into the sample container, rinse, and discard the water. Rinse the cap also.

> **NOTE:** This is to remove any contaminants left in the container during manufacturing.

   a. Dry the outside of the container with an absorbent towel.

11. Using the Funnel, pour the melted snow (water) into a container.
12. Decontaminate the sample container with cleaning wipes or clean water. Dry the outside of the container with an absorbent towel.
13. Package and label the sample in accordance with Section 6 “Sample Packaging and Labeling.”

4.6.6 Water Treatment Plant

Water treatment plants are responsible for purifying water to acceptable drinking water standards. Samples are taken regularly to verify standards are being met. FRMAC will not perform sampling at water treatment plants, but rather ask the plant for a water sample at the intake and the outlet. Intake samples will represent the quality of water before being treated while the outlet samples will represent the quality of water that is being dispersed for public use. These samples will be collected by water treatment plant personnel and mimic the standard regulatory samples they already produce. The only difference may be the requested volume of the sample (depending on laboratory analysis needs).

4.7 Vegetation Samples

Vegetation sampling will occur in each phase of the response. During the early phase, vegetation will be sampled to determine radioactivity levels of food that is ready for commerce. This also includes sampling pastures for cattle or other animals. During the intermediate phase, sampling of vegetation for commerce will continue, and in addition, sampling will also be performed for immature produce to help predict acceptability of the produce for commerce.

4.7.1 General Guidance

Samples may be taken from the side of the road, at farms, roadside stands, “pick your own” operations, orchards, retail stores and family gardens. Specific sampling locations are selected during the operational planning process and rely heavily on input from the state and local agencies. Personnel from supporting state or county agencies, the U.S. Department of Agriculture, or the U. S. Department of Health and Human Services will normally be present at the FRMAC to provide assistance and direction with choosing sample matrices and locations. When possible, use state trained personnel and procedures on sample collection teams.

Table 9. Special Equipment for Vegetation Sampling

Ruler / Tape Measure	Pruning Shears
Grass Clippers	Scissors
*Mechanical cutters/Harvesters	Gallon size sealable bags
Work gloves	

* Use of mechanical harvesters is encouraged to collect samples when practical. Manual collection of enough wheat or rice, for example, to make an appropriate size sample might be too time consuming.

4.7.1.1 Sample Site Selection

Sampling sites should be representative of the region of interest. The area should have a relatively uniform distribution of the vegetation of interest. In general, sample sites should be:

- Flat, open, and unprotected from the wind whenever possible i.e., away from trees, structures, overhanging objects, etc.
- Easily sampled—free of large rocks, trees, and other interference.
- Away from windrows or roads.

4.7.2 Early Phase Vegetation Sampling

The purpose of vegetation sampling during the early phase is to measure deposition, not plant uptake.

4.7.2.1 General Guidance

Collect vegetation samples from the same type plant, preferably a leafy, grassy type of vegetation, if available. Collect only the top portions of the plant, not the roots or stems.

In almost all radiation emergencies, leafy vegetables retain airborne contamination and may be a health problem if consumed. It is important to collect the vegetables and any moisture that may be on them, whether frozen or not.

The two major types of samples collected during the early phase are:

1. Food crops (market ready): This is food directly ingested by humans. Market ready samples come from farms, roadside stands or gardens. Market ready samples should be consistent with respect to readiness for harvest. Either the crop is already ripe or will be ripe and ready for harvest soon. The crop may be selected directly from plants or from crates. A notation should be made on the physical state of the sample.
2. Feed crops (indirect ingestion): These crops are hays and grains that will be consumed by animals and subsequently humans will consume the animals or animal byproducts. This procedure also applies to standing grains (wheat, rye, barley, buckwheat, oats, and soybeans) and standing hay. All are categorized as pasture deposition measurements. Samples may be taken from unsheltered baled or stacked hay or stored feed if these are being used as feed for animals.

Collect:

- Grab samples of each type of feed where animals may be feeding.
- Samples from the same type of plant, preferably grassy type of vegetation (if available).
- Samples of the green or leafy portions of the plant, not roots and stems. Avoid collecting weeds.

4.7.2.2 Procedure

1. Review the "Operator Aid FRMAC Early Phase Vegetation Sample" in Appendix D for an example of the process.
2. Prepare to take sample.
    a. Place all sampling tools and Sample Control Forms into a plastic bag to carry to Sample Location.
    b. To avoid contamination, place plastic sheeting on the ground and lay the clipboard, instruments, and tools on the sheeting.
    c. On a Sample Control Form, record the GPS reading, time, date, and other descriptive information. Note the grid area or approximate location from which the sample was taken.
    d. Perform an exposure or dose rate survey at a height of approximately 1 meter (3 feet) and a ground contamination survey at 2.5 cm (1 inch) above the collection area. See sections 3.3.1, 3.4.1, and 3.5.1 for applicable survey instructions.
    e. Record the survey results on a digital or paper Field Monitoring Log.
    f. Use bar code label or indelible ink pen to record sample control number on sample collection container.
3. Put on work gloves over disposable gloves.
4. Cut sample into pieces no larger than 6 inches and place into gallon sealable bag. Do not add additional leaves, stems, or other parts not considered edible.
5. When sampling in fields, measure the area of the sample collected. Record the length, width, and height on the Sample Control form or digital record.
6. Record the weight of the sample (may be performed later at the hotline).
7. Complete the Sample Control form or digital sample record.
8. Clean any tools used in sample collection with cleaning wipes or clean water before reuse. If unable to clean the equipment in the field, place the equipment in a plastic bag and deliver to the hotline for decontamination.
9. Package and label the sample in accordance with Section 6 "Sample Packaging and Labeling."

4.7.3 Intermediate Phase Vegetation Sampling

As the incident moves from the Early Phase to the Intermediate Phase, vegetation sample collection methods will change to more in-depth methods. Sampling may require the whole plant (including roots).

4.7.3.1 General Guidance

Collection of other types and parts of vegetation will have to be considered, to measure for plant uptake from the soil into the plant and ultimately human ingestion. When choosing types of vegetation to sample consider the following:

- The time of year to harvest the crop
- If the food is market ready (when vegetation is ripe and ready for consumption)
- Whether sufficient time has passed for plants to uptake radionuclides.

For food samples, collect only the edible portions of vegetation consumed by humans. For feed samples (vegetation consumed by animals and livestock that will ultimately be consumed by humans), collect the whole plant leaves, fruits, stalk, and roots.

4.7.3.2 Procedure

1. Prepare to sample.
    a. Place all sampling tools and Sample Control Forms into a plastic bag to carry to the sample location.
    b. To avoid contamination, place plastic sheeting on the ground and lay the clipboard, instruments, and tools on the sheeting.
    c. On a Sample Control Form, record the GPS reading, time, date, and other descriptive information. Note the grid area or approximate location from which the sample was taken.
    d. Perform an exposure or dose rate survey at a height of approximately 1 meter (3 feet) and a ground contamination survey at 2.5 cm (1 inch) above the collection area. See sections 3.3.1, 3.4.1, and 3.5.1 for applicable survey instructions.
    e. Record the survey results on a digital or paper Field Monitoring Log.
    f. Use bar code label or indelible ink pen to record sample control number on sample collection container.
2. Put on work gloves over disposable gloves.
3. Cut sample into pieces no larger than 6 inches and place into gallon sealable bag. Do not add additional leaves, stems, or other parts not considered edible.
    a. For food samples, do not add additional leaves, stems, or other parts not considered edible.
    b. For feed samples, collect the whole plant: leaves, fruits, stalk, and roots.

> **NOTE:** The sample volume needed to meet laboratory analysis detection limits is variable depending on radionuclide of interest and plant type.

4. When sampling in fields, measure the area of the sample collected. Record the length, width, and height on the Sample Control form or digital sample record.
5. Record the weight of the sample (may be performed later at the hotline).
6. Complete the Sample Control form or digital sample record.

7. Clean any tools used in sample collection with cleaning wipes or clean water before reuse. If unable to clean the equipment in the field, place the equipment in a plastic bag and deliver to the hotline for decontamination.
8. Package and label the sample in accordance with Section 6 “Sample Packaging and Labeling.”

4.8 Smear (Swipe) Sample

A smear sample can be used to determine removable (loose) surface contamination on nonporous fixed items. Smear samples can be used in place of ground deposition samples in urban environments. Performing a ground contamination survey at the smear location will provide a total contamination value. Combined with the smear providing a removable contamination value, one could calculate what percentage of the contamination is removable and fixed for a certain surface material.

4.8.1 Procedure

1. Select a representative sampling surface that is flat, smooth, and stationary, if possible.
    - A suitable surface is one which the smear could be swiped and would not roll up or fall apart. The surface should be as non-porous as possible. (Examples: Metal from a car is the first choice followed by a cement sidewalk. The last choice would be an asphalt roadway.)
2. Prepare to take a smear sample.
    a. If directed, mark the area to be smeared.
        i. For a standard smear, mark an area of 100 cm^2 or 10 x 10 cm (4 x 4 in).
        ii. For a large area wipe (or smear), mark an area of 1 ft^2 or 30 x 30 cm (1 x 1 ft).
    b. On a Sample Control Form, record the GPS reading, time, date, dimensions of smeared area and other descriptive information. Note the grid area or approximate location from which the sample was taken.
    c. As directed, perform an exposure or dose rate survey at a height of approximately 1 meter (3 feet) and a ground contamination survey at 2.5 cm (1 inch) above the smear area. See sections 3.3.1, 3.4.1, and 3.5.1 for applicable survey instructions.
    d. Record the survey results on a digital or paper Field Monitoring Log.
    e. Use bar code label or indelible ink pen to record sample control number on sample envelope or bag.
    f. Label the smear envelope or bag with the appropriate information (unique sample identification number, sample location, date, time, and collector's initials).
3. With a gloved hand, carefully rub the smear with moderate pressure over the pre-marked area in an “S”-shaped motion. Be consistent if performing multiple smears.
4. If the equipment is available in the field, perform a screening measurement (contamination survey) of the swipe and record the results on the Sample Control Form or digital sample record.
5. Place the smear in the envelope or bag. Take care not to shake off collected material.

> **NOTE:** Place only one smear per envelope. Multiple smears sharing the same envelope will cross contaminate the other smears.

6. If gloves have come into contact with any contaminated material, replace gloves before collecting another smear/swipe.
7. Package and label in accordance with Section 6 “Sample Packaging and Labeling.”

4.9 Milk Samples

Personnel from supporting state or county agencies, the U.S. Department of Agriculture, or the U.S. Department of Health and Human Services are normally present to assist Field Monitoring Teams. Current lists of dairy farms, milk receiving and transfer stations, and processing plants should be maintained by state agriculture agencies. Representatives from the county or state Department of Agriculture, U.S. Department of Agriculture, or the U.S. Department of Health and Human Services may be assigned to assist in the planning, liaison, and collection efforts.

Most states require some form of certification or specialized training to collect milk.

> **NOTE:** When working with a state that has specific sample procedures and with specially trained personnel to collect milk samples, FRMAC will incorporate their procedures and personnel. A representative from the county or the state Department of Agriculture or U.S. Department of Health and Human Services may be assigned to the field team as liaison. If there are no state specific procedures use the following guidance.

4.9.1 General Guidance

For a variety of reasons, milk samples are very important in a radiological incident. Timely sample collection and assay is required.

Table 10. Special Equipment for Milk Sampling

Funnel	Plastic Container 1 Quart / 1 Liter or larger (Water)
Ice chest (if required)	Ice (if required)
Preservative (if required)	Graduated eye dropper
Plastic Bags	Sample Control form

4.9.1.1 Sample Selection

Samples are normally taken from receiving and transfer stations, processing plants, and individual dairy farms. If possible, when raw milk is sampled, the sample should be taken from cows that have been grazing in the area of interest, not fed from stored feed.

Besides milk samples, it is important to collect samples of the hay, grass, feed, and water being consumed by the animals. Refer to Section 4.7 “Vegetation Samples” for instructions on how to collect a feed sample.

Different types of feed samples are collected under varying conditions to determine the impact of ground deposition radioactivity on the contamination of milk. In the early phase of the incident, ground deposition samples of the pasture should be collected in conjunction with a milk sample. Samples of forage (pasture) should be collected the same as vegetation in an:

- Open area away from buildings, trees, or other obstructions.
- Area where milk-producing animals are, have been, or are likely to graze.
- Area free of recent (post deposition) disturbance such as mowing, burning, trampling, etc.

4.9.2 Commercial Dairies

Pasteurized milk is generally a blend of milk collected from many locations. Obtain available information on milk sources. If possible, ask from which location(s) the milk is obtained.

Some commercial dairies have milking systems that are under vacuum during the milking cycle. These dairies will not be able to provide a sample until after the cycle is complete. It may be necessary, therefore, to leave a container for the dairy personnel to fill and pick up the sample later. Dairies also have an agitator in the refrigerated holding tanks; therefore, the sample is considered a composite. Note from what specific areas the milk is obtained on the Sample Control Form or digital sample record.

4.9.3 Small Farms

Since milk from family cows is limited (family use, feeding calves, etc.), replacement of the milk from a commercial source may be necessary. If it is necessary to obtain a sample from an individual animal, the owner should be asked to perform the task. Ask the person to put on disposable gloves before milking the cow or goat.

4.9.4 Procedure

> **NOTE:** The Field Monitoring Team itself does not milk animals or take samples from tanks. A member of the farm or State Agriculture department will collect the sample as requested.

1. Attempt to contact the farmer or dairy prior to arrival to request the required amount of milk be reserved for pickup.
2. Arrange an efficient route of travel for collecting milk samples. Include availability of milk, accessibility due to weather, etc.
3. Present sample containers to the primary contact at the sampling station. Primary contact at ranches and residences might be a family member; at dairies or processors, the main contact may be an office employee, herdsman, or other employee with signatory authority.

4. If it is necessary to obtain a sample from an individual animal, the owner should be asked to perform the task. Ask the person to put on disposable gloves before milking. Be sure the collection bucket and the cow's udder are clean.
5. Follow instructions of state or county personnel or plant workers.
6. To prevent contamination of collected milk, use only thoroughly clean sample containers during transit and handling.
7. Use bar code label or indelible ink pen to record sample control number on sample collection container.
8. Collect one sample of at least 1 Gallon (3.5 Liter). Sufficient volume is needed for laboratory analysis.
9. Collect raw or whole milk (cream mixed into the milk) whenever possible.
10. The Field Team Supervisor or the ICS 204FRMAC form will advise if preservative is to be added to the sample, if the sample is to be chilled, when to collect two samples or special milk samples, and the general area in which to collect them.
11. If for any reason the milk sample(s) cannot be obtained at the designated location, consult the Field Team Supervisor for an alternate source in close proximity to the designated location, and attempt to collect the sample or samples at the alternate location.
12. During hot weather, place all milk samples in an ice chest, as required.
13. Complete the Sample Control form or digital sample record.
14. Package and label the sample in accordance with Section 6 "Sample Packaging and Labeling."

4.10 *In Situ* Gamma Spectroscopy Measurements

In situ gamma spectrometry is a rapid method for the assessment of gamma emitting ground surface contamination. FRMAC Field Monitoring Specialists are trained to collect *in situ* measurements.

FRMAC deploys with calibrated and characterized mechanically cooled high purity germanium (HPGe) detectors. The standard set up of FRMAC *in situ* measurements is with the detector face 1 meter above the ground with the detector facing downwards.

Analysis is completed by the FRMAC Laboratory Analysis Division. At the initial stages of the emergency, the conversion of the spectrum line intensities (full-energy peaks) to surface contamination is performed assuming that the radioactivity is uniformly distributed on the surface of the ground. As time goes by, the radionuclides will migrate into the soil and the analysis may require compensation for this change through modeling or correction factors.

4.10.1 General Guidance

If exposure rates approach or exceed 1 mR/hour, the standard FRMAC mechanically cooled HPGe detectors will likely experience sufficiently high dead time (> 50%) potentially limiting the feasibility of their use. In these instances, a lower efficiency non-standard FRMAC HPGe detector may potentially be used.

Alternatively, if the radionuclides deposited do not significantly benefit from analysis using a high resolution HPGe detector, a robust and durable lower resolution NaI(Tl) scintillation detector may potentially be useful. Regardless, if exposure rates approach or exceed 3 to 5 mR/hour, in-situ gamma spectrometry may not be feasible.

Table 11. Special Equipment for *In Situ* Gamma Spectroscopy Measurements

Tripod	Sample Control Form
Tape measure	
High Purity Germanium Detector (Liquid Nitrogen or Mechanically Cooled)	
Laptop (Analysis Software and SD Card Reader External Data Storage Device)	
Camera (phone or tablet) for documentation of measurement site	

4.10.1.1 Sample Selection

The ideal sample collection area would be an open, flat, undisturbed area away from overhanging objects and with no agricultural or other activity since the initial radionuclide deposition. Review the "Operator Aid FRMAC In Situ Gamma Spectroscopy Measurements" in Appendix D for examples of selecting appropriate site characteristics.

4.10.2 Procedure

1. Before field team departure:
   a. Ensure the *in-situ* system is cooled down, as applicable, and ready to operate.
   b. Collect a background *in situ* measurement preferably in a low background area that will be representative of the sampling area.
   c. Collect a spectrum of a known radioisotope.
   d. Save the files with a unique file name (as well as an indicator if the spectrum is background or a known nuclide). Record all pertinent data on a digital platform or paper Field Monitoring Log.
2. Upon arrival at the pre-determined measurement area, select a location that is flat, open, smooth, not underneath any overhang, and contains minimal or no ground disturbance (i.e., that the land has not been plowed, or any other activity, that has un-naturally mixed the soil since the radionuclide deposition).
   a. Check the area with a survey meter to ensure that the sample location is not within an abnormal area of elevated radioactivity (hot spot).
   b. For HPGe measurements, select an area that ensures a dead time maintained at or below 60% if possible. General guidance is an area < 3 mR/hr.
3. Perform an exposure or dose rate survey at a height of approximately 1 meter (3 feet) and a ground contamination survey at 2.5 cm (1 inch). See sections 3.3.1, 3.4.1, and 3.5.1 for applicable survey instructions.
   a. Record the survey results on a digital or paper Field Monitoring Log.
4. Set up the *in-situ* system.

a. Set up tripod in a stable manner, in the middle of the selected site.
b. Set Detector facing down on the tripod, positioning it 1m above the ground surface.
c. Connect all cables to the electronic part of the system.
d. Switch on the system; check its basic functionality and verify that the dead time does not exceed any limits set by the Monitoring Manager.

5. Set the required measuring time as indicated on the ICS 204FRMAC.
   a. The default FRMAC *in situ* count time is 600 seconds (real time).
   b. Different count times will depend on the detector efficiency and the level of surface contamination. The recommended measurement time should be in the range of 100-1200 seconds.
6. Start data acquisition for the duration of the preset time.
7. While the system is counting, take a picture of the setup from 20-30 feet away showing the landscape. Upload this photo with the digital spectrum record or keep the file for transfer at the hotline.
8. After the measurement has stopped, save the collected spectrum with a unique file name (either use the instrument, date, and time in the file name, a Sample Control Form number, or the spectrum ID generated by the digital system).
9. Record applicable survey information (GPS reading, instrument number, live/dead/real time, measurement date/time, pictures, and other descriptive information) and upload the spectrum file to a digital collection software.
   a. If unable to upload the files in the field, then record applicable survey data on a sample control form and deliver all electronic spectra files to Sample Control personnel.

5 ENVIRONMENTAL DOSIMETRY

Where external exposure is a consideration, environmental dosimetry is used to measure environmental radiation levels. The placement of environmental dosimeters in and around a suspected deposition area is recommended for long term monitoring. These dosimeters can provide doses over an established period. FRMAC uses a four element optically stimulated luminescent dosimeter for environmental dosimetry.

Table 12. Special Equipment for Environmental Dosimetry

Environmental Dosimeters	Stakes or metal fence posts
Hammer (large)/Tool for driving stake or post	Tape
Shielded box	Tie wraps
Sealable plastic bags	Local Area Monitoring (LAM) Dosimeter form

5.1 Deployment

When a field team member receives environmental dosimeters, that team member assumes responsibility for their safe handling during transport and for their return if not used.

> **NOTE:** Do not expose environmental dosimeters to radiation sources during transport.

1. Obtain environmental dosimeters prior to field departure.
2. Be sure to carry transit control dosimeters during deployment to determine transit exposure.
3. During transport, store package of environmental dosimeters in a place where they are least likely to be damaged or exposed to radiation or heat, such as in a shielded box.
4. Place two environmental dosimeters in a sealable plastic bag. Seal bag firmly and secure bag to post or structure 1 meter (3 feet) from the ground, facing the center of the plume footprint or source.
5. Mark the location with flagging or ribbon that is clearly visible from the road.
6. Take a picture of the location from 20-30 feet away showing the landscape.
7. Complete the “Local Area Monitoring (LAM) dosimeter” form for each environmental dosimeter station. Record the following information on the form:
    - GPS coordinates of the dosimeters (Include precise directions in the “Description” column to each environmental station location so environmental dosimeters can be recovered.)
    - Dosimeter numbers
    - Date and time of deployment
8. Return the transit control dosimeters and “Local Area Monitoring (LAM) Dosimeter” forms to Sample Control.

5.2 Retrieval

To retrieve all environmental dosimeters that were deployed, the field team needs to bring transit control dosimeters and the “Local Area Monitoring (LAM) Dosimeter” forms.

1. Be sure to carry transit control dosimeters during retrieval to determine transit exposure.
2. Ensure that identifying numbers of collected environmental dosimeters match numbers recorded on the “Local Area Monitoring (LAM) Dosimeter” form.
3. Note on the “Local Area Monitoring (LAM) Dosimeter” form any environmental dosimeters damaged or missing from fixed stations.
4. Survey environmental dosimeters and/or containers for contamination with a GM pancake instrument prior to removal from the field.
    a. If the survey location has elevated levels of radiation or contamination and the contamination levels cannot be determined on either the dosimeter, or containers, or both, then treat them as if they were contaminated and complete step 5.
5. If the environmental dosimeters are contaminated:
    a. Transfer each set of environmental dosimeters from the contaminated packages to a clean, appropriately sized, sealable plastic bag or other protective container to avoid possible cross-contamination.
    b. Move to a low background area to determine contamination levels on the dosimeters and packaging if necessary.
    c. If contamination is still detected:
        i. Write the instrument reading on the bag with an indelible ink pen.
        ii. Note the instrument reading in the remarks section of the “Local Area Monitoring (LAM) Dosimeter” form.
        iii. Isolate the dosimeters from non-contaminated environmental dosimeters.
6. During transport, keep all environmental dosimeters in sealed plastic bags. Store them in a place where they are least likely to be damaged or exposed to radiation or heat, such as in a shielded box.

NOTE: Keep environmental dosimeters away from radiation sources.

7. Package and label in accordance with Section 6 “Sample Packaging and Labeling.”
8. Return all collected environmental dosimeters to Sample Control personnel along with completed “Local Area Monitoring (LAM) Dosimeter” forms and transit control dosimeters.

5.3 Storage

Environmental dosimeters remain in the custody of the Field Monitoring Team until relinquished to Sample Control or a courier. Exposed environmental dosimeters awaiting readout are stored in a shielded location, preferably shielded boxes. Two unexposed controls are placed in shielded containers within the storage area to establish background level.

6 SAMPLE PACKAGING AND LABELING

Samples must be packaged and labeled appropriately to protect the integrity of the sample. Security seals will be used to ensure that the sample is not tampered with or inadvertently opened.

> **NOTE:** The use of Alert and Special tags may be designated by the Monitoring Manager and Field Team Supervisor, and used as needed.

6.1 Security Seals

Security seals (see Figure 5) are used by Field Monitoring Teams to officially seal field samples. When no security seals are available, one can be made from masking or adhesive tape. Security seals help control sample integrity from collection to analysis.

> **NOTE:** The FRMAC chain of custody process is not a law enforcement evidence level chain of custody. Law enforcement procedures will be implemented by FRMAC personnel if requested to collect law enforcement evidence samples.

Before sealing the sample, write the following information on the Security Seal:

- Collection date
- Initials (by the person who collected the sample).

Place the Security Seal over the opening of the sample container or wrap around the sample container with the ends making a flag. Ensure the seal will break before the container is opened and access is gained to the sample.

Figure 5. Security Seal

6.2 Packaging and Labeling

This procedure applies to packaging and labeling of all field samples for transport to Sample Control by the Field Monitoring Teams.

6.2.1 Precautions

- Avoid cross-contamination.
- Wear disposable gloves.
- Perform contaminaton survey of gloves if contaminaton is suspected.
- Change gloves if contamination is confirmed.
- Segregate above background samples (as needed).
- In transit, store above background samples in a shielded area of the vehicle or as far away from passenger area as possible and separated from survey instruments when collecting measurements.
- Ensure samples are secure from movement during transport and will not be damaged.
- When exiting and entering vehicle, ensure samples are not dislodged from storage area.

6.2.2 Procedure

After performing the sample collection and preparation given in the specific procedure for the type of sample collected, complete the following to prepare the collected sample for transport to Sample Control.

1. If background permits, perform surface gamma radiation exposure rate survey of sample container. In most cases, the surveys should be conducted after the team has exited the deposition footprint. Complete the survey before turning samples in at the hotline.
2. Record results on the Sample Control form or digital sample record and complete all applicable sections.
3. Record results on the digital or paper Field Monitoring Log. If using a paper Sample Control form, enter the Sample Control Form Number on the paper Field Monitoring Log in the comments.
4. Use a bar code or write the sample number on the primary sample container (bag, bottle, etc.) and place it into a clean plastic bag, taking care not to contaminate outer surface of the bag.
5. If contamination levels are above releasable limits, place the bagged sample container and Sample Control Form into another plastic bag. Ensure all information is facing outwards and readable:

> **NOTE:** Ensure that the Sample Control form number and information is visible through the bag.

6. Load samples into the vehicle for transport to the hotline. Ensure that the exterior surface of the sample does not contact contaminated instruments, equipment, or vehicle surfaces during transport.
7. When leaving the vehicle, ensure that all samples are secure and that the vehicle is locked.
8. Transport samples to Sample Control personnel at the hotline or transfer to a courier maintaining chain of custody.

7 SAMPLE CONTROL

Sample Receiving and Control is part of the Laboratory Analysis Division of FRMAC. Sample Receiving is responsible for the receipt and administrative processing of field samples. Field Monitoring Teams deliver samples and the chain of custody is transferred to Sample Receiving personnel. Samples are surveyed for exposure rate and external package contamination levels, sorted, and sent to the sample storage area until they are forwarded to a radioanalytical laboratory for analysis.

> **NOTE:** The FRMAC chain of custody process is not a law enforcement evidence level chain of custody. Law enforcement procedures will be implemented by FRMAC personnel if requested to collect law enforcement evidence samples.

7.1 Chain of Custody

Chain of custody is the sample tracking and control process used for ensuring that samples and data maintain their original identity and integrity throughout the collection, shipment, and analysis processes. The record of chain of custody is currently kept on the paper Sample Control form and chain of custody. Sample information must be recorded on the paper Sample Control form (or digital form) and the chain of custody.

The chain of custody procedure requires that samples be identified and their location and handling be known from initial acquisition through eventual analysis, storage, or disposal. This includes logging all activities affecting the sample through signature documentation of receipt, possession, and release by all persons handling the sample up to the turnover to Laboratory Analysis Division personnel.

Each person handling samples is responsible for the security and documentation required for the chain of custody procedure. Samples are transferred only to authorized personnel.

The sample, with documentation, is under custody when:

- It is in the collection team's possession, or
- It is in view of the team, after being in the team's possession, or
- It was in the team's possession and locked up, or
- It is in a designated, secure area.

Each time the sample changes hands, the persons relinquishing and receiving the sample will sign the chain of custody.

7.1.1 Procedure

A member of the field team:

1. Initiates the chain of custody by sealing the sample container with a security seal.
    a. If security seals are not available, make a security seal using masking tape or adhesive tape.

   b. Do **NOT** use a Sample Control Form label for a security seal.
2. Initials and dates the security seal.
3. Records each sample ID on the chain of custody form for the batch of samples collected during the mission or uses an applicable digital chain of custody process. This can be done with barcode stickers or by pen. If handwritten, a best practice is to have another individual double check the legibility and accuracy of the IDs and date/initial the verification.
4. Uses the signature lines to transfer the custody of all samples between individuals or use an applicable digital application to track custody.

7.2 Sample Receiving Line

The Field Monitoring Team or Sample Courier, if one is used, is responsible for the proper packaging, handling, and transport of a sample until custody is transferred to Sample Control personnel.

1. The person collecting and delivering samples to the hotline must notify Sample Control personnel that samples are coming.
   a. To improve processing, include an estimate of the number and type of samples and estimated range of radiation readings.
2. Upon arrival at the hotline:
   a. Stop in a designated area (approximately 25 feet [8 meters] away from the hotline) and wait for instructions from Contamination Control Line / Sample Control personnel.
   b. Ensure that all labels are legible and can be read through sample bags.
   c. Check samples for evidence of leakage.
   d. If not completed, perform a radiological survey of the sample to identify segregation of high activity samples.

> **NOTE:** The FRMAC Laboratory Analysis manager will decide the threshold for declaring a sample “high activity” and special handling and storage procedures will be enacted for these samples at the discretion of this manager. This information will be communicated to the hotline personnel and may change during the course of the event as needed to support the response.

   e. Ensure all the required information is recorded on the digital or paper Sample Control forms.
   f. Ensure all samples are listed on the batch chain of custody form or digital record.
   g. Notify Sample Control personnel if repackaging is required.
   h. Notify Sample Control personnel of high activity samples.
3. Advise Sample Control personnel of any pertinent information concerning samples.
4. Ensure the “Local Area Monitoring (LAM) Dosimeter” forms are in boxes or bags with corresponding dosimeters.

NOTE: Keep environmental dosimeters away from radiation sources, such as field samples and instrument check sources. For dosimeter collection, storage, and transport, adequate dosimeter shielding will be needed to keep the dosimeters from being exposed from extraneous radiation.

5. Transfer the samples to Sample Control personnel by signing over the chain of custody paper document or performing a digital sample transfer. For environmental dosimeters, complete the chain of custody section on the "Local Area Monitoring (LAM) Dosimeters" form (if applicable).
6. Turn over all records and samples to Sample Control personnel who will review records for completeness and accuracy. Sample Control personnel may ask follow on questions and record information in the digital system or on the paper forms.

NOTE: Do not leave the area until instructed to do so by Sample Control personnel. This is to ensure that all required data has been collected, custody has been transferred, and to provide further details about the samples collected.

7. Proceed to the Contamination Control Line or return to the field as needed.

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8 FIELD LEVEL HEALTH AND SAFETY

Because the FRMAC H&S Division will borrow personnel from the FRMAC Monitoring Division and field teams will need to perform basic health and safety functions (such as personnel or equipment contamination surveys, contamination control, and contaminated waste handling), guidance is provided in this section. It is suggested that personnel refer to the “FRMAC Health and Safety Manual” for more information and to follow instructions by the H&S Manager during field operations.

8.1 Direct Method of Surface Monitoring

Equipment or personnel may need to be surveyed in the field for contamination. Surface contamination can usually be detected by direct monitoring methods. Use the direct method of surface monitoring to determine the fixed + removable surface contamination. Field team members should perform direct surveys to check for personal contamination after activities are complete at each monitoring and sampling location, during entry into vehicles, and upon exit of the vehicle at the hotline or other non-contaminated area. On occasion, direct measurements may be followed by an indirect method of using smears on representative portions of equipment.

8.1.1 General Measurement Techniques and Precautions

- Avoid damage or contamination of instrument window or probe area-covering material. If possible, take the measurement over a flat and smooth surface that is suitable for a subsequent smear sample.
- Do not use masking tape to pick up particles from the probe window. Residual adhesive on the window covering may cause additional contaminating particles and foreign material to adhere.
- Usual survey techniques involve making several surface measurements at regular distances over the area. The number of measurements depends on size of area and monitoring time available.
- Immediately discontinue use of damaged instruments and return them to the Instrument Staging Area as soon as practical.
- Since alpha particles have a short range in air, standoff attachments (Walking Stick) can be used to keep the probe about ¼ inch (0.64 cm) from the monitored surface.
- Speaker or headphone-equipped instruments are desirable for low-level monitoring because the audio will respond faster than the display.
- If surveying people, it is preferable to use headphone-equipped instruments.

8.1.2 General Beta/Gamma Contamination Survey Procedure

These surveys are used to determine if an object or person is contaminated.

1. Make sequential measurements over the entire surface, as appropriate, with the stationary detector or by slowly sweeping the detector over the surface.

   a. Hold the probe ~1/2 inch above the survey object's surface and scan at a rate of 1-2 inches per second.
   b. Avoid contact with the survey object as it could potentially puncture the thin windows on instruments and/or contaminate the probe/detectors.
2. Record data as directed on a digital platform, paper Field Monitoring Log, or "H&S Radiation Survey Report."
   a. Report all results to Field Team Supervisor as instructed.

8.1.3 General Alpha Contamination Survey Procedure

These surveys are used to determine if an object or person is contaminated.

1. Make sequential measurements over the entire surface, as appropriate, with the stationary detector or by slowly sweeping the detector over the surface.
   a. Hold the probe ~1/4 inch above the survey object's surface and scan at a rate of 1-2 inches per second.
   b. Avoid contact with the survey object as it could potentially puncture the thin windows on instruments and/or contaminate the probe/detectors.
2. Record all data as directed on a digital platform, paper Field Monitoring Log, or "H&S Radiation Survey Report."
   a. Report all results to Field Team Supervisor as instructed.

8.2 Indirect (Smear) Method of Surface Monitoring

The indirect (smear) method may be the primary monitoring procedure for facilities and equipment under conditions of high background, insufficient portable instrument sensitivity, lack of accessibility, etc. This method is not to be used on personnel (skin, clothing, or PPE). Use the indirect method to determine removable surface contamination values. Swipes and large area wipes are the most common equipment used to conduct indirect surface monitoring. Large area wipes provide an indication of the presence of removable contamination in a large or general area. Swipes are the preferred method as they can easily be surveyed with handheld instruments or proportional counters. The results from swipes are quantifiable so a direct comparison to administrative or regulatory limits is possible.

8.2.1 Procedure

1. Select a representative sampling surface that is flat, smooth, and stationary, if possible.
2. A suitable surface is one on which the smear could be swiped and would not roll up or fall apart. The surface should be as non-porous as possible. (Examples: metal from a car is the first choice followed by a cement sidewalk. The last choice would be an asphalt roadway.) Prepare to take a smear.
   a. Prepare a batch of smears by marking each with a unique identification number.
   b. Prepare a survey map as appropriate.

   i. If several smears are taken from one location; make an area drawing that identifies smears by number and location and submit with the “H&S Radiation Survey Report.”

  c. If directed, mark the area to be smeared.
     i. For a standard smear, mark an area of 100 cm^2 or 10 x 10 cm (4 x 4 in).
     ii. For a large area wipe (or smear), mark an area of 1 ft^2 or 30 x 30 cm (1 x 1 ft).

3. With a gloved hand, carefully rub the smear with moderate pressure over the pre-marked area in an “S”-shaped motion. Be consistent if performing multiple smears.
4. Place the smear in the envelope or bag. Take care not to shake off collected material.

> **NOTE:** Place only one smear per envelope. Multiple smears sharing the same envelope will cross contaminate the other smears.

5. Determine the amount of radioactive material on the smear by one of the following ways:
   a. Use an appropriate handheld instrument of known efficiency to count the surface of the smear. A GM (Geiger Mueller) pancake probe is usually used for beta/gamma and an appropriate alpha instrument for alpha contamination.

> **NOTE:** Ensure that the contamination release limits are greater than the minimum detectable activity (MDA) for the instrument and count times used. If not, then use an alpha/beta swipe counter to meet the release limits.

   b. Count the smears on an alpha/beta swipe counter to discern contamination from ambient background levels, if necessary.

6. Record all data as directed on a digital platform, paper Field Monitoring Log, or “H&S Radiation Survey Report.”
7. If a smear will be submitted for analysis, refer to Section 4.8 “Smear (Swipe) Sample.”
   a. Package and label in accordance with Section 6 “Sample Packaging and Labeling.”

8.3 Radioactive Waste during Operations

Field teams generate radioactive waste during operations. Most of the waste is from PPE, plastic sheeting or bags, and sampling equipment or supplies. Each field team should have at least one member of the team that is trained in proper contamination control techniques and available to assist in surveying the team and equipment for contamination while in the field.

Radioactive waste must be collected in a plastic bag(s) while in the field. The bag should be readily identified (by either color or label/marking) by each team member as the radioactive waste collection bag. Radioactive waste will be stored in the field team vehicle during the operational shift. When field team activities are complete, the radioactive waste is taken to the hotline and placed in the designated area.

8.4 Contamination Control Line

When a field team returns, Contamination Control Line (otherwise known as the hotline) personnel survey the members of field team, equipment, and vehicle to limit the spread of contamination. Review the “FRMAC Health and Safety Manual” for complete directions on hotline activities.

If the team is to return to the field, a routine survey is not taken of the vehicle. Field team personnel should be surveyed if exiting the vehicle.

If the Field Monitoring Team is not returning to the field, team personnel should follow the directions of the Contamination Control Line technician. The approximate sequence of activities is as follows:

1. Stay in the vehicle until the exterior is surveyed, unless otherwise instructed.
2. Allow Contamination Control Line personnel to survey your feet before exiting the vehicle.
3. Exit the vehicle.
4. Unload samples, instruments, equipment, and radioactive waste and place them in designated areas.
5. Process through the Contamination Control Line as instructed by Contamination Control Line personnel.

APPENDIX A:
FRMAC FIELD TEAM CONTACT

Field Team communications are the responsibility of the FRMAC Monitoring Division. For smaller events, the Field Team Supervisor will act as the main point of contact for the field teams. For large operations, and as necessary, the FRMAC Field Team Supervisor should assign one or more experienced Field Monitoring Specialist to act as the Field Team Contact.

OPERATIONS

Communications from TOC (Technical Operations Center) to the Field Teams is enabled using several methods including: the chat feature in FRMAC field team tablets, radio, and telephone. The primary function of the Field Team Contact is to ensure that all urgent traffic is quickly transmitted and that data and instructions are relayed to and from Field Monitoring Teams in a timely manner.

Under instructions from the Field Team Supervisor, the Field Team Contact relays information to designated Field Monitoring Teams that perform their duties as instructed. Field monitoring data are transmitted to the Field Team Contact. The data is received and transcribed into the RAMS or RadResponder database; subsequently these data points are reviewed and approved by the Field Data Supervisor and Monitoring Manager for verification of completeness and accuracy.

PROCEDURE

1. Field Team Supervisor provides the Field Team Contact a copy of each ICS 204FRMAC form.
2. Field Monitoring Teams initiate a communications check before departure.
   a. Field Team Contact acknowledges communication to each team.
3. Teams proceed to the measurement and sampling locations. Upon arrival, teams identify themselves and their locations to Field Team Contact, as directed.
4. Teams should contact the Field Team Contact at least once an hour to ensure team safety and progress of duties.
5. When spelling, teams should use the phonetic alphabet, as shown in Table A-1.
6. If the team encounters MPCD or FRMAC tablet operations issues they should contact the Field Team Contact, Field Team Supervisor, or eFRMAC personnel. If the issues cannot be resolved the team is informed to do one of the following:
   a. Return to FRMAC.
   b. If the MPCD is unavailable, the field team should continue collecting data on the FRMAC tablet until the MPCD connect returns or the team returns to the FRMAC
   c. If the FRMAC tablet stopped working and the team is unable to restart it, the team should continue collecting data using the paper Field Monitoring Log and Sample Control and chain of custody form.

d. If the data is urgent, the Field Team Contact must notify the team. The team should then transmit the data back to the Field Team Contact, who will record the data into RAMS or RadResponder.

7. If the Field Team Contact instructs a team to stand by, the team should be contacted by the Field Team Contact with further instructions as soon as possible.
8. During peak periods of data transmission, several teams may have readings to relay. When this occurs, teams are stacked; i.e., placed in sequence of original transmission. The Field Team Supervisor may override this sequence as dictated by circumstances or emergencies.

NOTE: It is important that teams keep transmissions of information as short as possible

9. Before a Team returns to the TOC they should notify the Field Team Contact of the completion of the mission. The Field Team Supervisor may supply the team with new or expanded survey routes to perform before returning. If new routes are not available the information discussed will include, estimated time of arrival and approximate number of samples. The Field Team contact should notify Sample Control at the hotline with the approximate return time.
10. Returning teams are required to notify the Field Team Contact when they arrive at the hotline.
11. The Field Team Contact must maintain contact until all teams have arrived at the hotline.

Table A-1. Phonetic Alphabet

A	ALPHA	**N**	NOVEMBER
B	BRAVO	**O**	OSCAR
C	CHARLIE	**P**	PAPA
D	DELTA	**Q**	QUEBEC
E	ECHO	**R**	ROMEO
F	FOXTROT	**S**	SIERRA
G	GOLF	**T**	TANGO
H	HOTEL	**U**	UNIFORM
I	INDIA	**V**	VICTOR
J	JULIET	**W**	WHISKEY
K	KILO	**X**	X RAY
L	LIMA	**Y**	YANKEE
M	MIKE	**Z**	ZULU

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APPENDIX B:
eFRMAC

The eFRMAC enterprise allows emergency response assets to provide more field data, faster with greater reliability to decision makers. This capability handles all aspects of data acquisition, management, analysis, and dissemination via secure protocols and standards, flexible client components, and hardened data collection devices. Previously, consequence management (CM) assets captured data on paper, called the data in via radio, and performed data entry into spreadsheets. Now, mobile data acquisition platforms transmit data through any internet protocol (IP) communication channel, manage the data at central command and controls assets, perform automated quality assurance (QA)/quality control (QC), and provide real-time digital visualizations to decision makers.

Multi-Path Communication Device (MPCD)

The MPCD is a vehicle-mounted device that provides a configurable communication pathway for field monitoring teams to transmit their collected radiological measurements and sample data for analysis by monitoring and assessment. The user (operator) enters radiological measurements and collected samples into a tablet running the Digital Field Monitoring (DFM) software which communicates wirelessly (802.11) to the MPCD.

The MPCD selects the lowest cost path through several commercial and standalone communications options. The device is capable of multiple configurations depending on needs and can accept data from any data source, and then autonomously packages, buffers, and transmits data back to a deployed command center or home team assets. The transmission capability is approved up to Unclassified Controlled Nuclear Information (UCNI) and meets all government-approved security doctrines for data transmission.

Tablet Digital Field Monitor program

The Digital Field Monitoring (DFM) Software is an application that runs on a surface tablet. It allows the user to enter their Event, Field Team, Location, Surface, Instrument and log Measurements and Samples with a GPS coordinate. The tablet then sends this information to the MPCD, which in turn sends it to the RAMS database. If no pathway is immediately available, the tablet holds the data until a communication pathway becomes available.

The Navigation Buttons

There are four navigation buttons within DFM:

- MAP – Map screen allows the users to track themselves and display route instructions.
- DATA – Data Screen allows users to select/enter their Event, Field Team, Location, Surface, and Instrument and enter- their Measurement and/or Sample along with a GPS coordinate. The Data screen is the screen used the most.
- CHAT – Communication interface for sending and receiving messages to the Consequence Management Center (CMC).
- MANAGE – Interface for viewing data that is synced and queued to be synced with RAMS.

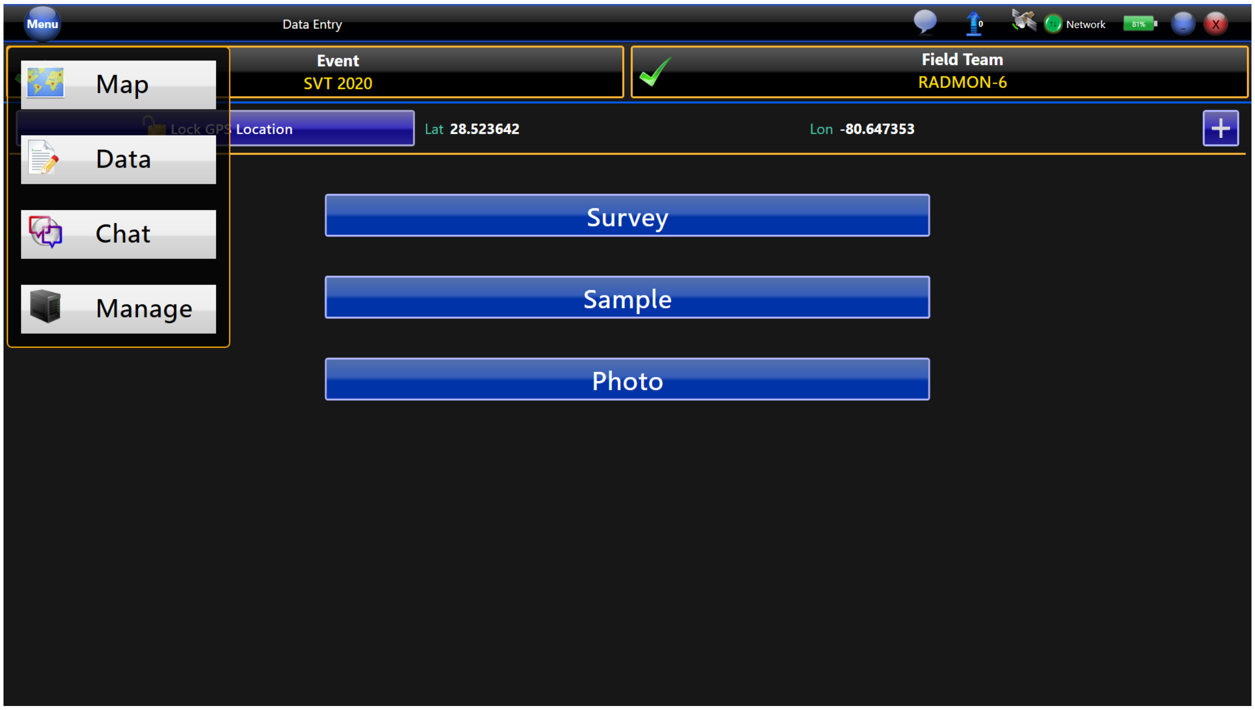

Figure B-1. DFM Screenshot

Radiological Assessment and Monitoring System (RAMS)

The Radiological Assessment and Monitoring System (RAMS) is a component of the eFRMAC enterprise. It consists of a central database running in conjunction with a web-based data management application. Its purpose is to facilitate the timely development and dissemination of FRMAC products by reducing the clerical burden associated with responding to a radiological incident. This helps reduce mistakes, provides a smoother operating environment, and augments post-incident review and lessons learned assessment.

The database is designed to manage all Teams, Instruments, Field Measurements, Field Samples, and Action Items generated during a FRMAC response. It also functions as an integration point for work product review and health physics calculations between CMWeb and TurboFRMAC, respectively.

Finally, it serves as central data source for disseminating data to National Atmospheric Release Advisory Center (NARAC), RSL's Enterprise Geographic Information System (GIS), and other interested parties (EPA, Nuclear Regulatory Commission [NRC] etc.).

This component maintains a common operating picture for all responders across agencies, locations, and mission responsibilities. The following tools are made available through this module:

- Real time operational summaries of measurements, samples, and analysis
- Contacts, resources, and documents
- Action item tracking and alerts
- Featured work product quick display

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APPENDIX C:
FORMS AND CHECKLISTS

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DAILY INSTRUMENT QC CHECKS

Event ____________________________. Name (Person/Team) _______________________________.

Performed By ______________________. Reviewed By _________________________________. Page _____. of ______.

Instrument Serial Number	Instrument Model Number	Depart Date/Time DDMMMYYYY 0000 (Military)	QC Check Source Type	Check Source ID #	Check Source Activity	Acceptable Operating Range	Depart Actual Reading	Return Date/Time DDMMMYYYY 0000 (Military) [If Required]	Return Actual Reading [If Required]

September 2020

DAILY INSTRUMENT QC CHECKS

The Daily Instrument QC Checks form is used to record quality control information for each instrument Daily Operations Checks, at the beginning of every shift or before use. End of Shift QC Checks are available if needed.

Event	Record name of event, if applicable
Name (Person/Team)	Record the name of person (team) filling out the form
Performed By	Name of person performing the QC checks
Reviewed By	Name of person reviewing the QC checks
Instrument Serial Number	Record instrument serial number, property number, or other organizational identifying numbers.
Instrument Model Number	Record instrument Model Number.
Depart Date/Time	Record departure date and time (using military notation) following the example below. Example: 02SEP2009 1745
QC Check Source Type	Write the type of check source used (Am-241, BKG, Pu-238, etc.).
Check Source ID #	Include ID number of check source, if available.
Check Source Activity	Record activity of source and units. If instrument has multiple ranges, record range used.
Acceptable Operating Range	Write acceptable range of operation.
Depart Actual Reading	Record actual meter reading (Reading × Scale) at time of departure.

These columns are available but not usually required.

Return Date/Time	Record return date and time (same as the depart date/time example).
Return Actual Reading	Record actual meter reading on return.

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FIELD MONITORING LOG

(I) **Team Name:** ______________________.   **Date (DDMMMYYYY):** ______________   **Event:** ______________

Collector Names: ______________________.   **Reviewed By** ______________   **Page** ____ **of** ______

	Military Time (2)	Location (Description of survey site, i.e., street address, town, intersection, highway) (3)	Latitude xxx.xxxxx (4)	Longitude xxx.xxxxx (5)	Instrument			Measurement Value (9)	Units (10)	Height & Units (11)	**Comments:** Include ALL pertinent measurement factors. **Environmental:** Ground Conditions, mist, rain, etc. **If samples are collected at this site**; Note Sample ID and type here (12)
					Meter ID (6)	Probe ID (7)	Radiation Type/Energy α β γ (8)				
(A)											
(B)											
(C)											
(D)											
(E)											
(F)											
(G)											
(H)											
(I)											
(J)											
(K)											
(L)											
(M)											
(N)											
(O)											

July 2020

FIELD MONITORING LOG

The Field Monitoring Log is used by Field Monitoring Teams to record field monitoring data when the eFRMAC Tablets with the Digital Field Monitor, Rad Responder or similar electronic program is unavailable. A Field Monitoring Log entry is completed for each radiation measurement taken.

(1)	**Team Name**	Name, number, letter, or name identifying the Field Monitoring Team reporting the data.
	Date (DDMMMYYYY)	Date of measurements Example 02SEP2020.
	Event:	Description of the reason measurements are being collected.
	Collectors Name(s)	List the Team Member Name(s) collecting measurements.
	Reviewed By	Name of Field Team Supervisor or Designee who reviewed the data.
	Page of	Page Numbers for continuation of Field Team measurements.
(2)	**Military Time**	Military time. (Time zone is always the FRMAC location time.)
(3)	**Location**	Description of survey location (i.e., street address, town, intersection, highway, farm, sector, distance, if applicable.)
(4)	**Latitude**	In degrees and decimal degrees (example: 36.123456)
(5)	**Longitude**	In degrees and decimal degrees (example: -113.123456).
(6)	**Meter ID**	Property number, serial number, or other organizational identifying number for the meter.
(7)	**Probe ID**	Property number, serial number, or other organizational identifying number for the probe.
(8)	**Radiation Type / Energy**	Record the radiation type / energy (α = Alpha, β = Beta, γ = Gamma)
(9)	**Measurement Value**	Record the actual instrument reading.
(10)	**Units**	Units in which instrument reads. (i.e., cpm, µrem/h, or mR/h, etc.)
(11)	**Height & Units**	Record the distance from detector to measurement surface (exposure rate is 1 meter).
(12)	**Comments**	Record any information pertinent to instrument measurements and any other environmental conditions. Record the Sample Collection Form Number (SCF-xxxxx) if samples were taken.

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1.	Event Name	2. Operational Period (Date/Time) From: To:	ICS-204 FRMAC Assignment List, Adapted for FRMAC Field Monitoring Teams

3.	FRMAC Monitoring Personnel	Name:	Contact Phone #(s)	Home Organization	4. Team Name
	Monitoring Manager				
	Field Team Supervisor				

5.	Resources Assigned		
	Field Monitoring Team Leader	Contact Phone #(s)	Home Organization
	Field Monitoring Team Member	Contact Phone #(s)	Home Organization

6. **Work Assignments:**

7. **Special Instructions / PPE:**

Approved Site Safety Plan Located at:

8.	FRMAC Contact	Phone Number	FRMAC Contact	Phone Number
	Field Team Contact:		PIO:	
	Monitoring/H&S Direct #:			
	MPCD Helpdesk:			

9. **Prepared by** ________________________________

Date/Time __________________________________

10. **Reviewed by** ______________________________

Date/Time ________________________________

FRMAC Field Monitoring Team Assignment ICS-204FRMAC

Purpose:

The ICS 204-FRMAC gives detailed instructions to each FRMAC Field Team. Once the Assignments are agreed to by the State, Monitoring & Sampling, and Assessment. The form will contain detailed contact information, survey route duties, PPE and turn back levels. Each FRMAC Field Team will get an ICS-204FRMAC form and a briefing on the content before departure into the field.

Preparation:

The ICS-204FRMAC is normally prepared by the Monitoring Manager, Field Team Supervisor or designee, using guidance from the Incident Action Plan.

Distribution:

A copy is supplied to the Field Team, Field Team Supervisor, and to Documentation Control.

Instructions:

A separate sheet is filled out for each Field Team.

1. Event Name	Enter the assigned name for this event.
2. Operational Period (Date/Time)	Team Start and Stop Date and Time entered in Military time. (Time zone is always the FRMAC location time.)
3. FRMAC Monitoring Personnel	Record the Monitoring Manager and Field Team Supervisor Contact Information (Name, Phone Number & Company) so the Field Team can contact them for information.
4. Team Name	The Alpha Numeric Name assigned to the Team. The format should be Phonetic Alphabet Date and shift. Example: "Alpha 2011-04-21 AM"
5. Resources Assigned	Record the Contact information for the field team: Field Monitoring Team Leader & Field Monitoring Team Member (Name, Phone Number & Company).
6. Work Assignments	Detailed instructions of what the Field Team is expected to complete in the field. The information will include survey locations with required measurements and samples.
7. Special Instructions / PPE	Detailed instructions typically relating to safety and operations such as personal protective equipment, allowable exposures and contamination levels. Turn Back Level is the maximum dose and contamination the team is allowed to enter. To reduce confusion all of the units listed should match the instruments used by the field team.
Approved Site Safety Plan Located at	Discloses the location of the Site Safety Plan which is available for review.
8. FRMAC Contact Number	List the position and Phone number of the most useful contacts for a Field Team.
9. Prepared by Date/Time	Signature date and time of the person who created the form.
10. Reviewed by Date/Time	After the team has been briefed and before they depart the person conducting the briefing will sign and date.

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Local Area Monitoring (LAM) Dosimeters

LOCATION				DOSIMETERS				
						Deployed	Retrieved	
#	Description	Latitude	Longitude	LAM #1 ID Number	LAM #2 ID Number	Date/Time Name	Date/Time Name	Comments
TRANSIT CONTROL DOSIMETERS								
Deployment Transit Control Dosimeter Number			1)			2)		
Retrieval Transit Control Dosimeter Number			1)			2)		
CHAIN OF CUSTODY								**DATE**
Relinquished By:				Received By:				
Relinquished By:				Received By:				
FOR HEALTH AND SAFETY DIVISION USE ONLY								
FRMAC to NNSS Transit Control Dosimeter Numbers								

LOCAL AREA MONITORING (LAM) Dosimeters

The *Local Area Monitoring Dosimeters* form is used to record information on the deployment and retrieval of environmental dosimeters, called LAMs.

Under "Location " section:

#	Enter the number of the station / location.
Description	Enter a description of the location.
Latitude and Longitude	Record the latitude and longitude of the station/location (in decimal degrees).

Under "Dosimeters" section :

LAM #1 ID Number	Record the ID number of one of the LAMs.
LAM #2 ID Number	Record the ID number of the other LAM.
Deployed Date/Time Name	Record the date/time when the LAMs are deployed and the name of the person who deployed them.
Retrieved Date/Time Name	Record the date/time when the LAMs are retrieved and the name of the person who retrieved them.
Under **Comments**	Include any additional, pertinent information.

Under "Transit Control Dosimeters" section :

Deployment Transit Control Dosimeter Numbers	Enter the transit control dosimeter number
Retrieval Transit Control Dosimeter Numbers	Enter the transit control dosimeter number

Under "Chain of Custody" section

Relinquished By	Name of person relinquishing control of the dosimeters
Received By	Name of person taking control of the dosimeters
Date	Date of the chain of custody exchange

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TEAM, INSTRUMENT, & EQUIPMENT INFORMATION LOG

Field Team Supervisor Initials: ______________________

Team Name		
Today's Date (DDMMMYYYY)		Start Time (Military)

FIELD TEAM MEMBERS INFORMATION			
	Field Monitoring Team Leader	**Contact Phone #(s)**	**Home Organization**
1			
	Field Monitoring Team Member	**Contact Phone #(s)**	**Home Organization**
2			
3			
4			
5			
6			

INSTRUMENT AND EQUIPMENT INFORMATION					
Radiation Detector	**Instrument / Equipment S/N**	**Model Number / Description**	**Radiation Detector**	**Instrument / Equipment S/N**	**Model Number / Description**

VEHICLE INFORMATION			
License Plate Number	**State**	**Make**	**Model**

This form must be completed and turned in to the Field Team Supervisor prior to field deployment

July 2020

The *Team, Instrument, & Equipment Information Log* is to track all the radiation detection instruments and equipment taken into the field by each team. This log **MUST** be completed and submitted to the Field Team Supervisor before departing the FRMAC.

Field Team Supervisor Initials	This form must be completed and turned in to the Field Team Supervisor prior to field deployment
Team Name	Record the Name of the assigned Field Monitoring Team
Today's Date	Record Today's Date (This form is filled out each day a team's deploys to the field. Example: DDMMMYYYY 20OCT2018.
Start Time	Is the Military Time before the Field Team Departs the TOC (Technical Operations Center)

FIELD TEAM MEMBER INFORMATION

Field Monitoring Team Leader	Record Name of the Field Team Leader
Field Monitoring Team Member	Record Name of each Field Team Member
Contact Phone #(s)	Cells Phone Numbers to contact Field Team Members
Home Organization	Company Name of each Field Team Member

INSTRUMENT AND EQUIPMENT INFORMATION

Some of the equipment issued to Field Teams can include radiation detection instrumentation, electronic dosimeters, breathing zone air samplers, air sample pumps, generators, etc.

Radiation Detector	Check the box if the instrument will be used for electronic data entry (RAMS/RadResponder). This includes all radiation detectors, air samplers, and in-situ systems. Do not check the box for equipment (such as soil sampling equipment, generators, MPCDs, and tablets).
Instrument / Equipment S/N	Record the Instrument Serial Number, Property Number, or other organizational identifying number for each instrument and equipment checked out by the Field Team.
Model Number / Description	Record the Model Number (type) or description for each instrument and equipment checked out by the Field Team.

VEHICLE INFORMATION

License Plate Number	Record the License Plate Number of the field team vehicle.
State	Record the state correspoding to the License Plate Number of the field team vehicle.
Make	Record the make of the vehicle.
Model	Record the model of the vehicle.

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SAMPLE CONTROL FORM & CHAIN OF CUSTODY | **SCF -**

Sample Information Entered into: ☐ DFM Tablet ☐ RadResponder

Sampling Information (*to be filled out by the Field Team*)			
Field Team:	Collector's Name:		Home Org:
Latitude:	Location Description:		
Longitude:			
Collection Date:	Collection Time (24hr):	Area Exposure Rate:	Sample Dose Rate:
Collection Comments:			

Sample Type (use only once)

Air	Personnel Occupational ☑	Environmental ☐	Filter size & Type: ☐ Paper ☐ Cartridge ☐ 2" ☐ 4" ☐ Other	
	Date/Time ON:	Date/Time OFF:	**OR**	Total Volume: units:
	Start Flow Rate & units	Stop Flow Rate & units		
	Companion Filter Type SCF # ☐ Paper ☐ Cartridge		Pump Serial Number	
Ground Deposition (Surface Soil and Vegetation).	Depth of soil: cm		Height of Vegetation: (Height less than 6 inches) cm	
	Sample surface area: cm²		Weight of Sample gram	
Milk	☐ Stored Feed ☐ Pasture ☐ Other:		Volume:	
	Milking Date:	Milking Time:		
Soil	Depth of soil sample: cm		Volume (cm3): L W D	
Water	☐ Surface ☐ Ground / Well ☐ Potable / Tap ☑ Other:		Volume:	
Other	☐ Spectra / Instrument ☐ Feed ☐ Food ☐ Vegetation ☐ Other ☐ Swipe		Description:	
	Sample Area (cm^3): L W H			

Sample Receiving (*to be filled out by sample control & hotline technician*)		
Receipt Contact Dose Rate uR/hr:	☐ **Contamination Check:** Forms and sample bags surveyed.	Weight of Sample gram
Remarks/Special Instructions		

Custody Transfer (Signatures)			
Relinquished By:	Date/Time	Received By:	Date/Time
Relinquished By:	Date/Time	Received By:	Date/Time
Relinquished By:	Date/Time	Received By:	Date/Time
Relinquished By:	Date/Time	Received By:	Date/Time

Original with Sample **Copy to Sample Control** **January 2020**

SAMPLE CONTROL & CHAIN – OF – CUSTODY FORM

Field	Data
Sample Information Entered Into	Check if "Sample Information" is recorded using MPCD Tablet or Rad Responder. If checked then only Chain-of-Custody signature is needed.
SCF -	If no Barcode or Sample Control Number, then create one (SCF-XXXXX).
Collection Team ID	Enter Team Name or Number.
Collector's Name	Enter Collectors Name (Can be team captain).
Home Org	Enter Collectors Home Organization.
Location Description	Enter a description of the sample location. This can be an address with a description of the location in relation to local landmarks (i.e., near stop sign). This is required if GPS Coordinates are not supplied
Latitude/Longitude	Estimated from map or read from GPS. The preferred format is degrees and decimal degrees. *(i.e .,* Longitude = -108°.27976).
Collection Date	Enter the "Date" the Sample was Collected (dd-mmm-yyyy 02SEP2009). For air or composite samples this is the "Date Off" (end date of collection period).
Collection Time	Enter the Time the Sample was Collected (24 hour clock). For composite samples this is the "Time Off" Enter the "Date" the Sample was Collected (dd-mmm-yyyy 02SEP2009). For air or composite samples this is the "Date Off" (end date of collection period). (end time of collection period).
Area Exposure Rate	Record the average area Exposure Rate where the sample is to be collected.
Sample Dose Rate	When background permits, then enter the dose rate of the sample container.
Collection Comments	Enter any pertinent information on the collection process (i.e., unusual occurrences). Include extra Sample Description if needed.
Sample Type	Complete the appropriate information for the "Sample Type". Use only one form per sample.
Air Sample	Choose if this sample is for Personnel / Occupational or long term environmental anlaysis
	Type and Filter Size, Date On & Off (dd-mmm-yyyy), Time On & Off (24hr). Enter either Start & Stop Flow Rate or Total Volume and Units. Enter Air Sampler Serial Number.
Additional Air Filter, Provide Sample #	Enter additional SCF # for each separate Air Filter Media taken at same location. (i.e., Paper & Charcoal Cartridge)
Ground Deposition	Is sample of deposition on the surface can include Surface Soil and Vegetation. Enter Depth of soil sample in centimeters. Enter the surface area sampled in $centimeters^2$ (square centimeters). Enter the height of vegetation present. Do not collect a sample if vegitation is over 6 inches. List companion sample number for the soil sample (Vegetation Sample ID).
Milk Sample	Check the "Feed Type". If "Other", describe in the remarks. Enter Milking Date (dd-mmm-yyyy) & Time (24hr). Enter Miking Time when the sample was collected.
Soil Sample	Enter Depth of soil sample in centimeters. Enter the Volume in cm^2. If needed manually record Volume Length x Width x Height. Sample weight is recorded at the hotline.
Water Sample	Check the "Source" of the water sample. If "Other", describe. Record the Volume.
Other	Check the sample type: "Spectra / Instrument" (Spectra to be saved in RAMS or RR), Feed – Animal Consumption, Food – Human Consumption, Vegetation – Default unless told to use Feed or Food, "Other" - Supply Description or "Swipe"
Sample Area (cm)	Record the Volume / Sample Area.
Description	Enter the description of sample and the size or volume of sample (i.e., Vegetation 1-gal sealable bags grass, Swipe 100 cm^2).
Receipt Contact Dose Rate	Samples are checked for contact dose rate as they pass through the hot line. Record the instrument reading and units.
Contamination Check	Check exterior of sample bags and forms for contamination. This step is performed at the hot line.
Weight of Sample	Record the Weight of Soil, Vegetation, Feed, Food and other like Samples. Recorded at the hotline.
Remarks/Special Instructions	Enter any special instructions (*i.e .,* homogenize sample). Indicate whether the sample must be prepared before being forwarded to the laboratory. Enter unusual circumstances discovered during sample receipt. Do not include problems recorded on the Non-Conformance Memo.
Relinquished by	Signed by person releasing custody of the sample. The custody must be relinquished to a person or secured area
Date/Time	Date and Time (24 hr) custody transferred
Received by	Signed by the person receiving the sample

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APPENDIX D:
OPERATOR AIDS

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Collect a FRMAC Staplex High Volume Air Sample Pump

Choose a Location

Suggested Equipment

Air Sample Pump
Tripod
Sample Cassette (4in)
Paper Filter (4in)
Quart Sealable Bag
Tweezers
Security Seal
Sample Control & Chain of Custody form
Generator (if required)
Extension Cord (if required)
Gloves

Gather all the required equipment before you depart for the field. This is a list of suggested equipment. Add or remove equipment as needed.

Locate the pump in an open area away from buildings, trees or other overhead obstructions. Rule of thumb is to locate the pump at least two times the height away from the closest obstruction.

Perform an exposure rate survey (waist high) and a contamination survey (ground). Record the measurements.

Position sample head approximately 1.5 meters off the ground (approximate breathing zone height). Point the Sample Head in the direction of the release.

If using a generator ensure the exhaust is downwind from the sample head.

Take a picture of the Air Sample Pump and surrounding Area. Submit with the other sample collection information.

May 2020

Collect a FRMAC Staplex High Volume Air Sample Pump

Assemble the Sample Head

Air Sample Cassette, paper filter.

Install the paper filter fuzzy side out.

If the front and back of filter cannot be determined, then place an ink spot on the front of the filter near the edge. Record this in the comments on the Sample Control Form.

Assemble the cassette.

Attach the Sample Cassette to the Pump.

Zero out the run time meter.

Air sample Cassette installed.

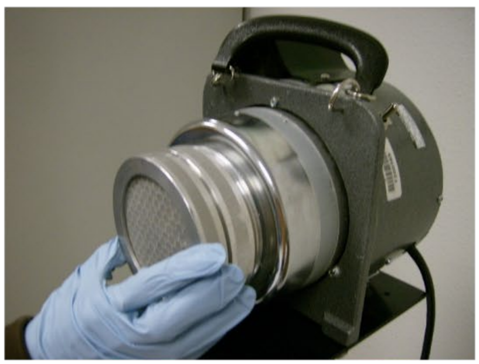

Start the air sample.

Collect a FRMAC Staplex High Volume Air Sample Pump

Check the Flow Rate.

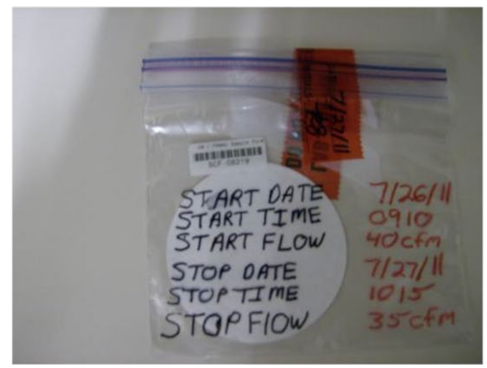
Record start date/time and flow rate on the sample bag. If required, record the start of the generator runtime. Put a barcode on the bag.

Before you STOP the pump, record stop date/time and flow rate on the sample bag.



Remove the Sample Cassette.

In a secure location, using tweezers, place the filter paper in a sample bag. Place a Security Seal on the bag.



Complete a Sample Control and Chain of Custody Form for each sample and input into the tablet. In the comments, reference the associated SCF number.

If background permits, survey the sample bag and record results on the SCF.

May 2020

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Collect a FRMAC F&J Low Volume Air Sample Pump

Choose a Location

Suggested Equipment

Air Sample Pump
Tripod
Sample Cassette (2in)
Paper Filter (2in)
Cartridge (Charcoal or Silver Zeolite)
Quart Sealable Bag
Tweezers
Security Seal
Sample Control & Chain of Custody form
Generator (if required)
Extension Cord (if required)
Gloves

Gather all the required equipment before you depart for the field. This is a list of suggested equipment. Add or remove equipment as needed.

Locate the pump in an open area away from buildings, trees or other overhead obstructions. The rule of thumb is to locate pump at least two times the height away from the closest obstruction.

Perform an exposure rate survey (waist high) and a contamination survey (ground). Record the measurements.

Position the sample head approximately 1.5 meters off the ground (approximate breathing zone height). Point the Sample Head in the direction of the release.

If using a generator ensure the exhaust is downwind from the sample head

Take a picture of the Air Sample Pump and surrounding Area. Submit with the other sample collection information.

Assemble the Sample Head

Air Sample Cassette, paper filter, and charcoal cartridge.

Install the paper filter fuzzy side out.

If the front and back of the filter cannot be determined, then place an ink spot on the front of the filter near the edge. Record this in the comments on the Sample Control Form.

Assemble the cassette.

Install the cartridge. Ensure the Air Flow Arrow is pointing in the correct direction.

Assemble the head.

Collect a FRMAC F&J Low Volume Air Sample Pump

Insert the Sample Cassette assembly into the air sampler.

Air sample Cassette installed.

Opening air sampler

Battery button

“POWER” button

(DC) Battery Charge

Flow/time/total volume indication button

Make sure Flow is showing.

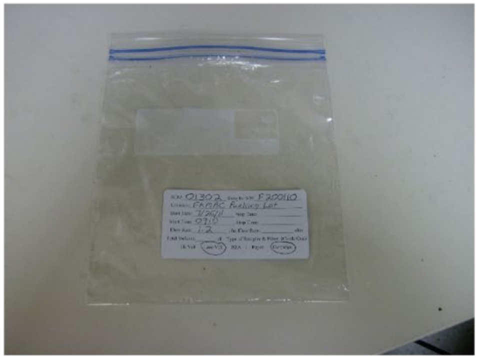
Press “RESET” to start Pump

Wait till flow stabilized.

Close the Lid.

May 2020

Collect a FRMAC F&J Low Volume Air Sample Pump



Record start date/time and flow rate on the sample bag. Put a barcode on the bag.

Press Button to see the Total Volume.

Before you STOP the pump, record the stop date/time and flow rate on the sample bag.

Press Button to return to Flow. Press "RESET" to Stop Pump.

Remove the Sample Cassette.

In a secure location, using tweezers, place filter and cartridge (if used) into separate sample bags.

Place a Security Seal(s) on the bag(s).

Complete a separate Sample Control and Chain of Custody Form for each sample and input into the tablet. In the comments, reference the associated SCF number.
If background permits, survey the sample bag(s) and record results on the SCF.

May 2020

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Collect a FRMAC Ground Deposition Sample

Early Phase

Suggested Equipment

Soil Sample Jig (10 x 10 x 2 cm)
Claw Hammer
Gallon Sealable Bag
Bags, 15 x 24
Security Seal
Sample Control & Chain of Custody form
Gloves

Gather all the required equipment before you depart for the field. Place into 15 x 24 bag to carry to sample location. This is a list of suggested equipment. Add or remove equipment as needed.

Collect and bag Soil and Vegetation as one.

At the sample location, arrange all needed supplies on a clean surface

Choose a location to collect the Ground Deposition sample in an open area, away from buildings, trees, or other overhead obstructions. Choose a location with as little vegetation as possible. **Less than 6 inches high of vegetation is recommended.**

Place jig at the sample location, with as little vegetation as possible. No more than 6 inches of grass or material.

Perform an exposure rate survey (waist high) and contamination survey (ground). Record the measurements.

Take a picture of the sample location and surrounding area. Submit with the other sample collection information.

Push the jig to 2 cm depth. Tap with the hammer if needed.

July 2020

Collect a FRMAC Ground Deposition Sample

Dig a trench with the trowel. Use claw hammer if needed to loosen the soil.

Slide the trowel under the jig. Use the hammer if necessary to push the trowel under the jig.

Clean Person: Roll the bag until a lip has been created. Hold bag under lip ensuring that the bag remains open for the Sampler to place the sample (soil and vegetation) into the bag, without touching the outside of the bag.

Pick up jig and trowel with the sample (soil and vegetation). Place content into 1 gallon sealable bag.

Roll the bag around the sample.

Keep the opening away from breathing area.

Place a SCF barcode and Security Seal on the bag. Complete the Sample Control and Chain of Custody Form and input into the tablet.

If background permits, survey the sample bag and record results on the SCF.

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Collect a FRMAC Standard Soil Sample

Suggested Equipment

Soil Sample Jig (10 x 10 x 2 cm)
Claw Hammer
Gallon Sealable Bag
Bags, 15 x 24
Security Seal
Sample Control & Chain of Custody form
Gloves

Gather all the required equipment before you depart for the field. Place into 15 x 24 bag to carry to sample location. This is a list of suggested equipment. Add or remove equipment as needed.

Choose a location to collect the sample.

Locate the sample in an open area away from buildings, trees, or other overhead obstructions.

Perform an exposure rate survey (waist high) and contamination survey (ground). Record the measurements.

Take a picture of the sample location and surrounding area. Submit with the other sample collection information.

At the sample location, arrange all needed supplies on a clean surface.

Place jig at sample location, with as little vegetation as possible. If vegetation was not necessary to be collected, then remove the vegetation. If vegetation is to be collected, then cut the vegetation as close to the surface as possible and collect as a Vegetation Sample.

Push the jig to 2 cm depth. Tap with the hammer if needed.

Collect a FRMAC Standard Soil Sample

Dig a trench with the trowel. Use claw hammer if needed to loosen the soil.

Slide the trowel under the jig. Use the hammer if necessary to push the trowel under the jig.

Clean Person: Roll the bag until a lip has been created. Hold bag under lip ensuring that the bag remains open for the Sampler to place the sample into the bag, without touching the outside of the bag.

Pick up the jig and trowel with the soil sample. Place content into 1 gallon sealable bag.

Roll the bag around the soil.

Keep the opening away from breathing area.

Place a SCF barcode and Security Seal on the bag. Complete the Sample Control and Chain of Custody Form and input into the tablet.

If background permits, survey the sample bag and record on the SCF.

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Collect a FRMAC Emergency Phase Water (Open Source) Sample

Choose a Location

Suggested Equipment

Sample Container (1 Gallon / 4 Liter Cubetainer)
Funnel
Bucket
Rope
Bags, 15 x 24
Security Seal
Sample Control & Chain of Custody form
Generator (if required)
Extension Cord (if required)
Gloves
Distilled or deionized water

Gather all the required equipment before you depart for the field. This is a list of suggested equipment. Add or remove equipment as needed.

Choose a sampling location. Perform an exposure rate survey (waist high) and a contamination survey (ground). Record the measurements. Take a picture of the sample location and surrounding area. Submit with the other sample collection information.

At the sample location, arrange all needed supplies on a clean surface.

Choose a location to collect the sample. Ensure enough water is available to fill a one-liter sample container.

Choose an area that is open, not sheltered by trees or high brush. Little or no current.

Place a SCF barcode on the sample container.

Rinse out the sample container and cap with deionized or distilled water.

Collect a FRMAC Emergency Phase Water (Open Source) Sample

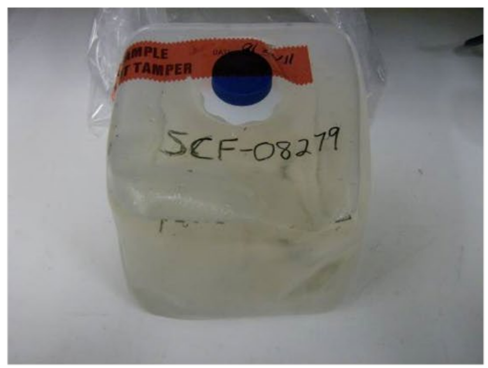
If needed attach the rope to the bucket.

Collect the surface water.

Using the funnel, fill the 1 gallon (4 liter) sample container. Stop 1 inch from the top.

If needed, rinse the outside of the container with deionized or distilled water. Dry the outside of the sample container.

To prevent leaks, wrap tape around the lid and container (not shown in the picture). Place a Security Seal over the opening.



If needed, use an indelible marker to write the SCF Number on the sample container.
Place into a clean plastic bag.

Complete the Sample Control and Chain of Custody Form and input into the tablet.

If background permits, survey the sample bag and record results on the SCF.

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Collect a FRMAC Emergency Phase Water (Tap) Sample

Suggested Equipment

Sample Container (1 Gallon / 4 Liter Cubetainer)
Funnel
Bucket
Rope
Bags, 15 x 24
Security Seal
Sample Control & Chain of Custody form
Gloves
Distilled or deionized water

Gather all the required equipment before you depart for the field. This is a list of suggested equipment. Add or remove equipment as needed.

Choose a location to collect a tap or well sample.

Take a picture of the sample location and surrounding area. Submit with the other sample collection information.

Perform an exposure rate survey (waist high) and contamination survey (ground). Record the measurements.

At the sample location, arrange all needed supplies on a clean surface

Place a SCF barcode on the sample container.

Rinse out the sample container and cap with deionized or distilled water.
Purge the tap to get a sample from the well supply and not the lines.

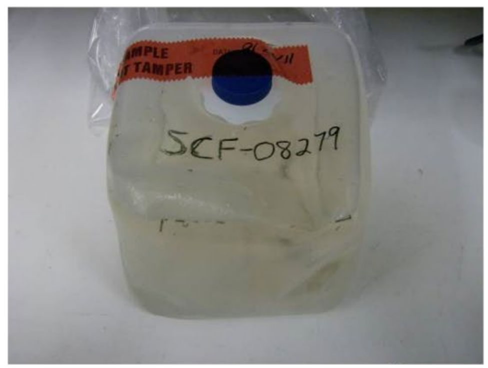
Collect a FRMAC Emergency Phase Water (Tap) Sample

Fill the bucket.

Using the funnel fill the 1 gallon (4 liter) sample container. Stop 1 inch from the top.

If needed, rinse the outside of the container with deionized or distilled water. Dry the outside of the sample container.

To prevent leaks, wrap tape around the lid and container (not shown in the picture). Place a Security Seal over the opening.



If needed, use an indelible marker to write the SCF number on the sample container.

Place into a clean plastic bag.

Complete the Sample Control and Chain of Custody Form and input into the tablet.

If background permits, survey the sample bag and record results on the SCF.

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Collect a FRMAC Emergency Phase Vegetation (Leafy & Grain) Sample

Early Phase Vegetation Sample

Suggested Equipment

Pruning Shears
Gallon Sealable Bag
Bags, 15 x 24
Tape measure
Grass Clippers
Knife
Security Seal
Sample Control & Chain of Custody form
Gloves

Gather all the required equipment before you depart for the field. Place into 15 x 24 bag to carry to sample location. This is a list of suggested equipment. Add or remove equipment as needed.

Choose a location to collect the sample. Locate the sample out in the open, away from buildings, trees or other overhead obstructions.

Take a picture of the sample location and surrounding area. Submit it with the other sample collection information.

Perform an exposure rate survey (waist high) and a contamination survey (ground). Record the measurements.

At the sample location, arrange all needed supplies on a clean surface.

Clean Person: Roll the bag until a lip has been created. Hold bag under lip ensuring that the bag remains open for the (Sampler) to place the sample into the bag, without touching the outside of the bag.

Only collect the edible portions of the plant. Clip pieces 6 inches or less (to fit in the bag).

Stop before the bag is bulging and will not seal.

May 2020

Collect a FRMAC Emergency Phase Vegetation (Leafy & Grain) Sample

Measure the length, width and depth of the sample collected. Record this information.

Place a SCF barcode & Security Seal on the bag. Complete the Sample Control and Chain of Custody Form and input into the tablet.

If background permits, survey the sample bag and record results on the SCF.

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Operator Aid: FRMAC *In Situ* Gamma Spectroscopy Measurements

Introduction

The purpose of taking high-purity germanium (HPGe) *in situ* spectra in the early stages of an event is to measure the isotopic ratios and concentrations. The ratios provide information on what materials were released, and how they settled to the ground. The concentrations provide absolute measurements of how much material settled. Both of these items are important when estimating the doses people will receive.

When *in situ* measurements are repeatedly performed at the same location, information on how the deposited radioactivity is changing can be assessed. In the early stages of an event, the radioactivity may be increasing, indicating that material is settling to the ground. Later measurements are expected to provide information on how the deposited activity is weathering. Weathering can mean migration of the material into the soil through precipitation or removal/redistribution by such things as wind, rain, or decontamination efforts.

Equipment Required to Perform Measurement

- ORTEC Detective
  - Charging station (Bring to the field)
  - AC and DC power cords
  - External battery (2590 w/cord)
  - SD Card
- Tripod kit
  - Contamination control sleeves for the legs
- CM Tablet
  - USB to SD card reader
  - External battery supply
  - Power cord
- Multi Path Communication Device (MPCD)
  - Entire inventoried kit
- Handheld Radiation Detection equipment i.e., Frisker, dose rate meter
- Known Cs-137 source (Do not bring into the field)

Operator Aid: FRMAC *In Situ* Gamma Spectroscopy Measurements

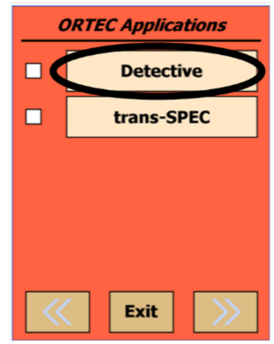
Equipment Preparation

- Inventory all equipment
  - ORTEC Detective
  - Power adapter and cables
  - Battery pack and cables
  - SD card
  - Tripod with bags on legs for contamination control
  - FRMAC tablet
  - Laptop computer (*optional*)
  - GPS (*optional*)
  - Camera (*optional*)
- Confirm/Set date and time to local time on Detective
- Check/Update the energy calibration on Detective
- Check preset time (*if available*)
- Check/Update spectrum storage location to SD card
- Check spectrum file format is set to both Ortec and ANSI
- Set/Update default description (*FIS#* and *team*)
- Perform an automatic energy calibration

System Setup

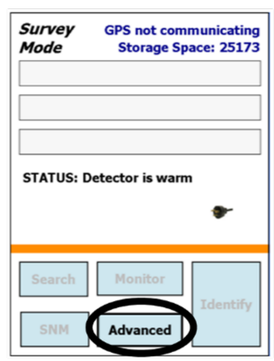
- Connect the Detective into the charging station, then using either the AC or DC power cord, plug the station into a power source.
- Turn on the PDA and check the systems Date and Time.
- Choose the Detective program if at the Windows start screen.

Charging Station

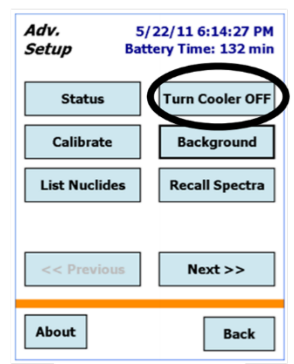


Detective Selection Screen

- Select **Advanced**
- Select **Turn Cooler ON**



Advanced Menu

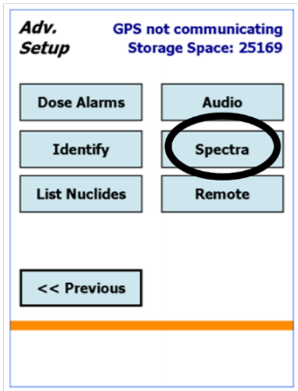


Cooler Controls

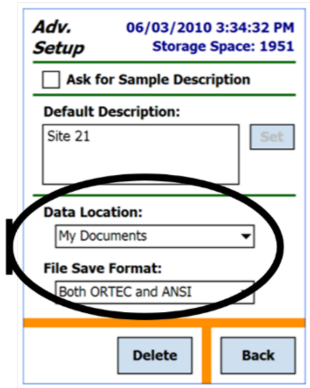
- The Detective must be plugged into the charging station to start the cooler and get it to the proper operating temperature
  Note: The detector may need 24 hours to reach the operating temperature.

Operator Aid: FRMAC *In Situ* Gamma Spectroscopy Measurements

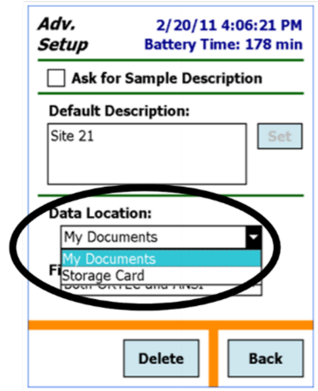
- **Set Spectrum Storage** location by clicking on the **Advanced** menu.
  - Then More (Next) until you can Choose **Spectra.**
  - Under **Data Location**: Choose **Storage Card/Data** then under **File Save Format:** Choose **Both Ortec and ANSI**



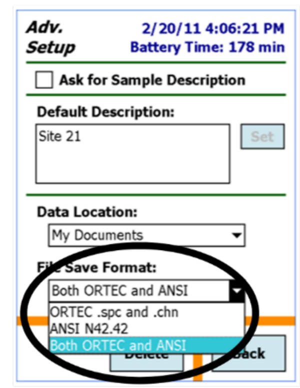
Advanced Menu / Next



Advanced Menu (Spectra)



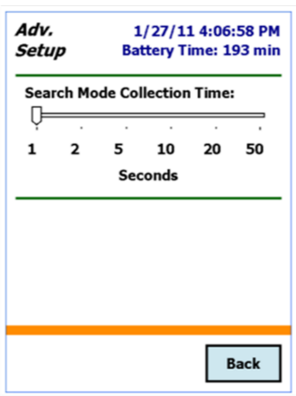
Data Location Selections



File Formats

Note: Ensure the Detective has an SD Card inserted. There is a Lock switch on the left side of the SD card. Make sure the Lock switch is in the unlock position.

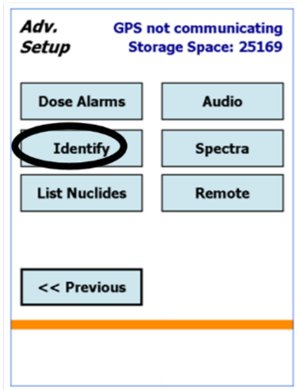
- Set **Sample Time** by clicking on **Advanced** then **Search** and moving the **slider to (1s)**.



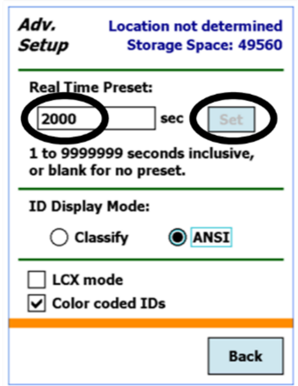
Sample Time Setting

Operator Aid: FRMAC *In Situ* Gamma Spectroscopy Measurements

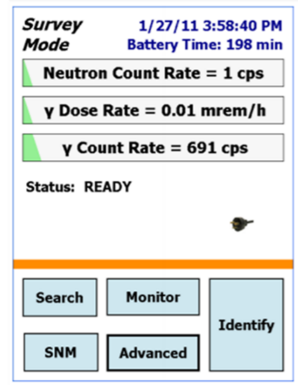
- **Set Count Time by Selecting** the **Advanced** button, then **More (Next)**.
  Select the **Identify** button this will bring up the **Real Time Preset** box.
  - Set to **600 seconds for 10 min count** (or whatever count time you were instructed). Be sure to press **SET** if you change the time.
  - Then press **Back**, **Previous**, and **Back** to get back to the main screen that has the **Identify** button.



Advanced Menu / Next



Where to set count time presets

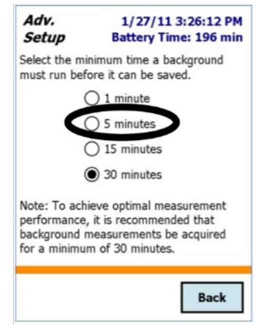


Main User Screen

Automatic Energy Calibration of the ORTEC Detective

Resources: Detective and a 1µCi to10µCi ^{137}Cs source

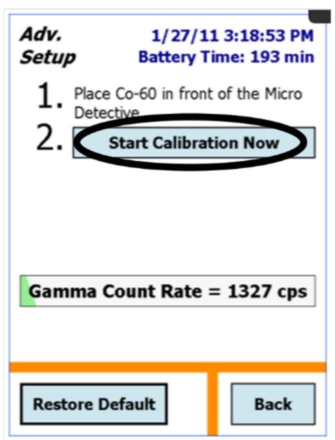
- Ensure the *in situ* system is cooled down and ready to operate.
- If the Detective is connected to a computer via USB cable, disconnect it.
- Before calibrating the Detective, set the Background count time. Select **Advanced,** then **Next** to get to the **Bkg Settings**. Make sure it is set for **5 Minutes**. Then go back to the previous screen.
- Select the **Calibrate** button. Place the Cs source in front of the detector then Select the **Start Calibration Now** button on the Detective. Follow the instructions on the PDA screen.
  - If improved calibration is found, choose **Use Improved Calibration.**



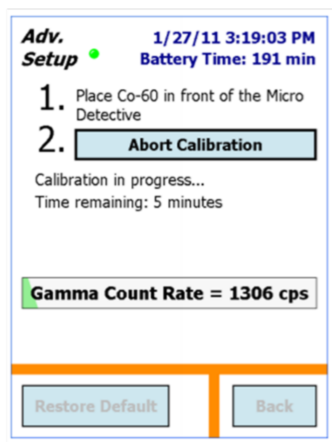
Background Time Setting

- At this point you will have to take a new Background.
  - Remove the Cs source from the area (it will interfere with background reading if nearby).
  - **Select** the **Background button.**

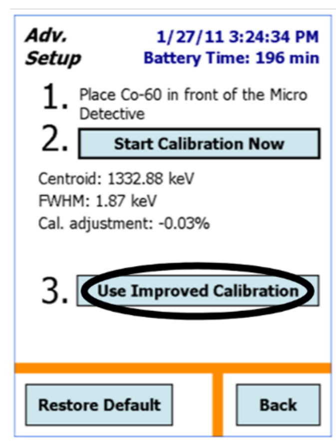
  Note: This Background will be saved on the Detective's internal memory, not the SD card.



Calibration Start Screen



Calibration in Progress Screen



Calibration Completion Screen

Setup for Background and Known Source Measurements

Before departing, unless told otherwise, take a 10-minute count with a Known Source (Cs-137) and a 10-minute Background outside the Technical Operations Center (TOC). **Save** this on the **SD Card** and then using the **Card Reader and the MPCD Tablet send this Data to RAMS** before leaving for the field.

Prior to field team departure

- Ensure the *in situ* system is cooled down and ready to operate.
- Set the required measuring time as indicated in the field team instructions (Reference Page 5 of this document).
- Assemble Tripod and tape the Tripod feet up to prevent contamination.
- Collect a background *in situ* measurement preferably in a low background area that will be representative of the sampling area. Be sure that no check sources are nearby. Reference pages 8-11 for selecting a site, *in situ* setup, and measurement collection.
  - Record the file name. Once the file can be renamed, rename it with a unique name as well as an indicator that the spectra is a background (example: FIS-9_Alpha_12-25-2020_BKG).
- Collect a spectra of a known radioisotope. This can be done at the same location as the background (as long as the addition of a radioactive source will not interfere with backgrounds being performed by other teams). Reference pages 8-11 for selecting a site, *in situ* setup, and measurement collection.
  - Record the file name. Once the file can be renamed, rename it with a unique name as well as an indicator that the spectra is a known source (example: FIS-9_Alpha_12-25-2020_KNOWN_Cs).
- Submit *in situ* measurements via the tablet (Reference page 12 of this document).

Operator Aid: FRMAC *In Situ* Gamma Spectroscopy Measurements

Site Selection (Best Practices)

- Upon arrival at the pre-determined location, choose an area that is flat and without large obstructions (walls, berms, ditches, or cliffs) to a radius of 50 ft, and do not have heavy foliage overhead or other overhangs. The area should have minimal or no ground disturbance (i.e., that the land has not been plowed, or any other activity, that has unnaturally mixed the soil since the radionuclide deposition).
- Use a handheld exposure rate meter to perform rough surveys of about 20x20 feet to see that the rate is constant (within measurement errors). Select an area that ensures a dead time maintained at or below 60% if possible. General guidance is an area that is < 3 mR/hr.

In situ measurement site guidance:

- Sampling should be conducted only in undisturbed environments.
- Area exposure rate should be less than 3 mR/hr or result in dead time that is less than 60%.
- Ensure a photo is taken of the area.
- This page shows examples of suitable locations for *in situ* measurements.

Site Selection (Undesirable)

If you are unable to find an ideal location close to the location in the field team instructions, collect the measurements and record all the issues. Ensure a photo is taken of the area.

This page shows examples of less than desirable locations for *in situ* measurements.

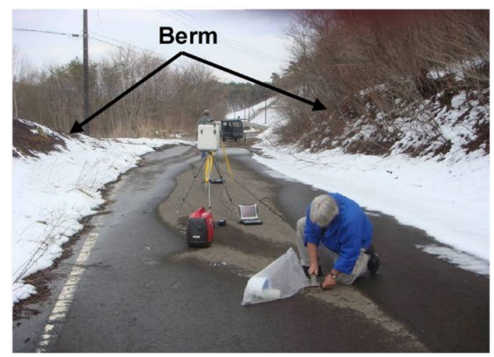
This would be a good location if the parking lot was undisturbed and the rain had not washed out the deposition.

Drop off or discontinuity present. Also unknown when the soil disturbance occurred.

Avoid tilled fields, pavement, and vegetation-pavement transition.

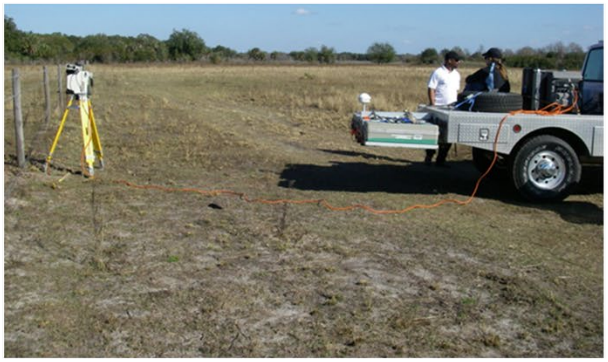
Culvert or discontinuity present. Unknown when the soil disturbance occurred.

Pole and culvert too close. Unknown if the road is open to traffic. A possible mix of undisturbed and disturbed deposition present.



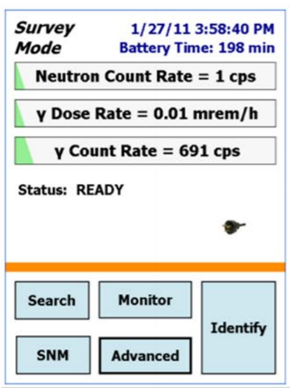
If the road is open to traffic, disturbed deposition present. In between two berms on each side of the road.

HPGe *In Situ* System Setup



Disconnect HPGe from power source (if battery level permits). If the battery level is low, provide power to the HPGe from an external power source and extension cord
or external battery.

Set up tripod in a stable manner at the desired location. Set the detector facing down on the tripod, positioning it 1m above the ground surface.



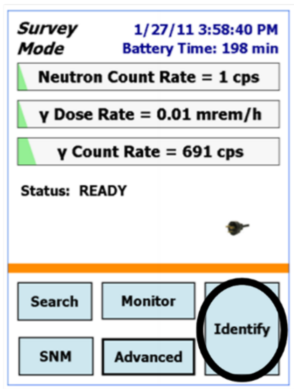
Switch on the system. Check its basic functionality and verify that the dead time does not exceed any limits as noted in the field team instructions.

If it is raining or snowing, cover the HPGe with a waterproof covering.

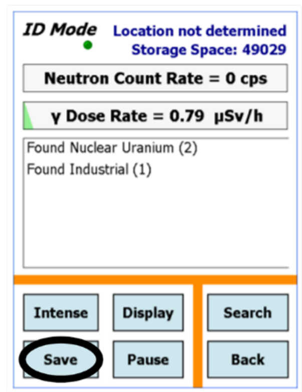
Operator Aid: FRMAC *In Situ* Gamma Spectroscopy Measurements

Collecting an *In Situ* Measurement

- Push the **Identify** button, from the Main Menu, to collect the data.
- Spectrum will accumulate until user pauses or the Preset Count time has been reached. **If user exits, before saving, then the spectra is lost.**
  - While the system is counting, take a picture of the setup from 20-30 feet away showing the surrounding landscape.
- **Click on Save**. It will save the spectrum file on the **SD Card by Date and Time.**
- **Take notes of the time and any pertinent information** (instrument live time, dead time, real time and about the terrain at the measurement location).
  - This information will be entered later into the tablet.
- Submit *in situ* measurements and photo via the tablet (Reference page 12 of this document).



Identify button shown



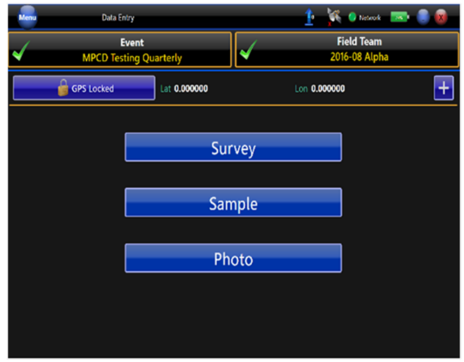
Save button shown

DFM PROGRAM Submitting a Sample (Spectra)

Any FRMAC tablet can be used with any DETECTIVE.

The following will be collected and transmitted through the DFM Tablet and submitted as a Sample:

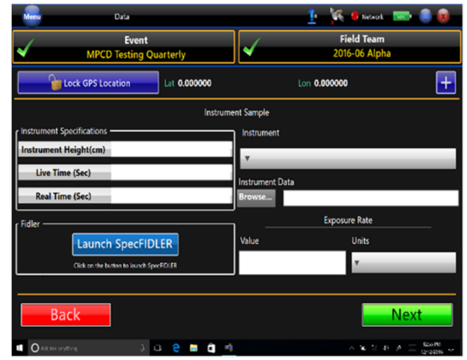
- Known source (Cs-137)
- Background (Collected in a representative area before departure to the field)
- Measurements (spectra collected during field team deployments)



Open the **DFM** (Digital Field Monitoring Program) on the tablet.

Press “**Sample**.”
Choose “**Instrument**.”

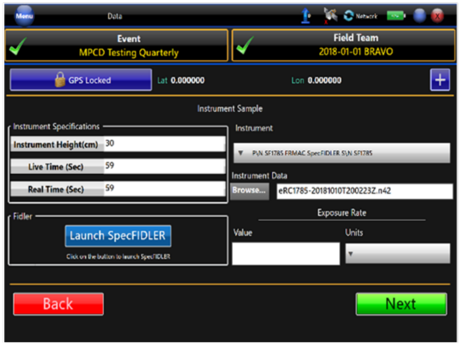
Insert the SD card from the DETECTIVE into the USB Card reader into the Tablet.



In the “Instrument Specifications” section:

- Record the Instrument Height (cm) – if using the tripod, then the height is 100 cm.
- Record the Live Time (Sec) – Count Time from Detective.
- Record the Real Time (Sec) – If Unknown use the Count Time.

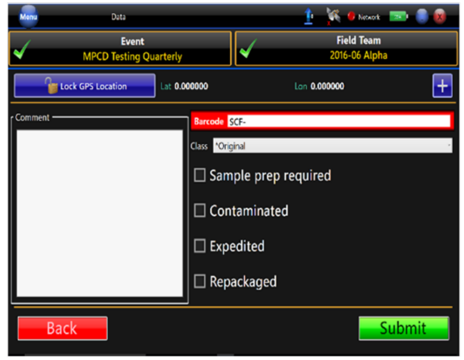
DFM PROGRAM Submitting a Sample (Spectra) continued



Choose the correct Detective in the **"Instrument" drop down list**. For a quick search, type the name or description of the detector.

Click "**Browse**" to find the applicable spectra file on the SD card. After selecting the file, click "Open" and ensure that the file name is in the "Browse" text box in DFM.

Record the exposure rate value and units. Choose **"Next."**

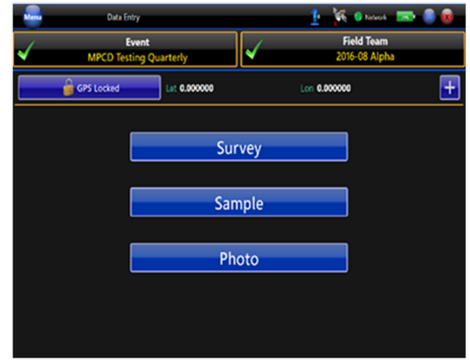


In the **"Barcode"** section, assign a barcode from a Sample Control Form.

In the "**Comments**" section, include if the spectra is a background, known nuclide, or a sample and any other pertinent information.

Press "**Submit**" to send the spectrum and other information to the database.

Secure the SCF form, so the barcode number will not be reused.



Pictures are required. The tablet has a camera. Take pictures of the tripod from a distance so the data analyst is aware of the terrain or if someone has to return they know where the measurement was taken.

Click the **Photo** button to put the tablet in camera mode.

Tap on the small camera icon (center, right side of the tablet) to take pictures.

To exit, use the close button located at the top right. Be sure to send pictures when sending the data for each measurement.

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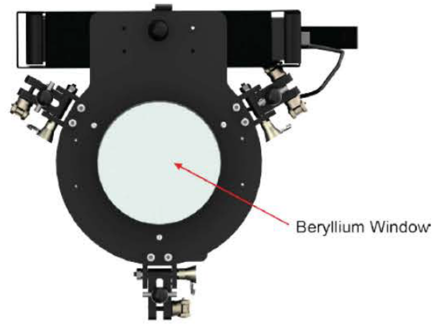
Operator Aid: FRMAC SpecFIDLER

Assemble the SpecFIDLER

Suggested Equipment
SpecFIDLER
Fully Charged Li-Ion Battery
Tablet Computer
Am-241 Radioactive Source



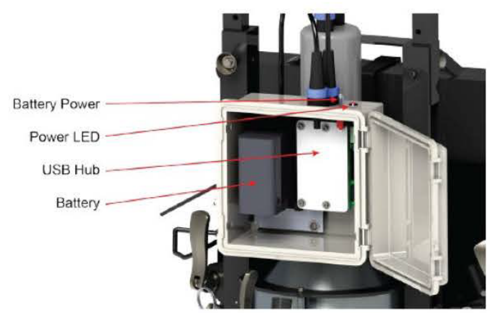
Beryllium window is very fragile and easily damaged. Remove the protective cap to inspect window. If Undamaged it is safe to use. If the window is damage **DO NOT USE! Tape the Cap to the detector and tag "Out of Service"**. Notify Field Team Supervisor.

Detector height is 30 cm with legs extended down and out.

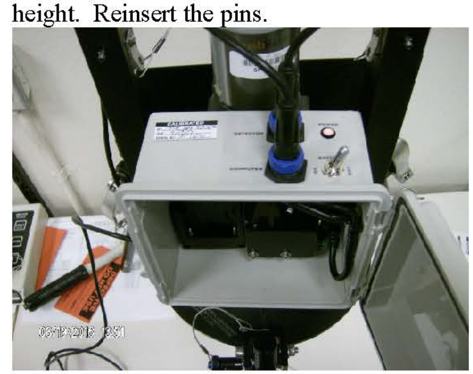
To extend legs Loosen clamps, Tighten Clamps to secure height.

Pull the Pin to Lift handle to desired carry height. Reinsert the pins.

Pull the Pin to swing the Legs Out. Reinsert the Pin secure the leg. Pin Close to detector is for storage. Pin away from detector is for use.



Attach USB Cable to the "Computer" USB on the Battery housing. Install the Li-Ion battery inside the Battery housing. Ensure both battery contacts make a connection. **Turn the Power Switch ON before you connect the Tablet.**



NOTE: Once the Tablet is connected the Battery Light is ON whether the Switch is ON or OFF. If the battery is not installed the HV will be supplied from the Tablet and shorten Tablet Battery life.

January 2019

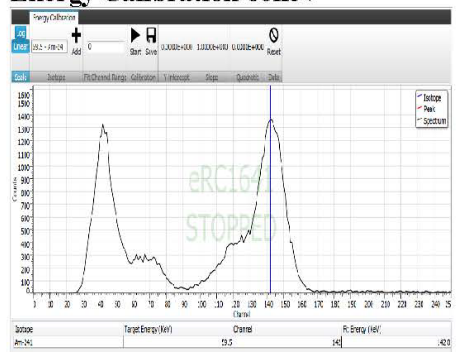
Energy Calibration

Energy Calibration (Speedometer Tab)

An Energy Calibration should be collected at the beginning of each shift.

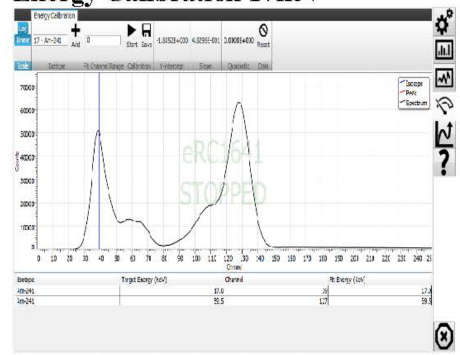
Energy Calibration is the process of assigning the peaks of certain isotopes to specific channels. Once it is completed, the spectrum scale will be based on energy, instead of channel.

Energy Calibration 60keV



Start the SpecFIDLER Program
Choose the "Energy Calibration" Tab
Place Am-241 Source Under the Detector
Press "**Start**" to start a count
Choose 59.5 – Am-241 from the "Isotope" drop down
Place the cursor in the center of the 60 KeV peak (Right), after at least 1000 Counts have collected
Press "**Add**"

Energy Calibration 17keV



Choose 17 – Am-241 from the "Isotope drop down
Place the cursor in the center of the 17 KeV peak (Left) after at least 1000 Counts have collected
Press "**Add**".
Press "**Stop**" to stop current count
Press "**Save**" to save the new Energy Calibration
Close the SpecFIDLER program

DFM PROGRAM (DIGITAL FIELD MONITORING) Submitting a Sample (Spectra)

Any Tablet can be used with any SpecFIDLER. Ensure the current Setting file has been loaded on the MPCD Tablet before use. Verify the Calibration Sticker Calibration Date matches the SpecFIDLER.exe Settings Tab Efficiency Calibration Date.

For each days mission Keep the Same Tablet and SpecFRIDLER for all measurments.

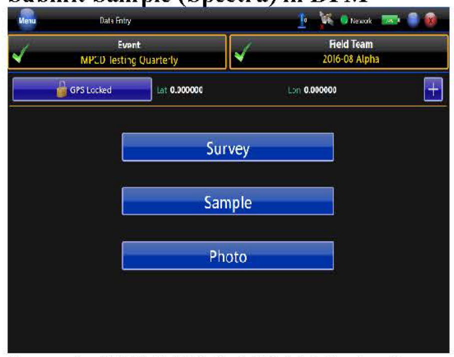
Start of Shift

- Complete an Energy Calibration

The following will be collected and transmitted through the DFM Tablet and submitted as a Sample:

- Known Measurment (Am-241)
- Background (Collected in Parking Lot before departure into the Field)
- Unknown Spectra Collected throught out the day)

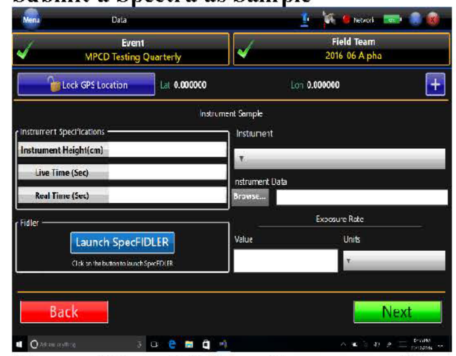
Submit Sample (Spectra) in DFM



Open the **DFM** (Digital Field Monitoring Program)
Press "**Sample**" to submit a Spectra

To submit a "Survey" (Measurment result) see page 5

Submit a Spectra as Sample



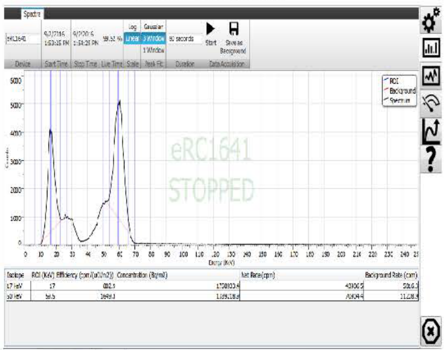
Choose "**Sample**" Than "**Instrument**"
Ensure SpecFIDLER is attached to the Tablet
"**Launch SpecFIDLER**"
Wait for the SpecFIDLER program to start in the **Spectra Tab**

January 2019

Operator Aid: FRMAC SpecFIDLER

DFM PROGRAM (DIGITAL FIELD MONITORING) Submitting a Sample (Spectra)

Collect a Known Source



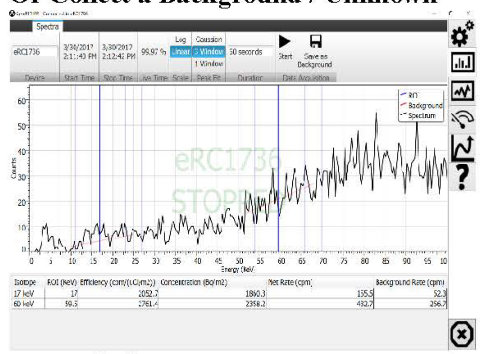
SET Peak Fit to "**1 Window**"
SET Duration to "**60 Seconds**"*
PLACE the Am-241 source centered below the detector Face
PRESS "**Start**"
RECORD all pertinent information on a Daily Instrument QC Check form including:
Instrument Serial Number:

- Instrument Type (Model Number): (*SpecFIDLER*)
- Depart Date / Time
- QC Check Source Type: (*Am-241*)
- Check Source ID #:
- Check Source Activity:
- Acceptable Operating Range: (*found on the Calibration Sticker*)
- Depart Actual Reading; 17 keV and 60 keV Concentration (*Bq/m2)*

*60 Seconds is a Default. Field Team Supervisor will inform you if a longer count is needed

GOTO the **Return to DFM** slide

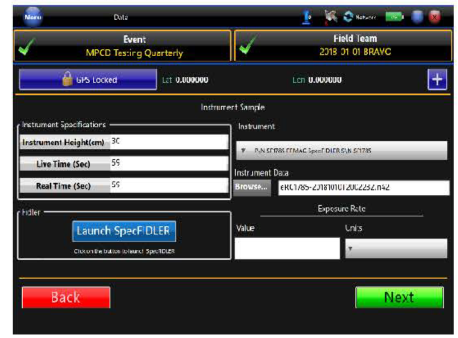
Or Collect a Background / Unknown



SET Peak Fit to "**1 Window**"
SET Duration to "**60 Seconds**"
PRESS "**Start**"
*For Background, At the completion of the Count press "**Save as Background**"
NOTE the following on a piece of paper:
17keV Conectration (Bq/m2)**
60keV Conectration (Bq/m2)**

**In RAMS the 17keV & 60 keV Concentration is stored as two separate Survey probes and recorded as a "Survey" See "To Submit a Survey" on page 5

Return to DFM



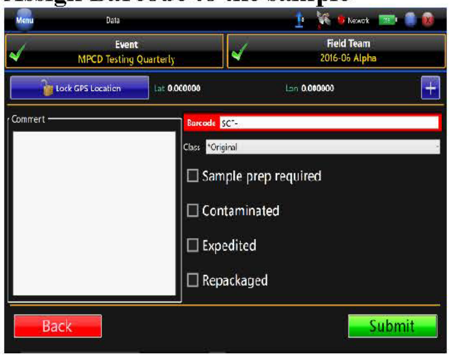
At the End of the Count Time, Close the SpecFIDLER program. After the Shutdown, DFM will be populated with the Instrument Specifications including Instrument Serial Number# and the Saved Spectra file name.
Review the information is complete.
Press "**Next**".

January 2019

Operator Aid: FRMAC SpecFIDLER

DFM PROGRAM (DIGITAL FIELD MONITORING) Submitting Survey (Measurement)

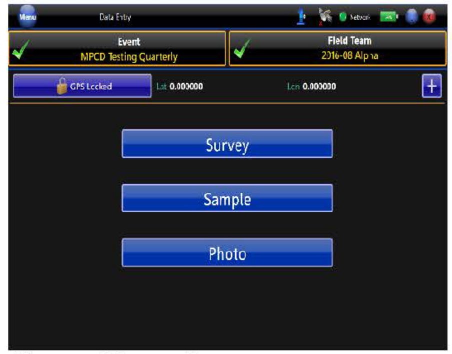
Assign Barcode to the sample



Assign a Barcode from Sample Control Form.
Record any "**Comments**". Including if this is a Background, Known or any other pertinent information.

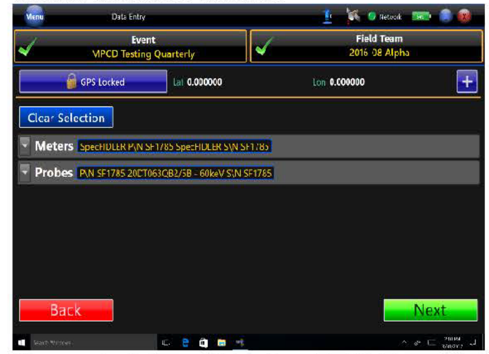
Press "**Submit**".
Secure the SCF form, so the Number will not be reused.

To Submit a Measurement



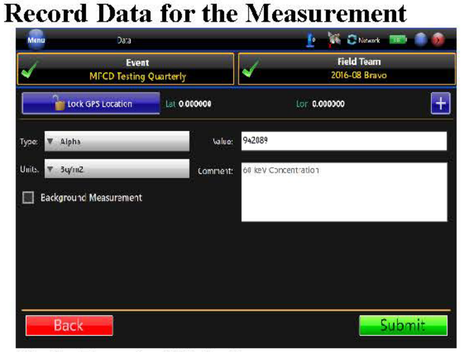
Choose "**Survey**"
To record the SpecFIDLER Measurement values

Choose the Meter & Probe



Choose the Meter of the SpecFIDLER used.
Choose the Probe for 17keV or 60 keV
* In RAMS the 17keV & 60 keV Concentration is stored as two separate Survey probes and recorded as a "Survey"
Choose "**Next**"

Record Data for the Measurement



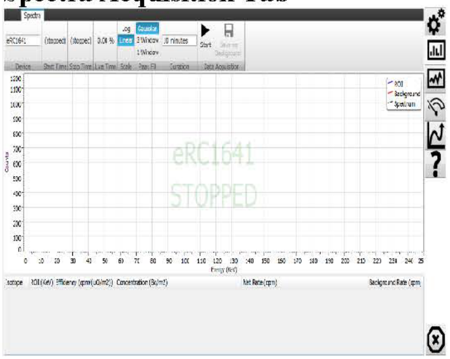
Verify Type is "**Alpha**"
Choose "**Bq/m2**" for the Units
Record the 17keV & 60 keV Concentration value for each probe. Press "**Submit**".

Submit a picture of the SpecFIDLER and surrounding Area with the Sample Collection Information.

January 2019

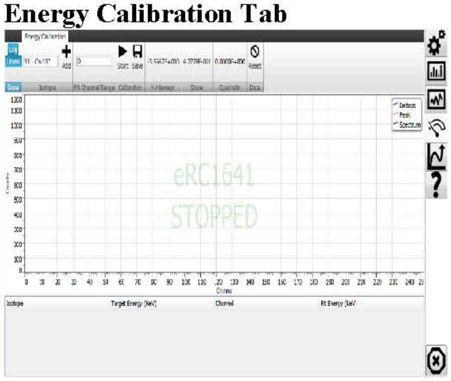
SpecFIDLER Program Tabs

Spectra Acquisition Tab



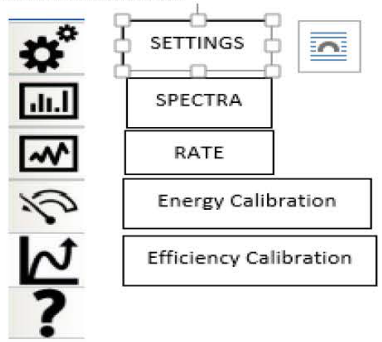
Attach USB cable to Tablet.
Start the SpecFIDLER Program located on the Desk Top. The Screen Defaults to the Spectra Screen. The SF Serial Number should be seen in the background.

Energy Calibration Tab



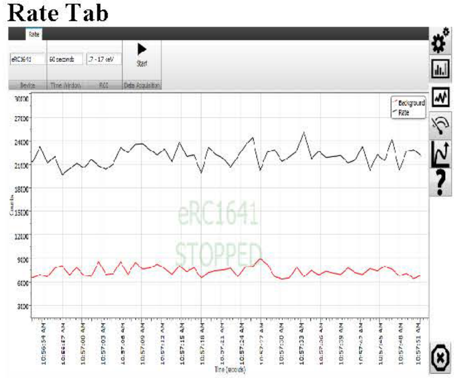
Energy Calibration is performed at beginning of shift or after major Temperature change

TAB Definitions



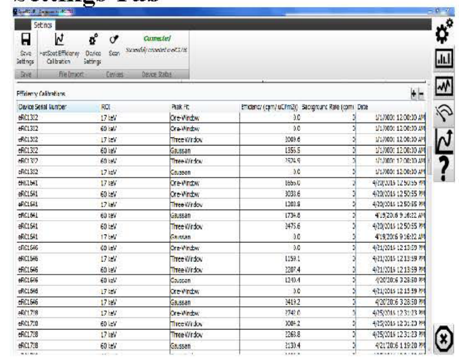
Select the Required Tab
"SPECTRA" Tab is the Tab used to collect measurements.
"SETTINGS" Tab Shows Instrument Settings.
"Energy Calibration" Tab Used to set up Instrument and check Gain Shifts

Rate Tab



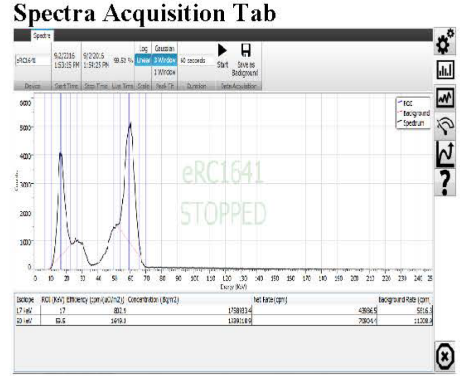
Rate Mode is used with the legs raised to locate maximum readings when scanning a large area.

Settings Tab



VERIFY the Calibration date on the Calibration Sticker is the same on the Efficiency Calibration date in the Settings Tab. If the Dates do not match the current Efficiency Calibration and Acceptable Operating Range for the Concentration (Bq/m2) will not be correct.

Spectra Acquisition Tab



Spectra Acquisition is used to collect measurements.

Operator Aid: FRMAC SpecFIDLER

Safe Handling of the Beryllium Window for All Users
The FIDLER (Field Instrument for Detecting Low Level Radiation) detector is a thin window Sodium Iodine Crystal with a Beryllium window.

Beryllium (Be) is a chemical Element. Inhalation of Beryllium dust can lead to Chronic Beryllium Disease. Solid Be windows are OK to work with.

As you are packing and unpacking the detectors and before use and during use examine the Be window. If the window is damaged, secure the protective cover to the detector using tape, Tag the system Out Of Service and notify Field Team Supervisor.

Training for MSTS personnel operating a FIDLER
Beryllium Awareness Briefing (WBT) (1E00W403) will be made a prerequisite to the CMRT Field Monitoring Team, Advanced Training Course for the Field Monitoring Specialist position.

Collateral credit is given by taking course one of the following courses

- Chronic Beryllium Disease Prevention Program (1E000404)
- Underground Worker Safety Training - 8 Hr. MSHA (1E000668)
- Toxic Metals Awareness – WBT (1E00W705)

Training for MSTS personnel responsible for the care and maintenance of FIDLER detectors
Follow the directions in "CD-P-450.014 Chronic Beryllium Disease Prevention"
Complete Chronic Beryllium Disease Prevention Program (Instructor Led) -1E000404

FIDLER DETECTOR DESCRIPTION

A nuclear weapons accident involving a fire or explosion could disperse plutonium isotopes over several square kilometers of varied terrain. A reliable method for determining environmental contamination levels must be available to evaluate the health and safety concerns.

A standard technique for measuring plutonium contamination levels involves the detection of alpha particles. This technique presents a problem for environmental measurements due to the fact that alpha particles are easily absorbed by soil, vegetation, water, etc. The SpecFidler is designed to overcome the problems associated with alpha particle detection by detecting the low energy photons emitted by plutonium and americium.

The SpecFidler uses the FIDLER detector to detect low-energy (11 to 21 keV) x-rays from plutonium and low-energy (26 to 60 keV) gamma rays from americium. The FIDLER's scintillator consists of a 12.7 cm diameter, 0.16 cm thick NaI (Tl) crystal. The detector entrance window is made of low-Z beryllium, 0.0127 cm thick.

The FIDLER detector is very sensitive to photons with energies from 5 to 100 keV, with very little Compton background from higher-energy photons. The FIDLER converts each counted photon into an electrical pulse whose height is proportional to the energy of the photon. The SpecFidler sorts the pulses by energy and develops an energy spectrum. From this spectrum, the SpecFidler can distinguish which photons are from americium and which photons are from plutonium.

Two regions of the spectrum, called regions of interest (ROI), are used in the calculation of plutonium and americium concentrations. The lower region (ROI 17) encompasses the L x-rays (11 to 21 keV) emitted by both plutonium and americium, commonly called the 17 keV peak. The upper region (ROI 59.5) encompasses the 60 keV peak of gamma rays emitted by americium. Each region is defined by lower and upper limits that are set during the calibration procedure. The limits are set at the approximate channel where the counts are less than or equal to one-half the counts in the peak channel.

The SpecFidler is controlled by tablet or laptop that has the installed SpecFidler application.

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CMRT / FRMAC Breathing Zone Air Sampler (BZA) Operator Aid

Issue BZA

- Obtain a charged BZA, Hose, Cassette and New Filter paper.
  - Use tweezers to install new filter into the cassette.
  - Ensure the blue paper separator is not with the filter.
  - Ensure the black gasket is in the cassette holder top.
  - Do not over tighten the cassette holder.
- Attach cassette to **BREATHING ZONE** of wearer (shirt collar).
- Attach pump to belt.
- Press ON/OFF to start pump.
- Wait for the pump to complete a self test and to stabilize to the desired flow rate (typically 2.0 lpm).
- Note the Start Time and Flow Rate.
- To pause the pump run time Press PAUSE/HOLD.
- Press PAUSE/HOLD to resume run time.
- When departing from the area Press ON/OFF to stop the run time and pump.
- Turn pump into designated Field Team Member to process the filter.

CMRT / FRMAC Breathing Zone Air Sampler (BZA) Operator Aid

Receiving and processing the filter paper

- A Field Team Member will be assigned responsibility to receive the BZA filters count on a scaler and complete a FRM-0108F "Radiological Survey Report – Breathing Zone Air (BZA) Spreadsheet" form (this form originates from the M&O contractor of the NNSS).
- Follow the instructions on the back of the form.
- Up to 6 people can be put on one FRM-0108F. A new form will be created for each day.
- If the pump was issued to a team, record each team member's name in the other columns.
- The Health & Safety division will maintain an electronic copy of each FRM-0108F.
- Record the required information on a draft paper version of FRM-0108F until you have access to a computer and the electronic FRM-0108F is available. Follow the Instructions on the back of the form.
- As the team returns and turns in the BZA filter, record the information before the team is released. Follow the instructions on the back of the form.
- Using tweezers, remove the filter paper and place into an envelope.
    - Label the envelope with the name and date of the filter.
- At this time, you can release the Team.
- Charge the BZA battery for the next use.
    - A fully charged battery will give you over 17 hours of use.
    - 14 hrs are required for a full battery charge.
- Take the filter to a Ludlum 3030 or iSOLO swipe counter.
- Follow the Instructions on FRM-0108F to fill in the remaining information.
- The remaining rows will be calculated on the electronic spreadsheet.
- Print a Hard copy. Print and sign your name in RCT Name field.
- Turn in the completed spreadsheet to the Health & Safety Manager or designee to review the DAC levels.

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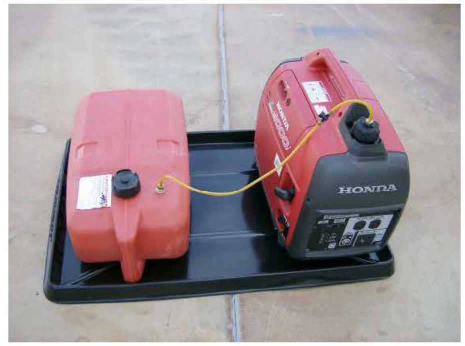
Operator Aid: FRMAC Generator Use

Suggested Equipment
Generator
Gasoline
External Gas Tank (if required)
Extension Cord (if required)
Gloves
Screwdriver
Drip Pan (if required)
GFI Adapter
Fire Extinguisher (if required)

Gather all the required equipment before you depart for the field. This is a list of suggested equipment. Add or remove equipment as needed.

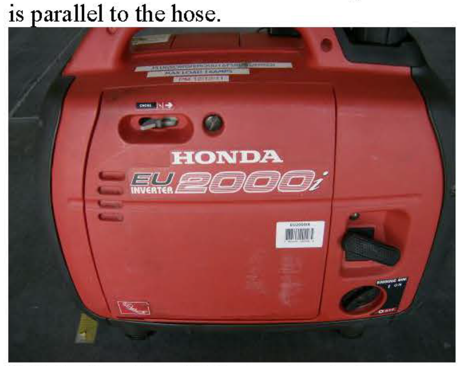


If required, place generator in a Drip Pan. If using an external tank make sure they are on the same level. Fill both tanks with gasoline. Use a funnel if needed. If using the external tank ensure the generator tank is completely full. Open the Breather valve on the gas cap. The valve on the external tank is Open when it is parallel to the hose.

Turn the engine switch to ON
Move the Choke to Full ⇨
Pull the handle until the engine starts.
Wait until engine warms up, move half. After 1 minute or so move the choke to Run.

If the generator has not been used recently and will not start:

Open the engine cover. Loosen the screw to the fuel drain. Pull the handle until gas flows. Close the drain screw and engine cover.



Pull the handle until the engine starts.
Wait until engine warms up, move half. After 1 minute or so move the choke to Run.

Eco Throttle should be ON to conserve fuel. Do not overload the circuits. If Overload Alarms is lit, turn Off generator and check circuits. Than restart generator. If Oil Alert light comes on, check Oil level.

July 2020

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APPENDIX E:
FRMAC STANDARD UNITS

The primary reason for establishing standard reporting units for FRMAC operations is to enhance communications and minimize the occasions for errors. The use of the common units by all groups ensures that all results presented to decision makers are consistent and understandable and that decision trees and tables are easily applied.

Commonly Used Units

Measure	Conventional Units	S.I. Units
Activity	Ci	Bq
Dose	Rem	Sv
Dose rate	mrem/hr	Sv/h
Exposure Rate	mR/hr	mGy/h
Surface isotopic deposition	$\mu Ci/m^2$	Bq/m^2
Air sampler flow-rates	cfm	m^3/hour
Air concentrations	µCi/mL	Bq/m^3
Liquid concentrations	pCi/L	Bq/L
Soil concentration	µCi/g	Bq/kg
Tissue concentration	µCi/g	Bq/kg
Vegetation concentration	µCi/g	Bq/kg
Smear/swipe samples	dpm/100 cm^2	Bq/cm^2
Surface contamination	dpm/100 cm^2	Bq/cm^2

Units of Measure

- **Time**

For the FRMAC Monitoring Division, local time (where the incident is located) and using a 24-hour clock (military time) is used for mission planning and operations. For reporting data, time units usually are reported in the UTC time zone and in a 24-hour clock (military time). However, some digital collection tools will automatically convert local time to a UTC time. If the incident crosses multiple time zones, then a standard time should be determined (based on location and number of time zones involved) and disseminated to all participants.

Example: 2:15 PM is written: 1415
7:42 AM is written: 0742

- **Date**

  Dates will be reported as Day/Month/Year, DDMMMYYYY.

  Example: 01JAN2020

- **Meteorology**

Wind speed	miles per hour (mph)
Wind direction	angle **from** which wind is blowing in degrees (closest 5 degrees, true north is 0 degrees)
Wind elevation	in feet above ground level or above mean sea level (MSL)
Temperature	degrees °F (°C)

- **Map Orientation**

  Map and/or photo orientation must be with TRUE North straight up.

- **Distance**

  Long distances must be reported in miles (SI unit would be kilometers). It is common for radiological measurement heights to be reported in the metric system (example: exposure rates are taken 1 meter above the ground).

- **Location/GPS Units**

  The location of all monitoring data must be reported in latitude and longitude units, when available, and a physical description (street corner, road junctions, etc.) for map location. All global position satellite coordinates should be reported in Decimal Degrees.

  Example: 36.24163, -115.01954

> **NOTE:** Decimal Degrees should be recorded to the fifth decimal as above to ensure accuracy when data points are projected onto a map.

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APPENDIX F: GLOSSARY

Absorbed Dose[2]	Energy absorbed by matter from ionizing radiation per unit mass at the location of interest in a material. Units are rad (S.I. units are Gray; 1 Gy = 100 rad).
Administrative Control Levels (ACLs)	Multi-tiered numerical exposure levels established below occupational exposure limits described in 10 CFR 835 to assure that personnel radiation exposures are administratively controlled and limited. Supervisors with increasing levels of authority are required to approve justification for incrementally higher levels of radiation exposure within Administrative Control Levels.
Aerial Measuring System	An airborne system used to detect, locate and measure low levels of airborne radiation. In addition to multi-spectral sensing capabilities and instrumentation for determining geodetic positions, the system can acquire aerial photography.
Airborne Radioactive Material	Radioactive material dispersed in air. Airborne radioactive material may include colloidal suspensions, windblown dust, fumes, mists, vapors, gases or any other airborne media.
Alpha Detector	A detector capable of sensing positively charged particles with the characteristics of the nucleus of a helium atom that are emitted during decay of some radioactive elements.
Alpha Particles (α)	Positively charged particles with characteristics of the nucleus of a helium atom emitted during radioactive decay of some elements.
Assessment	Evaluation and interpretation of information to develop a basis for making decisions; for example, an evaluation of radiometric data that may include dose estimates and recommendations for protective actions to minimize harmful effects from radiation.
Background Radiation[1]	Radiation from naturally occurring radioactive materials, cosmic sources, global fallout from atmospheric testing of nuclear weapons, radon and progeny at existing levels existing in buildings or the environment and consumer products containing nominal amounts of radioactive material or producing nominal amounts of radiation.
Beta Particles (β)	Negatively charged particles emitted from the nuclei of atoms during radioactive decay with characteristics of an electron.

Celsius	A temperature system based on a 0-degree freezing point and a 100-degree boiling point for water.
Civil Support Team (CST)	The mission of National Guard Weapons of Mass Destruction Civil Support Teams (WMD-CST) is to support local and state authorities at domestic WMD/NBC incident sites by identifying agents and substances, assessing current and projected consequences, advising on response measures, and assisting with requests for additional military support.
Consequence Management Response Team (CMRT)	CMRT is the Department of Energy National Nuclear Security Administration personnel and assets to support a FRMAC operation.
Contamination	A condition that exists when an unwanted material has spread to previously unaffected areas at levels that may be harmful to public health and the environment or interfere with various measurements.
Controlled Area	Any area managed by or for DOE where access is managed to protect individuals from exposure to radiation and radioactive material.
Cooperating Agency	Cooperating Agencies include other Federal agencies that provide technical and resource support to the Department of Homeland Security and the Coordinating Agencies.
Coordinating Agency	The Coordinating Agency is that Federal agency which owns, has custody of, authorizes, regulates, or is otherwise deemed responsible for the radiological facility or activity involved in the incident. In the event of an incident the following agencies can be the Coordinating Agency for said incident: Department of Defense, Department of Energy, Department of Homeland Security, Environmental Protection Agency, National Aeronautics and Space Administration, and the Nuclear Regulatory Commission.
Critical	A state of fissile material when the fission neutron production rate exactly equals the rate at which neutrons are lost so that the number of neutrons remains constant and a chain reaction can be sustained. The degree of criticality is estimated by the ratio between the mass of active material that is present in the system and the critical mass under identical physical conditions.
Decay Product	A radioactive or stable radionuclide that results from radioactive disintegration.

Decay Rate	Characteristic rate that an atom is spontaneously transformed into a different nuclide accompanied by emission of alpha or beta particles, or gamma rays from the atom's nucleus.
Decontamination	Removal or reduction of unwanted material from a place, media or person.
Deposition	The accumulation of (radioactive) material on unprotected surfaces of plants, structures, soil, or the bottom of ponds, streams, etc., from airborne release(s).
Dose[1]	Synonymous with Absorbed Dose. Energy absorbed by matter from ionizing radiation per unit mass at the location of interest in a material. Units are rad (S.I. units are Gray; 1 Gy = 100 rad).
Dose Rate	Amount of energy absorbed from ionizing radiation by a mass at the location of interest in a material per unit time.
Dosimeter	An instrument for measuring the accumulated or total dose from exposure to ionizing radiation.
Duplicate Sample	A sample with approximately the same mass, volume and material consistency as the initial sample.
Emergency Dose Limit	A temporary dose limit above the projected absorbed dose that will result in potential health risks to exposed individuals. These emergency dose limits are used during radiological emergencies.
Emergency Operations Center (EOC)	The center from which emergency response personnel and teams receive field instructions and directions during emergency situations. Emergency Operations Centers are usually staffed and operated by state and local personnel.
Emergency Operations Facility (EOF)	A licensee-controlled and operated support center for management of emergency response, coordination of radiological and environmental assessments, development of recommended public protective actions, and coordination of emergency response with Federal, state, and local agencies.
Emergency Planning Zone (EPZ)	A predefined area surrounding a nuclear facility used to facilitate emergency planning. Boundaries generally depend on projected internal exposure rates from ingestion and inhalation of contaminants. In relation to emergency response, an EPZ is an area where existing emergency response plans are implemented to assure that prompt and effective actions can be taken to protect the public.

Emergency Response Level	The concentration of radionuclides in agricultural products, milk, or water which if ingested would result in a projected dose commitment equivalent to an emergency Protective Action Guide (PAG).
Evacuation	The process of removing people from a hazardous area to a safe area. As used here, evacuation refers to removal of a population for a short period (not more than a few days), and relocation refers to removal for longer periods.
Exposure	A measure of the ionization induced in air by X-ray or gamma radiation. The unit of exposure is the Roentgen.
External Dosimetry[1]	A measure of that portion of the dose equivalent received from radiation sources located outside the body.
Federal (organizations)	Agencies, departments, or other entities of the Federal government.
Federal Radiological Monitoring and Assessment Center (FRMAC)	A center in the vicinity of a radiological incident that coordinates the offsite Federal radiological monitoring and assessment in response to an incident that threatens the health or well-being of affected populations. The center, which operates at offsite locations in the affected state(s) or tribal area(s), does not generally need to be located near the emergency operations centers (EOC), as long as operations involving the Coordinating Agency, FRMAC and local entities can be coordinated. The Coordinating Agency has overall responsibility for coordination and/or operation of the incident.
Federal Radiological Preparedness Coordinating Committee (FRPCC)	An organization that includes representatives from the Federal Emergency Management Agency (Committee Chair), U.S. Nuclear Regulatory Commission, U.S. Environmental Protection Agency, U.S. Department of Health and Human Services, U.S. Department of Energy (DOE), U.S. Department of Transportation, U.S. Department of Defense (DOD), U.S. Department of Agriculture, U.S. Department of Commerce, U.S. Department of State, U.S. Department of Housing and Urban Development, National Aeronautics and Space Administration, and other Federal departments and agencies on an ad hoc basis where appropriate.
Field Monitoring	Periodic or continuous measurement of the amount of an analyte, contaminant or the intensity of a radiation field at one or more locations in an area and analysis of results to identify hazards or potential health effects.
Gamma Exposure Rate Boundary	Boundary of the area for evacuation to minimize radiation exposures from a plume of airborne contaminants.

Gamma Rays (γ)	Short wavelength electromagnetic radiation (photons) emitted from the nucleus of an atom during radioactive decay with energies that range from 10 keV to 9 mega electron volt (MeV).
Gamma Spectrometry	Simultaneous measurement of the intensity of gamma radiation emitted at different energies emitted during radioactive decay of various mixtures containing radionuclides. *In situ* measurements use a spectroscopy system pointing down at 1 meter looking for ground deposition.
Geiger-Mueller Counter (GM counter)	A radiation detector that uses the bias voltage across a gas-filled chamber to drive an ion current triggered by a primary ionizing event. The charge collection is independent of the number of primary ions produced during absorption of radiation; rather the charge collection is a function of the bias voltage and avalanche current.
Grab Sample	A single, randomly selected sample that represents the composition at the particular instant in time where the material is obtained.
Grain	Kernels of wheat, corn, etc., used for human consumption or livestock feed.
Green Chop	Grass, legumes, or plants that are chopped and fed green to livestock.
Ground Deposition	Radioactive Material deposited on the ground.
Ground Level Plume Boundary	The point where radiation levels are approximately five times normal background levels.
Ground Shine	Radiation from material deposited on the ground.
Half-Life	Time required for the activity of a radioactive element to decrease to one-half of the initial radioactivity.
Hay	Any grass, legume, or plant that has been cured or dried for use as feed for livestock.
High Radiation Field[1]	Any area, accessible to individuals, in which radiation levels could result in an individual receiving a deep dose equivalent in excess of 0.1 rem (0.001 Sv) in 1 hour at 30 cm from the radiation source or from any surface that the radiation penetrates.

Incident Command Structure — ICS is based upon a flexible, scalable response organization providing a common framework within which multiple agencies can work together effectively. ICS is designed to give standard response and operation procedures to reduce the problems and potential for miscommunication on such incidents.

Incident Phase — Incidents (or emergencies) are divided into three phases (a) an early phase, (b) an intermediate phase, and (c) a late phase.

Early Phase – The time interval at the beginning of a nuclear incident when immediate decisions based primarily on predictions of radiological conditions in the environment are necessary for effective use of protective actions. The early phase may last from hours to days. The early phase is assumed to last four days for the purpose of dose projection.

Intermediate Phase – The time interval beginning after sources and releases has been brought under control and reliable environmental measurements are available for use as a basis for decisions on additional protective actions. This phase continues until protective actions are terminated. This phase may overlap the early and late phases and may last from weeks to many months. The intermediate phase is assumed to last for one year for the purpose of dose projections.

Late Phase – The time interval that begins when recovery actions, designed to reduce radiation levels in the environment to permanently acceptable levels begin. This phase ends when recovery actions have been completed. The late phase (or recovery phase) may extend from months to years.

Ingestion Exposure Pathway — Internal dose attributable to consumption of contaminated water and food such as milk or fresh vegetables.

Inhalation Dose — Internal dose attributable to inhalation of radioactive material from a plume or resuspended contamination.

Interdiction — An action to prevent use of contaminated areas and agricultural products from these areas to minimize risks to public health.

Ionization Chamber — An instrument that provides a measure of the ionizing radiation intensity by collecting charged ions generated by the interaction of the radiation that interacts with the gas in a sealed chamber. Charge associated with ions formed under the influence of an imposed EMF (Electro Magnetic Frequency) and collected at the anode and cathode of the chamber.

Irradiation — Exposure to ionizing radiation.

Isopleth	A line on a map or chart connecting points of equal concentration, dose, or dose rate.
Isotopes	Forms of the same element having nearly identical chemical properties but differing in their atomic masses. A radioisotope is an unstable isotope of an element that decays or disintegrates spontaneously, emitting radiation.
Joint Nuclear Accident Coordination Center (JNACC)	A joint DOE/DOD capability that maintains current information on the location of specialized DOE and DOD teams capable of providing nuclear weapons accident assistance. The DOE and DOD elements of JNACC are also responsible for initiating actions to deploy response teams in the incident of a significant nuclear weapon accident.
Local (organization)	The local government agency or office having the principal or lead role in emergency planning and preparedness. Generally, this will be a county government. Other local government entities; *e.g.*, towns, cities, municipalities, tribes, etc., are considered to be sub organizations with supportive roles to the principal or lead local government organization responsible for emergency planning and preparedness. In some cases, there will be more than one lead organization at the local level. One designated lead organization is preferable.
MPCD	Multi Path Communication Device is a vehicle-mounted device that provides a communication pathway for field monitoring teams to transmit their collected radiological measurements and sample data for analysis by monitoring and assessment.
Monitoring	Continuing collection of data to assess information, determine adequacy of radiation protection practices and to identify potentially significant changes in conditions or radiation protection.
NARAC	The National Atmospheric Release Advisory Center, NARAC, provides tools and services to the Federal Government, that map the probable spread of hazardous material accidentally or intentionally released into the atmosphere.
Neutron (n)	An electrically neutral subatomic particle having a mass 1.67495 x 10^{-27} kg and a mean life of 900s, which is stable when bound in an atomic nucleus.
Noble Gas	Chemically inert gases including radioactive isotopes.

Nuclear Power Plant
Any device, machine, or assembly that converts nuclear energy into some form of useful power, such as mechanical or electrical power. In a nuclear electric power plant, heat produced by a reactor is generally used to make steam to drive a turbine that in turn drives an electric generator.

Nuclear Reactor
A system in which a fission chain reaction can be initiated, maintained, and controlled. Essential components include a core and fissionable fuel. Other components include a moderator, shielding, coolant, and control mechanisms.

Offsite
The area outside the boundary of a site or facility but within the area of influence.

Offsite Federal Support
The Federal role assisting during mitigation of offsite consequences during an emergency and protection of public health and safety, including assistance identifying and implementing measures to protect public health.

Onsite
Area within the boundary of a site or facility established by the owner or operator, a transporter or the Coordinating Agency of the affected facility for administrative control during an emergency. Specifically, the onsite area includes everything within the boundary of a nuclear power plant, a DOD installation, a DOE facility, a National Defense Area, or a National Security Area. It also includes the controlled area surrounding a radioactive spill in a transportation incident.

Onsite Federal Support
Assistance by a Federal agency that owns, authorizes, regulates, or is otherwise responsible for the radiological facility, material being transported, etc.; for example, the Coordinating Agency. Federal support is in response to state and local assistance efforts and supports the owner or operator's efforts to manage and thereby prevent or minimize offsite consequences during an incident.

Owner or Operator
Party responsible for a nuclear facility or vehicle used to transport radioactive material. The owner or operator may be a Federal agency, a state or local government, or a private business.

Plume
A visible or measurable discharge of a contaminant from a given point of origin, which may include discolored or thermal water, particulates in air, among others; for example, a plume of smoke.

Airborne radiation leaking from a damaged reactor.

Downwind area where a release could pose a health risk to those exposed to contaminants.

Plume Exposure Pathway
The principal mechanisms for exposure in a plume including whole body external exposure to gamma radiation, inhalation and ingestion.

Potable Water	Water that is suitable for human consumption.
Precipitation Collector	A device to collect precipitation including rain, sleet, and snow. Precipitation is usually collected in a large metal funnel or a plastic sheet suspended on a frame in a pre-established open area.
Preventive PAG – Ingestion Exposure Pathway	Protective action guides intended to maintain the committed effective dose equivalent (CEDE) at levels such that the projected dose equivalent to the thyroid, bone marrow and other internal organs is 1.5 rem or less and whole body exposure is less than 0.5 rem.
Preventive Response Level	Concentration of a radionuclide in food, milk, or water that if ingested would result in a CEDE equivalent to the PAG.
Projected Dose	An estimate of the radiation dose that affected individuals could potentially receive unless protective actions are implemented.
Protective Action	An action taken to avoid or reduce exposure.
Protective Action Guide (PAG)	The projected dose to an individual from an unplanned release of radioactive material at which a specific protective action to reduce or avoid that dose is recommended.
Personal Protective Clothing	Clothing worn by a radiation worker to prevent contamination of the body or personal clothing.
Public Information Officer (PIO)	Representative from a Federal Agency, who works in cooperation with other Federal, State, and local agencies, to coordinate public releases of information during an incident.
Rad[1]	Unit of absorbed dose equal to 100 ergs per gram or 0.01 joule per kilogram (0.01 Gy).
Radiation[1]	Alpha particles, beta particles, gamma rays, x-rays, neutrons, high-speed electrons, high-speed protons, and other ionizing particles.
Radiation Emergency Assistance Center/ Training Site (REAC/TS)	A multi-purpose medical/training facility located at Oak Ridge, Tennessee that can provide medical care for all types of radiological injuries, assist during radiological emergencies and provide medical and health physics advice and training.

Radioactive Decay	Disintegration of the nucleus of an unstable nuclide by spontaneous emission of alpha or beta particles, photons, neutrons, etc.
Radioactivity	The spontaneous emission of particulate and/or electromagnetic radiation either from unstable atomic nuclei or as the result of a nuclear reaction.
Radio Assay	Analysis of any substance to determine the quantity and type of radioactive isotopes that is present; for example, in food, soil, and other matrices.
Radioiodine	Radioactive nuclides of iodine, of particular interest because of their impact on the thyroid gland.
Radiological Assistance Program (RAP) Team	RAP provides resources (trained personnel and equipment) to evaluate, assess, provide advice, isotope identification, search for, and assist in the mitigation of actual or perceived nuclear or radiological hazards. The RAP is implemented on a regional basis, with coordination between the emergency response elements of state, local, and federal agencies.
Radiological Emergency	An incident involving environmental releases of radioactive material that poses an actual or potential hazard to public health and safety.
Radiological Emergency Response Team (RERT) EPA	The RERT is a group of skilled experts who are specially trained to respond to environmental emergencies and, more specifically, to provide on-scene assistance to deal with the human health and environmental impacts of terrorist attacks.
Radionuclide	Natural or man-made radioactive element having an atomic number characteristic of the number of protons but with an atomic mass that depends on the number of neutrons characteristic of a specific nuclide.
Reentry	Temporary entry into a restricted zone under controlled conditions.
Release	Controlled or uncontrolled escape of radioactive or other contaminants into the environment.
Rem	Unit of dose equivalent. The dose equivalent (rem) is equal to the absorbed dose in rad multiplied by a quality factor, distribution factor and any other necessary modifying factor(s) (1 rem = 0.01 Sv)
Restricted Area	Any area where access is limited and controlled by the owner, operator or employer to protect individuals from exposure to radiation or radioactive materials.

Resuspension — Reintroduction of surface particulates into air by wind, traffic, etc.

Return — Reoccupation of areas cleared for unrestricted residence or use.

Roentgen (R)[3] — The quantity of X- or gamma-radiation such that the associated emission per 0.001293 g of air produces, in air, ions carrying 1 esu of electricity of either sign.

Sampling Head — The device installed on an air sampler that holds the filter through which the sampled air passes.

Shelter — A structure or other location offering shielding from nuclear radiation in the environment.

Shielding — Any material or barrier that absorbs or attenuates radiation.

Source Term — The quantity of radioactive material released to the environment usually described as the activity per unit time. Source terms should be characterized by chemical and physical properties of specific radionuclides.

State (organization) — The state government agency or office having the principal or lead role in emergency planning and preparedness. There may be more than one state involved, resulting in separate application of evaluation criteria for the affected states. To the extent possible, however, one state should be designated as the lead.

Survey Meter — Hand-held, portable instruments used to measure radionuclide concentrations or dose and exposure rates.

Turbidity — Turbidity is the measure of relative clarity of a liquid. It is an optical characteristic of water and is a measurement of the amount of light that is scattered by material in the water when a light is shined through the water sample.

Turn-back Level — A predetermined radioactivity level at which monitoring activities cease and monitoring personnel are withdrawn from an area.

Whole-body Dose[4] — An absorbed dose or dose equivalent from penetrating radiation when the magnitude of the absorbed dose (or dose equivalent) is essentially uniform over the whole body.

[1] Borders, R. J. Dictionary of Health Physics & Nuclear Sciences Terms. Hebron CT, RSA Publications: 1991.

[2] 10 CFR 835, Occupational Radiation Protection.

[3] International Congress of Radiology, 1937.

[4] NCRP Report No. 94, “Exposure of the Population in the United States and Canada from Natural Background Radiation” 1987.

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APPENDIX G:
REFERENCES – FRMAC MANUALS

Information contained in FRMAC manuals (cited below) may be valuable for reference purposes during an emergency. These manuals are available to the public on the Nevada National Security Site website:

https://www.nnss.gov/pages/programs/FRMAC/FRMAC_DocumentsManuals.html

FRMAC Operations Manual. This provides an overview of the operations and functions of the FRMAC during the emergency phase so that each participant can understand the individual tasks and their interface with the overall mission. The internal working operations are described from initial notification and the collection of data to the final distribution of data to the states(s) and the Coordinating Agency.

FRMAC Assessment Manual, Volumes I and II. The FRMAC Assessment Manual Volume I is the tool used to organize and guide activities of the FRMAC Assessment Division. This manual integrates many health physics tools and techniques used to make these assessments. The FRMAC Assessment Manual Volume II is a collection of pre-assessed scenarios. These pre-assessed scenarios contain default assessment parameters and techniques that could be applied to produce results that are consistent with the methodologies outlined in the FRMAC Assessment Manual Volume I.

FRMAC Monitoring and Sampling Manual, Volume I. The purpose of this manual is to detail the FRMAC Monitoring Division Operations during an emergency response. This manual describes the role and organization of the FRMAC Monitoring Division, deployment activities, and workflow development and implementation which includes default field team instructions.

FRMAC Health and Safety Manual. The manual provides guidance for radiation safety, industrial hygiene, occupational safety, and, emergency medical care. The manual includes information on radiation exposure guidelines, personnel dosimetry, contamination control (including limits on contamination for release of equipment to uncontrolled areas), radioactive and hazardous waste packaging, and personal protective equipment.

FRMAC Laboratory Analysis. The *FRMAC Laboratory Analysis Manual* provides general guidance and some specific diagrams and forms to establish a common operating environment for FRMAC, and other, laboratory analysis personnel with regards to sample control and sample result data quality assurance. This manual is intended to provide enough guidance for stand-alone use without limiting FRMAC's ability to integrate the work with other agencies and jurisdictions and laboratories.

The purpose of the *FRMAC Fly Away Lab Manual* is to provide guidance to Fly Away Laboratory (FAL) personnel responsible for the analysis of time sensitive radiological samples. The manual provides guidance on the instruments used, calibrations, and analysis.

The *FRMAC Gamma Spectroscopist Knowledge Guide* was developed as a training and reference manual for FRMAC gamma spectroscopists. The knowledge guide is geared towards applied HPGe gamma spectroscopy with an emphasis on examples. As such, the knowledge guide generally provides a limited but sufficient discussion of physics concepts.

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APPENDIX H:
REFERENCES – GENERAL

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Johnson Thomas E., Birky Brian K. (Eds.). (2012). *Health Physics and Radiological Health*, 4th edition. Baltimore, MD: Lippincott Williams & Wilkins, a Walter Kluwer business.

National Council on Radiation Protection and Measurements. (1978). *Instrumentation and Monitoring Methods for Radiation Protection* (NCRP 57).

U.S. Environmental Protection Agency. (2012). Sample Collection Procedures for Radiochemical Analytes in Environmental Matrices (EPA/600/R-12/566)

U.S. Environmental Protection Agency. (2017). PAG Manual: Protective Action Guides and Planning Guidance for Radiological Incidents (EPA-400/R-17/001).

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