DOE/NV/25946--1558

FEDERAL RADIOLOGICAL MONITORING AND ASSESSMENT CENTER

Monitoring Manual
Volume 2

Radiation Monitoring and Sampling

July 2012

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the U.S. Government. Neither the U.S. Government nor any agency thereof, nor any of their employees, nor any of their contractors, subcontractors or their employees, makes any warranty or representation, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the U.S. Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the U.S. Government or any agency thereof.

DOE/NV/25946--1558

FEDERAL RADIOLOGICAL
MONITORING AND ASSESSMENT CENTER

Monitoring Manual

Volume 2

Radiation Monitoring and Sampling

Approved By

Craig Lyons

Craig Lyons
Monitoring and Sampling Working Group
Remote Sensing Laboratory, NSTec

Colleen T. O'Laughlin

Colleen T. O'Laughlin, Program Manager
Consequence Management/Federal Radiological Monitoring and Assessment Center
U.S. Department of Energy, National Nuclear Security Administration
Nevada Site Office, Las Vegas, Nevada

Daniel Blumenthal

Daniel Blumenthal
Consequence Management Program Manager
Office of Emergency Response
U.S. Department of Energy, National Nuclear Security Administration
Headquarters Office of Emergency Operations
Washington, D.C.

David Bowman

David R. Bowman, Acting Director
Office of Emergency Response
U.S. Department of Energy, National Nuclear Security Administration
Headquarters Office of Emergency Operations
Washington, D.C.

This Document is UNCLASSIFIED

Angela Anderson
Derivative Classifier

This work was supported by the U. S. Department of Energy, National Nuclear Security Administration Nevada Site Office, under Contract No. DE-AC52-06NA25946.

This page intentionally left blank

FRMAC MONITORING DIVISION MANUAL VOL. 2

REVISION HISTORY

Date	Pages Changed	Revision
September 2002 (Originally Issued as Vol. 1)	Original	Rev. 0
December 2005 (Reissued as Vol. 2)	Realignment with NRP	Rev. 1
March 2012	Complete revision	Rev. 2

This Page Intentionally Left Blank

ACKNOWLEDGEMENTS

The FRMAC Monitoring Working Group and several additional individuals contributed their time and efforts in writing and/or reviewing this document. These individuals are recognized below.

FRMAC Monitoring Working Group

Chair, Craig Lyons	National Security Technologies, LLC
Robert Augdahl	National Security Technologies, LLC
Michael Ferriola	U.S. Environmental Protection Agency
Roger Goodman	U.S. Environmental Protection Agency
Paul Greenbaum	National Security Technologies, LLC
Michael Howe	U.S. Department of Homeland Security / FEMA
Terry Kraus	Sandia National Laboratory
C. E. Maples	Y-12 National Security Complex
Toby Morales	State of Arizona
Colleen O'Laughlin	U.S. Department of Energy
Joshua Pate	U.S. Environmental Protection Agency
Peter A. Petch	U.S. Environmental Protection Agency
Sam Poppell	U.S. Environmental Protection Agency
Mark Sells	U.S. Environmental Protection Agency
Arthur Shanks	Sandia National Laboratory
Rich Sorom	National Security Technologies, LLC
Chuck Strain	Savannah River Site / RAP Region 3
Bob Stueckrath	National Security Technologies, LLC
Richard Stump	Sandia National Laboratory / RAP Region 4
Dan Sweeney	U.S. Department of Defense
Lori Thomas	U.S. Department of Energy
Don Van Etten	National Security Technologies, LLC
Steve Woods	California Department of Homeland Security

Additional Contributors

Charles Adams	Florida Bureau of Radiation Control
Allan Allshouse	National Security Technology, LLC
Brennen Brunner	MN Homeland Security and Emergency Management

This Page Intentionally Left Blank

Contents

Acknowledgements v

1.0 Introduction 1

2.0 Guidance and Orientation for Field Personnel 3

2.1 Public Affairs 3

2.2 Safety 3

2.3 General Instructions 4

3.0 Field Monitoring 5

3.1 Team Structure 5

Technical skills recommended include: 5

Other desired skills include: 5

3.2 Field Team Briefing 6

3.2.1 Condition of the incident 6

3.2.2 Scope of work to be performed 6

3.2.3 Conditions of the deployment location 6

3.2.4 Personal Protective Equipment (PPE) 7

3.2.5 Dosimetry 7

3.2.6 Communications 7

3.2.7 Hold points/turn-around points 8

3.2.8 Return briefing 8

3.3.1 Preoperational Check 8

3.3.2 Quality Control Check 9

3.4 Airborne Radioactive Material Surveys 11

3.4.1 Survey Uses 11

3.4.2 Procedure 11

3.5 Ground Deposition Monitoring Surveys 11

3.5.1 Survey Uses 12

3.5.2 Procedure 13

3.6 Beta/Gamma-Emitting Radioactive Material Surveys 13

3.6.1 Procedure 13

3.7 Alpha-emitting Radioactive Material 15
3.7.1 Alpha Contamination Meter 15
3.8 X-ray/Low-Energy Gamma Detector 16
3.8.1 FIDLER Systems 16
4.0 Sample Collection 17
4.1 General Guidance 17
4.2 Equipment and Supplies 17
4.3 Duplicate Samples 18
4.4 Air Samples 18
4.4.1 General Precautions 19
4.4.2 Air Sample Types 19
4.4.3 Air Sampling Collection Procedure 21
4.4.4 Air Sample Pump Power Considerations & Precautions 23
4.5 Soil Samples for Ground Deposition 25
4.5.1 General Guidance 25
4.5.2 Ground Deposition 26
4.5.3 Soil with Vegetation 28
4.5.4 Dry or Sandy Soil 28
4.5.5 Wet Soil 29
4.5.6 Sediment 29
4.6 Water Samples 29
4.6.1 General Guidance 29
4.6.2 Well Water for Public Drinking 30
4.6.3 Surface Water for Public Drinking 31
4.6.4 Rain Collection System 33
4.6.5 Snow Collection 35
4.7 Vegetation Samples 36
4.7.1 General Guidance 36
4.7.2 Early Phase Ground Deposition 37
4.7.3 Intermediate Phase Ingestion Pathway Sampling 39
4.8 Smear (Swipe) Sample 40
4.9 Milk Samples 41

4.9.1 General Guidance 42
4.9.2 Commercial Dairies 42
4.9.3 Small Farms 42
4.10 In Situ Ground Deposition Samples 44
4.10.1 General Guidance 44
5.0 Sample Packaging and Labeling 47
5.1. Security Seals 47
5.2 Packaging and Labeling 48
5.2.1 Precautions 48
5.2.2 Procedure 48
6.0 Sample Control 51
6.1 Chain-of-Custody 51
6.2 Sample Receiving Line 52
6.3 Contamination Control Line 53
7.0 Equipment Contamination Surveys 55
7.1 Direct Method of Surface Monitoring 55
7.1.1 Measurement Techniques 55
7.2 Indirect (Smear) Method of Surface Monitoring 56
7.2.1 Procedure 56
8.0 Other Portable Instrumentation 59
8.1 Global Positioning System 59
8.2 Geiger-Mueller Detectors 59
8.3 Other Instrumentation 59
8.4 FIDLER-Based Instruments 59
8.4.1 FIDLER Measurements 60
8.4.2 Instrument Selection 60
8.5 Calibration Records 60
8.6 Post-Calibration Performance Test 61
9.0 Environmental Dosimetry 63
9.1 Special Equipment 63
9.2 Deployment 63
9.3 Retrieval 64

9.4 Storage 65
10.0 FRMAC Standard Units 67
10.1 Radiological Units 67
10.2 Units of Measure 67
10.2.1 Time 68
10.2.2 Date 68
10.3 Meteorology 68
10.4 Map Orientation 68
10.5 Location 68
10.6 GPS Units 68
Appendix A Forms And Checklists 69
Appendix B Operator Aids 83
Appendix C FRMAC Field Team Contact 103
Appendix D Monitoring, Health and Safety Instrument* 107
Appendix E eFRMAC 109
E-1 Multi-Path Communication Device 109
E-2 Tablet Digital Field Monitor program 109
E-3 Radiological Assessment and Monitoring System (RAMS) 111
Appendix F Quick navigation and reporting links Radiological Units Of Measure 113
Appendix G Acronyms 115
Appendix H Glossary 117
Appendix I References – FRMAC Manuals 127
Appendix J References – General 129

Figures

1. Organization of FRMAC Monitoring Group 1
2. Ten Point Monitoring Strategy 12
3. Sample Frame 27
4. Security Seal 47
5. Digital Field Monitor (Screen Shot) 110

1.0 INTRODUCTION

The 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 Monitoring group during a FRMAC response to a radiological emergency. Figure 1 shows the organization of the FRMAC Monitoring Group. Complete FRMAC organizational charts, including information on how the FRMAC Monitoring and Sampling group fits into the Unified Command structure, are available in the FRMAC Operations Manual.

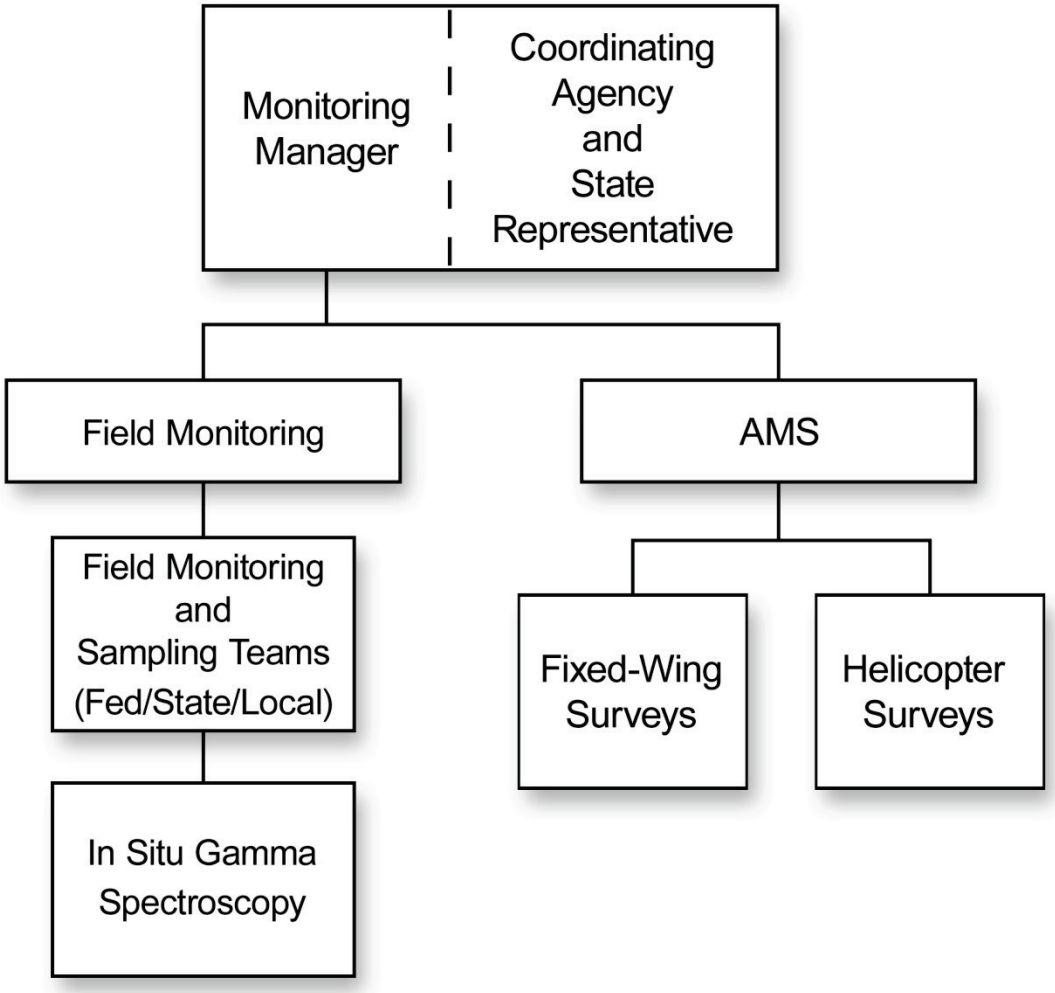


FIGURE 1. ***Organization of FRMAC Monitoring Group***

This Page Intentionally Left Blank.

2.0 Guidance and Orientation for Field Personnel

2.1 Public Affairs

The public has a right to know the facts, and 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 NNSA Public Information Officer has the responsibility to do that. Therefore, Field Monitoring Teams, and others who may come in contact with the general public will be provided specific guidance on responding to queries about the accident and response operations.

Field Teams:

- May explain what they are doing and why
- May not provide data directly to the public
- May provide phone numbers for the Public Information Officer (PIO)

2.2 Safety

The **Field Team Supervisor** with direction from the Monitoring Manager & Health & Safety Manager will:

- Ensure that the Field Monitoring Teams are in a state of readiness and dispatch them from the FRMAC
- Designate the type of equipment needed, the level and type of Personal Protection Equipment (PPE) and discuss contamination control requirements with team members before they leave the FRMAC

Health and Safety (H&S) will provide information to the Field Team Supervisor for implementing the use of personnel protective clothing, respirators, other radiological protective equipment or prophylaxis drugs including thyroid-blocking drugs.

Team Members will be aware of administrative control levels, turn-back levels, and accepted organization limits for emergency workers as established by the H&S group:

- Team members are responsible for their own safety. No sample is worth the loss of life or limb. 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 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.
- Teams will collect field samples as directed. The team will perform an exposure rate survey of each sample and then move to next location. If the background is too high, the team will wait until they return to a low background area to complete the survey of the sample.
- Teams should make all reasonable efforts to comply with turn-back guidance.

2.3 General Instructions

- All monitoring and sampling activities shall be conducted so that exposures are maintained as low as reasonably achievable (ALARA).
- Teams are under the direction of the Monitoring Manager & Field Team Supervisor, who will provide direction and the location for collection of environmental and food samples.
- Teams will, to the best of their ability, identify, record, and transmit all field information in a precise, accurate and timely manner.
- Teams will document all sampling and measurement activities on the appropriate forms and report to Field Team Contact, as directed.
- If possible, teams will determine in advance if special access or special hazards may be encountered at the time of sample collection. They will obtain access permission from landowners or their agents, or from federal or local government jurisdictions. Arrangements will 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.

3.0 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 implement precautionary actions to protect the responders. Additionally, teams collect environmental samples such as soil and water for definitive radioisotope analyses to confirm initial measurements as instructed.

3.1 Team Structure

It is important during an emergency response to use individuals who are skilled, experienced, and familiar with the monitoring equipment, sampling collection and preparation procedures. It should be recognized, however, that responders performing routine monitoring and sampling should also receive specific training for non-routine and emergency monitoring and sampling in which higher readings may be expected, greater care in sample handling techniques may be needed, or 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 appropriate training and are equipped with appropriate monitoring equipment.

Large responses involving multiple agencies will have diversity in the training, experience, and knowledge of the responders. To balance this diversity, it is suggested that teams are built by integrating responders from various agencies, combining responders that are more experienced with those less experienced in order to create balanced teams. This type of team building could result in some loss cohesion but will result in a gain of overall capability as the best skill mix and local knowledge of all the responders are combined. Each team should be comprised of at least two members (three members are preferable). One member should be designated Field Team Leader.

Technical skills recommended include:

- Radiation dose rate and surface contamination measurement techniques
- Contamination control techniques
- Personal Protective equipment
- Emergency response scenarios training
- Sampling techniques
- Sample management

Other desired skills include:

- Emergency communication equipment such as two-way radio
- Map reading and global positioning system (GPS) equipment.

On-the-Job training will be developed and given to all of the field teams on site as required to ensure there is an acceptable minimum capability for the event.

3.2 Field Team Briefing

Field teams will be briefed on a daily basis prior to the start of work. A representative of the Health & Safety Division will conduct part of the briefing, the Monitoring Manager or Field Team Supervisor will complete the briefing. All responders for each shift are required to attend. Most of this information is contained on the ICS-204-FRMAC form. See Appendix A for an example. The type of information to be included in the briefing includes.

3.2.1 Condition of the incident

Give a 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

3.2.2 Scope of work to be performed

Monitoring needs will 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:

- Define the plume footprint (area monitoring)
- Sample collection
- In Situ measurements
- Personnel surveys
- Monitoring of critical facilities
- Monitoring of vehicles
- Decontamination of personnel and equipment

3.2.3 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

3.2.4 Personal Protective Equipment (PPE)

Field teams will be briefed on PPE requirements prior to potential exposure. Teams will be briefed on the PPE to be used for each hazard, as well as when to don and doff PPE, such as anti-contamination (anti-c) clothing and/or respiratory protection. PPE will be Level C or Modified.

3.2.5 Dosimetry

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

- Whole body dosimeter
- Personal air sampling
- Entered into a Bioassay program
- Supplemental dosimeter

3.2.6 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

3.2.7 Hold points/turn-around points

Turn-around or hold points will be established when the hazard exceeds the level of prescribed protection. Points shall be established for field teams where additional controls (such as gloves/boots, anti-c's, or respiratory protection) will be required. The H&S Manager will determine turn-around points based on expected conditions and risk involved, such as:

- Turn-back levels for radiological, chemical, heat/cold, etc.
- Call in points
- Access control points

3.2.8 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 Log*s, and be debriefed by the Field Team Supervisor and a member of the Assessment group.

3.3 Field Team Duties

- Receive initial briefing and initial assignments from the Field Team Supervisor and H&S representative.
- Obtain appropriate equipment and information. Refer to Appendix A for sample forms. Refer to Appendix C for a list of Standard FRMAC Monitoring, Health and Safety Instrument & PPE available to the team.
- Obtain a pocket dosimeter and/or self-reading dosimeter, Breathing Zone Air Sample Pump and Bioassay instructions from H&S, if required.
- Record initial dosimeter reading on a digital or paper *Field Monitoring Log* before departing for the field.
- Check dosimeter reading every hour during exposure or as requested by the Field Team Supervisor and record data on a digital or paper *Field Monitoring Log*.
- 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.

3.3.1 Preoperational Check

1. Check instrument for:

- All the needed probes and parts are present
- Physical damage
- Unusual/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 his designee.
3. Zero instruments having manual electronic ZERO function
4. Operational checks of radiation survey instruments should be performed periodically and after doing any minor maintenance such as changing batteries or fixing a loose cable.

3.3.2 Quality Control Check

1. Check each instrument, and probe at the beginning of each shift or before use
2. Ensure the calibration is current and has not expired
3. Check the battery
4. Look for normal background response
5. Perform a response check with Radioactive Material if the correct QA Source is unavailable
6. Perform instrument source checks if QA sources are available:
   - Use appropriate check source for type of radiation for which instrument is calibrated and will be used to detect
   - Perform check in predetermined geometry to give defined exposure or count rate
   - Ensure reading is within the acceptable range
   - Perform preceding step on each scale calibrated for use
   - Complete a *Daily Instrument QC Checks* form and give the form to the Field Team Supervisor or his designee
   - Perform proceeding steps for each Instrument and probe to be used
7. Operational checks of radiation survey instruments should be performed periodically and after doing any minor maintenance such as changing batteries or fixing a loose cable.
8. Complete a *Team, Instrument, & Equipment Information* form and submit the form to the Field Team Supervisor before departing for field.

Bag instruments if instructed by the Field Team Supervisor, or as required for surveys in contaminated areas.

Take background reading with each survey instrument and initial readings with global positioning system (GPS) device and record on a digital or paper *Field Monitoring Log*. These readings can be used by Assessment as a reference background.

Tape a plastic sheet in the back of the response vehicle to create a clean work area for Contamination Control measures.

Ensure a MPCD (Multi-Path Communications Device) with a Tablet computer has been installed in the response vehicle and is communicating properly

Don protective clothing and respiratory equipment, if necessary, as instructed by the Field Team Supervisor and Health & Safety

Conduct communications checks when leaving the FRMAC.

- Call in background readings from appropriate survey instruments and GPS coordinates, and then maintain communication with Field Team Contact. (See Appendix B).

Proceed to designated monitoring area, following the directions on the Team's ICS-204-FRMAC form. The Field Team Supervisor will monitor meteorological and dose assessment information and provide updated information, as necessary.

Use the most sensitive instrument to provide a first indication of encountering radiation from plume or contaminated area.

Place probe of exposure rate instrument on the dashboard next to the window to monitor any changes while in transit.

If turn back levels (as indicated on ICS-204-FRMAC) are reached, proceed to a safe location and notify Field Team Contact of location and readings.

Conduct further plume traverse/tracking only as directed on the ICS-204-FRMAC or by the Field Team Contact.

During plume/deposition transit time, close all vehicle windows and vents and either use the recirculation switch on the heat / air conditioning system or shut off the heat / air conditioning system as directed.

Upon arrival at monitoring location, conduct requested surveys and sampling and then report these results to Field Team Contact as directed.

3.4 Airborne Radioactive Material Surveys

A "plume" typically refers to an active airborne release; it may be used to reference the pattern in which materials are deposited on the ground, also called Ground Deposition.

NOTE:

The airborne plume phase of an incident typically will happen in the first few hours. FRMAC may not be available to perform surveys until later into the response. All Field Teams need to be cautious of contamination resuspension or Radioactivity Airborne areas.

CAUTION:

Minimize operations in a high radiation field, which is an area with readings in excess of 100 milliRoentgens per hour (mR/hr). Use a gamma exposure rate of 100 milliRoentgens per hour (mR/hr) as a high radiation default turn-back level. Pull back to an area of lower level and notify Field Team Contact if turn-back level is reached.

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.

3.4.1 Survey Uses

Surveys are used to identify:

- Inhalation exposure from the plume
- External exposure from the plume
- Absorption due to contamination of skin and clothes

3.4.2 Procedure

The most effective method to determine if Airborne Radioactive Material is present is to collect an Air Sample then count the filter for activity. See section 4.4 Air Sampling for guidance.

3.5 Ground Deposition Monitoring Surveys

After the release of radioactive material, the affected area should have both air and ground deposition monitoring surveys should be 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.

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 and will allow quick normalization of computer plume models to match actual release measurements. The strategy is not intended to guide selection of monitoring activities for follow-on cleanup and site restoration tasks.

To execute the Ten Point Strategy, the initial responders should gather radiological monitoring data for the 10 points shown in Figure 2. 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.

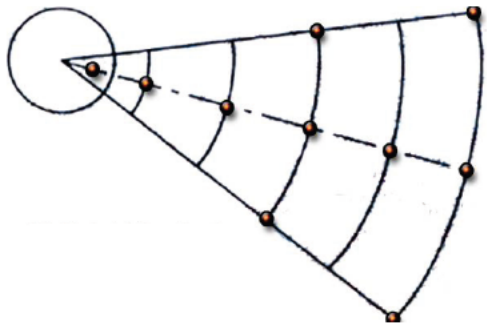


Figure 2. Ten Point Monitoring Strategy

On the example diagram, the distance between the downwind arcs is 1 kilometer and the arc is 30 degrees. The radius of the inner circle is 500 meters. The number of points and distance between the points and the arc are determined by the size of the incident. The strategy includes several points directly downwind and several the outside the arcs.

After some or all of the data have been gathered, the CMHT assessment scientist should evaluate the data and request normalization of initial plume plots based on the data.

This strategy will allow a quick comparison of real-world data to plume projections to be made and allow responding personnel to provide effective recommendations on protection of responders and the local population.

3.5.1 Survey Uses

Surveys are used to identify:

- Area Boundaries within which exposure rates and/or contamination levels exceed derived levels for relocation and remediation shelter-in-place
- External exposure rates from ground deposition
- Primary and secondary ingestion pathways of contaminated food and water
- Appropriate sample collection locations

- Potential Absorption of radioactive material due to contamination of clothes and contamination of skin from ground contamination
- Inhalation of resuspended radioactive particles

3.5.2 Procedure

The required PPE, turn-back levels, survey points and number of samples, vary depending upon changing scenarios and will be determined on a case-by-case basis.

General precautions:

1. Ground deposition measurements for an area should be made 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 to the side of the road.
2. To determine deposition boundaries either
   - Start in a normal background area and work your way inward to an area where gamma exposure rates appear above set levels. or
   - From inside the deposition area work outward to area where gamma exposure rates appear to be at normal background levels.
3. Ground deposition surveys on a roadway are used to survey and evaluate the contamination levels of a road.

3.6 Beta/Gamma-Emitting Radioactive Material Surveys

This group includes reactor fission products such as cobalt-60, cesium-137, uranium, thorium, and many radiopharmaceuticals.

3.6.1 Procedure

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

- Wrap the instrument(s) in plastic cling wrap to prevent contamination, as directed. The active area of the detectors should **not** be covered.
- Begin on lowest scale, switching scales as necessary.
- To ensure the team is aware of changes in the Exposure Rate, monitor instruments during travel between survey points, along roadways in and around the contaminated area.
- Make initial gamma measurements from inside a slowly moving vehicle with the vehicle windows closed.

- Position the detector, as close to the outside window of the response vehicle, while affording the ability to watch the instrument display.

Use the audio on the instrument if it is available as the meter audio will respond faster than the display.

- At the survey location, as you depart the vehicle, closely monitor the instruments response for exposure rate & or contamination levels to determine the best sample location.
- 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 to the side of the road.

For Beta/Gamma-emitting Radioactive Material surveys, take 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) at each designated location. 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.

- 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 on Air Sample.
- If the beta/gamma (open window) measurement close to the ground is significantly higher than the open window measurement at waste level, this indicates deposition of radioactive material on the ground. Because of an infinite plane geometry and unlimited range of gamma radiation, it is likely that ground level and waist high gamma (closed window) measurements will be similar.
- Gamma exposure (window closed) measurements must also be recorded as they can be used as a calibration factor once the plume and/or deposition has been characterized; for example, to convert AMS data to dose.

1. For contamination surveys, use a pancake Geiger-Mueller (GM) or similar detector thin window pointing down. Hold the probe ~ ½ inch above the survey object's surface and scan at a rate of 1-2 inches per second. 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 on a digital or paper *Field Monitoring Log*; report all results to Field Team Contact as instructed.
3. Periodically check dosimeters and notify Field Team Contact if readings exceed administrative control levels.
4. Take measurements at additional locations as directed by Field Team Contact.

3.7 Alpha-emitting Radioactive Material

Alpha-emitting radioactive materials include uranium, plutonium, americium, and other actinides.

CAUTION

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

3.7.1 Alpha Contamination Meter

Alpha radiation has very short range. A zinc sulfide scintillator or proportional counter is used as the measuring device.

- 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.

NOTE

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.

3.7.1.1 Procedure

1. Use an instrument appropriate for the target radionuclide(s)
    - Wrap the instrument(s) in plastic cling wrap to prevent contamination, as directed. The active area of the detectors will not be covered.
2. Begin on lowest scale, switching scales as necessary
3. For deposition surveys, choose an undisturbed, relatively level, open areas 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. For contamination surveys, use an appropriate alpha detector with the window pointing down. Hold the probe as close to the object as possible without touching the surface being careful not to puncture the thin windows on instruments and/or contaminate the probe/detectors.
    - For alpha-emitting Radioactive Material surveys, use the alpha contamination instrument, make measurements at no more than 1/4 inch from the ground at each designated location.

- An air sample may be needed to verify true airborne Radioactive Material. See section 4.4 on Air Sample.
- Record all data on a digital or paper *Field Monitoring Log*; report all results to Field Team Contact as instructed.

5. Periodically check dosimeters and notify Field Team Contact if readings exceed administrative control levels.

3.8 X-ray/Low-Energy Gamma Detector

X-rays are released during alpha decay. Some actinides (like plutonium and americium-241) also release low-energy gamma rays. The preferred instrument to quantify ground contamination is a Field Instrument for Detecting Low Energy Radiation (FIDLER). It has the ability to measure the photons, which are not affected by geometry or overburden.

3.8.1 FIDLER Systems

- 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 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 in $\mu Ci/m^2$

3.8.1.1 Procedure

- Take measurements with the detector about 30 cm (1 foot) above the ground. Where possible, measurements should be made at least 15 feet off the roadway.
- Bring standard alpha contamination meters to help identify survey locations and check for personnel and equipment contamination.

4.0 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 chapter 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 Initial Response. Detailed sampling procedures will need to be developed as the incident moves from the Initial Response. The Monitoring Manager will supply directions on what is the maximum accepted activity on a sample that Laboratory Analysis can process. This decision will be based on input from Assessment, Laboratory Analysis and State or Local partners.

NOTE:

A *Sample Control Form and Chain of Custody* accompanies each sample matrix. An Air Sample paper filter and cartridge are considered 2 samples. This is to track the different analysis methods needed for each sample matrix.

- At the sampling location take ground measurements, as directed (i.e., Exposure & Contamination).
- After collection perform a radiation measurement on the Sample container.
- It may be necessary to collect field samples and then move, to a low background area away from the plume to conduct the field measurement.
- Record data on a digital or paper *Field Monitoring Log*.
- Report results to Field Team Contact as directed.
- Package and label the samples according to "Sample Packaging and Labeling," Section 5.0.

4.2 Equipment and Supplies

This is a suggested list from the Sample Collection duffel bag and does not reflect all the material that may be needed

Sample Collection Tools (Suggested):

Soil Sampling Jig (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

eFRMAC Tablet and or Clipboard w/forms, Sample Control, digital or paper *Field*

Monitoring Log
Security Seals

Supplies:

Absorbent Towels (Maslin Cloths)	Pens, Ink, Magic, Pencil
Bags, Quart Sealable	Plastic Cling Wrap (Roll)
Bags, Gallon Sealable	Plastic Sheet / Drop Cloth
Bags, 36x54 Clear	Security Seals
Bags, 16x24 (Boot)	Tape, Duct
Disinfectant Wipes or Decon Bottle	Tape, 2in Masking
Kimwipes	Tape, Contaminated Material
Multi Tool (Leatherman)	

Plastic Containers 1 Gallon (3.5 Liter) or 1Quart (1Liter) (Water)*

* 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 which is collected in the same manner, location, and time, and analyzed for the same parameters. A Split sample is one sample that is separated into two separate containers. The total volume does not change. 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. Any 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 be 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 leads to unneeded actions where no hazard exists. 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 of 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 length of sample 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.

To provide background data, Field Monitoring Teams will take samples from normal, uncontaminated sampling locations in addition to other samples.

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.

When retrieving a filter from an obviously loaded air sampler, it is important to make careful notes about the condition of the sample, the flow rate, and local conditions. If the filter head is clogged with dust or snow:

- Remove the sample head without scraping off any of the collected material.
- Be careful to keep the dirt or snow from leaking out of the sample container as it comes loose or melts.
- Then, treat the filter normally, as an unclogged filter.

4.4.2 Air Sample Types

1. High Volume Air Samper is generally considered to have a flow greater than 10 cubic feet per minute.
    - High Volume Air Samples will typically use either a filter paper or Impactor.

NOTE:

FRMAC will use a glass fiber filter paper unless otherwise directed.

Low Volume Air Sampling is considered less than 10 cubic feet per minute.

- Low Volume samples can consist of
  - i. filter paper alone, or
  - ii. with a cartridge.

NOTE:

For a FRMAC emergency the standard cartridge used will be either silver impregnated zeolite cartridges or charcoal.

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.

4.4.2.1 High Volume Special Equipment (Suggested)

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

4.4.2.2 Low-Volume Special Equipment (Suggested)

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

* 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.

4.4.3 Air Sampling Collection Procedure

NOTE:

If possible, assemble the equipment before entering the plume. When the sampler will be left unattended for extended time, place all forms in a sealed plastic bag and attach or secure the bag to the sampler.

Review the "Operator Aid FRMAC Air Sample Pump Staplex High Vol" on page 85 and the "Operator Aid FRMAC Air Sample Pump F&J Low Volume" on page 88 for an example of the process.

Inspect all equipment for

- Apparent physical damage.
- Contamination, if equipment has been previously used.

Make sure the pump switch is in the Off position.

In order to collect a representative air sample, choose a location that is in an open area. Do not sample under trees, bushes, or other overhanging objects. Avoid areas next to roads.

Survey the site using an appropriate survey meter, taking readings approximately 1 meter (3 feet) and at 2.5 cm (1 inch) above ground. Record the readings on a digital or paper Field Monitoring Log.

Install a filter paper into the sampling head assembly.

- Obtain a new, unused filter; inspect it for physical damage. If damaged, obtain a new filter.
- If you are unable to identify front and back of filter paper you can write an "X" in the edge of the filter paper under the retaining ring. Glass fiber filters should be installed "rough side out" for air sample collection.
- Remove the particulate filter retaining ring. Using forceps, center the new filter in the holder. Touch the filter as little as possible.
- Reinstall the retaining ring, tightening it finger-tight to produce a proper seal. Ensure that the filter remains centered in assembly.

CAUTION:

Over-tightening the retaining ring may tear the filter.

If a cartridge is used, obtain new, unused cartridge.

- 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.
- Remove the cartridge retaining assembly.
- Note direction of flow indicated on the cartridge in assembly, ensuring that the airflow direction indicated on the cartridge and the sampler airflow match. Arrow on the cartridge should point toward the sampler.
- Reinstall the retaining ring, tightening it finger-tight to produce the proper seal.

Setup the Tripod and position the sample considering the following:

- Locate the Sample Head off the ground, approximately 1.5 meters (5 feet). This is to sample from standard breathing zone.
- 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.
- Unrestricted airflow.

Connect the sample head assembly to the sampler. Tighten finger-tight to produce proper seal.

Start one *Sample Control Form* for the filter paper and a separate SCF for the cartridge.

Record the sample location, sampler number and other information on a *Sample Control Form*.

Start the Air Sample Pump.

Determine the initial flow rate on the rotometer and record the start date, start time and flow rate on the *Sample Control Form* for the filter paper and one for the cartridge.

Run the sampler as directed by the ICS-204-FRMAC form or monitoring plan.

Prior to turning the sampler off, determine the ending flow rate.

Stop the Air Sampler Pump.

Record the ending flow rate, stop date, and stop time on the *Sample Control Form*.

Perform a survey of the Filter paper, if required.

- Record all data on a digital or paper *Field Monitoring Log*; report all results to Field Team Contact as instructed

Put on disposable gloves.

Removing the Filter Paper

- Use the bar code label or write the sample control number on sealable plastic bag using an indelible ink pen.

- Remove the filter paper carefully using forceps. If excessive dust or snow is on the filter paper, fold upwards in half with the collection side in.
- Place the filter paper in a glassine envelope if available.
- Place the filter paper in a sealable plastic bag. Seal the bag. Do not tear or cut the filter paper

Removing the Cartridge

- Use the bar code label or write the sample control number on a sealable plastic bag using an indelible ink pen.
- Remove the cartridge carefully.
- Place the cartridge in a sealable plastic bag. Seal the bag.

Prepare the sample for transport to Sample Control in accordance with "Sample Packaging and Labeling," section 5.0.

4.4.4 Air Sample Pump Power Considerations & 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.

4.4.4.1 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 times difficult.

If AC line power is unavailable then consider a generator.

4.4.4.2 AC powered Air Sample Pumps

- AC powered Air Sample Pumps are the most durable and easiest to operate.

- When possible, locate the Air Sample at a Police or Fire Station as this will be more secure if the sample will run 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.

4.4.4.3 Generator Supplied AC Power

When checking out a generator, keep a fire extinguisher close by.

Before departure, learn how to setup and operate the generator quickly in case of an emergency, and use all of the generator controls, output receptacles and connections. Ask questions if needed.

- If a generator and gas can needs to be transported inside a vehicle, ensure the windows are open for ventilation.
- For generators placed in outdoor areas, use a GFI Surge protector between the pump & generator when possible, to prevent fires.
- Position the generator far enough away from the sampler and downwind so that exhaust fumes are not picked up by the sampler.
- 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.
- If the generator is stored outdoors, unprotected from the weather, check all electrical components on the control panel before each use.
- The exhaust system gets hot enough to ignite some material. Keep flammable material away from the generator. Allow the generator to cool before moving into a vehicle or indoors.

4.4.4.4 Internal DC Battery

Some types of Air Sample 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.

4.4.4.5 Battery Power from the Vehicle

CAUTION:

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.
- Attach the ground cable to a metal object in the engine compartment, not directly to negative terminal.

4.5 Soil Samples for Ground Deposition

4.5.1 General Guidance

This procedure addresses the collection of different types of soil under varying conditions. In the early phase, soil is collected for surface contamination monitoring, not plant uptake prediction. The most important variable is the surface area of the sample. The depth of the sample is also important, as all activity is deposited on the surface of the soil and unnecessary depth will dilute the sample results. This entire procedure should be reviewed and portions modified to fit the type of soil to be sampled.

4.5.1.1 Sample Selection

In order to collect a representative soil sample, choose soil that is relatively dry, except for sediment, 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. If the area to be sampled is covered with vegetation, leaves, etc., decide if the debris will be removed or if you need to treat that portion as a separate vegetation sample (see "Soil with Vegetation," section 4.5.3).

4.5.1.2 Soil Sampling Special Equipment (Suggested)

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

4.5.2 Ground Deposition

Refer to "General Guidance," above, for an equipment list and soil sampling information.

4.5.2.1 Procedure

Review the “Operator Aid FRMAC Early Phase Soil Sample” on page 92 for an example of the process.

Prepare to take the sample.

- Place all sampling tools and the *Sample Control Form* into a plastic bag to carry to sample location.
- To avoid contamination, place plastic bags on the ground; lay the clipboard, instruments, and tools on the bags.
- On the *Sample Control Form*, record the GPS reading, location, time, date, and other descriptive information.
- Put on work gloves over disposable gloves.
- Survey the site using an appropriate survey meter, taking readings approximately 1 meter (3 feet) and at 2.5 cm (1 inch) above ground. Record the readings on a digital or paper *Field Monitoring Log*.
- Use a bar code label or indelible ink pen to record the sample control number on the gallon size sealable bag.

Place the open end of the sampling frame (Figure 3) in the center of the sample area to form a 10 × 10-cm (4 × 4-in) square sample area. Press or tap the cutter edge into the soil to the stops (2 cm deep).

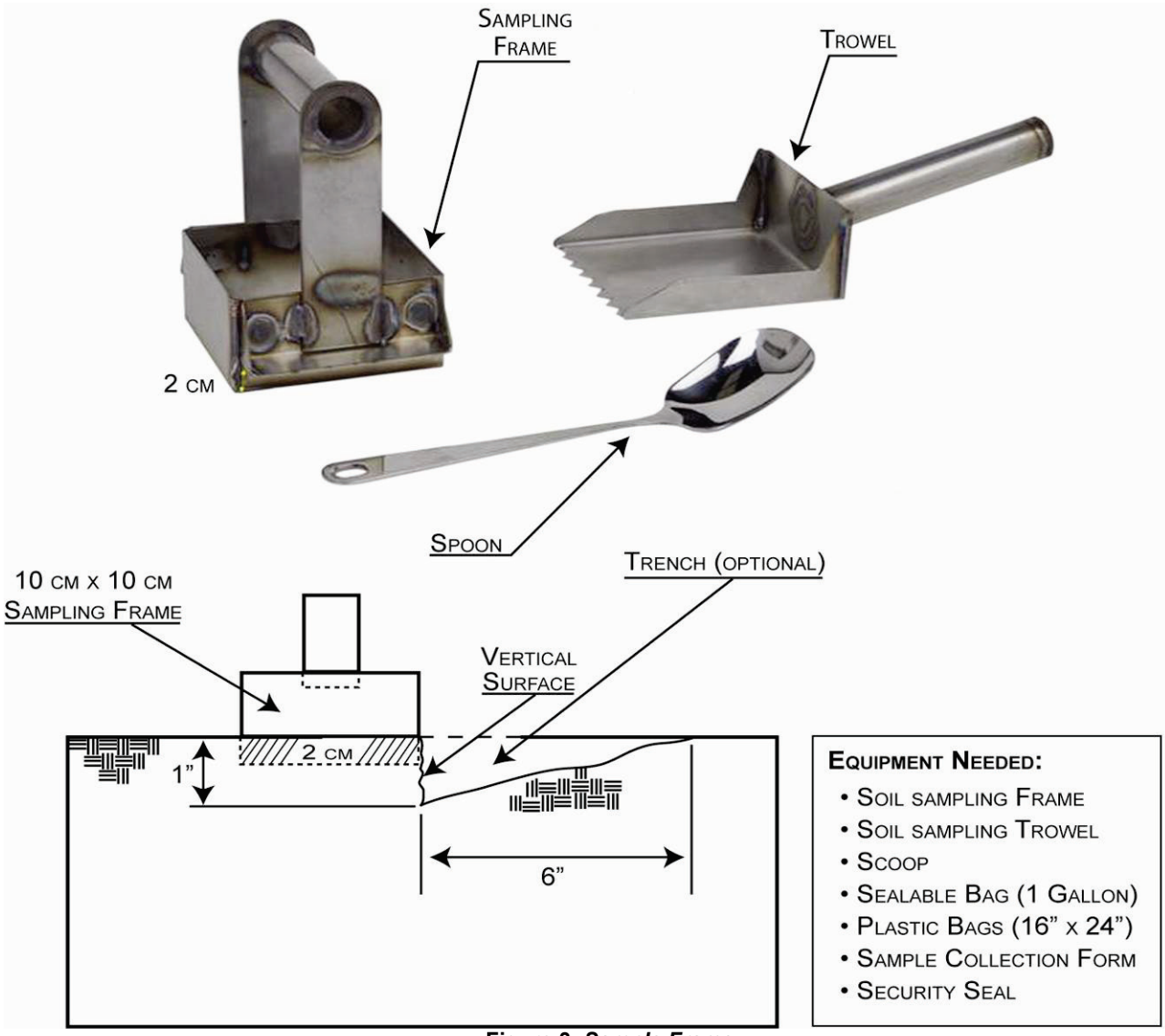


Figure 3. ***Sample Frame***

Be careful not to disturb the sample collection area while digging the trench.

Using a trowel, dig a trench large enough to slide the trowel under the sample. The trench should be no larger than 30 cm long × 15 cm wide × 4 cm deep (12 × 6 × 1.5 in). Fashion a vertical surface that is as straight as possible, Figure 3. Use the claw part of the hammer or shovel to loosen the soil as needed.

Slide the flat trowel under the sampling frame, pick up the trowel, frame and sample, and slowly dump it into a sealable bag. If needed, tap the handle of the trowel to push the trowel under the frame.

Record the depth taken on *Sample Control Form*.

Record the estimated weight of the sample, if this will not be performed at the Sample Receipt Line.

Clean the sampling equipment with disinfectant wipes or water.

Package and label the sample in accordance with "Sample Packaging and Labeling," section 5.0.

4.5.3 Soil with Vegetation

When it is necessary to collect a deposition soil sample that is covered with grass, weeds, or other organic material, clip closely and treat it as a vegetation sample. Bag it separately.

Collect soil as outlined above, depending on the soil condition. Note the location and surface area on the *Sample Control Form*

4.5.3.1 Procedure

If the vegetation will be analyzed then collect the sample according to section 4.7 Vegetation Sampling. If the vegetation is not needed, then discard.

- Vegetation Sample 1: Remove and collect all ground cover vegetation, cutting vegetation as closely as possible, to the soil layer, minimizing disturbance of soil.
- Soil Sample 2: Collect the soil sample, including root mass of grass.

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.

CAUTION:

At all times, try to minimize the amount of plant matter in the sample.
Do not scrape or sweep the surface of the ground.

4.5.4 Dry or Sandy Soil

Unconsolidated or sandy soil that is extremely dry and falling apart should be sampled carefully without digging a trench next to the area. From a known area, collect the soil by carefully lifting the surface area off the measured plot using a spoon.

4.5.5 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.

4.5.5.1 Soil Sampling under Snow

If snow has fallen since 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 Snow Sample, Section 4.6.5) then take a soil sample. Record sample control number of the co-sample on the *Sample Control Form*.

4.5.6 Sediment

Radioactive Material from an incident can be deposited on the bottom of a river, lake or pond in the sediment. Physical samples of sediments can provide detailed descriptions of sediment quality within the bottom of a river, lake or pond. Grab sampling is a common technique used to examine the surface sediment (from about 10-15 cm deep). 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. There are several different techniques for sediment coring including piston corers, hand corers, gravity corers, vibra-corers, 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.

Detailed Sediment Sampling procedures will have to be developed with input from the State and local agencies for each incident and specific to each body of water.

4.6 Water Samples

4.6.1 General Guidance

4.6.1.1 Sample Selection

Water samples must be representative of the body of water the FRMAC is trying to analyze. 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. Use common sense in selecting a representative sample. Choose a location with minimal turbidity and little or no vegetative debris.

4.6.1.2 Special Equipment (Suggested)

Absorbent towels	Plastic funnel
Bucket/Collection container	Rope
Plastic Bags	Disposable gloves

Plastic Containers 1 Gallon (3.5 Liter) or 1Quart (1Liter) (Water)*

* Sufficient volume is needed for laboratory analysis

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

Review the "Operator Aid FRMAC Early Phase Water Sample (Tap)" on page 96 for an example of the process.

Prepare to take a sample.

- Place all sampling tools and the *Sample Control Form* into a plastic bag to carry to sample location.
- To avoid contamination, place plastic bags on the ground; lay the clipboard, instruments, and tools on the bags.
- Survey the site using an appropriate survey meter, taking readings at approximately 1 meter (3 feet) and at 2.5 cm (1 inch) above ground. Record the readings on a digital or paper *Field Monitoring Log*.
- 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.).
- Use a bar code label or indelible ink pen to record the sample control number on the collection container.

Locate the tap nearest the pump.

Turn on the pump and/or open the tap. Allow the water to purge for one minute (40 feet well) or longer to allow for collection of a representative sample collection.

NOTE:

EPA requires a minimum 3 x displacement for well purging.

Use the funnel, if necessary, put small amounts of water into 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.

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.

Turn off the faucet and/or well.

Decontaminate the funnel with disinfectant wipes or clean water and place in a plastic bag.

Dry the exterior of the sample container with an absorbent towel.

Package and label the sample in accordance with "Sample Packaging and Labeling," Section 5.0.

4.6.3 Surface Water for Public Drinking

NOTE:

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.

Surface water refers to lakes, ponds, streams, rivers, etc.

Sample Site Selection

Choose an area that is open, not sheltered by trees or high brush, if possible.

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.

Avoid areas where surface debris could inhibit sampling.

Avoid areas of high turbidity or high sediment, if possible.

Inlet/outlet areas of water treatment plants may both need to be sampled. Samples from still water areas may also be required.

Take sample from midstream, if possible.

Take sample as close to the surface as possible.

When a lake or reservoir is sampled, the sample should represent water that makes up the largest portion of reservoir.

Operating from bridges, docks, or boats is the ideal method to facilitate open-water collections.

Avoid stirring up sediment and do not include it in the sample.

Sampling buckets should not be allowed to sink to the bottom.

Use proper safety equipment around water bodies, such as personal flotation devices (PFDs) or rope and harness, etc.

4.6.3.2 Procedure

Refer to "General Guidance," Section 4.6.1 for the equipment list and water sampling information

Review the "Operator Aid FRMAC Early Phase Water Sample" on page 94 for an example of the process.

Prepare to take a sample.

Place all sampling tools and the *Sample Control Form* into a plastic bag to carry to sample location.

To avoid contamination, place plastic bags on the ground; lay the clipboard, instruments, and tools on the bags.

Survey the site using an appropriate survey meter, taking readings approximately 1 meter (3 feet) and at 2.5 cm (1 inch) above the ground. Record the readings on a digital or paper *Field Monitoring Log*.

On a *Sample Control Form*, record the GPS reading, location, time, date, and other descriptive information.

Use a bar code label or indelible ink pen to record the sample control number on the collection container.

If the funnel and bucket have been previously used, they should be as clean as reasonably achievable.

Use the funnel, if necessary, to put small amounts of water into 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.

Set the sample container in a stable location on the ground with the funnel inserted in the opening.

Stand downstream of bridges or structures.

Lower the bucket into the main channel of stream, using care not to disturb sediments and aquatic vegetation.

Collect a bucket of water and pour it into the sample container until the water in container is within 2 cm (1 in) of top.

Clean the funnel and bucket with disinfectant wipes or clean water.

Dry the container with an absorbent towel.

Complete the Sample Control form.

Record the estimated weight of the sample, if this will not be performed at the Sample Receipt Line

Package and label the sample in accordance with "Sample Packaging and Labeling," Section 5.0.

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 have a tendency 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**).** Sufficient volume is needed for laboratory analysis

4.6.4.1 Special Equipment (Suggested)

Sheet of plastic
Bucket, 5 gallon (~20 liters)
Funnel Graduated cylinder (at least 1 liter [1 quart])
Plastic Containers, 1 gallon (3.5 liter) or 1quart (1 liter) (water)*
4 stakes
some string
a weight
Plastic Bags
Ruler/Tape Measure

* Sufficient volume is needed for laboratory analysis

4.6.4.2 Building a Makeshift Rain Collection System

1. It is necessary to know the finished surface area of the plastic.

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.

Cut a small slit in the center of the plastic and center the bucket under the hole.

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.

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.

4.6.4.3 Procedure

Refer to "General Guidance," Section 4.6.4.1, for equipment list and rain water sampling information.

1. Choose an area that is open, not sheltered by buildings, trees, or high brush, when possible.

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.

Note on the *Sample Control Form* the date and time when the rain collection system was set up.

When returning to collect the rain sample, survey with a beta/gamma survey instrument, if applicable.

Prepare to take a sample.

On the *Sample Control Form*, record the GPS reading, location, start time, stop time, start date, stop date and other descriptive information.

Use a bar code label or indelible ink pen to record the sample control number on the collection container.

Measure the precipitation.

- Transfer the rainwater to a graduated cylinder directly, if possible.
- If the water cannot be transferred directly to a graduated cylinder, pour the rainwater into a bucket. Measure the amount of water with a graduated cylinder. Record the volume on the *Sample Control Form*.

Collect the sample.

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

NOTE:

This is to remove any contaminants left in the container during manufacturing.

- 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.
- Remove funnel and cap all containers.

Rinse and decontaminate rainwater collection system with disinfectant wipes or clean water before leaving. Include both catch basin and rain collection jug.

Dry the container with an absorbent towel.

Package and label the sample in accordance with "Sample Packaging and Labeling," Section 5.0.

4.6.5 Snow Collection

4.6.5.1 Sample Site Selection

During an incident, if the Plume passed over an area covered in snow, then water samples collected from the snow may be needed. Snow samples should be collected in an area free from disturbance (trees, shrubs, buildings, etc). When taking a snow sample, try to remove a sample to pre-emergency depths. Sometimes you can tell by the crust on previous snow depth. Document the surface area. Avoid areas of drifting and scouring.

4.6.5.2 Special Equipment (Suggested)

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 1Quart (1Liter) (Water)*	

* Sufficient volume is needed for laboratory analysis

4.6.5.3 Procedure

Ensure disposable gloves are worn for sample collection, changed, and disposed of between samples.

1. 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.

On a *Sample Control Form*, record the GPS reading, location, time, date, and other descriptive information.

Use a bar code label or indelible ink pen to record the sample control number on the collection container.

Using a trowel, scoop snow approximately two inches deep from the one-foot grid into a plastic bucket.

Complete Sample Control Form and affix label and Security Seal to plastic bucket.

Place the bucket and the copy of the Sample Control Form inside plastic bag and seal.

Rinse any equipment used to collect the sample (e.g., trowel).

NOTE:

The laboratory may require the sample to be transferred from a bucket to a smaller container. This may happen at the sample control area at a later time.

Use a bar code label or indelible ink pen to record the sample control number on the container

As the snow melts, pour the water into a graduated cylinder using the funnel to determine the volume.

Using a funnel, if necessary, put a small amount of water into the sample container, rinse, and discard the 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.

Using the Funnel, pour the melted snow (water) into a container

Dry container with absorbent towel.

Complete Sample Control Form.

Rinse any equipment used to collect the sample (e.g., trowel).

Package and label the sample in accordance with "Sample Packaging and Labeling," Section 5.0.

4.7 Vegetation Samples

4.7.1 General Guidance

Sampling may be taken from the side of the road, at farms, roadside stands, "pick your own" operations, orchards, retail stores and family gardens. Specific selection is made by State Representative with input from the Monitoring Manager.

Sampling sites should be:

- Representative of the region of interest

- Openly exposed to deposition; i.e., away from trees, structures, etc.
- Easily sampled—free of large rocks, trees, and other interference

The sampling area should have:

- Relatively uniform distribution of vegetation
- Vegetation that covers the ground

In a field or garden, collect a representative sample from an area that is flat, open, and unprotected from the wind whenever possible; i.e., away from trees, structures, etc. Do not sample under trees, bushes, or other overhanging objects. Avoid windrows or areas next to roads.

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.

Personnel from supporting state or county agencies, the U.S. Department of Agriculture, or the U. S. Department of Public Health will normally be present at the FRMAC to provide assistance and direction with choosing sample matrixes and locations. **When possible, use State trained personnel and procedures on sample collection teams.**

4.7.2 Early Phase Ground Deposition

4.7.2.1 Sample Selection

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

Market Ready Food (Direct Ingestion) is food directly ingestion into man. **Market Ready sample** will 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 in the near future. The crop may be selected directly from plants or from crates. A notation should be made on the physical state of the sample**.**

Feed crops (Indirect Ingestion) are hays and grains that will be consumed by animals and subsequently man will consume the animals. 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 Special Equipment (Suggested)

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

4.7.2.3 Procedure

Review the "Operator Aid FRMAC Early Phase Vegetation Sample" on page 98 for an example of the process.

Prepare to take sample.

Place all sampling tools and *Sample Control Forms* into a plastic bag to carry to Sample Location.

To avoid contamination, place plastic bags on the ground and lay the clipboard, instruments, and tools on the bags.

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.

Survey the site using an appropriate survey meter, taking readings approximately 1 meter (3 feet) and at 2.5 cm (1 inch) above ground. Record all readings on a digital or paper *Field Monitoring Log*.

Use bar code label or indelible ink pen to record sample control number on sample collection container.

Put on work gloves over disposable gloves.

Cut sample into pieces no larger than 4 inches and place into gallon sealable bag. Do not add additional leaves, stems, or other parts not considered edible.

Measure (Length, Width & Height) Area of the sample collected.

Record the Length, Width & Height on the Sample Control form.

Complete the Sample Control form.

Record the weight of the sample if it will not be weighed at the Sample Receipt Line.

Clean any tools used in sample collection with disinfectant wipes or clean water before reuse.

Package and label the sample in accordance with "Sample Packaging and Labeling," Section 5.0.

4.7.3 Intermediate Phase Ingestion Pathway Sampling

4.7.3.1 General Guidance

As the incident moves from the Early Phase to the Intermediate Ingestion Phase, vegetation sample collection methods will change to more in-depth methods. 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:

- Time of year
- Market Ready - when will vegetation be ripe and ready for harvest
- Has sufficient time past for plant uptake.
- Collect only the edible portions of vegetation consumed by humans.

For 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 Special Equipment (Suggested)

Pruning Shears	Shovel
Grass Clippers	Scissors
Mechanical cutters/Harvesters	Work gloves
Ruler / Tape Measure	

4.7.3.3 Procedure

1. Place all sampling tools and *Sample Control Forms* into a plastic bag for carrying to the sample location.

To avoid contamination, place plastic bags on the ground and lay the clipboard, instruments, and tools on the bags.

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.

Survey the site using an appropriate survey meter, taking readings approximately 1 meter (3 feet) and at 2.5 cm (1 inch) above ground. Record all readings on a digital or paper *Field Monitoring Log*.

Use bar code label or indelible ink pen to record sample control number on sample collection container.

Put on work gloves over disposable gloves.

Cut sample into pieces no larger than 4 inches and place into gallon sealable bag. Do not add additional leaves, stems, or other parts not considered edible.

NOTE:

To determine Ingestion Pathway Protection Action Guides (PAG) the sample volume needed for Vegetation Sampling may increase. Depending on the plant type this may take several bags.

Measure (Length, Width & Height) Area of the sample collected.

Record the Length, Width & Height on the Sample Control form.

Complete the Sample Control form.

Record the estimated weight of the sample if it will not be weighed at the Sample receipt Line.

Clean any tools used in sample collection with disinfectant wipes or clean water before reuse.

Package and label the sample in accordance with "Sample Packaging and Labeling," Section 5.0

4.8 Smear (Swipe) Sample

A smear sample can be used to determine loose (removable) surface contamination on nonporous fixed items. Smear samples can be used in place of soil samples in urban environments.

4.8.1 Procedure

1. Select a representative sampling surface that is:
    - Flat, smooth, and stationary, if possible.
        - Smear can be rubbed on and smear will not roll up or fall apart.
        - As non porous as possible. Metal from a car is the first choice, then a cement sidewalk; the last choice would be an asphalt roadway.

Mark off known area such as:

- Standard Smear is 100 cm^2 or 10 × 10 cm (4 × 4 in) or approximately the size of a dollar bill.
- Large Area Smear is 30 × 30 cm (1 ft^2 or 1 × 1 ft)

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.

Survey the site using an appropriate survey meter, taking readings approximately 1 meter (3 feet) and at 2.5 cm (1 inch) above ground. Record all readings on a digital or paper *Field Monitoring Log*.

Use bar code label or indelible ink pen to record sample control number on sample envelope or bag.

Label the smear envelope or bag with the appropriate information (sample location, date, time, and collector's initials).

With two gloved fingers, carefully rub the smear over the pre-marked area in an "S"-shaped motion. Apply moderate pressure; be consistent if performing multiple smears.

Take care not to shake off collected material.

Place the smear in the envelope or bag.

Package and label in accordance with "Sample Packaging and Labeling," Section 5.0.

4.9 Milk Samples

Personnel from supporting state or county agencies, the U.S. Department of Agriculture, or the U.S. Department of Public Health will normally be present to assist Field Monitoring Teams. Current lists of dairy farms, milk receiving and transfer stations should be maintained by state agriculture agencies. Representatives from the county or state Department of Agriculture or the U.S. Department of Health Services may be assigned to assist in the planning, liaison, and/or 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 or 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 Services may be assigned to the field team as liaison. If there is no state specific procedures use the following guidance:

4.9.1 General Guidance

4.9.1.1 Sample Selection

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

Different types of feed samples are collected under varying conditions to determine the impact of ground deposition radioactivity on the contamination of milk.

- Samples of forage (pasture) should be collected the same as vegetation in an:
  - Open area away from buildings, trees, or other obstructions,
  - Where milk-producing animals are, have been, or are likely to graze.

The immediate area from which the sample is to be collected should be free of recent (post deposition) disturbance such as mowing, burning, trampling, etc.

Refer to "Vegetation Samples," Section 4.7 for instructions on how to collect a sample.

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.

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.

When 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.

4.9.3.1 Special Equipment (Suggested)

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

4.9.3.2 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.

Attempt to contact the farmer or dairy prior to arrival to request the required amount of milk be reserved for pickup.

Arrange an efficient route of travel for collecting milk samples. Include availability of milk, accessibility due to weather, etc.

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 office employee, herdsman, or other employee with signatory authority.

When 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.

Follow instructions of state or county personnel or plant workers.

To prevent contamination of collected milk, use only thoroughly clean sample containers during transit and handling.

Use bar code label or indelible ink pen to record sample control number on sample collection container

Put on work gloves over disposable gloves

Collect one sample of at least 1 Gallon (3.5 Liter). Sufficient volume is needed for laboratory analysis

Collect raw or whole milk (cream mixed into the milk) whenever possible.

The Field Team Supervisor or the ICS-204-FRMAC 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.

If for any reason the milk sample(s) cannot be obtained at the designated location, consult Field Team Contact for an alternate source in close proximity to the designated location, and attempt to collect the sample or samples at the alternate location.

During hot weather, place all milk samples in an ice chest as required.

Package and label the sample in accordance with "Sample Packaging and Labeling," Section 5.0.

Deliver all milk samples to Sample Control. Each sample is to be accompanied by a completed *Sample Control Form*.

4.10 In Situ Ground Deposition Samples

In Situ gamma spectrometry is a rapid method for the assessment of gamma emitting ground surface contamination. Allowance must be made for the nature of the site.

NOTE:

The Field Monitoring Specialist usually assists the in situ Scientist in the collection of the sample. Select Field Team Specialist may be trained to collect in situ measurements without an in situ scientist present.

4.10.1 General Guidance

Choosing the detector type depends on several circumstances and conditions. If available, a Germanium detector has the advantage of high resolution, this enables more specific identification of individual radionuclides, and consequently a more accurate determination of the activity of each radionuclide present in the sample. However, its delicate design, sensitivity for damage and the need for cooling to very low temperatures, usually with liquid nitrogen, will limit the range of applicability. On the other hand the simpler, robust and durable NaI(Tl) scintillation detector has the advantage of withstanding the corrosive effects of the environment, even though the user must be content with a limited resolution achievable with this type of detector. Immediately following a large release, a HPGe with lower efficiency is more useful than high efficiency. The higher efficiency detectors are more susceptible to detector dead time in an area of high activity.

4.10.1.1 Sample Selection

In this respect open, flat, smooth and in undisturbed areas, away from overhanging objects, would be ideal, with no agricultural or other activity having destroyed the vertical concentration profile since the initial radionuclide deposition. Care must be taken to place the detector in the defined position. Typically, 1meter above the ground with the detector head facing downwards.

Review the "*Operator Aid FRMAC Early Phase In Situ Site Selection Sample*" on page 100 for an example site selection.

Analysis

Analysis will be completed by the Assessment and Laboratory Divisions because in emergencies the conversion of the spectrum line intensities to surface contamination is usually done by assuming that the radionuclides are distributed evenly on the plane of the ground surface. Depending on several conditions (dry or wet deposition, time elapsed since the accident, chemical properties of the soil, surface roughness, etc.) this assumption may lead to an underestimation of the total activity of the contaminants initially deposited on a unit area of the ground. This deviation, however, is unlikely to exceed a factor of 2 if the measurement is done in the early or intermediate post-accident phase (i.e., shortly after the deposition)

4.10.2 Special Equipment (Suggested)

High Purity Germanium Detector (LN or Mechanically Cooled)
Tripod Sample Control form
Laptop (Analysis Software & SD Card Reader External Data Storage Device

4.10.3 Procedure

1. Before Departure ensure the in situ system is cooled down and Ready to Operate.

   Select a location that is

   a. open
   b. smooth
   c. flat area
   d. no over hang
   e. Little or no agricultural or other activity destroying the vertical concentration profile was done since the radionuclide deposition.

   On a *Sample Control Form*, record the GPS reading, time, date, dimensions of smeared area and other descriptive information.

   Check with the survey meter that you are not choosing hot spot.

   a. Survey the site using an appropriate survey meter, taking readings approximately 1 meter (3 feet) and at 2.5 cm (1 inch) above ground. Record all readings on a digital or paper *Field Monitoring Log*.

   Set up the in situ system

   a. Set up tripod in a stable manner, in the middle of the selected site
   b. Set Detector down looking 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 dead time.

Set the required measuring time.

a. Typical count time is 600 seconds, unless told otherwise.
b. Different count time will depend on the detector efficiency and the level of contamination the recommended measurement time shall be selected in the range of 100-1000 s.

Start data acquisition for the duration of the preset time.

After the measurement has stopped, save the collected spectrum under appropriate file name (SCF #).

Deliver all Spectra Files to Sample Control. Each sample is to be accompanied by a completed *Sample Control Form*.

5.0 Sample Packaging and Labeling

NOTE:

The use of Alert & Special tags may be designated by the Monitoring Manger and Field Team Supervisor, and used as needed.

5.1. Security Seals

Security Seals (Figure 4) are used by Field Monitoring Teams to seal field samples officially. 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. When working with law enforcement, specific procedures will be implemented to collect law enforcement evidence samples.

Before sealing the sample, write the following information on the *Security Seal*.

Write the collection date.

Initial the sample (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.

Security Seal

Figure 4. Security Seal

5.2 Packaging and Labeling

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

5.2.1 Precautions

- Avoid cross-contamination.
- Wear disposable gloves.
- Change gloves frequently if contamination is suspected.
- 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 / entering vehicle, ensure samples are not dislodged from storage area.

5.2.2 Procedure

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

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 Sample Receipt.

Record results on *Sample Control Form* and complete all applicable sections.

Record results on the digital or paper *Field Monitoring Log*. If using paper Sample Control form, enter the Sample Control Form Number on the paper *Field Monitoring Log* in the comments.

Use 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.

If contamination levels require it, place the bagged sample container and Sample Control Form into another plastic bag. Ensure all information is facing outwards and readable:

NOTE:

Ensure that *Sample Control Form* Number and information is visible through the bag.

Load samples in vehicle for transport to Sample Control. Ensure that the exterior surface of the samples does not contact contaminated instruments, equipment or vehicle surfaces during transport.

When leaving vehicle, ensure that all samples are secure and vehicle is locked.

Transport samples to Sample Control or transfer to courier maintaining Chain-of-Custody.

This Page Intentionally Left Blank

6.0 SAMPLE CONTROL

Sample Receiving and Control is part of the Laboratory Analysis group of a FRMAC. Sample receiving is responsible for the receipt and administrative processing of field samples. Field Monitoring Teams deliver samples, and 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 Preparation area, then to a Radioanalysis Laboratory for processing.

NOTE:

The FRMAC Chain-of-Custody process is not law enforcement evidence level Chain-of-Custody. When working with law enforcement, specific procedures will be implemented to collect law enforcement evidence samples.

6.1 Chain-of-Custody

Chain-of-Custody is the sample tracking and control procedure 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 kept on the paper *Sample Control Form & Chain of Custody*. Sample Information will be recorded on either the digital or paper *Sample Control Form & 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.

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 teams possession, <u>or</u>
- It is in view of the team, after being in your teams possession, <u>or</u>
- It was in your teams possession and you locked it up, <u>or</u>
- 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 section of the *Sample Control Form*.

6.1.1 Procedure

The person who collects the sample:

1. Initiates the Chain-of-Custody by sealing the sample container with a *Security Seal*.
    - If *Security Seal*s are not available, make one using masking tape or adhesive tape.
    - Do not use a SCF sample label for a *Security Seal.*

Initial the *Security Seal*, including date.

Transfers custody of the sample, usually to Sample Control, by completing and signing the Chain-of-Custody section of the *Sample Control Form*.

6.2 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 it is received and acknowledged and custody transferred to the Sample Receiving personnel.

The person collecting and/or delivering samples to Sample Receipt will:

1. Notify Field Team Contact as soon as possible from the field that samples are coming in to Sample Receipt. To improve processing, include estimate of number and type of samples and estimated range of radiation readings.

Upon arrival at Sample Receipt:

- Stop in a designated area (approximately 25 feet [8 meters] away from Sample Receipt) and wait for instructions from Contamination Control Line / Sample Control personnel.
- Ensure that all labels are legible and can be read through sample bags.
- Check samples for evidence of leakage.
- If not completed, perform a radiological survey of the sample to identify segregation of high activity samples.
- Ensure all the required information is recorded on the digital or paper *Sample Control Forms.*
- Notify Sample Control personnel if repackaging is required.
- Notify Sample Control personnel of high activity samples.

Advise Sample Control personnel of any pertinent information concerning samples.

Ensure *Local Area Monitoring (LAM) TLDs* forms are in boxes or bags with corresponding TLDs.

CAUTION:

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

Complete the Chain-Of-Custody section on the *Sample Control Form* and *Local Area Monitoring (LAM) TLDs* form.

Turn over all records and samples to Sample Control personnel.

NOTE:

Do not leave the area until instructed to do so by Sample Control personnel.

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

6.3 Contamination Control Line

When a field team returns, Contamination Control Line personnel survey the Field Monitoring Team, equipment, and vehicle to limit the spread of radioactive material.

- If the team is to return to the field, a routine survey is not taken of the vehicle or field team personnel.
- 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 will be as follows:
    1. Stay in the vehicle until the exterior is surveyed, unless otherwise instructed.
    2. Allow the technician to survey your feet before exiting the vehicle.
    3. Exit the vehicle.
    4. Unload samples, instruments, and equipment and contaminated trash, place them in designated areas.
    5. Process through the Contamination Control Line as instructed by Contamination Control Line personnel.

Review Health and Safety Manual for complete directions on Hotline Activities.

This Page Intentionally Left Blank

7.0 EQUIPMENT CONTAMINATION SURVEYS

Equipment may need to be surveyed in the field for contamination. Surface contamination can usually be detected by direct monitoring methods. The indirect (smear) method may be the primary monitoring procedure under conditions of high background, insufficient portable instrument sensitivity, lack of accessibility, etc. On occasion, direct measurement may be followed by smears of representative portions.

7.1 Direct Method of Surface Monitoring

Use as a method to determine the fixed + removable surface contamination.

7.1.1 Measurement Techniques

- 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.
- Dislodge contaminating particles from the window or probe area by lightly tapping instrument or probe.
- 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.
- Alpha surveys of large areas are qualitative because only representative locations can be checked. 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.
- The holes in the probe window can be repaired with small pieces of opaque tape, paint or black finger nail polish; sensitive area will be decreased and some measurement error will be introduced. When temporary repairs have been made, instruments should be returned 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 0.25 inches (0.64 cm) from the monitored surface.

7.1.2 Procedure

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

2. If the detector passes over an isolated, small-diameter source, the number of pulses produced by the source in the detector will be inversely proportional to the scanning speed.

CAUTION:

Nominal scanning velocity should not exceed 5 cm (2 inches) per second.

3. Hold the probe as close as possible to the surface of the object for accurate measurements without touching, contaminating or puncturing the probe.
4. Hold the probe stationary no more than 0.64 cm (0.25 inches) from the probe window to the monitored surface.
5. Hold sensitive window or probe area over each part of the surface monitored long enough to observe the average value of the meter needle fluctuation.
6. Speaker- or headphone-equipped instruments are desirable for low-level monitoring because the audio will respond faster than the display.
7. Record all measurements on a *Radiation Survey Report*.

7.2 Indirect (Smear) Method of Surface Monitoring

Use as a sensitive method to determine the removable surface contamination.

7.2.1 Procedure

1. Select a representative sampling surface that:
   - Is flat, smooth, and stationary, if possible.
   - Smear can be rubbed on and smear will not roll up or fall apart.
2. Mark off known area such as:
   - Standard Smear is 100 cm^2 or 10 × 10 cm (4 × 4 in) or approximately the size of a dollar bill.
   - Large Area Smear is 30 × 30 cm (1 ft^2 or 1 × 1 ft)
3. Label the smear envelope or bag with the appropriate information (sample location, date, time, and collector's initials).
4. With two gloved fingers, carefully rub the smear over the pre-marked area. Apply moderate pressure; be consistent if performing multiple smears. Use an “S” shaped motion to collect the wipe sample.

5. Take care not to shake off collected material.
6. Determine the amount of radioactive material on the smear with the appropriate instrument of known efficiency (including geometry). A GM (Geiger Mueller) pancake probe is usually used for beta/gamma and an appropriate alpha instrument for alpha contamination.
7. Place the smear in an envelope or bag.
8. Record readings on a *Radiation Survey Report*.

NOTE:

If several smears are taken from one location; make an area drawing that identifies smears by number and location and submit with a radiation Survey Report.

If smear will be submitted for analysis, refer to "Smear (Swipe) Sample," Section 4.8.

Package and label in accordance with "Sample Packaging and Labeling," Section 5.0.

This Page Intentionally Left Blank

8.0 Other Portable Instrumentation

Portable survey equipment for FRMAC is supplied and calibration maintained for a response by National Security Technologies and other responding organizations. It is acknowledged that there are many instruments with similar capabilities that will be deployed for a FRMAC response by other agencies. Those that meet the QC requirements and have the capability to measure with the appropriate sensitivity may be used upon approval of the Monitoring group.

8.1 Global Positioning System

A Global Positioning System (GPS) is a navigational instrument that uses signals from satellites orbiting the earth to determine its present location and guide its user to a destination. The readout will be recorded in degrees and decimal degrees. Several brands of GPS instruments are available. Field Monitoring Teams will be provided with GPS units. The eFRMAC Tablets and MPCD's have build-in GPS antennae into to record GPS coordinates automatically.

8.2 Geiger-Mueller Detectors

Although Geiger-Mueller (GM) detectors typically have a beta shield or thin window, they cannot quantitatively measure the beta dose rate, as they are typically calibrated in Roentgens/hour (defined for photons in air) for gamma exposure rate. The beta shield may be opened to detect the presence of beta radiation and/or contamination, but gamma quantification information will be lost as the instrument no longer has a flat energy response for gamma rays and it will also now detect low energy photons. Beta results from a GM instrument are relative cpm measurements only and should be checked with an ion chamber.

8.3 Other Instrumentation

Additional instruments such as ion chambers, scintillators, and proportional counters will be used when available and as necessary.

8.4 FIDLER-Based Instruments

The FIDLER Field Instrument Detector for Low Energy Radiation is a thin windowed Sodium Iodine crystal used to identify ground deposition of Plutonium. 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 Am-241 will be the surrogate for the total plutonium deposition. The Assessment scientists will determine the Am/Pu ratio. The H&S officers will also base their PPE requirements, primarily respiratory protection, based on the initial Am-241 results.

8.4.1 FIDLER Measurements

Ideally, the survey areas should be flat, treeless/building-less areas of bare ground, asphalt or concrete surfaces, or closely cut grass areas.

Avoid carrying the FIDLER detectors in fields with tall weeds that can brush against the detector face.

8.4.2 Instrument Selection

The FIDLER probe attached to a multi channel analyzer is the preferred FRMAC instrument for the plutonium contamination detection surveys. FRMAC will supply Stradivarius or Violinist. Each has the ability to collect and save spectra and report the results as estimated activity for both Americium and Plutonium in $\mu Ci/m^2$. A FIDLER probe attached to a count rate meter, will display counts for 1 or 2 channels (17 and or 60 keV).

8.5 Calibration Records

Calibration records are required to meet ANSI N323A for all Radiation Detection Instruments used by the FRMAC.

1. Confirm that a calibration sticker is applied to each instrument.

If the instrument is out of calibration or performance tolerance and cannot be used, Tag it Out of Service with

- Name
- Date
- Reason

To utilize the eFRAMC RAMS (Radiological Assessment and Monitoring System) database effectively, detailed information about the instrument meter and probe is needed. Some of the information captured in RAMS 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

8.6 Post-Calibration Performance Test

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

- QC source checks when the appropriate sources are available
- Operational checks in the field

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

This Page Intentionally Left Blank

9.0 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 plume deposition area is recommended for long term monitoring. These dosimeters can provide doses over an established period.

9.1 Special Equipment

Use the following equipment as necessary or as directed:

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

9.2 Deployment

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

CAUTION:

Do not expose environmental dosimeters to radiation sources during transport.

1. Obtain environmental dosimeters from designated official.
2. Use transit controls for deployment and retrieval of dosimeters.
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.

Complete *Local Area Monitoring (LAM) TLD* forms for each environmental dosimeter station. A TLD is a thermoluminescent dosimeter.

1. Include precise directions to each environmental station location so environmental dosimeters can be recovered.
2. Mark the location with flagging or ribbon that is clearly visible from the road.
3. Take and record GPS readings.
4. Note deployment of each environmental dosimeter on a digital or paper *Field Monitoring Log*.
5. Record TLD numbers on the *Local Area Monitoring (LAM) TLDs* form and dosimeter package.
6. Take GM readings and record GM survey results on a digital or paper *Field Monitoring Log* and in the Remarks section.

Return transit controls and *Local Area Monitoring (LAM) TLDs* forms to Sample Control.

9.3 Retrieval

1. Retrieve all environmental dosimeters that were deployed.
2. Be sure to carry transit controls to determine transit exposure.
3. Survey environmental dosimeters and/or containers for contamination with a GM pancake instrument prior to removal from the field.
4. If contaminated, 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. Control contaminated waste appropriately.
5. If contamination is still detected, write the instrument reading on the bag with an indelible ink pen and note the instrument reading in the Remarks section of the *Local Area Monitoring (LAM) TLDs* form. Isolate from non-contaminated environmental dosimeters.
6. Place a Security Seal over the opening of the bag.
7. During transport, keep all environmental dosimeters in sealable plastic bags. Store them in a protected area, preferably in a shielded box.

CAUTION:

Keep environmental dosimeters away from radiation sources.

Ensure that identifying numbers of collected environmental dosimeters match numbers recorded on the *Local Area Monitoring (LAM) TLDs* form. Note on the *Local Area Monitoring (LAM) TLDs* form any environmental dosimeters damaged or missing from fixed stations.

8. Package and label in accordance with "Sample Packaging and Labeling," Section 5.0.
9. Return all collected environmental dosimeters to Sample Control along with completed *Local Area Monitoring (LAM) TLDs* forms and transit controls.

9.4 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.

This Page Intentionally Left Blank

10.0 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.

The RAMS database when setup correctly will automatically convert to FRMAC acceptable units.

10.1 Radiological Units

Some common units are given below:

	Conventional Units	S.I. Units
Dose	Rem	(Sv)
Exposure Rate	mR/hr	(mGy/h)
Surface isotopic deposition	$\mu Ci/m^2$	(MBq/m^2)
Air sampler flow-rates	cfm	(m^3/min)
Volume activity concentrations		
Air Concentrations	µCi/ml	(Bq/ml)
Liquids	mCi/L	(Bq/L)
Soils	mCi/g	(Bq/g)
Tissue	mCi/kg	(Bq/kg)
Vegetation	mCi/kg	(Bq/kg)
Contamination		
Smear samples	dpm/100 cm^2	(Bq/100 cm^2)
Surfaces	dpm/100 cm^2	(Bq/100 cm^2)

10.2 Units of Measure

Units will be those necessary to meet reporting requirements such as PAGs.

10.2.1 Time

Time units will be reported as FRMAC time (where the Incident is located) at measurement location in military units. FRMAC time will 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**

10.2.2 Date

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

Example: 02SEP2009

10.3 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)

10.4 Map Orientation

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

10.5 Location

The location of all monitoring data will be reported in latitude and longitude units, when available, and a physical description (street corner, road junctions, etc.) for map location.

10.6 GPS Units

All global position satellite coordinates should be reported in (DEGREES. DECIMAL DEGREES).

Example: N 036.24163
W -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.

APPENDIX A
FORMS AND CHECKLISTS

Appendix A is a list of the most common forms used by Monitoring & Sampling. The instructions for a form are found on the page opposite the form for ease of use. Go to FRMAC website http://www.nv.doe.gov/nationalsecurity/homelandsecurity/frmac/forms.aspx for the most current downloadable version of the forms. The forms are available in pdf and either Microsoft Word or Excel 2004.

Form Name	Sample Form (Page #)	Instructions (Page #)
10. *Daily Instrument QC Checks*	71	72
11. *Field Monitoring Log*	73	74
12. *ICS-204-FRMAC*	75	76
13. *Local Area Monitoring (LAM) TLDs*	77	78
14. *Sample Control Form*	79	80
15. *Team, Instrument, & Equipment Information Log*	81	82

This page intentionally left blank

DAILY INSTRUMENT QC CHECKS

Event _____. Team Name _____

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]

October 2011

DAILY INSTRUMENT QC CHECKS

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

Event Write name of event.

Team Name Write team name /number.

Instrument Serial Number Write instrument serial number, property number, or other organizational identifying numbers.

Instrument Type Write instrument type.

Depart Date/Time Record departure date following example below.

Record departure time using military notation, as 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 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 x Scale) at time of departure.

These Columns are not usually required.

Return Date/Time Record return date and time following example above.

[If Required]

Return Actual Reading Record actual meter reading on return.

[If Required]

FIELD MONITORING LOG

(I) Team Name: _____. Date(DDMMMYYYY): _____

Field Team Names: _____. Reviewed By _____

	Time (Military) (2)	Location Description (Address, distance from road) Attach map/drawing if necessary (3)	Latitude xxx.xxxxx (4)	Longitude xxx.xxxxx (5)	Measurement Surface (6)	Meter ID (7)	Probe ID (8)	Value (Measurement) (9)	Units (10)	Radiation Type / Energy (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)
(A)											
(B)											
(C)											
(D)											
(E)											
(F)											
(G)											
(H)											
(I)											
(J)											
(K)											
(K)											
(K)											
(K)											
(L)											

October 2011

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 program is unavailable.

(1) Team Name	Name, number, letter, or name identifying the Field Monitoring Team reporting the data.
Date (DDMMMYYYY)	Date of measurements Example 02SEP2009.
(2) Time (Military)	Military time. (Time zone is always the FRMAC location time.)
(3) Location Description	Survey location*; i.e.,* street address, town, intersection, highway, farm, sector, distance, if applicable.
(4) Latitude xxx.xxxxx	In degrees and decimal degrees **xxx.xxxxx**.
(5) Longitude xxx.xxxxx	In degrees and decimal degrees xxx.xxxxx.
(6) Measurement Surface	Examples: filter, soil, grass, etc
(7) Meter ID	Property number, serial number, or other organizational identifying number for the meter.
(8) Probe ID	Property number, serial number, or other organizational identifying number for the probe.
(9) Value (Measurement)	Actual or corrected instrument reading.
(10) Units	Units in which instrument reads.
(11) Radiation Type/Energy	For FRMAC purposes, use descriptive comments such as alpha, beta, gamma, neutron, Pu (plutonium), Am (americium), etc.
(12) Comments	Any information pertinent to instrument measurements and any other environmental conditions. Sample Collection Form Number (SCF-xxxxx)

NOTE: A *Field Monitoring Log* entry is completed for each radiation measurement taken.

1. Event Name	2. Operational Period (Date/Time) From: To:	FRMAC Field Monitoring Team Assignment ICS 204-FRMAC

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

Turn Back:

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 204-FRMAC

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-204 form and a briefing on the content before departure into the field.

Preparation The ICS 204-FRMAC is normally prepared by the Monitoring Manager, field Team Supervisor or designee, using guidance from the Monitoring & Assessment 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.) The date and time will match the Team Operational time in the RAMS database and MPCD's
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 shift "Alpha 20110421 am".
5. Resources Assigned	Record the Contact information for the people to that team. Field Monitoring Team Leader & Field Monitoring Team Member (Name, Phone Number & Company).
6. Work Assignments	Is the detailed instructions of what the Field Team is expected to complete in the field. The information will include Survey Locations, Measurements needed and Sample required.
7. Special Instructions / PPE	Is detailed Personal Protection Equipment required, allowable exposure 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 teams instrument Units.
Approved Site Safety Plan Located at	Closes location a copy for the Site Safety Plan is located, and available for review
8. FRMAC Contact Number	List the position and Phone number of the most useful contact 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.

LOCAL AREA MONITORING (LAM) TLDs

STATION				TLDs				
#	Description	Latitude	Longitude	Number 1	Number 2	Deployed Date/Time Initials	Retrieved Date/Time Initials	Remarks

CHAIN OF CUSTODY			DATE
Relinquished By:	Received By:		
Relinquished By:	Received By:		
Deployment Transit Control TLD Numbers	1)	2)	
Retrieval Transit Control TLD Numbers	1)	2)	
FOR LABORATORY USE ONLY			
FRMAC-to-Laboratory Transit Control TLD Numbers			

Original to Data Center **Yellow Copy to Field Monitoring** **Pink Copy to Laboratory** **September 2002**

LOCAL AREA MONITORING (LAM) TLDS

The *Local Area Monitoring (LAM) TLDs* form is used to record information on the deployment and retrieval of environmental TLDs, called LAMs.

Top portion - Enter information when LAMs are deployed and again when they are retrieved.

Under **Station** record:

#-The number of the station / location.

Description - Location information.

Latitude and Longitude - Latitude and longitude of the station (routinely in degrees and decimal degrees).

Under **TLDs**, record:

Number 1 Record the number of one of the LAMs.

Number 2 Record the number of the other LAM.

Deployed and Retrieved
Date and initial when the LAMs are deployed.
Date and initial when the LAMs are retrieved.

Under **Remarks**, include:

Any additional, pertinent information.

Chain of Custody - To be signed when relinquishing LAMs.

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

☐ TABLET - Sample information entered on Tablet

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

Sample Type (use only once)					
Air	Sampler ID #	Type:	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			
	Additional Air Filter, Provide Sample #				
Milk	☐ Cow ☐ Goat ☐ Other:	☐ Stored Feed ☐ Pasture ☐ Other:			
	Milking Date:	Milking Time:	Number of Animals		
Soil	Depth of soil sample: cm	Vegetation collected with soil sample? ☐	If "YES" check box if "NO" leave blank		
	Sample surface area: cm²	If vegetation in separate container, provide sample #:			
Water	☐ Surface ☐ Ground / Well ☐ Potable / Tap ☐ Other:				
Other	☐ Food ☐ Feed ☐ Instrument ☐ Swipe ☐ Other:	Description:			
	Sample Area (cm): L W H				

Sample Receiving (*to be filled out by sample control & hotline technician*)			
Processing Priority:	☐ Urgent ☐ Duplicate ☐ Split ☐ Composite ☐ Blank		
Receipt Contact Dose Rate uR/hr:	☐ **Contamination Check:** Forms and sample bags surveyed.	Weight of Sample gram	
Analysis Requested:			
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** **October 2011**

SAMPLE CONTROL & CHAIN - OF - CUSTODY FORM

Field	Data
Tablet	Check if "Sample Information" is recorded using MPCD Tablet. Only Chain-of-Custody 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).
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).
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" (end time of collection period).
Area Exposure Rate	Record the average area Exposure Rate where the sample is to be collected.
Contact Dose Rate	If background permits, then enter the dose rate at contact with the sample container.
Collection Comments	Enter any pertinent information on the collection process (i.e., unusual occurrences).
Sample Type	Complete the appropriate "Sample Type". Use only one sample per form.
Air Sample	Enter Air Sampler ID, 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.
Additional Air Filter, Provide Sample #	Enter additional Air Sample # for each separate Air Filter Matrix taken at same location. (i.e., Paper & Charcoal Cartridge)
Milk Sample	Check the "Type" of milk sampled. If "Other", describe. Enter the "Feed Type" the cattle eat. If "Other", describe in the remarks. Enter Milking Date (dd-mmm-yyyy) & Time (24hr)
Soil Sample	Enter Depth of soil sample in centimeters. Enter the surface area sampled in centimeters^2 (square centimeters). If a separate vegetation sample was collected indicate so and enter the sample number of the SCF for the vegetation sample. DO NOT ENTER TWO SAMPLES ON A SINGLE SCF.
Water Sample	Check the "Source" of the water sample. If "Other", describe.
Other	Check the sample type Food – Human Consumption, Feed – Animal Consumption, "Instrument" (Spectra to be saved in RAMS), " Swipe" or "Other
Sample Area (cm)	Record the Area the Vegetation or Swipe Sample was taken from (Length, Width and Height).
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).
Processing Priority	Identify Rush (Priority or Urgent) samples designated by the monitoring manager. 1 is high priority.
Duplicate Sample #	A duplicate sample is a second sample collected at the same location. Create duplicate paperwork and assign a new sample number to the duplicate and record the other sample number here.
Split Sample#	A split sample is a single sample collection split into two sample containers. Create duplicate paperwork and assign a new sample number to the split sample and record the new sample number here.
Receipt Contact Dose Rate	Samples are checked for activity 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, Water & Vegetation Samples.
Analyses Requested	Record analysis requested by Assessment or Monitoring and Sampling Supervisors if known.
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. Does 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

TEAM, INSTRUMENT, & EQUIPMENT INFORMATION LOG

Field Team Supervisor Initials _____

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

FIELD TEM MEMBERS INFORMATION

	Name (Last, First, Middle Initial)	Contact Phone #(s)	Home Organization
1			
2			
3			
4			
5			
6			

INSTRUMENT AND EQUIPMENT INFORMATION

Instrument / Equipment Number	Instrument / Equipment Type	Instrument / Equipment Number	Instrument / Equipment Type

MPCD & Tablet Number	Cellular Phone Number	Cellular Phone Number	Radio Number

VEHICLE INFORMATION

License Plate Number	State	License Plate Number	State

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

October 2011

TEAM, INSTRUMENT & EQUIPMENT INFORMATION LOG

The *Team, Instrument, & Equipment Information Log* is completed and submitted to the Field Monitoring Supervisor before leaving the FRMAC.

Filed 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 and or number 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 20OCT2009.

Start Time – Is the Military Time before the Field Team Departs the TOC (Technical Operations Center)

FIELD TEM MEMBERS INFORMATION

Name (Last, First, Middle Initials) – List the full name of each Field Team Members

Contact Phone #(s) – Is the Cells Phone Number to be used by the Team

Home Organization – Is the Company Name of each Field Team Members

INSTRUMENT AND EQUIPMENT INFORMATION

Instrument / Equipment Number- Record the Bar Code Number or Serial Number for each Instrument and equipment checked out and used by the Field Team

Instrument / Equipment Type - Record the Model Number (Type) for each Instrument and equipment checked out and used by the Field Team

Instruments are used to report Exposure Rate and or Contamination levels are recorded in the Left two columns (i.e., ADM-300, BGP-100, BP-100, and AP-100)

Some of the equipment issued to each Field teams can include Electronic Dosimeters, Breathing Zone Air Samplers, Air Sample Pumps, and Generators ect.

MPCD & Tablet Serial Number - Serial Number of the Multi Point Communication Devise to each team

Cellular Phone Number – Record the contact Phone number(s) used by the Team

Radio Number – Record the Serial Number of the portable Radio issued to each team

Vehicle Information

License Plate Number and State – Record the License Plate Number and State for the vehicle assigned to the Team. If the Team has two vehicles record the information in the second location.

APPENDIX B
OPERATOR AIDS

Appendix B shows examples of the some of the Operator Aids used for different processes. The instructions for each step are shown under each picture. Go to FRMAC website http://www.nv.doe.gov/nationalsecurity/homelandsecurity/frmac/manuals.aspx for the complete list and most current downloadable version of the Operator Aids.

Operator Aid	Page No.
Operator Aid FRMAC Air Sample Pump Staplex High Vol	85
Operator Aid FRMAC Air Sample Pump F&J Low Volume	88
Operator Aid FRMAC Early Phase Soil Sample	92
Operator Aid FRMAC Early Phase Water Sample	94
Operator Aid FRMAC Early Phase Water Sample (Tap)	96
Operator Aid FRMAC Early Phase Vegetation Sample	98
Operator Aid FRMAC Early Phase In Situ Site Selection Sample	100

This page intentionally left blank

Collect a FRMAC Staplex High Volume Air Sample Pump

Choose a Location

Suggested Equipment

Air Sample Pump
Tripod
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 out in the Open. Away from buildings, trees or other overhead obstructions. Rule of thumb is to locate pump at least two times the height away from the closest obstruction.

Survey Area Exposure Rate (waist high) & Contamination (ground). Record measurements.

Position sample head approximately 1 meter 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.

Collect a FRMAC Staplex High Volume Air Sample Pump

Assemble the Sample Head

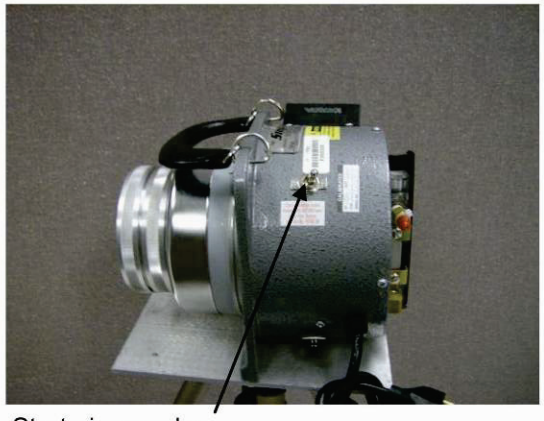
Air Sample head, paper filter.

Install paper filter. Fuzzy side out. Red line is on back of paper

Assembled head.

Attach Sample Head to Pump.

Air sample head installed.

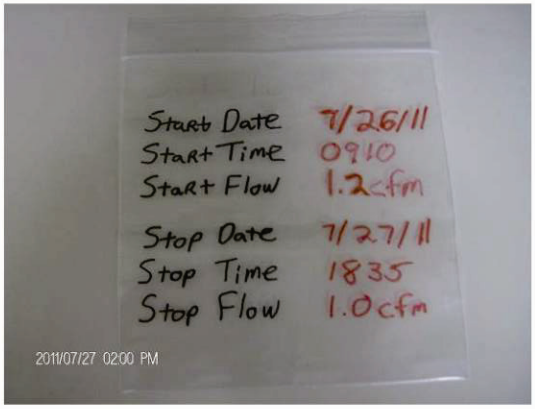


Start air sample.

Collect a FRMAC Staplex High Volume Air Sample Pump

Check Flow Rate.

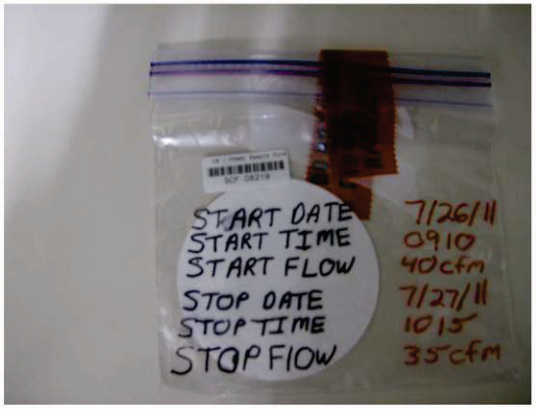
Record Start Date, Time and Flow Rate on Sample Bag. Put Barcode on Bag



Before you STOP the pump, record Stop Date, Time and Flow Rate on Sample Bag

Remove Sample Head assemble

Using Tweezers, Places Filter Paper in a Sample bag. Place a Security Seal on the bag.



Complete a Sample Control & Chain of Custody Form for each sample and input into the Tablet.

If Background permits survey the Sample

Collect a FRMAC F&J Low Volume Air Sample Pump

Choose a Location

Suggested Equipment

Air Sample Pump
Tripod
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 out in the open 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.

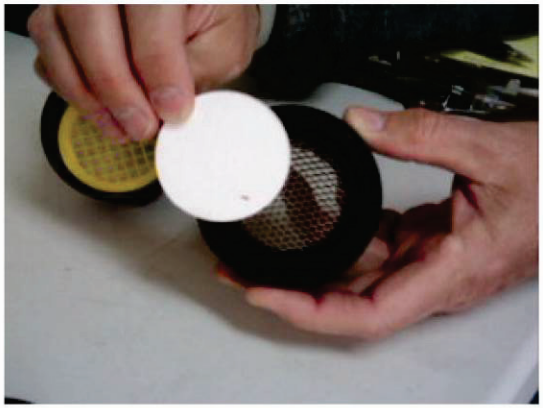
Survey Area Exposure Rate (waist high) & Contamination (ground). Record measurements.

Position sample head approximately 1 meter off the ground (Approximate breathing zone height). Point the Sample Head in the direction of the release

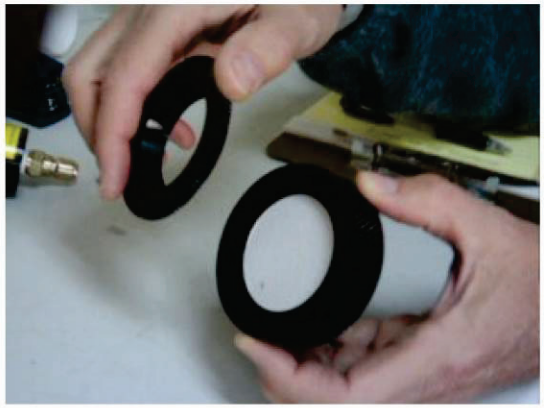
If using a generator ensure the exhaust is downwind from the sample head

Assemble the Sample Head

Air Sample head, paper filter, and charcoal filter



Install paper filter. Fuzzy side out. Red line is on back of paper



Assembling head

Install charcoal filter

Assembling head

Collect a FRMAC F&J Low Volume Air Sample Pump

Insert head assembly into air sampler

Air sample head installed.

Opening air sampler

Battery button Power button

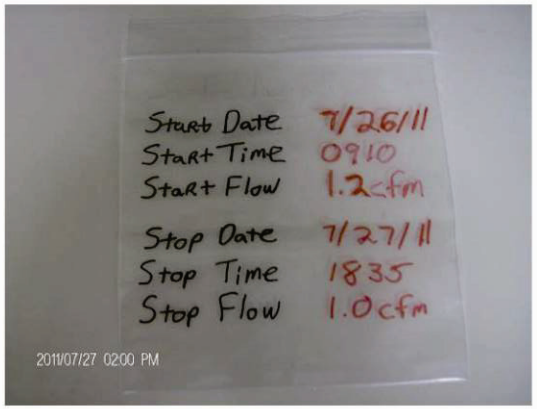
Flow/time/total volume indication button
Make sure Flow is showing

Press Reset to start Pump
Wait till flow stabilized.
Close the Lid

Collect a FRMAC F&J Low Volume Air Sample Pump

Record Start Date, Time & Flow Rate on Bag. Put Barcode on Bag

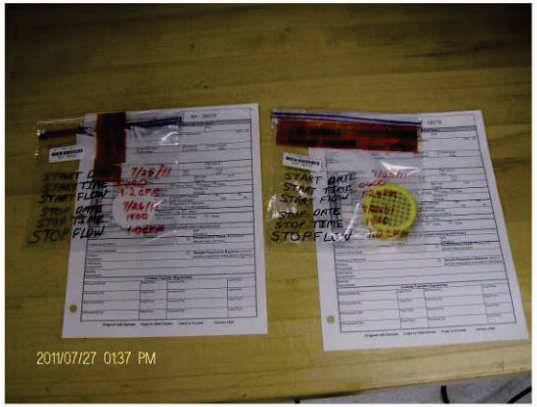
Press Button to see Total Volume



Record Stop Date, Time & Flow Rate or Total Volume on Bag.

Remove head assemble

Using Tweezers, Places Paper and or Cartridge into separate Sample bags. Place a Security Seal on the bag.



Complete a separate Sample Control & Chain of Custody Form for each sample and input into the Tablet.

If Background permits survey the Sample

Collect a FRMAC Emergency Phase Soil Sample

Suggested Equipment

Soil Sample Jig
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 sample

Locate the sample out in the Open, away from buildings, trees or other overhead obstructions.

Survey Area Exposure Rate (waist high) & Contamination (ground). Record as a measurement.

Gather the needed equipment place in a bag to carry to collection site.

Place jig at sample location, with as little vegetation as possible.

If vegetation is present, remove as much vegetation as possible.

Push Jig to 2 cm depth. Tap with Hammer if needed.

Collect a FRMAC Emergency Phase Soil Sample

Dig trench with trowel, use claw hammer If needed to loosen soil.

Slide Trowel under jig, use hammer if necessary to push 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 (dirty person) to place the sample into the bag, without touching the outside of the bag.

Pick up Jig and Trowel with the sample. Pour content into 1 gallon Sealable Bag

Roll the bag around the soil.

Keep the opening away from breathing area

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

If Background permits survey the Sample and record on SCF.

Collect a FRMAC Emergency Phase Water (Open Source) Sample

Choose a Location

Suggested Equipment

Cubetainer (1 Gallon)
Funnel
Bucket
Rope
Bags, 15 x 24
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.

Survey Area and pick Location (Exposure Rate and Contamination)

Gather the needed equipment place in a bag to carry to collection site.

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

Place a SCF barcode on the cubetainer.

Collect a small amount of sample water and rinse out the sample container.

Locate the sample out in the Open. Away from buildings, trees or other overhead obstructions. Little to no current

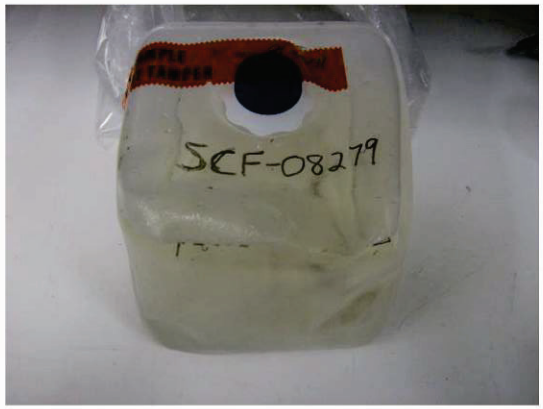
Collect a FRMAC Emergency Phase Water (Open Source) Sample

If needed attach the rope to the bucket
Collect the surface water

Using the funnel fill the 1 liter container.
Stop 1 inch from the top

Dry the outside of the Sample container

Place a Security Seal over the opening.



If needed using a indelible marker, write the SCF Number on the Cubetainier.

Place into a clean plastic bag.

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

If Background permits survey the Sample

Collect a FRMAC Emergency Phase Water (Tap) Sample

Suggested Equipment

Cubetainer (1 Gallon)
Funnel
Bucket
Rope
Bags, 15 x 24
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.

Choose a location to collect "TAP" / "WELL" sample.

Survey Area Exposure Rate (waist high) & Contamination (ground). Record as a measurement.

Gather the needed equipment place in a bag to carry to collection site.

Place a SCF barcode on the Sample Container.

Collect a small amount of sample water and rinse out the sample container.

Purge the tap to get a sample from the well supply and not the lines.

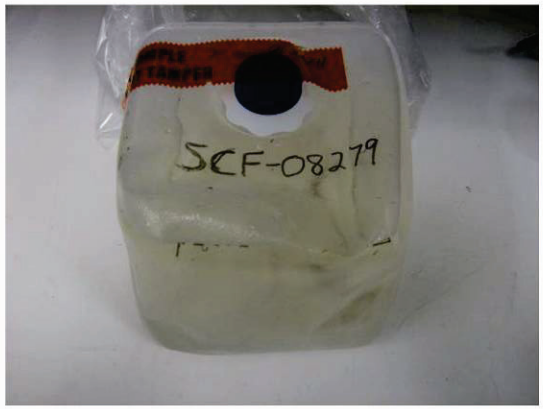
Collect a FRMAC Emergency Phase Water (Tap) Sample

Fill the bucket.

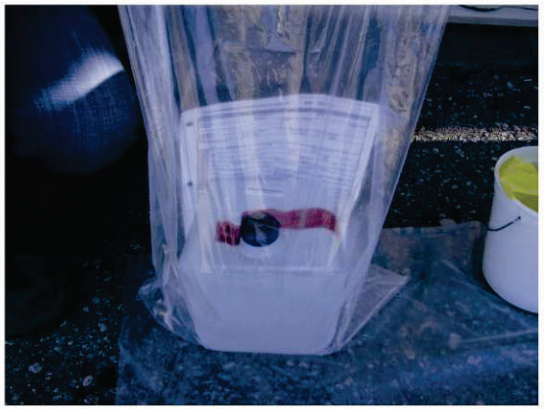
Using the funnel fill the 1 liter container.
Stop 1 inch from the top

Dry the outside of the Sample container

Place a Security Seal over the opening



If needed using a indelible marker, write the SCF Number on the Cubetainier.
Place into a clean plastic bag.



Complete the Sample Control& Chain of Custody Form and input into the Tablet
If Background permits survey the Sample

Collect a FRMAC Emergency 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 sample.

Locate the sample out in the Open, away from buildings, trees or other overhead obstructions.

Survey Area Exposure Rate (waist high) & Contamination (ground). Record as a measurement.

Gather the needed equipment place in a bag to carry to collection site.

Clean Person: Roll the bag until a lip has been created. Hold bag under lip ensuring that the bag remains open for the (dirty person) 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.

Stop before the bag is bulging and will not seal.

Collect a FRMAC Emergency Phase Vegetation Sample

Measure the Length, Width and Depth of the sample collected

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

If Background permits survey the Sample and record on SCF.

Operator Aid FRMAC Early Phase In Situ Site Selection

In Situ Sample Measurement Guidance
When choosing a site to collect In Situ measurements:
Sampling should be conducted only in undisturbed environments.

Choose the largest plots of land, as practical, to ensure there is a minimum radius around the detector of 5 meters, larger is better

Example of Representative Environments

Example of Representative Environments

Photograph the detector to show the wider environment around the sampling site, if available

Example of Representative Environments

Example of Representative Environments

This is good location if parking lot is undisturbed and rain has not washed out deposition

Operator Aid FRMAC Early Phase In Situ Site Selection

If you are unable to find the ideal location close to where your instruction told you to collect a sample, collect the sample and record all the issues.
Then proceed to an ideal location and collect a second sample.

Photograph the detector to show the wider environment around the sampling site, if available

Example of Non representative Environments

Drop Off or (Discontinuity) and unknown when the Disturbed Soil happened

Avoid tilled fields, pavement, and vegetation-pavement transition
Culvert or (Discontinuity) and unknown when the Disturbed Soil happened

Pole and culvert too close. If road is open to traffic .Unknown undisturbed deposition present

If road is open to traffic .Unknown undisturbed deposition present

This Page Intentionally Left Blank

APPENDIX C
FRMAC FIELD TEAM CONTACT

Field Team communications are the responsibility of the FRMAC Monitoring group. For large operations, the Field Team Supervisor should assign one or more experienced Field Monitoring Specialist to act as the Field Team Contact(s).

OPERATIONS

Communications from TOC (Technical Operations Center) to the Field Teams will happen using several methods including the MPCD through the RAMS Database, Radio and/or Telephone. The primary function of Field Team Contact is to ensure that all urgent traffic is transmitted quickly 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 database; subsequently these data points are reviewed and approved by the Field Data Supervisor and Monitoring Manager for verification of completeness and accuracy. The data are then available and distributed throughout the FRMAC.

PROCEDURE

Field Team Supervisor gives Field Team Contact a copy of each *ICS-204-FRMAC* form.

Field Monitoring Teams initiate a communications check before departure.

Field Team Contact acknowledges communication to each team.

Teams proceed to the sites. Upon arrival, teams identify themselves and their locations to Field Team Contact, if directed.

Teams will contact the Field Team Contact at least once an hour to ensure Team Safety and progress of duties.

When spelling, teams use the phonetic alphabet shown on the next page.

When communicating with Field Team Contact, 10-Codes, listed on the next page, can be used.

If the team encounters MPCD or tablet operations issues they will contact the Field Team Contact, Field Team Supervisor or eFRMAC personnel. If the issues cannot be resolved the team will be informed to do one of the following:

16. Return to FRMAC

17. If the MPCD is unavailable, the field team will continue collecting data on the tablet until the MPCD connect returns or the team returns to the FRMAC
18. If the Tablet stop working and the team is unable to restart it, the team will continue collecting data using the paper *Field Monitoring Log* and Sample Control & Chain of Custody form.
19. If the data is urgent, the Field Team Contact will notify the team who will then transmits the data back to the Field Team Contact, who will record the data into RAMS.

If Field Team Contact instructs a team to **stand by,** the team will be contacted by Field Team Contact as soon as possible.

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.

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 will notify the Sample Receiving and Hot Line with the approximate return time.

Returning teams are required to notify Field Team Contact when they arrive at the Sample Receiving Line.

Field Team Contact will maintain contact until all teams have arrived at the Sample Control Receiving Line & Hot Line.

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

10-CODES

10-1	transmission garbled, unreadable
10-2	transmission loud and clear
10-4	affirmative, yes
10-7	out of service
10-8	in service
10-9	please repeat transmission
10-19	return to base
10-20	location
10-21	phone call to Field Team Contact

This Page Intentionally Left Blank

APPENDIX D
MONITORING, HEALTH AND SAFETY INSTRUMENT*

Personnel Protective Equipment (PPE)*			
Description	Phase 1	Phase 2	Total
Tyvek Coveralls XXXL	5	0	5
Tyvek Coveralls XXL	8	200	208
Tyvek Coveralls XL	4	205	209
Tyvek Coveralls L	1	60	61
Shoe Covers XL (pair) (Disposable)	18	350	368
Gloves, Latex XL (pairs)	60	500	560
Gloves, Cotton (pairs)	10	168	178
Full Face Respirator L w/P-100 HEPA	3	10	13
Full Face Respirator M w/P-100 HEPA	2	12	14
Full Face Respirator S w/P-100 HEPA	0	3	3
P-100 Ultra Filter Particulate (HEPA) cartridge (additional)	0	20	20
GMR-I-P-100 Canister (for Iodine)	0	10	10
First Aid Kits	4	0	4
Safety Glasses	1	6	7
Description	Phase 1	Phase 2	Total
MPCD's with Tablets	8	12	20
Deploy Laptops with Turbo FRMAC & Deploy files	4	4	8
Deploy Laptops with Deploy Files	0	16	20
Secure Fax	1	2	3

* Note: This list is representative of the equipment and material NNSA brings during a Phase I and II response. This list is representative of that used at the time of this writing, and changes regularly as new equipment and technologies become available. It does not address what other agencies bring as part of the FRMAC or Augmentation.

This Page Intentionally Left Blank

APPENDIX E
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.

E-1 Multi-Path Communication Device

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 PC 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.

E-2 Tablet Digital Field Monitor program

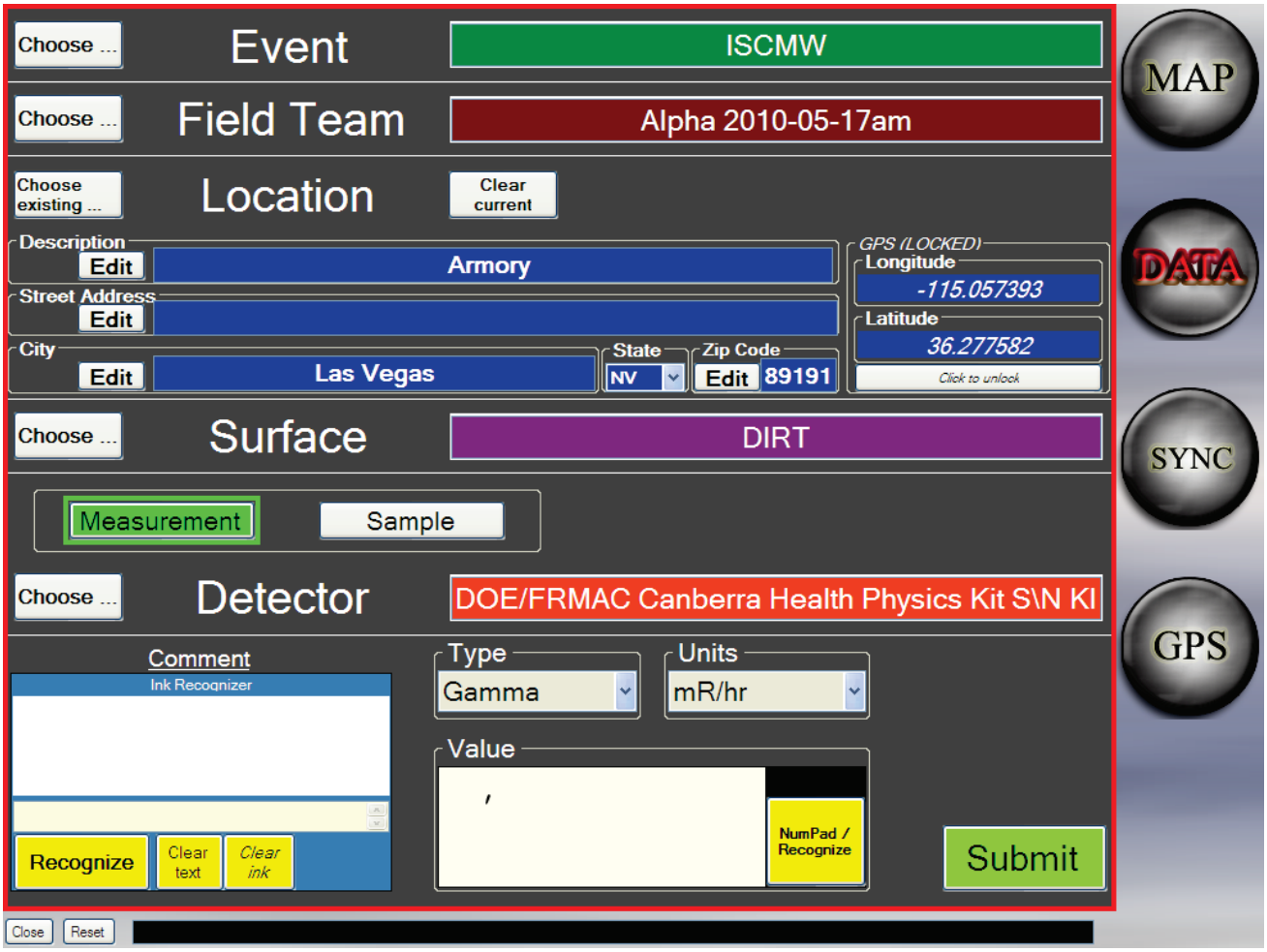
The *Digital Field Monitoring* (DFM) Software is an application that runs on the tablet PC. It allows the user to enter their Event, Field Team, Location, Surface, Instrument and log Measurements and Samples with a GPS coordinate. The tablet then sends this information to the MPCD, which in turn sends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

The Navigation Buttons

There are four navigation buttons within DFM:

7. MAP - Map screen allows the users to track themselves and display radiation information
8. 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. See figure 5 Digital Field Monitor (Screen Shot)
9. SYNC - Sync screen allows the user to monitor transmitted and untransmitted measurements entered into the "Data" portion of DFM.
10. GPS - GPS screen allows the user to monitor the status of the GPS in the tablet PC and within the MPCD dome.

Figure 5. ***Digital Field Monitor (Screen Shot)***



E-3 Radiological Assessment and Monitoring System (RAMS)

The Radiological Assessment and Monitoring System (RAMS) is a component of the (eFRMAC) FRMAC 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 will help to reduce mistakes, provide a smoother operating environment, and augment 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 NARAC, RSL's Enterprise GIS, and other interested parties (EPA, 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:

11. Situation reports: team status, meetings, and announcements
12. Real time operational summaries of measurements, samples, and analysis
13. Contacts, resources, and documents
14. Action item tracking and alerts
15. Featured work product quick display

This Page Intentionally Left Blank

Appendix F
Quick navigation and reporting links Radiological Units Of Measure

Bq	Becquerel
cfm	cubic feet/minute
Ci	curie
cm	centimeter
cpm	counts/minute
cps	counts/second
dpm	disintegrations/minute
er	exposure rate
g	gram
Gy	Gray
keV	kiloelectron volt
kg	kilogram
lb	pound
lpm	liters per minute
MeV	mega electron volt
mph	miles per hour
psi	pounds/square inch
R	Roentgen
rad	radiological absorbed dose
rem	Roentgen equivalent man
Sv	sievert

This Page Intentionally Left Blank

APPENDIX G
ACRONYMS

ALARA	As Low As Reasonably Achievable
CM	Consequence Management
CMHT	Consequence Management Home Team
CMRT	Consequence Management Response Team
DFM	Digital Field Monitoring program
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DHS	U.S. Department of Homeland Security
ECAM	Environmental Continuous Air Monitor
eFRMAC	Electronic FRMAC Enterprise
EOC	Emergency Operations Center, DOE
EOF	Emergency Operations Facility, Licensee
EPA	U.S. Environmental Protection Agency
EPZ	Emergency Planning Zone
FIDLER	Field Instrument for Detecting Low Energy Radiation
FRMAC	Federal Radiological Monitoring and Assessment Center
GM	Geiger-Mueller
GPS	Global Positioning System
H&S	Health and Safety
ICRP	International Commission on Radiological Protection
ICS	Incident Command Structure
ID	Identification
LAM	Local Area Monitor
MPCD	Multi Path Communication Devise
MSL	Mean Sea Level
NARAC	National Atmospheric Release Advisory Center
NCRP	National Council on Radiation Protection
NIMS	National Incident Management System
NNSA	U.S. DOE National Nuclear Security Administration

NNSA/NSO	U.S. DOE National Nuclear Security Administration, Nevada Site Office
NRC	Nuclear Regulatory Commission
NRP	National Response Plan
PAG	Protective Action Guide
PIO	Public Information Officer
PPE	Personnel Protection Equipment
QA	Quality Assurance
QC	Quality Control
RAMS	Radioactive Assessment and Monitoring System
RSL	Remote Sensing Laboratory (USDOE)
SCF	Sample Control Form
SOP	Standard Operating Procedure
TLD	Thermo Luminescent Dosimeter

APPENDIX H
GLOSSARY[1]

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.

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

[2] 10 CFR 835, Occupational Radiation Protection.

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)	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 radionuclide's 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 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. (a) **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. (b) **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 1.67495×10^{-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 from consumption of food or water contaminated with radioactive materials.
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.
Personnel 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.
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.

[3] International Congress of Radiology 1937

[4] NCRP 94 1987

APPENDIX I
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 NNSA/NSO Website:

http://www.nv.doe.gov/nationalsecurity/homelandsecurity/frmac/default.htm

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 1 & 2. Provides methods to easily relate field data to the potential for exceeding emergency health effects thresholds, protective action guides (PAGs), and Emergency Worker Limits. The manual also provides methods to estimate dose.

FRMAC Monitoring Division Manual, Volume 1. This manual was written for those personnel who will be called upon to provide technical data, input, and decisions.

FRMAC Radiological Emergency Response 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 Manual. This manual provides guidance for radiochemical analysis of samples collected during a radiological emergency to provide scientifically defensible data of acceptable quality.

This Page Intentionally Left Blank

APPENDIX J
REFERENCES – GENERAL

American National Standard Radiation Protection Instrumentation, ANSI N323A-1997, April 1997, Test and Calibration, Portable Survey Instruments

U.S. Department of Health, Education, and Welfare. 1970. *Radiological Health Handbook*. Rockville, MA.

Dodd, B. and L.L. Humphries. 1988. "Hazards Assessment of Worst Case Transportation Accidents Involving Typical Radioactive Material Shipments." *Health Physics Society Journal*, Vol. 55, No. 6.

International Commission on Radiological Protection. 1977. *Handling, Storage, Use, and Disposal of Unsealed Radionuclides in Hospitals and Medical Research Establishments*. ICRP Publication 25. Pergamon Press, New York, NY.

International Commission on Radiological Protection. 1983. *Radionuclide Transformations – Energy and Intensity of Emissions*. ICRP Publication 38. Pergamon Press, New York, NY.

Kocher, D.C. 1981. *Radioactive Decay Data Tables (Version 4)*. Report DOE/TIC-11026. Technical Information Center, U.S. Department of Energy, Washington, D.C.

National Council on Radiation Protection and Measurements. 1982. *Nuclear Medicine – Factors Influencing the Choice and Use of Radionuclides in Diagnosis and Therapy*. NCRP Report No. 70. Washington, D.C.

National Council on Radiation Protection and Measurements. 1989a. Exposure *of the U.S. Population from Diagnostic Medical Radiation*. NCRP Report No. 105. Washington, D.C.

National Council on Radiation Protection and Measurements. 1989b. *Radiation Protection for Medical and Allied Health Personnel*. NCRP Report No. 105. Washington, D.C.

U.S. Environmental Protection Agency. 2006. Sample Collection Procedures for Radiochemical Analytes in Environmental Matrices EPA/600/S-07/001. Office of Research and Development.

RESPONSE
RECOVERY
READINESS
TRIBAL
STATE
LOCAL
FRMAC
FEDERAL RADIOLOGICAL MONITORING AND ASSESSMENT CENTER