FEDERAL RADIOLOGICAL

MONITORING AND ASSESSMENT CENTER

Monitoring and Sampling Manual

Volume 1, Revision 3

Monitoring Division Operations

April 2019

DISCLAIMER

FEDERAL RADIOLOGICAL MONITORING AND ASSESSMENT CENTER

Monitoring and Sampling Manual

Volume 1, Revision 3

Monitoring Division Operations

April 2019

APPROVED BY:

Jeremy Gwin
Monitoring and Sampling Working Group Chair
Nevada National Security Site

Alvin W. Morris IV
FRMAC Program Manager
U.S. Department of Energy, National Nuclear Security Administration

Daniel J. Blumenthal
Consequence Management Program Manager
U.S. Department of Energy, National Nuclear Security Administration

Jackson Q. Crocker
Director, Office of Nuclear Incident Response
U.S. Department of Energy, National Nuclear Security Administration

This page intentionally left blank

REVISION HISTORY

Date	Pages Changed	Revision
September 2002	Original	Rev. 0
December 2005	Realignment with NRP	Rev. 1
July 2012	Complete revision	Rev. 2
April 2019	Complete revision	Rev. 3

This page intentionally left blank

ACKNOWLEDGEMENTS

The Federal Radiological Monitoring and Assessment Center (FRMAC) Monitoring and Sampling Working Group and several additional individuals contributed their time and efforts in writing and/or reviewing this document. These individuals are recognized as follows:

FRMAC Monitoring and Sampling Working Group

Name	Organization
David Asselin	Conference of Radiation Control Program Directors (MI)
Robert Augdahl	Nevada National Security Site
Robyn Corcoran	USDA APHIS
Jeremy Gwin	Nevada National Security Site
Mike Howe	FEMA
Brian Hunt	Sandia National Laboratory
Terry Kraus	Sandia National Laboratory
Patty Lowe	Y-12 Consolidated Nuclear Security (RAP 2)
Doug McBride	Nevada National Security Site
Ben McGee	Nevada National Security Site
Toby Morales	Conference of Radiation Control Program Directors (AZ)
Alvin Morris	U.S. Department of Energy, National Nuclear Security Administration
David Oertli	United States Air Force
Sam Poppell	U.S. Environmental Protection Agency
Rich Sorom	Nevada National Security Site
Mary Stiker	Conference of Radiation Control Program Directors (IN)
Roy Windham	Savannah River Site (RAP 3)
Ken Yale	U.S. Environmental Protection Agency

Additional Contributors

Name	Organization
Lainy Cochran	Sandia National Laboratory
Sandra Elkouz	U.S. Environmental Protection Agency
Jeremy Johnson	U.S. Environmental Protection Agency
RaJah Mena	Nevada National Security Site
Jezabel Stampahar	Nevada National Security Site

This page intentionally left blank

TABLE OF CONTENTS

List of Figures

List of Tables

Appendices

This page intentionally left blank

LIST OF ACRONYMS

AFB	Air Force Base
AGL	Above Ground Level
ALARA	As Low As Reasonably Achievable
AMS	Aerial Measuring System
APM	Advance Party Meeting
ASAP	As Soon As Possible
BWR	Boiling Water Reactor
CM	Consequence Management
CMAC	Consequence Management Advance Command
CMHT	Consequence Management Home Team
CMRT	Consequence Management Response Team
CMweb	Consequence Management website
DHS	Department of Homeland Security
DOE	Department of Energy
dpm/100 cm^2	disintegrations per minute per 100 square centimeters
DQO	Data Quality Objective
DRL/DIL	Derived Response Level/Derived Intervention Level
ECAM	Environmental Continuous Air Monitor
EMAC	Emergency Management Assistance Compact
EOC	Emergency Operations Center
EPA	Environmental Protection Agency
ESF-12	Emergency Support Function #12
FBO	Fixed Base of Operations
FEMA	Federal Emergency Management Agency
FIDLER	Field Instruments for Detection of Low-Energy Radiation
FLA	Fly Away Laboratory
FMP	Forward Monitoring Post
FMS	Field Monitoring Specialist
FRMAC	Federal Radiological Monitoring and Assessment Center
FTL	Federal Team Lead
FTS	Field Team Supervisor
GIS	Geographic Information System
GM	Geiger-Mueller
GPS	Global Positioning System
HPGe	High-Purity Germanium
hr	hour
H&S	Health and Safety
HSIN	Homeland Security Information Network
IAP	Incident Action Plan

IC/UC	Incident Command/Unified Command
ICRP	International Commission on Radiological Protection
ICS	Incident Command System
IDLH	Immediately Dangerous to Life or Health
keV	kiloelectron Volt
MDA	Minimum Detectable Activity
MARS	Mobile Aerial Radiological Surveillance [RSL]
mGy	milliGray
MPCD	Multipath Communication Device
mR	milliRoentgen
mrad	millirad
mrem	millirem
M&S	Monitoring and Sampling
mSv	milliSievert
NaI(Tl)	Sodium Iodide (Thallium doped)
NARAC	National Atmospheric Release Advisory Center
NIT	Nuclear Incident Team
NNSA	National Nuclear Security Administration
NRC	Nuclear Regulatory Commission
NRP	National Response Plan
PAG	Protective Action Guide
PDF	Portable Document Format
PIO	Public Information Officer
PPE	Personal Protective Equipment
PWR	Pressurized Water Reactor
QA	Quality Assurance
QC	Quality Control
RAMS	Radiological Assessment and Monitoring System
RAP	Radiological Assistance Program
REAC/TS	Radiation Emergency Assistance Center/Training Site
RNAC	Radiological/Nuclear Air Coordinator
RSL	Remote Sensing Laboratory
RTG	Radioisotope Thermoelectric Generator
SEOC	State Emergency Operations Center
SOP	Standard Operating Procedure
TLD	Thermoluminescent Dosimeter
VSP	Visual Sample Plan
$\mu Ci/m^2$	microcuries per square meter

1 INTRODUCTION

The Federal Radiological Monitoring and Assessment Center (FRMAC) is a federal asset available on request by the United States (U.S.) Department of Homeland Security (DHS) and state and local agencies to respond to a nuclear or radiological incident. The FRMAC is an interagency organization with representation from the National Nuclear Security Administration (NNSA), which is a semi-autonomous agency within the U.S. Department of Energy (DOE), the U.S. Department of Defense, the U.S. Environmental Protection Agency (EPA), the U.S. Department of Health and Human Services, the Federal Bureau of Investigation, and other federal agencies. The NNSA has the responsibility to maintain the operational readiness of the FRMAC and to deploy it.

The FRMAC mission is to coordinate and manage all federal radiological environmental monitoring and assessment activities during a nuclear or radiological incident within the U.S. in support of state, local, and tribal governments, the DHS, and the federal agency with primary authority for federal response.

1.1 The Monitoring Division Role in the FRMAC

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

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

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

A discussion of Standard Operating Procedures (SOPs) for field radiation monitoring and sample collection for use by the Monitoring Division during a FRMAC response to a radiological emergency may be found in the *Federal Radiological Monitoring and Assessment Center Monitoring Manual, Volume 2, Radiation Monitoring and Sampling*.

When Monitoring Division team members are selected for tasks, some will be assigned to support the Health and Safety (H&S) Division. The Monitoring Division provides technicians to support specific H&S Division activities, including the following:

- Operation of the hotline
- Facility surveys
- Assistance with H&S functions at checkpoints
- Assistance at population assembly areas which require support from the FRMAC

1.2 Monitoring Division Manager Duties

The Monitoring Manager works closely with other FRMAC Division managers to determine the need for field measurements, sampling, radioisotope analyses, and H&S requirements. The Monitoring Division's operations are prioritized based on the needs of the FRMAC to address objectives. The Monitoring Manager is responsible for ensuring that the radiation measurements, environmental samples, and results from analyses meet the data quality objectives established during the emergency. State and local agencies are encouraged to integrate resources with the FRMAC in their monitoring and sampling efforts; however, the Monitoring Manager is responsible for coordinating monitoring activities to minimize the duplication of efforts and assuring the compatibility of results if state and local agencies choose to conduct separate operations.

One of the duties of the Monitoring Manager in the early stage of the response is to participate in the Advance Party Meeting to establish communication with the various federal, state, and local response organizations. The Monitoring Manager also provides assistance in setting sampling and monitoring priorities and developing a strategy for responding to the radiological incident. It is important that the Monitoring Manager utilize the "Consequence Management Advance Command (CMAC) Arrival Checklist" (see Appendix A) to ensure that all relevant information has been supplied, which will be required to complete various documents and forms.

The Monitoring Manager will be required to provide situation reports to the FRMAC Technical Team Leader or the FRMAC Director during the response. The report will typically include the status of monitoring activities, availability of field teams, and progress on the objectives set forth in the Incident Action Plan (IAP) or from requests made during the operational period.

1.3 FRMAC and Monitoring Division Organizational Structures

Figure 1 illustrates both the organizational structure of a FRMAC and how the Monitoring Division fits into the overall FRMAC organization. Figure 2 illustrates the organizational structure of the Monitoring Division.

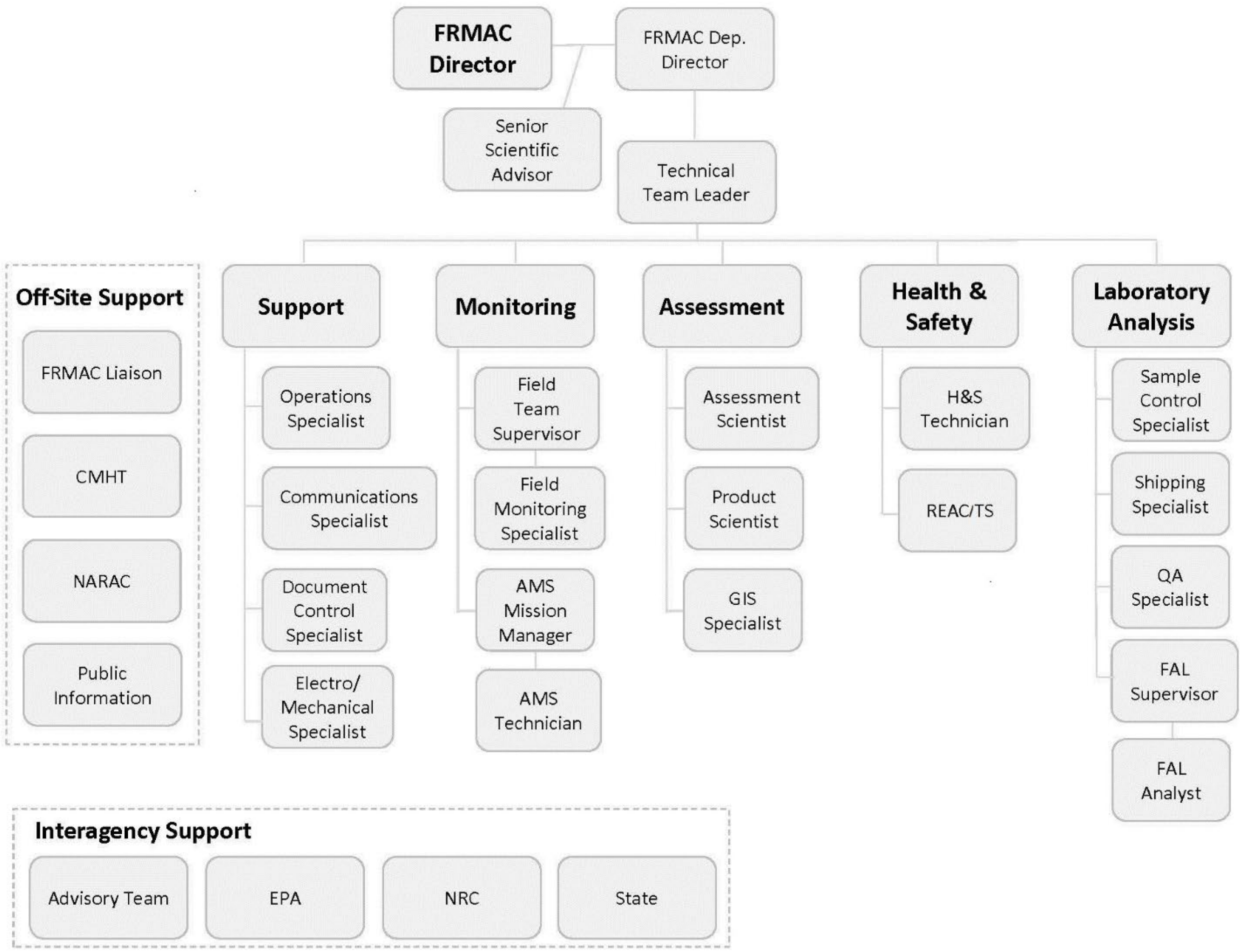


Figure 1. FRMAC Organizational Structure

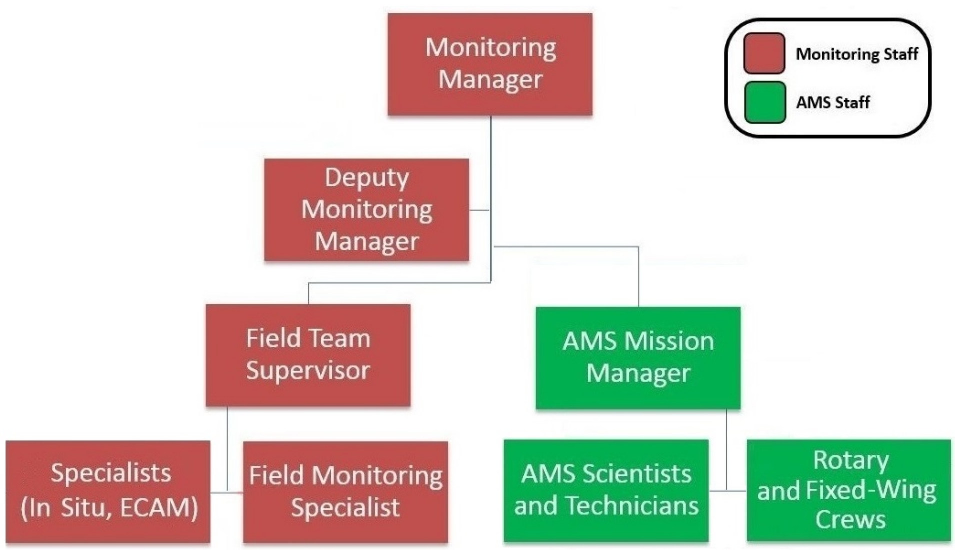


Figure 2. Monitoring Division Organizational Structure

This page intentionally left blank

2 DEPLOYMENT ACTIVITIES

The Consequence Management Response Team (CMRT) will be deployed and the FRMAC will be established following the guidance provided in the *FRMAC Operations Manual*. The CMRT is expected to integrate deployed Radiological Assistance Program (RAP) team members into any applicable Monitoring Division role. This section outlines general deployment, but with more focus on the Monitoring Division deployment activities.

2.1 CMAC Deployment

The CMAC may be deployed ahead of the CMRT. The Monitoring Manager is part of the CMAC. For a non-comprehensive checklist of CMAC responsibilities, with special focus on the CMAC (as a group) and Monitoring Manager responsibilities, see Appendix A.

2.2 AMS Deployment

The Aerial Measuring System (AMS) will most likely deploy before the CMRT. The AMS Mission Manager will coordinate the flight. In this regard, the AMS is nearly autonomous from the rest of the FRMAC. The AMS will generally arrive at the incident location between 6 and 12 hours after asset activation. The first flights typically performed are conducted in a serpentine pattern to determine the extent of the contamination, an isodose pattern to determine an approximate boundary, or a parallel line flight to determine a more detailed footprint of the contamination. For more details on the AMS first five flights concept, see Appendix B. The AMS Mission Manager should notify the Monitoring Manager of the first flight mission details (general location of the flight, the flight pattern, and approximate duration of the flights). After the first flights are completed and the FRMAC is established, the AMS Mission Manager coordinates future mission details with the Monitoring Manager.

2.3 CMRT Deployment

The CMRT will generally arrive at the incident location between 6 and 12 hours after asset activation. The responsibilities of Monitoring Manager pre-deployment (without the deployment of a CMAC) are similar to those responsibilities outlined in the “CMAC Arrival Checklist” (see Appendix A). Other Monitoring Manager duties during the response are to:

- Attend planning meetings to brief the Command on the resources and capabilities of the FRMAC Monitoring Division, upon request.
- Participate in regular tactics and planning meetings to support development of the IAP, upon request.
- Participate in the development of the FRMAC Execution plans.
- Brief the Deputy Monitoring Manager, the AMS Manager, and Field Team Supervisors (FTSs).
- Develop field team instructions.
- Work with the AMS Mission Manager to determine aerial survey missions.
- Coordinate activities with the Operations Section for both field teams and aerial assets.
- Receive reports from the FTSs and AMS Mission managers.
- Review and approve field data (may delegate to the FTS).

- Post the completed Incident Command System (ICS) forms and other documentation to the Consequence Management website (CMweb). **NOTE:** This task may be delegated.
- Relay information up the command chain.
- Support the H&S Division with staffing and resources.
- Prioritize conflicting action requests and tasks.
- Request resources from the Command to support monitoring teams in the field, when needed.

The Monitoring Manager could request an AMS Mission Manager to reside at the FRMAC location to develop missions for AMS aircraft and to coordinate with the Radiological/Nuclear Air Coordinator (RNAC) or the Air Operations Branch Director, if applicable. Deputy Monitoring managers will generally manage Monitoring Division operations while the Monitoring Manager attends various meetings. The Quality Assurance (QA) of incoming field data should be performed by the FTS or Deputy Monitoring managers by following the "Quality Assurance/Quality Control (QA/QC) Checklist for Monitoring" (see Appendix C).

FTS responsibilities during the response are to:

- Ensure necessary equipment is ready for deployment (may enlist the help of the on-call Field Monitoring Specialists [FMSs]).
- Establish field teams and points of contact.
- Provide the daily field team briefing, as assigned.
- Reroute or change the tasking of field teams, as directed.
- Review and approve field team data.
- Report information from the field team to the Monitoring Manager.

FMS responsibilities during the response are to:

- Perform instrument checks before field activities.
- Ensure tablets and communication devices properly function before field activities.
- Follow the guidance provided in the field team instructions.
- Communicate status to the FTS.
- Help less-experienced field team members and/or specialty field teams.
- Support the H&S Division, as assigned.

As part of the response, Monitoring Division personnel and resources that do not perform monitoring and sampling duties may be assigned. Personnel may be assigned to support the facility or the field teams as runners for sample recovery or to distribute needed supplies to the field. Personnel may be assigned to support the H&S Division by setting up a hotline at the facility or to staff checkpoints in the field. Decontamination stations, which may be required at various locations, would be managed in accordance with applicable FRMAC guidance. The FMS and/or the FTS may be assigned to the H&S Manager to oversee the hotline operation or assist with other H&S duties as assigned. Additional FMSs may be assigned to integrate with multi-agency field teams, conduct contamination surveys at the hotline for personnel and/or vehicles, or assist with sample control.

A large-area deposition would create an extended area of contamination that would require monitoring teams to travel excessive distances from the FRMAC. FRMAC management would evaluate monitoring activity priorities and may set up Forward Monitoring Posts (FMPs). FMPs would be staffed as resources arrive and would operate in coordination with direction from the FRMAC.

2.3.1 CMHT Support

In the event of a CM/FRMAC response, a primary role of the Consequence Management Home Team (CMHT) is to support the FRMAC incident response while the CMRT is en route to the incident scene and to provide support to the RAP responders or state or local first responders who may already be on scene gathering early data. The CMHT support includes collecting early radiation data from the on-scene Emergency Response teams and entering that data into the Radiological Assessment and Monitoring System (RAMS) database. The CMHT assists in analyzing data, evaluating hazards, and providing incident information and data products to protective action decision makers. The Remote Sensing Laboratory (RSL) serves as the operations center for the CMHT. The CMHT provides a telephone bridgeline for decision makers, scientists, state authorities, and other assets to discuss the situation and any available data before the CMRT has set up the FRMAC or in the event the FRMAC is not requested. The CMHT will continue to support the incident for as long as necessary.

CMHT support to the Monitoring Division may include the following:

- Obtaining the initial National Atmospheric Release Advisory Center (NARAC) prediction model
- Collecting and analyzing data from the local first response teams to the incident scene
- Planning missions for AMS aircraft
- Collecting and analyzing data from deployed RAP and AMS teams
- Preparing an “Advance Party Meeting Checklist” (see Appendix D)
- Preparing data products

This page intentionally left blank

3 INITIAL FRMAC ACTIVITIES

3.1 Priorities and Activities

The FRMAC reports monitoring data results and assessments to the Incident Command or Unified Command (IC/UC), the Advisory Team, and the state, tribal, and local governments. In turn, the IC/UC and the state, tribal, and local governments will use this information to determine if new or additional protective actions are necessary. The highest priority for FRMAC activities is to protect the public's health and safety; therefore, the needs of the IC/UC and/or the state, tribal, and local governments dictate the priorities for radiological monitoring and assessment activities. There will be times, particularly in the early stages of a response, when the demand for information and assistance may exceed the FRMAC's resources. If that happens, monitoring priorities must then be established.

After an incident that results in the releases of radioactive material into the environment, the priorities generally focus on the following:

- Determining if the release has terminated
- Assessing the extent of the radiological release and determining the radionuclides of concern
- Determining if secondary processes are still dispersing the radioactive material out to a wider area (i.e., contamination run-off from precipitation/resuspension or migration caused by winds or mechanical disturbances)
- Evaluating potential radiation dose or effects to the population
  - Identifying areas that exceed protective action guidelines for evacuation and/or shelter-in-place
  - Identifying when those who are sheltered-in-place can be relocated from a contaminated area
  - Identifying areas that exceed protective action guidelines for relocation
  - Identifying which transportation corridors are safe to travel
  - Identifying which areas warrant a food embargo or merit further sampling
- Evaluating the impacts to critical facilities or infrastructure
- Evaluating potential radiation dose or effects to emergency responders
- Monitoring institutions, facilities, and/or residences located in the evacuated zone which were not evacuated or where people must reenter

3.1.1 Advance Party Meeting (APM)

The APM was originally created with the operational objective that a physical meeting would occur with federal, state, tribal, or local authorities once the FRMAC is established or arrives on scene. A formal meeting between all local and FRMAC management personnel may be limited or impractical because of situational constraints. As an alternative, the CMHT may complete the APM objectives via teleconferences while the CMAC and/or the CMRT is in transit. The pertinent information collected from these calls is then forwarded to the CMAC.

The APM is extremely important, not only because it initiates large-scale response activities to characterize the extent of the radiation in the off-site area, but also because it sets the tone for interaction between the various response agencies. However, resources are integrated or activities coordinated, so it is important to open effective lines of communication and to understand the needs of the IC/UC to allow for the early establishment of a cooperative relationship.

The APM should take place as soon as practical upon arrival at the response scene. The FRMAC Director, the CMAC, representatives from state/local response organizations, the primary authority, and the deployed RAP Team Leader meet at the APM. The "Advance Party Meeting Checklist" (see Appendix D) should be utilized to obtain event information and priorities.

The Monitoring Manager will use all pertinent information disclosed in the APM to complete the "CMAC Arrival Checklist" (see Appendix A), with a special focus on the Monitoring Manager's responsibilities. If further information is required to fulfill the responsibilities of the Monitoring Division, the Monitoring Manager will communicate with the appropriate point of contact to obtain the desired information.

3.1.2 Interaction with State, Local, Tribal, or Other Federal Agencies

The Monitoring Manager will need to establish contact with the Operations Section Chief, or the Incident Commander on the scene, to learn what surveys and monitoring activities have been completed. First responders may integrate with the FRMAC or continue separately, but they will need to coordinate activities as the incident unfolds. Other key contacts will be local law enforcement and/or state officials who may be required to escort field teams to various off-site areas to perform their duties.

In the event that the local response organizations performing monitoring, sampling, assessment, and mapping duties and the FRMAC are not integrated, it is important to establish a means of communication to allow the coordination of activities among the divisions. This coordination could be accomplished by performing the following:

- Exchanging liaisons within the technical areas to assist in coordinating planning
- Holding daily planning meetings or conference calls to plan each day's activities
- Exchanging the developed daily activity plans to allow modifications to plans to minimize duplicated efforts

The FRMAC is there to assist the requesting agency and organization with characterizing the incident and to provide the data needed to support public protection decisions. It is therefore important to establish the customer's requirements at the APM to open discussion between the IC/UC and state, local, and tribal concerns and consider their views regarding the highest initial priorities.

3.1.3 Site Selection and Setup

Setting up the FRMAC will be done in accordance with the guidance in the *FRMAC Operations Manual*. The Monitoring Division could potentially have personnel staffed at local airports, the FRMAC main location, the FMP, or various hotlines throughout the area. Locations should be vetted through the FRMAC management chain to ensure that there is enough space and resources for the assets at the proposed location.

3.1.4 CMRT Initial Monitoring Team Deployment

If priorities were not established in the APM, or the CMRT arrives and field teams are ready to deploy in the field without specific guidance from the IC/UC, then FRMAC Monitoring Division default guidance will be followed. Default guidance is provided in Appendix E of this manual and includes the following ICS forms:

- ICS 234, “Work Analysis Matrix”
- ICS 204, “Assignment List”
- The initial ICS 204FRMAC, “Assignment List, Adapted for FRMAC Field Monitoring Teams,” for five monitoring teams named Alpha, Bravo, Delta, Echo, and Foxtrot

The mission of Alpha, Bravo, and Delta teams could be applied to each FRMAC response scenario. Alpha Team’s work assignment is to transect the plume near the release point and take exposure rate and contamination surveys only. The goal is to verify quickly plume projections and AMS data. Bravo and Delta teams should perform transects of the plume farther downwind than Alpha Team. These teams should take exposure rate and contamination surveys, high-volume air samples, ground deposition samples, and the first in situ gamma spectrometry measurements on the ground. The default guidance for Echo Team is not necessary for all FRMAC responses. If Environmental Continuous Air Monitors (ECAMs) are deemed necessary, then Echo Team will set up ECAM systems at the FRMAC and at other desirable locations. The mission of Foxtrot Team is to support AMS to get quickly a calibration line characterized with ground truth data. This mission could be completed 2–3 days after arriving at the deployed location.

The default guidance contains the necessary information to start field monitoring activities by providing initial objectives, field team instructions, and default hold points and turn-back limits. In 2018, the FRMAC Monitoring and Sampling Working Group received and approved the default guidance. Field team routes are not included in the default guidance and therefore will need to be created. With minimum effort, the various default guidance ICS forms can be quickly completed and delivered to the IC/UC.

Appendix F contains the “Initial Monitoring and Assessment Plan” which provides more details than ICS 234, “Work Analysis Matrix,” for those entities that prefer a more verbose description of the initial actions performed by the Monitoring Division. Appendix F also contains the justification behind the FRMAC Monitoring Division default plans.

To allow quicker deployment of field teams, the FTS may handle the initial team deployments while the Monitoring Manager participates in the APM or coordination activities. The Monitoring Manager will provide any additional pertinent information received during the APM to the FTS if it affects the initial planning.

The teams will receive a safety briefing, preferably from a member of the H&S Division, containing default hold points, turn-back limits, and other safety-related topics. The FTS will brief the teams on all available information about the release, and then inform each team about their route assignments and activities.

Once the Monitoring Manager returns from the APM, the execution plan and field team instructions should be developed for the next operational period. Any currently deployed field teams will not be recalled, but the next shift will work from these approved plans.

3.1.5 Ten-Point Monitoring Strategy

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

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

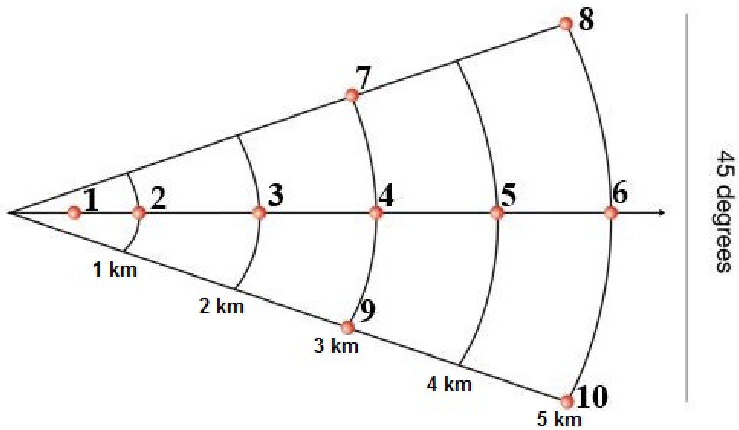


Figure 3. Ten-Point Monitoring Strategy

To execute the Ten-Point Monitoring Strategy, responders should gather radiological monitoring data for the 10 points depicted in Figure 3. Conditions or local terrain may prevent access to some of the 10 points. If that occurs, responders should collect as many of the 10 points as possible. The CMHT can help initial responders to select the 10 points using the latest NARAC model runs and the Geographic Information System (GIS) to provide map coordinates or street intersections.

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

The Ten-Point Monitoring Strategy is not required to be performed before other measurements from different locations are collected. Therefore, if the AMS has flown the deposition footprint, this strategy should not be performed.

4 WORKFLOW DEVELOPMENT AND IMPLEMENTATION

The Monitoring Division will implement default plans if no guidance or objectives were provided by the IC/UC. When the IC/UC provides objectives through the ICS planning process, the FRMAC needs to document tactics and methods that will be used to complete the objectives. Part of the documentation process is creating an execution plan. An execution plan requests input from all FRMAC Division managers to address the needs of each FRMAC division to complete each IC/UC objective. The execution plan is not recorded on an official ICS form, though content from the plan will be included in various ICS forms. The execution plan must be saved for documentation purposes.

With a completed execution plan, there would be enough information to complete various ICS forms. Editable Portable Document Format (PDF) versions of ICS forms are available online (at https://training.fema.gov/icsresource/icsforms.aspx or at other websites). The following non-comprehensive list contains typical ICS forms that would be required during the response:

- ICS 234, "Work Analysis Matrix"
- ICS 215, "Operational Planning Worksheet"
- ICS 204, "Assignment List"
- ICS 204FRMAC, "Assignment List, Adapted for FRMAC Field Monitoring Teams" (otherwise known as *the ICS 204FRMAC form* in this document)

When completing ICS 215, always plan for what is needed to complete the objective, not what assets might be currently available. Think of the resources as unlimited because the worksheet will help obtain needed resources through the IC/UC.

When completing ICS 204, keep the work assignments and special instructions general. Treat the field teams as a whole when completing the form, unless otherwise directed.

The ICS Command Staff may require other ICS forms; e.g., ICS 220, "Air Operations Summary," for air operations. ICS 234, ICS 215, ICS 204, and any other applicable ICS forms should be forwarded to the Operations Section Chief for their awareness and for ICS planning purposes. The ICS 204FRMAC form, which does not need to be given to the Operations Section Chief, was specifically developed for the FRMAC Monitoring Division to address the details of the field team assignments. Save the completed ICS forms for documentation/historical purposes.

The development of the execution plan and field team instructions should be synchronized with the IC/UC planning cycle as the radiological monitoring and sampling priorities evolve during the incident. The tasks assigned to the Monitoring Division that have been completed, and those that are still incomplete, should be reported to the Operations Section Chief and the FRMAC Technical Team Lead at the end of the shift via ICS 214, "Activity Log."

4.1 Daily Field Team Instructions Development

Once the execution plan is completed and approved, field team instructions must be devised to implement it. Field team instructions are documented on the ICS 204FRMAC form. The form is completed daily, or for each operational period, and describes in greater detail the techniques that will be used to obtain sample and measurement data to characterize the incident. The form will address how field teams will collect data to support the priorities listed in the execution plan. For an example of the form, see Appendix E. The form should be saved for documentation/historical purposes.

4.1.1 Daily Field Team Instruction Modification

The ICS 204FRMAC form may be modified to meet urgent requests that were received after the field team instructions were completed. A new ICS 204FRMAC form is not required to be developed for these urgent needs, but a revision to the existing form is sufficient. Each revised ICS-204FRMAC form should include the new requests made, the survey route modification, and monitoring activities that would complete the new tasks. The new information from the revised form will be communicated to the applicable field team.

4.2 Monitoring Methodology Rationale for Work Planning

The priorities set down by the IC/UC and the resources available to the FRMAC drive the factors to consider when developing the execution plan. It is important to remember that resources become available to the FRMAC in a phased manner and that the priorities need to be addressed with available resources.

4.2.1 Early Phase

During the early phase of the incident, the Data Quality Objective (DQO) requirements for analytical data needed to support assessment have higher Minimum Detectable Activities (MDAs) and higher error bar ranges than subsequent phases. Analytical precision requirements will increase over time. The sample chain-of-custody is established and maintained although the preliminary logistical support for sample collection, packaging, and transport to analytical laboratories may limit the number and type of samples submitted. DQOs are adjusted to be commensurate with the urgency of the decision at hand, and the risk of potential consequences from an incorrect decision. The relative role of field measurements, mobile laboratories, and fixed laboratories will depend on the radionuclides of concern for the specific incident or emergency.

4.2.2 Intermediate Phase

The intermediate phase will require a greater degree of data quality as longer-term exposure risks are evaluated, as well as the use of a sample chain-of-custody process. These more rigorous DQOs may require the use of fixed laboratories which have a greater capacity and more enhanced capabilities than mobile laboratories. The role of the on-site analytical capability of the mobile laboratories may also decline depending on their capacity and ability to adapt to these more rigorous DQOs.

4.2.3 Key Radionuclide Detection

Another key factor that influences the number of laboratory samples is whether field instruments readily detect the radionuclides in the mixture (or at least some key radionuclides):

- In the situation where some of the key radionuclides are readily detectable using field instruments, the number of laboratory samples can be significantly reduced. In this situation, laboratory samples may be required to supplement the field measurements to verify the overall mixture or to verify how the mixture is changing either spatially or temporally. Once the dynamics of the mixture are confirmed from the laboratory analysis, the vast majority of the data used to characterize the plume will be the results from field instrument measurements.
- In the situation where none of the key radionuclides are readily detectable using field instruments, the number of laboratory samples will be significantly increased. In this situation, all of the data used to characterize the plume will be generated from either fixed or

mobile laboratories. This situation will result in many hundreds to many thousands of samples being collected and analyzed.

4.2.4 Continuous Plume or Waterborne Release Detection

> **NOTE:** The Monitoring Manager shall consult with the FRMAC and/or IC/UC H&S personnel to confirm that no non-radiological hazardous constituents are in the plume that could create Immediately Dangerous to Life or Health (IDLH) conditions for the monitoring teams.

- Based on information received from the monitoring aircraft and the meteorological conditions, deploy monitoring teams to travel roads near the incident site to search for the plume.
- Each team should be equipped with plume sampling and radioiodine analysis capability. Teams should traverse assigned areas until contact is made with the plume. The team will operate the air-sampling equipment and conduct handheld measurements as they transect the plume path.
- To sample and characterize areas downwind of a plume release, place gamma monitors with telemetry, air samplers, and Thermoluminescent Dosimeters (TLDs) at representative locations between the incident scene and populated areas. All three devices should be at each monitoring location, if possible. Emphasis should be given to the prevailing wind direction if it is known.
- Place additional gamma monitors, air samplers, and TLDs at representative-populated areas.
- Teams monitoring water pathways should obtain appropriate and representative water samples. These samples should be obtained from reservoirs, streams, rivers, estuaries, bays, and other bodies of surface water. Water treatment facilities should also be sampled at the point of entry into the system and at the end of the system.

4.2.5 Deposition Measurements by Ground Teams

Identify isotopic mix and verify deposition models by taking appropriate radiation measurements using available roadways to traverse the predicted footprint. The chosen roadways and flight paths should intersect a representative number of predicted radiation contours. The routes should generate additional data points to supplement the initial ten-point monitoring survey results, if applicable. The monitoring strategy for the routes and spacing of survey locations should include input from:

- The Assessment and Laboratory Analysis divisions on the types of data and sampling requirements (e.g., type of air sampler and sampling time).
- Assessment and GIS on the spacing of data points relative to the ground deposition contours and map scale for the various briefing products. For most incidents, the spacing for deposition surveys can vary from hundreds of feet near the release point to many miles between data points down range where the deposition is more uniform.
- The IC/UC H&S Officer regarding traffic barricades into the exclusion zone and the location of vehicle and personnel hotline exits from the exclusion zone. In addition, local law enforcement may exclude ground survey teams from some areas because of safety issues.

Depending on the type of radiological release and the suspected source term, some basic, general principles can be applied as follows:

- Gross alpha and beta measurements will provide many more data points per total survey time if there has not been any appreciable precipitation or weathering of the deposition. The Monitoring and Assessment managers need to concur that a gross alpha or beta measurement is a sufficient surrogate result for a key constituent.
- In situ gamma spectrometry systems are the preferred field team instrument to be used with an exposure rate meter to confirm the gamma-emitting constituents in the deposition footprint. The number of field in situ measurements should be planned to limit total exposure to the ground team members. Generally, in situ measurements should be performed in areas where the exposure rate is less than 3 milliRoentgen per hour (mR/hr) because of system dead time. An alternate strategy is to use the in situ system outside of the deposition footprint as a soil or vegetation sample counter to determine ratios and decay, if applicable.
- Also as a rule of thumb, measurements and/or samples should be collected at every order-of-magnitude change in measured radiation levels. The FRMAC Assessment and Laboratory Analysis divisions should specify the number of samples and minimum and maximum exposure rate screening levels for samples to be returned from the field for subsequent analysis.

4.2.6 Deposition Measurements by Aircraft

One emergency response asset available to the Monitoring Manager is the use of AMS aircraft to perform flyover surveys of the incident site. The AMS has both fixed-wing and helicopter-mounted survey equipment that can be flown over a deposition site at various altitudes to determine ground deposition area and levels. Often AMS aircraft will be requested very early in a response. The AMS group will often write, review, and get approval for the initial mission plan at the RSL located at either Nellis Air Force Base (AFB), Nevada, or Andrews AFB, Maryland. The AMS Home Team Scientist will use the “AMS Home Team Scientist Checklist” (see Appendix G) when developing the mission plan and for other responsibilities.

Additional AMS aircraft can be deployed from the Savannah River Site, South Carolina, or by the EPA based in the Dallas, Texas, area. The FRMAC AMS Mission Scientist develops subsequent mission plans before review and approval by the Monitoring Manager and the H&S Manager. The mission plans can then be incorporated into the daily field team instructions. The FRMAC AMS Mission Scientist will use the “AMS Mission Scientist Checklist” (see Appendix H) when developing the mission plan.

The fixed-wing aircraft and helicopter require the use of a Fixed Base of Operations (FBO) facility to conduct aerial survey missions. In most responses, deployments occur from a commercial or military airport. The AMS flight crew chooses the FBO facilities based on their relative distance from the incident area and the availability of commercial electrical power, aviation fuel, and telephone and internet services.

For many scenarios, the AMS aircraft will not be located near the FRMAC facility. The mission scientist and pilot-in-command will receive directions from the FRMAC Monitoring Manager via commercial telephone or satellite phone systems, or from the CMHT. Most of the AMS data products will be submitted to the FRMAC via the CMHT after they have been transmitted via the aircraft telemetry systems or after post-flight data processing and internet transmittal from the FBO.

For the fixed-wing system, the nominal survey altitude is 305 m (1,000 ft) above ground level with flight line spacing of square kilometers per hour ~500 m (1,600 ft) at a ground speed of

72 m per second (m/s) (140 knots). At the nominal altitude of 1,000 ft, the fixed-wing field of view is ~2,000 ft in width. At the nominal mission altitude and field of view, the fixed-wing can coarsely map ground deposition at a rate of ~39 square kilometers per hour (kph) (15 square miles per hour [mph]). The primary fixed-wing data products include a map product of the gross count data points and a contour map product display of the nominal exposure rates at 1 m above the ground. The data processing time required to complete each set of flight data is approximately 1–2 hours. The ground-monitoring field teams should not expect the exposure rate levels obtained by aerial measurement to match those obtained during ground deposition transects. In addition, the deposition boundary defined by the fixed-wing aircraft may only be accurate to within a few hundred feet.

For the helicopter system, the nominal survey altitude is 46 m (150 ft) above ground level with flight line spacing of 92 m (300 ft) at a ground speed of 36 m/s (70 knots). The preferred aerial platform for performing a detailed aerial survey is the helicopter because of its larger-volume Sodium Iodide [Thallium doped] (NaI[*Tl*]) detector array, lower flying altitude, and greater spatial resolution. A map produced from helicopter data provides greater detailed information for decision makers.

The higher sensitivity and line spacing used for radiological mapping surveys allows the data to be contoured in the units (counts, exposure rate, manmade) necessary for comparison to long-term guidance levels. Flying at an altitude of 46 m (150 ft) will provide a ground-monitoring window (field of view) of approximately 92 m (300 ft) in width. In this manner, the helicopter can map the ground deposition at a rate of ~10 square kph (4 square mph). The radiological survey flights are normally limited to daylight hours. However, nighttime flights will be considered on a case-by-case basis.

After each survey flight, a detailed data analysis is performed with the computer analysis equipment on site. The data processing time required to complete each flight data set is ~1–3 hours. Completed survey deliverables are as follows:

- A contour map of the inferred exposure rate at 1 meter above ground level
- A contour map(s) of specific isotope surface area activity identification, and magnitude of dominant isotopes (gamma energy spectra)

The AMS Mission Manager, or designee, will need to discuss with the Monitoring Manager the appropriate location of the AMS calibration line. The AMS Mission Manager will need to inform the Monitoring Manager when, at what frequency, and how many sample points the calibration line would need to be suitably characterized by the field teams. The calibration line will be established after the initial flights and it may be 2–3 days after the initial flights before a suitable calibration line is found. Field teams will support the AMS by providing exposure rate surveys with the pressurized ion chamber and High-Purity Germanium (HPGe) measurements along the identified calibration line.

The minimum detectable activity limits of the AMS aerial platforms for a typical radiological survey are listed in Table 1. Sensitivity values are given for typical isotopes in units of microcuries per square meter ($\mu Ci/m^2$), assumed to be surface deposition with no mixture in the soil. Detection sensitivities will vary, depending upon altitudes flown, line spacing, deposition variability, and analysis processing.

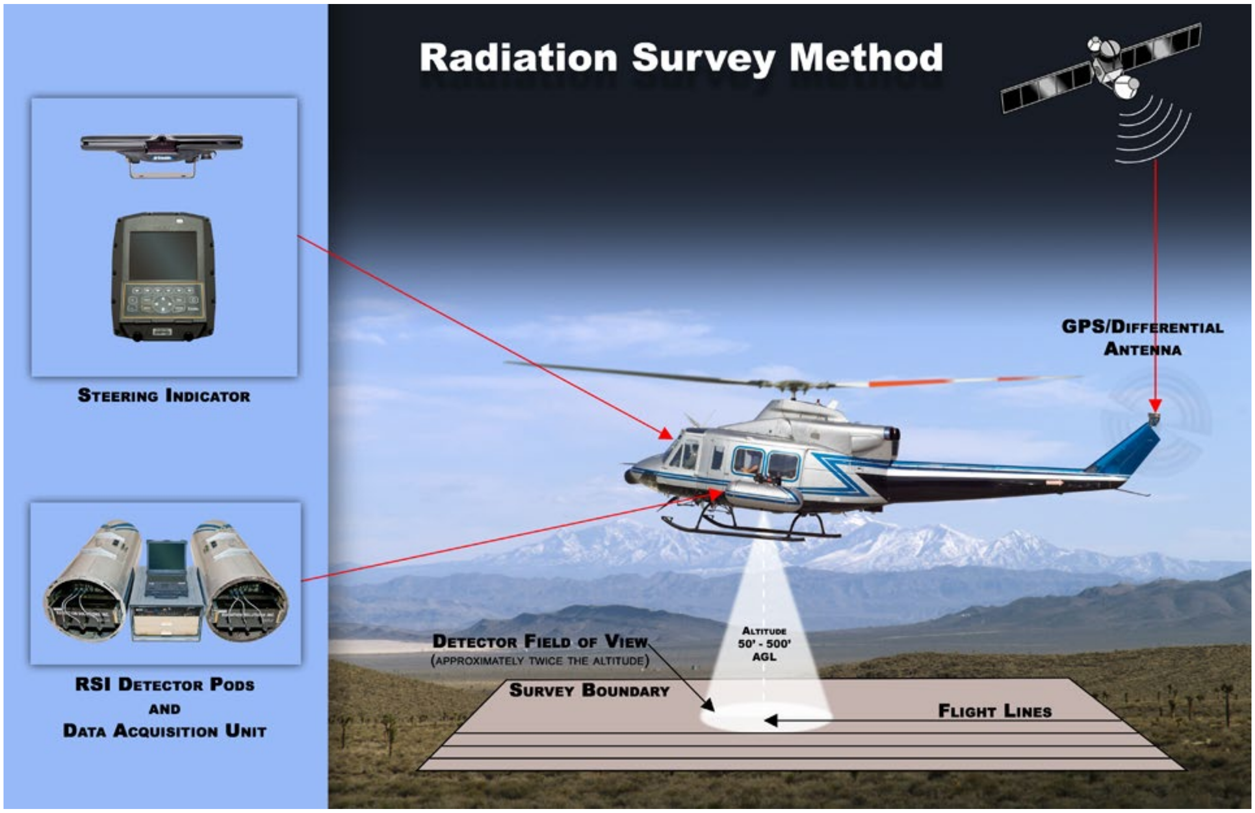


Figure 4. Typical Aerial Radiological Survey Setup

Table 1. AMS Minimum Detectable Activities

Radionuclide	Photopeak Energy (kiloelectron Volts [keV])	Surface Area Deposition[a] (μCi/m^2)	
		Fixed-Wing Aircraft[b]	Helicopter[c]
Americium-241 (^{241}Am)	60 keV	430	0.2
Cesium-137 (^{137}Cs)	662 keV	2.0	0.05
Cobalt-60 (^{60}Co)	1,173–1,333 keV	0.3	0.02
Iodine-131 (^{131}I)	365 keV	4.0	0.06

[a] The MDA value is the three-sigma value resulting from the counting statistics in the spectral energy window of the photo peak of interest.

[b] Fixed-wing systems are equipped with one to three 2" x 4" x 16" NaI(*Tl*) log flown at an altitude of 305 m (1,000 ft) above ground level, a flight line spacing of 500 m (1,600 ft), and an average ground speed of 72 m/s (140 knots). Flying at higher altitudes (e.g., 1,500 ft) will reduce detectability by a factor of 3 or more.

[c] Helicopter systems are equipped with three to twelve 2" x 4" x 16" NaI(*Tl*) logs flown at an altitude of 46 m (150 ft) above ground level, a flight line spacing of 92 m (300 ft), and an average ground speed of 36 m/s (70 knots). Processing the data using a 9-second averaging routine can enhance the detectability up to a factor of 3.

4.2.7 Shelter-In-Place Location Monitoring

Based on the aerial-monitoring and meteorological data, monitoring should be initiated in the downwind direction from the plume footprint. Monitor where people are residing in the non-evacuated areas. Attempt to monitor along the edge of the inhabited zones closest to the evacuated areas. Place representative, continuous particulate and reactive gas air samplers and TLDs in these close-in inhabited areas to measure resuspension, integrated exposure, and possible future plume releases. The actual placement of the samplers should be determined by the number of samplers available, population distribution, and local wind conditions. The following types of facilities usually have electrical power available and are satisfactory places to locate air samplers:

- Fire and police stations
- County and state road maintenance facilities
- Schools and public park facilities
- City, county, and state municipal buildings
- Hospitals

If none of these facilities are available, attempt to locate the samplers at service stations, convenience stores, or residences. As a last resort, use the portable generators to supply the electrical power for the samplers.

4.2.8 Critical Institution, Facility, and Transportation Corridor Monitoring

Critical transportation corridors (e.g., interstate highways, federal and state highways), critical institutions, and facilities (e.g., fire and police stations, emergency operations centers, power stations, water treatment plants) within the deposition footprint may be in use throughout the entire response. Numerous repeated surveys may be requested as local authorities attempt to decontaminate the roads and facilities used for evacuation and response teams. Monitoring efforts along transportation corridors and in critical institutions and facilities must be coordinated with state and/or local officials in order to mitigate the impact to evacuation and response efforts.

It is necessary to monitor the exteriors of the critical institutions and facilities as well as the interiors. When tasked to survey critical institutions and facilities, verify the protocol for entering both evacuated and non-evacuated buildings and whether local uniformed police or firefighters should accompany the monitoring teams. Interior monitoring will include the acquisition of swipes from representative surfaces, contamination surveys, and exposure rate surveys. Environmental TLDs should be placed inside and outside of each occupied structure to determine general area dose. Representative individuals at each location could be assigned a TLD to wear, if warranted. If available, gamma-rate recorders should be placed inside the structures. The appropriateness of locating particulate and reactive gas air samplers at these stay-in locations should be determined. A brochure describing basic facts about radioactivity and exposure reduction techniques for inhabited structures should be distributed (https://emergency.cdc.gov/radiation/contamination.asp).

4.2.9 Site Characterization

For monitoring and sampling activities for commercial nuclear power plants, the Monitoring Division may use the U.S. Nuclear Regulatory Commission (NRC) sector divisions of the off-site area (16°–22.5° sectors). If the FRMAC response is other than an NRC-related incident, the Monitoring Division can create survey grid maps oriented about the incident site by using

FRMAC GIS capabilities. In addition, the EPA may provide guidance on data requirements for the late-phase recovery and clean-up operations expected after the incident has been stabilized. To characterize the area and to identify hot spots, at least one monitoring team should be assigned to each survey grid. If practical, monitoring activities should be initiated at a distance well beyond the deposition footprint and moved in toward the incident center. As a monitoring team travels within their assigned grid, a serpentine pattern will be followed using available roads as safe vehicle travel allows. The sites where representative radiation measurements are taken should include all pre-established state, local, and facility monitoring locations. Soil and vegetation samples should be collected as directed. At representative locations, including within the evacuated areas, a continuous air sampler and an environmental TLD should be positioned. Together they will provide a measure of re-suspension and integrated radiation exposure at that location. These will complement those placed near the evacuated/inhabited areas.

4.2.10 Drinking Water

In coordination with state and/or local officials, drinking water samples should be collected from surface supplies (e.g., rivers, lakes, canals) and open-air water treatment facilities located in the affected areas. In some instances, and in coordination with state and/or local officials, drinking water samples may be collected from private or public wells, cisterns, and water distribution systems. Concurrent with drinking water sampling, alpha, beta, and gamma measurements are typically taken adjacent to any water supply and water treatment facilities to document the probable surface deposition after plume passage. It may be requested that sediment samples be collected along with surface water located within the deposition footprint. The surface water sample should always be collected prior to the collection of a sediment sample at the same location to minimize suspended solids that could potentially affect the representativeness of the water sample.

4.2.11 Farms, Dairies, and Food Processing Plants

The monitoring and sampling of farms, dairies, and food processing plants will, in all likelihood, be conducted at the request of state or local officials. Routine sampling occurs to determine food safety during non-emergencies. It is recommended that the FRMAC field team join with the local samplers to obtain a representative sample. If no priorities or requests are received, the FRMAC should consider the following:

- Farms and dairies within the deposition footprint will receive last priority for Monitoring Division resources because contamination is assumed to have occurred based on their location. In addition, their products are likely to have been embargoed immediately after the deposition footprint had been confirmed.
- Farms outside of the deposition footprint will be monitored in order of crop perishability.
- Milk, food, and animal feed processing facilities outside of the evacuated area will be monitored and sampled in the order of their priority as listed in the operational IAP.

4.3 Specific Monitoring and Sampling Activities

The ICS 204FRMAC form will provide guidance to the field teams for performing monitoring and sampling activities. The form will specify the surveys to be taken, the survey techniques to be used, the routes to take, and the frequency at which the surveys will be taken.

Surveys and samples are to be performed in accordance with the methodologies outlined in the *Federal Radiological Monitoring and Assessment Center Monitoring Manual, Volume 2,* *Radiation Monitoring and Sampling*. The required surveys will be based on the type of release. Ground surveys near the expected plume or deposition area are normally spaced closer together than those farther away. One major reason for the close spacing is to reduce the chance of the team missing a hold point or turn-back limit and receiving an unnecessary dose. Another reason is the possibility of missing the boundaries of the deposition. If surveys are spaced too far apart, it is possible to drive into or through the contamination or even traverse the plume completely.

In the first hours of the response, the emphasis will be on establishing the type and amount of radioactive contamination in the area and determining whether there is any resuspension in the air from the ground deposition. Follow-on teams can more completely characterize the distribution of the radioactive material in the environment.

Routes for the monitoring teams will be developed using the best available information on the incident release. These will include NARAC plots and AMS flyover data, on-site monitoring, and off-site results gathered by first responders. The routes developed will depend on the priorities of the situation. Generally, the first routes established will be to verify the NARAC models to define the edges of the deposition and to begin defining evacuation routes or shelter-in-place locations for the public. In addition, routes will be developed to collect air, soil, water, and vegetation samples at locations throughout the affected area.

Teams are dispatched with maps, equipment, and instructions on how to accomplish the tasks outlined in the ICS 204FRMAC form. As the field teams collect survey data and samples and report the results back to the FRMAC, a clearer picture of the situation will develop. This information will necessitate changes to the response priorities or prompt other agencies to request additional survey or monitoring information. FRMAC Division managers will be required discern these evolving needs and incorporate them into the execution plan.

The prescribed tool for other agencies to make requests to the Monitoring Division is through the IC/UC planning process. Incident objectives and priorities are received through the IC/UC command chain. The FRMAC Director and Division managers can prioritize requests for action. Action requests are handled according to the priority of the request and not the order in which they are received. Urgent requests will generally be handled as soon as possible or the same day. Routine requests will generally be written into the next day's ICS 204FRMAC form unless they can easily be incorporated into current activities or covered by a team that has completed their planned activities.

4.3.1 Sampling Frequency

NOTE ON COLLECTING SAMPLES: Care should be exercised in collecting environmental samples. The radioanalytical laboratories can be easily inundated. A sufficient number of samples must be collected to characterize the environment and to satisfy monitoring requirements, but the collection of samples should be performed prudently.

4.3.1.1 Soil Sampling

During the response, the three main types of soil samples that would be collected are: ground deposition, surface, and core. The frequency of collection and size of the soil sample will be established with the Assessment and Laboratory Analysis divisions.

- Ground deposition samples would be performed in the early phase of the incident. Ground deposition samples combine both the soil and the vegetation to get a total deposition activity per 100 square centimeters (cm^2). The ground deposition sample is acquired with a standard soil-sampling jig that measures 2 x 10 x 10 cm and includes any vegetation attached to the sampled soil.

- Surface soil sampling could be used throughout the response, but especially during the intermediate and late phase of the response when radionuclides have sufficient time to weather into soil. This is typically done with the same standard soil-sampling jig for ground deposition sampling. Using the jig will yield a consistent soil sample volume. Surface soil samples do not include attached vegetation.
- Core sampling could be performed in the intermediate and late phases of the response. This type of sample would be used when the radioactivity concentration in the soil is weathered farther than the depth of the surface soil samples.

4.3.1.2 Air Sampling

Particulate and reactive gas samples and whole air samples for noble gas analysis are taken daily. In most situations if samplers are in operation when a plume release occurs, the samples will be changed out following plume passage.

The run times for the various high-volume and low-volume air samplers will be established with the Assessment and Laboratory Analysis divisions. Some of the parameters include the following:

- Radionuclide mixture
- Contamination levels and an initial resuspension factor estimate
- Weather conditions—primarily wind speeds and direction and the precipitation forecasts during the sampling period
- Minimum and maximum radioactivity to be collected on the sampling media
- Projected air volume to satisfy the minimum detectable activity for lab detection equipment
- Projected run-times from batteries or portable generators if commercial power is not available

4.3.1.3 Water Sampling

Surface drinking water supplies and open-air water treatment facilities located within the deposition footprint should be sampled following passage of the plume, and then re-sampled daily. Daily sampling should continue until water usability is determined (i.e., meets drinking water standards or guidance). Surface drinking water supplies located outside of the deposition footprint—but in close enough proximity to be impacted—should be sampled daily for a minimum of 3 days or until acceptable levels are achieved.

4.3.1.4 Vegetation Sampling

The purpose of FRMAC vegetation sampling is to measure deposition and plant uptake. In almost all radiation emergencies, leafy vegetables retain deposited contamination and may be a health problem if consumed. The location and frequency of vegetation sampling is dependent on objectives.

The two major types of vegetation samples collected include food and feed crops are as follows:

- Market-ready food is directly ingested by the populace. Market-ready vegetation samples will come from farms, roadside stands, or gardens. Market-ready samples should be consistent with respect to readiness for harvest. Either the crop should already be ripe or will be ripe and ready for harvest in the near future.

- Feed crops are hays and grains that will be consumed by animals. Subsequently, man will consume the animals. Typical products include standing grains (wheat, rye, barley, buckwheat, oats, and soybeans) and standing hay. Samples may be taken from unsheltered baled or stacked hay or stored feed if these are being used as feed for animals.

4.3.1.5 Milk Sampling

Following a single release containing radioiodine, the radioiodine will begin to appear in the milk of exposed cows and goats in 3–4 hours. The radioiodine concentration will attain a maximum in ~3 days. For these reasons, milk sampling should begin the day after the plume passes. If milk from a particular dairy is to be characterized, sampling should begin with the first milking after the plume passes and continue daily until acceptable levels are achieved. When the milk is collected, samples of the animals' feed and water should also be collected.

> **NOTE:** From the same exposure, goat's milk will have radioiodine concentrations four times greater than those in cow's milk.

4.3.1.6 TLDs

The lower levels of detection for personnel and area TLDs are approximately 0.1 milliSievert (mSv) and 0.1 milliGray (mGy) (10 millirem [mrem] and 10 millirad [mrad]), respectively. The TLDs should be deployed for a sufficient length of time so that meaningful data that meet FRMAC objectives are produced.

4.4 Field Team Deployment and Coordination

Actual deployment of personnel and resources will be dependent on the severity of the incident. During a CMRT deployment, only six technicians are available for field teams to cover initial 24-hour operations. Ideally, each field team will consist of three persons. If no local assistance is available, then the teams will be comprised of two persons until additional resources can be assigned.

An FTS deploys with the CMRT. The FTS assists the Monitoring Manager by coordinating the teams and equipment while the manager is working on the plans necessary to get the teams into the field. The manager also ensures that paperwork is complete and given to Document Control in the FRMAC prior to deployment. The FTS will use the "Field Team Supervisor Checklist" (see Appendix I) to ensure that all tasks have been addressed.

With additional resources, more teams become available. If arrangements were made during the APM, state, tribal, local, and regional personnel should be available to the Monitoring Division. Each team will consist of a minimum of two members plus equipment, but may include additional members. A three-person team is considered ideal with one member from DOE/NNSA, one member from EPA or another organization with technically trained personnel, and one member as a local responder who knows the area. Two-person teams, which are capable of completing assigned tasks, could be hampered by trying to navigate through unfamiliar areas, watching the road for hazards, and monitoring instrumentation when in or near the plume deposition area.

When selecting teams, the relative experience of the team members should be considered. It is optimal to have a mix of experienced and less experienced people on a given team. For a "Field Monitoring Specialist Checklist," see Appendix J. For a listing of Monitoring Team positions and the required knowledge and skills, see Appendix K. Also, it is important to remember that different organizations may have different ALARA (As Low As Reasonably Achievable) dose limits. When forming teams, the most restrictive limits of an organization on a team will be the guide. If a situation arises where limits may need to be exceeded, the organizations would need to grant approval or a different team will be used to complete the task.

4.5 Equipment and Logistics

Equipment for the FRMAC is also deployed with personnel. The Monitoring Division deploys with radiation detection instrumentation, dosimetry, and Personal Protective Equipment (PPE) in order to complete monitoring and sampling duties. All equipment is inspected and maintained on a regular basis, and equipment that requires calibration is done so as scheduled. All equipment will arrive ready for immediate use. The FRMAC deploys with various radiation detectors such as exposure rate survey meters, alpha and beta/gamma contamination probes, FIDLERs (Field Instruments for Detection of Low-Energy Radiation) (for low-energy gamma detection), HPGe detectors, low- and high-volume air samplers, breathing zone air samplers, and alpha and beta swipe counters. The FRMAC also deploys with sample collection kits to collect various environmental samples (air, soil, vegetation, water, etc.). Not all monitoring equipment will be necessary for each event. It is the duty of the Monitoring Manager and the FTS to select the appropriate equipment for the response.

An important consideration is that other agencies may also be responding to the radiological emergency and would be incorporated into the FRMAC. With the vast variety of instrumentation available and in use throughout the country, there is no way to know what could be incorporated into the response. However, it is important to gather from the other agencies the instrument calibration data for each instrument. Also, any correction factors or other information that will aid in the interpretation of readings collected with the instrument in the field should be known. This information may not be immediately available, but it should be obtained quickly.

The Logistics and Support Section of the FRMAC, under the direction of the Support Manager, will make vehicle arrangements for the field teams. When possible, these vehicles will be minivans or sport utility vehicles to accommodate field teams' equipment. The vehicle should be configured to minimize the spread of contamination by covering the seats, floorboards, and trunk with plastic sheeting. The trunk of the vehicle would be used for storing equipment or collected samples.

The field teams will be dispatched with the equipment necessary to complete their mission. The FTS will need to verify that teams have performed operability checks on the equipment and that the equipment and field teams are entered correctly into the RAMS database before field teams depart for field activities.

4.6 Monitoring Maps

Field teams will need maps of the area to complete their mission. Efforts will be made to secure all available maps of the local area upon landing. Local airports and car rental agencies are a good source for obtaining local maps. These local maps can be used for area familiarization and, if necessary, to plot routes for the field teams. For an electronic version, the Consequence Management Center and corresponding Digital Field Monitoring software allow the field team to view monitoring routes and their current location on a map via the field team tablet. Cell phones may also be used to provide directions and locations on maps.

The FRMAC has a variety of tools to produce electronic map displays. Electronic maps can be used at the FRMAC to track the progress of teams. In addition, predictive maps of plume deposition are available electronically to assist in briefings prior to deploying field teams. Hard copies of the predictive maps can be given to the teams, as one of the primary missions is to verify the legitimacy of the predictive model.

As the incident progresses, additional maps will be created by the Assessment Division from the data collected by the FRMAC. Monitoring Status maps are created at least once per operational period. These maps summarize the location and type of all radiological monitoring and sampling data collected up to the current time. Monitoring Results maps are produced after field data have been reviewed and approved by the Monitoring and Assessment divisions. These maps should reflect the levels of radiation, concentration, or dose rates.

The Monitoring Status maps can be displayed electronically within the FRMAC. Because they continually grow in the density and diversity of measurements, they provide guidance to the Monitoring Manager and the FTS on the performance of the monitoring teams. They can also show gaps in the aerial coverage of data points necessary for modeling to the Protective Action Guides (PAGs).

The FRMAC GIS can provide maps that show roadblocks, checkpoints, decontamination stations, and evacuated areas, which may all be helpful to the various teams in the field. Specific FRMAC monitoring and sampling maps will be given to field teams based on team assignments and routes. It is expected that the GIS electronic and hard copy maps will replace local maps as the response capability expands.

4.7 Forms

Throughout the FRMAC response, it will be important to document everything that is done in order to facilitate information sharing and to provide a record of events. Many forms are used in a response. Listed below are the forms specific to the Monitoring Division along with a brief explanation. Instructions for completing the forms are included on the back of each form as well as in the *Federal Radiological Monitoring and Assessment Center Monitoring Manual, Volume 2, Radiation Monitoring and Sampling*.

- Team, Instrument, and Equipment Information Log: Used to collect team information such as personnel assignments, instrumentation, radios, a Global Positioning System (GPS), and vehicles used by field teams.
- Multipath Communication Device (MPCD) and Data Tablet running a Digital Field Monitor program: Used by field teams to record data collected in the field.
- Field Monitoring Log: Used by field teams to record data collected in the field if MPCD is not available.
- Sample Control Form: Used by field teams to record information pertaining to samples collected in the field; serves as the Chain of Custody for the sample as well.
- Daily Instrument Quality Control (QC) Checks: Used to record instrument quality control checks.
- Local Area Monitoring TLDs: Used to record pertinent information of Environmental TLDs used in the field.
- FRMAC Survey Form: Used by the FMS to record surveys in buildings or for H&S purposes.

This page intentionally left blank

5 FIELD TEAM BRIEFINGS

Field teams will be briefed on a daily basis prior to the start of work and departure into the field. A representative of the H&S Division will conduct part of the briefing, focusing on the current H&S plan requirements. The Monitoring Manager or the FTS will complete the briefing for the monitoring objectives and priorities for the operational period. All field team personnel for each shift are required to attend.

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:

- Sample collection
- Area monitoring
- Vehicle-based monitoring
- Personnel surveys
- In situ measurements

The types of information to be included in the daily briefing are described in sections 5.1 and 5.2.

5.1 Monitoring Operations

Basic information about the work scope for the shift is required. Basic information includes:

- **Incident Information:** This will cover the status of the incident such as duration and type of release, radioactive constituents if known, and data gathered by on-site or first responders.
- **Monitoring Objectives and Priorities:** Field teams will be told what type of measurements/samples are to be taken and generally where those measurements/samples are located.
- **Routes:** Maps, expected routes, and route activities will be covered to assist each team in accomplishing their mission.
- **Special Concerns:** Areas that require specific entry/exit requirements based on the nature of the incident (contamination control, sample methods, changes since the previous operational period, etc.).
- **Communication Protocols:** The devices, protocols, and frequency for relaying data back to the Technical Operations Center.
- **Public Affairs Information:** What and how to communicate with the general public concerning the functions that field teams are performing in the field, and who the public can contact for further information.

5.2 Health and Safety

H&S topics relevant to the response will need to be addressed as part of the daily briefings. Existing radiological, chemical, biological, or other hazards need to be communicated to monitoring teams. It allows them to be prepared for encountering any expected or possible circumstances such as the following:

- Climate (weather conditions)
- Biohazards (e.g., snakes, ticks, deceased wildlife)
- Expected radiological contaminants/levels
- Expected chemical contaminants/levels
- Possibility of terrorist activity and use of weapons of mass destruction
- Traffic (Has the area been evacuated?)
- Response of local population

Turn-back limits and hold points will be established when the hazard exceeds the level of the prescribed protection. If a field team exceeds the turn-back limits, they should immediately exit the area, notify the FTS, and return to the hotline (or other designated return location). Hold points shall be established for field teams where additional controls will be required to continue work. If the field teams encounter a hold point, then the team must check in with the FTS to receive further instructions. Possible instructions may be to don additional PPE (such as gloves/boots, coveralls, or respiratory protection) and continue work, enact stay-time restrictions, or turn back at these levels. Initially, the use of default hold points and turn-back limits is sufficient if no useful guidance is provided during the early phase of the response. The H&S Manager will determine turn-back guidance based on expected conditions and risk involved.

Field teams will be briefed on PPE requirements. The 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 clothing and/or respiratory protection. The FRMAC deploys with PPE that meets level D or C requirements typical for entry into radioactive contaminated areas (coveralls, shoe covers, gloves, and respirators). Entries into impacted areas that require level A or B PPE require interagency coordination.

Field teams will be briefed on the dosimetry requirements. The FRMAC H&S representative will ensure personnel have the appropriate dosimetry, such as whole-body dosimetry, supplemental dosimetry, or personal air sampling. Bioassays should also be discussed if there is credible evidence that an internal dose is possible.

Once existing or expected hazards are identified, the methods required to mitigate these hazards must also be communicated and provided. Special clothing requirements for weather conditions should be identified and provided. Local climate conditions should be announced (e.g., roads that flood, roads that freeze). Traffic conditions and roads to be avoided based on traffic, climate, hazardous and/or radiological conditions should also be communicated.

All personnel need to be made aware of emergency response procedures. This includes the general reporting of fires, medical emergencies, accidents, and any unusual activities. Monitoring teams also need to understand proper handling of contaminated victims or materials. Phone numbers for local medical centers and emergency contact information will be provided to all field teams prior to deploying from the FRMAC.

Debriefing of participants should be incorporated into the daily routine (at the end of each shift) to capture lessons learned and identify hazards that should be discussed in the next shift's safety briefing.

6 TRANSFER OF FRMAC TO EPA

Although it is difficult to specify in advance when the transfer of this coordination responsibility would occur, certain conditions must be met prior to this transfer. DOE may request that the EPA consider the transfer when the DOE believes it practical and appropriate to do so, and the EPA will consider this request. The transfer will be based upon the following five criteria:

- The immediate emergency condition is stabilized.
- Off-site releases of radioactive material have ceased, and there is little or no potential for further unintentional off-site releases.
- The off-site radiological conditions are evaluated and the immediate consequences have been assessed.
- An initial long-range monitoring plan has been developed in conjunction with the affected local, state, and tribal governments and appropriate federal agencies.
- The EPA has received adequate assurances from the other federal agencies that they are committing the required resources, personnel, and funds for the duration of the federal response.

To facilitate the transfer, additional joint DOE-EPA guidance documents have been written. As suggested in the “Nuclear/Radiological Incident Annex to the Response and Recovery Federal Interagency Operational Plans,” a FRMAC transition team should be created during the response to work on the transfer process. The transfer process may be included in the IC/UC demobilization section plans. The EPA will create a FRMAC organizational structure to meet its requirements to conduct long-term monitoring, environmental cleanup, and population resettlement.

6.1 Long-Range Monitoring Plan Development

Involving the EPA in the Monitoring Division to aid in the development of a long-range monitoring plan could occur soon after the end of the early phase. Involving the EPA early on in the process could help achieve bullets 3 and 4 in Section 6. A Deputy Monitoring Manager may need to be assigned and dedicated to participate in the long-range monitoring planning task.

Consider using the software tool Visual Sample Plan (VSP) to demonstrate monitoring data and current and/or future sampling goals. VSP supports the development of a defensible sampling plan based on statistical sampling theory and the statistical analysis of sample results to support confident decision-making. VSP couples site, building, and sample location visualization capabilities with optimal sampling design and statistical analysis strategies. VSP provides statistical methods to help determine the number and location of samples to ensure that a surveyed area is characterized with an acceptable level of confidence. The value of VSP increases with the quantity of collected data because of VSP’s ability to analyze existing data to drive monitoring and sampling plans to meet specific goals. The use of VSP could improve the efficiency of sampling efforts and, as a result, reduce both financial costs or time spent sampling.

The long-range monitoring plan must be written to address the response elements required to meet the priorities established during the transition talks. Plan for what is needed for the long-range monitoring and be cognizant of what assets will be available.

The long-range monitoring plan is a generic plan that provides a path for completing the priorities established during stakeholder meetings. The plan should list the equipment and radiation-monitoring techniques used to accomplish the priorities listed. The plan should propose monitoring locations and frequencies. The finalized, approved long-range monitoring plan is to be designed to support the local recovery plan. The initial long-range monitoring plan, which includes important pathways and that supports the clean-up and recovery activities, must be developed no later than the intermediate phase, but with the realization that it will likely change over time in conjunction with the development of the recovery plan.

APPENDIX A:
CMAC ARRIVAL CHECKLIST

This checklist, which was written as guidance for the Consequence Management Advance Command (CMAC), will greatly aid the effectiveness of the federal response. However, it may not fit all scenarios because of the variability of the state/Incident Command System (ICS) structure and their willingness, or time constraints, to participate. Keep in mind that the CMAC is there to help, not to take over.

The "CMAC Actions (together as a group)" section was written in the context of the CMAC's initial actions while staying physically together as a group. Once the CMAC is on the ground, the first thing to do is to call the Consequence Management Response Team (CMHT) for updates. ***NOTE:*** *Some of the actions in the group section could have been provided to the CMHT while the CMAC was en route. Meet with key contacts to introduce yourselves and your roles, at a minimum.*

The "Breakout" sections outline key tasks for each individual CMAC member to perform. These tasks were written in the context that CMAC members are physically separated from each other and supporting their local counterparts. For this reason, there is overlap in some responsibilities.

CMAC Actions (together as a group)

1. Contact the CMHT after arrival.
   a. Get situational report on what transpired during travel, including the following:
      (1) Event name
      (2) Event location (address, intersection, coordinates)
      (3) Radionuclides involved
      (4) Event time (Is it an ongoing release?)
      (5) Aerial Measuring System (AMS) status
   b. Get location of Incident Command (or other response locations such as Emergency Operations Centers [EOCs]) and key contacts (Radiological Assistance Program [RAP] Federal Team Lead [FTL] and key state players).
   c. Get any requests CMHT needs from the field.
2. At Incident Command, meet with the FTL (10–20 minutes).
   a. Introductions (name and response position)
      (1) Note the key Department of Energy (DOE) players (FTL, Team Scientist, Team Captain, etc.) and the key state players, and get their respective contact information.
   b. Explain this is a short meeting and you would like to have another meeting with the state players immediately after this (still with the key DOE players remaining).
   c. Explain who you are as a team, your roles, and what Consequence Management (CM) can offer (response team, home team, AMS, etc.).
   d. Discuss current priorities, objectives, and goals.
   e. Discuss how the RAP (or another response organization) is accomplishing these goals.
      (1) Find out what data types the RAP are collecting.
      (2) Advise, as necessary, as to how to accomplish objectives.

(3) Identify both the current products and identify what the state should know.

f. Discuss that a transition in organization will occur when the Federal Radiological Monitoring and Assessment Center (FRMAC) is established.

g. Discuss what the state currently is requesting/demanding from the FTL and any foreseeable issues.

3. At Incident Command, meet with the FTL and state reps (10–30 minutes).

   a. Introductions (name and response position)

      (1) Note key State players and their respective contact information.

   b. Explain this is a short transition meeting.

   c. Explain who you are, your roles, and what CM can offer (response team, home team, AMS, etc.).

   d. Discuss current priorities and objectives.

      (1) Explain, as necessary, as to how to accomplish objectives.

         (a) Make available the FRMAC Monitoring Division default guidance, if needed.

         (b) Explain the initial field team missions, if needed.

      (2) Identify the current protective actions.

      (3) **MANAGE EXPECTATIONS:** Identify how long certain tasks take (e.g., when assets can arrive, when assets can start working, how many teams are available, how long measurements take per team, how long data products may take).

      (4) Brief the current products, if necessary, and explain how they can be applied to the situation.

      (5) Resolve any problems by offering solutions.

   e. Set up a reoccurring time that all parties (RAP, Nuclear Incident Team [NIT], state, CMAC, etc.) can call into the CMHT Bridgeline for situational awareness, tasking, and information.

   f. Discuss locations where the FRMAC could be located (Logistics is lead).

   g. End the meeting. Explain the CMAC will have a short meeting to divide tasks. Ensure a liaison is available to be with the state reps or at the EOC, as requested.

4. Meet as a CMAC for a path forward.

   a. Notify the CMHT when conference calls are scheduled and to relay pertinent information from the meetings.

5. Meet with the state counterparts to answer immediate questions and to plan the path forward, which includes the following:

   a. MANAGING EXPECTATIONS

   b. Planning future priorities/objectives

   c. Discussing tactics to implement to accomplish the priorities/objectives

   d. Identifying the Incident Command (IC) structure

Monitoring Manager Breakout Checklist

1. Meet with the RAP Team Captain.
   a. Find out the status of the 10-point monitoring plan.
   b. Address any issues (tablets, Multipath Communication Devices [MPCDs], instrumentation, technical, prohibiting circumstances, etc.).
   c. Identify where and what measurements/samples are being collected.
      (1) Verify that FRMAC monitoring methods are being used (e.g., exposure rate measurements are at 1 meter, contamination at contact, 10-minute high-volume air samples).
      (2) Verify that samples/measurements are correct to satisfy objectives.
   d. Verify that monitoring results are Quality Control (QC)-checked in the Radiological Assessment and Monitoring System (RAMS).
   e. Advise how and where to take more measurements (transects, plume pinch, etc.) after the 10-point monitoring is complete. **NOTE:** Consult with the Assessment and Health and Safety (H&S) Manager.
   f. Discuss CMRT arrival, the organization chart, and where the RAP can fit in to M&S roles (e.g., Team captains and leads could fulfill roles as Field Team Supervisors (FTSs) and Deputy Managers, while Health Physics Support Personnel can be Field Monitoring Specialists.). Ask for suggestions on who would be a good fit for these positions.
2. Periodically meet with the Assessment Manager for updates and tasks.
3. Establish communication with the AMS Mission Manager (to status and coordinate AMS needs).
4. Be prepared to answer questions from the state and other positions in the CMAC about assets, capabilities, timelines, and team make-ups (how to blend teams).
5. Establish a way for the state/locals to share data (if not already done by the CMHT).
   a. Ensure that if RadResponder is used, that they allow the RAMS to synchronize the event.
6. Identify and develop plans to integrate available field monitoring personnel from the primary authority, state, tribal, local, and/or other emergency response organizations.
   a. Use default plans if no objectives are received from the state/locals.
   b. If available, recruit state/local responders to be part of a field team (e.g., if they are not trained at radiological response, at least they could be drivers).
   c. Identify how monitoring personnel can pass through roadblocks into evacuated areas to perform monitoring duties.
7. Ensure that you are included on the CMHT Bridgeline calls.
8. Prepare field team instructions for the first operational period in consultation with the CMAC.
   a. When IC issues an Incident Action Plan (IAP), participate in the planning for the next operational period (the FRMAC implementation plan, the execution plan, and then prepare the ICS 204FRMAC form).

Assessment Manager Breakout Checklist

1. Meet with the state/responsible Radiological Health Manager
   a. Find out the capabilities of the group (assessment, the Geographic Information System [GIS], field teams).
      (1) Get key contact information (if not already done by the CMHT).
   b. Find out the current priorities and future priorities.
   c. Find out what questions they have and possible solutions.
   d. Discuss CMRT arrival, timelines, and a brief description of the organization chart.
   e. Identify where and what measurements/samples are being collected.
      (1) Investigate if FRMAC monitoring methods are being used (e.g., exposure rate measurements are at 1 meter, contamination at contact, 10-minute high-volume air samples).
      (2) Verify that the samples/measurements are correct to satisfy objectives.
   f. Advise how and where to take more measurements (transects, plume pinch, etc.) after the 10-point monitoring is complete to fulfill command's objectives. **NOTE:** Consult with the Monitoring and H&S Managers.
   g. Establish a way for the state/locals to share data (if not already done by the CMHT).
      (1) Ensure that if RadResponder is used, that they allow the RAMS to sync the event.
   h. Discuss the desired route to request products (e.g., via a CMweb request form, directly through the Assessment Manager, through liaisons).
   i. Discuss where products go (CMweb) and where the state would like to access them (CMweb, Homeland Security Information Network [HSIN], RadResponder.net), if not already done by CMHT.
   j. Find out who and where are the main product requesters.
2. Find out assessment-specific details.
   a. What International Commission on Radiological Protection (ICRP) guidance they use?
   b. What PAGs are in use?
   c. What are the Derived Response Levels/Derived Intervention Levels (DRLs/DILs)?
3. Find out product-specific details
   a. What needs to be changed from the first round of maps?
4. Verify that decision makers have access to a member of the A-team.
5. Periodically meet with the Monitoring Manager for updates and tasks.
6. Be prepared to answer questions from the state and other positions in the CMAC about: products, capabilities, timelines, data sharing, dose assessments, regulatory guidance (Protective Action Guides [PAGs], DRLs, etc.), National Atmospheric Release Advisory Center (NARAC) models, and any other CM activity.
7. Ensure that you are included on the CMHT Bridgeline calls.

8. Periodically call into the CMHT to discuss products/prioritization with the Technical Home Team Lead.
9. Provide input to the field team instructions for the first operational period in consultation with the CMAC.
    a. When IC issues an IAP, participate in the planning for the next operational period (the FRMAC Implementation Plan, the Execution Plan, and the ICS 204FRMAC form).
10. Provide support for and work with the CMAC Federal Team Lead.

Health and Safety (H&S) Manager Breakout Checklist

1. Meet with the state/responsible H&S Manager.
    a. Find out the capabilities of the group (non-radiological, radiological).
        (1) Get key contact information (if not already done by the CMHT).
    b. Find out the current H&S priorities and future priorities for the following:
        (1) Responders
        (2) The public
    c. Find out what questions they have and discuss possible solutions.
    d. Briefly discuss the CMRT arrival, timelines, and a brief description of the organization chart.
    e. Discuss what FRMAC H&S can provide as follows:
        (1) Hotline
        (2) Radiological safety practices
        (3) An H&S plan
    f. Find out who and where are the main product requesters.
    g. Be prepared to take the lead role in advising on radiological H&S for IC.
2. Meet with the CMAC Monitoring Manager and DOE Response leaders.
    a. Find out current turn-back limits (dose and contamination).
    b. Find out current hazards.
    c. Advise them.
3. Periodically meet with the CMAC for updates and tasks.
4. Be prepared to answer questions from the state and other positions in the CMAC about H&S, products, capabilities, timelines, etc.
5. Provide responder H&S advice to the CMAC and/or command.
6. Ensure that you are on the CMHT Bridgeline calls.
7. Provide input to field team instructions for the first operational period in consultation with the CMAC.
    a. When IC issues an IAP, participate in the planning for the next operational period (the FRMAC Implementation Plan, the Execution Plan, and the ICS 204FRMAC form).

b. In concert with the CMAC Assessment Manager and the CMAC Monitoring Manager, develop radiation exposure turn-back values and dose commitment levels for monitoring personnel based on mission requirements, ALARA, and applicable federal regulations.

c. In concert with the CMAC Monitoring Manager, provide information, advice, expertise to aid in ensuring that monitoring personnel have appropriate personal dosimetry and instructions on use, and understand exposure reporting and documentation requirements.

Liaison Breakout Checklist

1. Meet with the state/responsible Emergency Operations Center (EOC) and decision makers.

   a. **Get key contact information** (if not already done by the CMHT). Name, email address, phone address, title…

      (1) Decision makers

      (2) GIS

      (3) Local dose assessment scientists

      (4) Agriculture

      (5) Product requesters

   b. Find out the current priorities and future priorities.

   c. Find out what questions they have and possible product solutions.

   d. Briefly discuss FRMAC capabilities: the CMAC, CMRT arrival, timelines, and a brief description of the organization chart.

   e. Establish a way for the state/locals to share data (if not already done by the CMHT).

      (1) Ensure that if RadResponder is used, that they allow the RAMS to sync the event.

   f. Discuss the desired route to request products (e.g., via CMweb request form, directly through assessment manager, through liaisons, through ICS process).

   g. Discuss where products go (CMweb) and where the state would like to access them (CMweb, HSIN, RadResponder.net), if not already done by the CMHT.

   h. Brief/explain products.

2. Take product requests.

   a. Get name, phone number, and email address of requester.

3. Find out product-specific details.

   a. Call into the CMHT for clarification.

   b. Relay any specific mapping requests to the CMHT.

   c. Facilitate the resolution of problems, conflicts, and unmet needs.

4. Check CMweb for updated products and/or new products.

   a. Ensure the timely distribution to the requester of event-related information and data products received from the CMHT and CMweb.

   b. Provide interpretations/explanations of data products to the requester and others as appropriate.

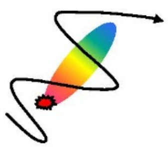
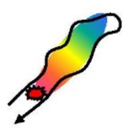
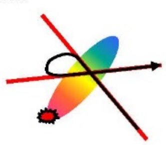
5. Verify that decision makers have access to a member of the A-team.
6. Coordinate requests, information, and data products between the Unified Command, and state and local EOCs and their point of contact at the deployed locations. These deployed locations may be associated with the Coordinating Official's Joint Operations Center.
7. Periodically speak with the CMAC for updates and tasks.
8. Be prepared to answer questions from the state and other positions in the CMAC about products, capabilities, timelines, data sharing, etc.
9. Ensure that you are included on the CMHT Bridgeline calls.
10. When necessary, call into the CMHT to discuss products/prioritization with the Technical Home Team Lead.

Operations Specialist Breakout Checklist

1. Meet with the state, federal, and responsible logistics personnel to plan for the arrival of the FRMAC.
    a. Location (if not already done by CMHT) as follows:
        (1) Indoor space of 10,000–20,000 square feet
        (2) Access to major highways/roadways
        (3) Close proximity to airports
        (4) Standard electrical power outlets (several circuits)
        (5) Space for parking mobile labs and numerous vehicles
        (6) Options are as follows:
            (a) Schools
            (b) Hockey rinks
            (c) Farm centers
            (d) Armories
2. Coordinate all logistical aspects of CM support, including (for pre-staging for follow-on responders) the following:
    a. Rolling stock (forklifts) for off-loading aircraft
    b. Ground transport for cargo
    c. Rolling stock (forklifts) at base of operations
    d. Securing base of operations
    e. Off-hours security
    f. Hotel rooms
    g. Rental vehicles
    h. Other logistics as needed

This page intentionally left blank

APPENDIX B:
AMS FIRST FIVE FLIGHTS

Flight #	Overall Purpose	Flight Pattern	Flight Parameters	Timeframe	Health and Safety Considerations	Mission Considerations	Mission Difficulty	Real-Time Monitoring or Post-Processing	Atmospheric Considerations
	What question(s) should be answered?	What pattern should be flown (picture or describe)?	What should be the suggested flight parameters flown?	When should this flight be conducted (or not conducted)? In time after the incident.	Are there any health and safety precautions that should be taken before, during, or after the flight?	What considerations should be made for the type of detectors (uplooker, GM), flight direction (down/up wind), or additional suggested equipment.	How difficult is the flight to perform? Seasoned AMS professional (High), MARS trained Individual (Medium), Person needs to be able to turn on the equipment (Low).	Is Real-time Monitoring required or can the data be processed after the flight is conducted?	What are some of the weather and atmosphere conditions that should be considered for the flight? How will this impact the data?
1	Is the plume still airborne?	Isodose, looking for the leading edge of the plume. 	Altitudes between 1,000'–2,000' or below inversion layer.	As soon as possible. This flight has the greatest risk of aircraft contamination and so should be flown with the most sensitive detectors looking for the lowest dose rates practical.	Health and safety issues are the same for all flights. The pilots are responsible for aviation safety, and have ultimate control over the flight. Radiation safety should always include the following steps: Before the flight: Estimate anticipated crew dose from models and previous measurements. During the flight: Measure crew dose rate and total dose. Every crew member should have a TLD and personal radiation monitor. A high-rate GM tube should be used in case the primary detector saturates. Collect an air sample in aircraft cabin for post-flight analysis. If there is any possibility of airborne contamination, a continuous air monitor should be used. After the flight: Check for aircraft contamination, monitor total crew dose for all flights, and measure air samples.	An up looking detector can be used to determine if the plume is still airborne. Every flight should include crew safety equipment including a high-rate GM tube and an air sampler. A continuous air monitor would provide real-time alpha and beta exposure rates.	The crew requirements for these flights are high - they require close coordination between pilots and operators, making decisions in real time during the flight about the path of the aircraft. The operators must also monitor the radiological conditions inside the aircraft to prevent overexposure of the crew.	Real-time or very quick post-processing, in order to inform life saving operations with enough lead time.	Weather conditions, including cloud ceiling, visibility, and winds, are factors determining whether or not the aircraft can fly safely. Flights are conducted under visual flight rules, and the pilots have ultimate control of aviation safety. If the aircraft can be safely flown, data can be collected. Soil moisture will impact data, but for emergency flights this should not be a consideration. Detailed surveys will make use of calibration lines, minimizing the impact of changing soil moisture conditions. Unusual events, such as heavy snowfall after deposition, will negatively impact the ability to delineate the footprint.
2	What is the approximate size and amount of deposition?	Serpentine 	Altitudes between 1,000' or below depending on the flight restrictions and dose rate limitations. Line spacing between 0.5 and 1.5 miles, depending on area to be covered and projected dose to crew. Choose one line of the pattern to fly both at the beginning and at the end of the mission to measure decay rate of fallout mixture.	After the plume is no longer airborne. Areas expected to expose crew members to high doses should be avoided.		The flight starts on the up-wind side of ground zero, and makes its first turn into the footprint in an area not expected to give the crew an excessive dose. The GM tube can supply data in areas where the main detector saturates.		Real-time or very quick post-processing, in order to inform life saving operations with enough lead time.	
3	What is the approximate outline of the evacuation area?	Isodose 	Altitudes between 1,000' using a dose rate limit prescribed by Assessment or Monitoring.	After the plume is no longer airborne.		The flight starts on the up-wind side of ground zero, and attempts to follow the outline of the footprint using a pre-determined dose rate. Steep dose rate gradients may preclude using this technique near ground zero.		Real-time data would be possible and perhaps useful to inform some very early decisions. But more work must be done in post-processing and model revision to project public exposure before the plume has completely fallen out or passed.	
4	What evacuation routes are safe?	Road 	Altitudes between 300'–1,000'	After the plume is no longer airborne, before evacuation orders are given. Precipitation events, particularly while the plume is airborne, can create localized hot spots.		This flight checks the radiological conditions along planned evacuation routes. The aircraft flies over roadways. If a hot spot is found, a detour can be planned around it. The detour would also be flown.	The crew requirements for these flights are medium to high. While the flight paths are straightforward, the operators still need to monitor the dose rate inside the aircraft cabin.	Real-time or very quick post-processing, in order to inform evacuation planning with enough lead time.	
5	What is the deposition footprint in detail?	Parallel lines 	Altitudes between 300'–1,000' The lower the altitude, the higher the resolution of the survey. In general, the radiation from an area twice as wide as the flight altitude is averaged as the aircraft passes over.	After the plume is no longer airborne.		These flights map out the area of contamination in greater detail. Care must be taken to limit crew exposure, especially if they are flown near ground zero and/or at lower altitudes.		Post-processing needed	

APPENDIX C:
QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) CHECKLIST FOR MONITORING

Before Field Teams Depart:

☐ Perform operability checks of instruments and document on field log.

☐ Field team makes background measurements (in the Radiological Assessment and Monitoring System [RAMS]) before departing.

When Data from Field Team is Received, Review the Sample and/or Survey Details in the RAMS for the Following:

☐ Measurement/sample matches the mission (ICS 204FRMAC assignment).

☐ Proper meter/probe was used.

☐ Measurement/sample is taken at the proper location.

☐ Measurement/sample date and time are correct.

☐ Measurement/sample raw value is reasonable.

☐ Measurement/sample is in the proper units.

☐ Field team name is correct.

☐ Check for any comments or descriptions.

☐ Check uploaded pictures/spectra/files were attached.

☐ Standardized values were converted correctly.

☐ Accept or reject the measurement in the RAMS (in standardized value section).

This page intentionally left blank

APPENDIX D:
ADVANCE PARTY MEETING CHECKLIST

FRMAC Advance Party Meeting

General Event Information

- Event Name:
- Location:
- Release Start Time:
- Release Stop Time:
- Further Details on Release:

Current Operational Overview

- What is the status of the protective actions taken for the public? Current Incident Action Plan (IAP) objectives (see page 2-3)?
- Current field team operations (number of field teams from each organizations):
- Have you activated an Emergency Management Assistance Compact (EMAC) or other compact agreements to get more resources? Was a ROSS requested?

Contact Information

- It is expected that an Incident Command organization chart, along with the names of the personnel filling the roles and their contact information (phone number and email address), would be provided to the Federal Radiological Monitoring and Assessment Center (FRMAC). The FRMAC will provide Incident Command with the Consequence Management Response Team (CMRT) organization chart listing personnel and contact information. In addition, the FRMAC will provide contact information for key personnel from the different federal agencies, which are part of the FRMAC.

Radiological Assessment Information

- Models - Have any models been created and if so, where are they being stored and how can they be accessed?
- PAGs - What Protective Action Guides (PAGs) are being used? What Derived Response Levels and assumptions were/will be used to implement the PAGs?

Data Sharing

- The survey and outline of the FRMAC data sharing protocol are outlined beginning on page 5.
- General immediate questions:
  - Environmental Radiological Data - Has there been any field sampling/monitoring data collected? How can the FRMAC obtain this data? RadResponder event?
  - With whom does the FRMAC share data products? Are there certain restrictions of which we should be aware?

This page intentionally left blank

Objective	Supporting Questions	Potential FRMAC Support	Priority
Determine evacuation/ shelter-in-place areas	• Is there a planned evacuation/ shelter-in-place order? • If so, is there a .kml, shapefile, or printed image of this area available?	☐ Verify with a model? ☐ Perform a flyover of the evacuation routes? ☐ Update model assumptions with new data?	
Determine areas for long-term relocation	• Has there been an assessment of long-term relocation impact areas? • If so, is there a .kml, shapefile, or printed image of this area available?	☐ Verify with a model? ☐ Update model assumptions with new data?	
Ensure worker doses are ALARA	• What are the dose limits for the workers in each responding organization? • What kind of devices are available to responders to verify their dose and dose rate? • How long are the work shifts? • Are there specific emergency tasks assigned which may cause a worker to exceed normal occupational limits?	☐ Stay-time product ☐ Integrated dose calculations ☐ Just-in-time training on radiological safety for emergency and/or non-emergency workers	
Define the extent of the deposition	• What is the basis of this question? • What is the threshold of interest (i.e., 10 times background)?	☐ Aerial Measuring System (AMS) data using breakpoints provided ☐ Updated National Atmospheric Release Advisory Center (NARAC) model using current assumptions and data	
Identify “safe” transportation corridors (road closure/re-open)	• Is there a list or map of identified potential transportation routes? • What dose along these corridors would be considered unsafe or warrant a road closure? • Is there a limit for fixed/removable contamination?	☐ AMS data along the identified routes ☐ Calculation of dose to passengers from all pathways ☐ Final report of findings and assistance in determining next steps	

Objective	Supporting Questions	Potential FRMAC Support	Priority
Support community reception centers	• Have reception centers been established? • Have reporting thresholds for portal monitors and other survey equipment been established? • Are the number of false positives as expected or is assistance required to adjust this?	☐ Assist in setting portal monitors to more reasonable alarm thresholds. ☐ Provide just-in-time training for reception center workers	
Evaluate critical infrastructure	• Is there a list of identified critical infrastructure available? • What is the status of surveys of these areas? • Are workers expected in these areas today, tomorrow, or later this week? • Do workers require health physics support to make entry and perform their work? • Has training been provided to these non-radiological workers? Is training assistance needed?	☐ Deployment of field team members to support workers with health physics surveys and Personal Protective Equipment (PPE) ☐ Provide just-in-time training on the basics of radiation safety	
Determine impacted agricultural areas	• Has any action been taken to protect agricultural business in the affected area? • If so, can the protection order and any imagery generated be provided? • Have surveys been planned for these areas? • What are the major crops/livestock/game of interest in this area? (May be answered offline with ESF-12 representative)	☐ Provide NARAC model with agriculture impacts ☐ Coordinate efforts with local ag-extension office to ensure most up-to-date information is exchanged	

Response Locations - Key locations for responders should be noted below.		
Location of Interest	**Facility Contact Name**	**Address and Phone Number**
FRMAC		
SEOC		
EOC 1		
EOC 2		
EOC 3		
Airfield for Fixed Base of Operations		
Community Reception Center		
Contamination Monitoring Checkpoints (Hotlines)		

Data Sharing

FRMAC data management works best when all data are accounted for and shared effectively. The following survey is intended to capture information about data collected during the response. It is also intended to provide a means to communicate how these data will be stored and shared. It is expected that this document will be updated as needed.

Survey and Sample Data

- Which data acquisition/storage system is used by the organization(s) support this incident?
  - RadResponder.net/application
  - Proprietary electronic system
  - Paper forms/logbooks
- Are there any state/local requirements that dictate how these data should be handled?
- Are there any particular sensitivities of which the FRMAC should be aware?
- Can state/local sampling procedures/protocols be shared with the FRMAC?
- Is there a data manager assigned to the state/local organization(s)?
- What kind of data are managed by the state/local organizations(s)
  - Handheld surveys
  - Environmental samples
  - In situ gamma spectroscopy
  - Dense data
    - Ground-based mobile
    - Aerial
    - Fixed sensors
  - Other

RadResponder Users

Event Name:

Ensure partnership with DOE-FRMAC is established.

Proprietary Electronic System Users

Is there an output file available which contains some or all available survey and sample data?

If so, how may this file be provided to the FRMAC?

Paper Forms/Logbooks

Can scanned copies of these forms be provided to the FRMAC?

File Sharing

The FRMAC stores and may make available data files such as .kml, shapefiles, layer files, finished map documents, and others.

Documents and data files, which have been reviewed and approved for wide distribution, will be stored here:

[*The FRMAC will insert link for NARAC file location for the Interagency Products and Data Folder*]

Working documents may be available for limited distribution as well.

Information Needed:

- Will the release of some or all FRMAC data product require approval or confirmation of state/local leadership?
- If so, who will this be and do they have any delegates who may approve in their absence?
- Can a list of potential CMweb users be provided, indicating clearly any access restrictions?

This page intentionally left blank

APPENDIX E:
MONITORING DIVISION DEFAULT GUIDANCE (ICS 234, ICS 204, ICS 204FRMAC)

This page intentionally left blank

WORK ANALYSIS MATRIX ICS 234		
1. Incident Name:	2. Operational Period From: To:	
3. Operation's Objectives DESIRED OUTCOME	**4. Strategies** HOW	**5. Tactics/Work Assignments** WHO, WHAT, WHERE, WHEN
A. Confirm model predictions and identify boundaries.	A.1 – Deploy Aerial Measurement System (AMS) fixed wing or helicopter to survey large areas. A.2 – Deploy FRMAC field teams.	A.1 – AMS fixed wing and/or helicopter will arrive ASAP at the nearest airfield (outside of contaminated zone). The first flights will verify if the plume is still airborne and to estimate the size of the contaminated areas. A.2 – Deploy FRMAC field teams ASAP to the various areas in and around the contaminated zones. Field teams will perform radiological surveys and collect environmental samples. Surveys and samples will provide data to support early phase decisions. Field teams will also support AMS to provide ground truth measurements to validate aerial data.
6. Prepared by: (FRMAC Monitoring Manager)		7. Date/Time:

This page intentionally left blank

1. Incident Name:	2. Operational Period: Date From: Date To: Time From: Time To:	3. Branch: Division: Group: FRMAC Staging Area: FRMAC Location

4. Operations Personnel: Name — Contact Number(s)

Operations Section Chief: ______

Branch Director: ______

Division/Group Supervisor: ______

5. Resources Assigned:

Resource Identifier	Leader	# of Persons	Contact (e.g., phone, pager, radio frequency)	Reporting Location, Special Equipment and Supplies, Remarks, Notes, Information
FRMAC Alpha		2		FRMAC Consequence Management Response Teams: Field teams for radiological characterization. Teams equipped with radiation detectors and PPE for radioactive contamination areas.
FRMAC Beta		2		
FRMAC Delta		2		
FRMAC Echo		2		
FRMAC Foxtrot		2		
AMS		4		Aerial Asset. Will arrive before FRMAC field teams.

6. Work Assignments: Deploy FRMAC field teams ASAP to the various areas in and around the contaminated zones. Field teams will perform radiological surveys and collect environmental samples. Surveys and samples will provide data to support early phase decisions. Field teams will also support AMS to provide ground truth measurements to validate aerial data. AMS fixed wing and/or helicopter will arrive ASAP at the nearest airfield (outside of contaminated zone). The first flights will verify if the plume is still airborne and to estimate the size of the contaminated areas.

7. Special Instructions: At least once every hour, contact the FRMAC Field Team Supervisor with a Safety and Status check. Passenger to monitor exposure rate instrument at all times when driving. In the presence of contamination, don shoe covers and disposable gloves. Don a full set of PPE when total surface contamination is greater than 100,000 dpm/100 cm^2 beta or 2,000 dpm/100 cm^2 alpha. Upon reentry to vehicle, survey hands and feet.

Turn-Back Limits: Exposure rate ≥ 500 mR/hr, 500 mrem per shift (immediately exit the area at these limits).

Hold Points (contact Supervisor for further instructions at these levels):

Alpha: 24 µCi/m2 or 5.4E5 dpm/100 cm^2 or meter off scale

Beta: 4.7E3 µCi/m^2 or 1E8 dpm/100 cm2 or meter off scale

Dose Rate: 50 mrem/hr (5 mrem/hr if the source is Sr-90 only)

Wear electronic dosimeter and TLD.

8. Communications (radio and/or phone contact numbers needed for this assignment)**:**

Name/Function — Primary Contact: indicate cell, pager, or radio (frequency/system/channel)

______/FRMAC Monitoring Manager ______

______/Field Team Supervisor ______

______/AMS Mission Manager ______

______/______ ______

9. Prepared by: Name: ______ Position/Title: FRMAC Monitoring Manager Signature: ______

ICS 204	**IAP Page** ______	Date/Time: ______

This page intentionally left blank

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

3. FRMAC Monitoring Personnel	Name:	Contact Phone #(s)	Home Organization	4. Team Name
Monitoring Manager			FRMAC / NNSA / MSTS	Alpha
Field Team Supervisor			FRMAC / NNSA / MSTS	(Hot area transect, fast field team)

5. Resources Assigned

Field Monitoring Team Leader	Contact Phone #(s)	Home Organization
Field Monitoring Team Member	**Contact Phone #(s)**	**Home Organization**

6. Work Assignments: Default Field Team Instructions: Collect a background survey and submit it to RAMS. Conduct a communications check before departure from parking lot. Take exposure rate measurements at 1 meter at the following locations: at each stop (**every half mile** along route). Take a contamination survey for alpha, beta, and gamma on contact for a collection time of 1 minute at the following locations: at each stop (**every half mile** along route).
Locations: Perform transects of the deposition as near as possible to the release site without exceeding the turn-back limits. After the transects, and if possible, perform measurements down the deposition centerline (i.e., move away from the release site). ***See Map for route.**

7. Special Instructions / PPE: Prepare vehicle interior for contamination. This team will go nearest to the release point. At least once every hour, contact the FRMAC Field Team Supervisor with a Safety and Status check. Passenger to monitor exposure rate instrument at all times when driving. In presence of contamination, don shoe covers and disposable gloves. Don a full set of PPE when total surface contamination is greater than 100,000 dpm/100 cm^2 beta or 2,000 dpm/100 cm^2 alpha. Upon reentry to vehicle, survey hands and feet. Report to Decontamination line for whole-body survey upon exiting the Controlled / Contamination Area.
Turn-Back Limits: Exposure rate ≥ 500 mR/hr, 500 mrem per shift (immediately exit the area at these limits).
Hold Points (contact Field Team Supervisor for further instructions at these levels):
Alpha: 24 μCi/m^2 or 5.4E5 dpm/100 cm^2 or meter off scale
Beta: 4.7E3 μCi/m^2 or 1E8 dpm/100 cm^2 or meter off scale
Dose Rate: 50 mrem/hr (5 mrem/hr if the source is Sr-90 only)
Wear electronic dosimeter and TLD.

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

This page intentionally left blank

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

3. FRMAC Monitoring Personnel	Name:	Contact Phone #(s)	Home Organization	4. Team Name
Monitoring Manager			FRMAC / NNSA / MSTS	Bravo
Field Team Supervisor			FRMAC / NNSA / MSTS	(Transect plume further down)

5. Resources Assigned

Field Monitoring Team Leader	Contact Phone #(s)	Home Organization
Field Monitoring Team Member	**Contact Phone #(s)**	**Home Organization**

6. Work Assignments: Default Field Team Instructions: Collect a background survey and submit it to RAMS. Conduct a communications check before departure from parking lot. Take exposure rate measurements at 1 meter at the following locations: at each stop (**every half mile** along route). Take a contamination survey for alpha, beta, and gamma on contact for a collection time of 1 minute at the following locations: at each stop (**every half mile** along route). Collect a high-volume air sample using a filter for a sample time of 10 minutes at the following locations: once every 3 stops and only in areas < 50 mR/hr. Take a ground deposition sample (soil + vegetation) at the same locations as high-volume air samples. Try to collect the sample where the vegetation is < 6 inches. In the tablet, check this as a short-term sample. Collect a spectrum using a Detective at 1 meter for a collection time of 10 minutes at the same locations as the high-volume air samples and only in an area < 3 mR/hr. Return to Sample Receipt to turn in samples.
Locations: Perform transects of the deposition without exceeding the exposure rate turn-back limit. Start farther away from the release than Team Alpha. After the transects, and if possible, perform measurements down the deposition centerline (i.e., move away from the release site). ***See Map for route.**

7. Special Instructions / PPE: Prepare vehicle interior for contamination. At least once every hour, contact the FRMAC Field Team Supervisor with a Safety and Status check. Passenger to monitor exposure rate instrument at all times when driving. In presence of contamination, don shoe covers and disposable gloves. Don a full set of PPE when total surface contamination is greater than 100,000 dpm/100 cm^2 beta or 2,000 dpm/100 cm^2 alpha. Upon reentry to vehicle, survey hands and feet.
Report to Decontamination line for whole-body survey upon exiting the Controlled / Contamination Area.
Turn-Back Limits: Exposure rate ≥ 500 mR/hr, 500 mrem per shift (immediately exit the area at these limits).
Hold Points (contact Field Team Supervisor for further instructions at these levels):

Alpha: 24 μCi/m^2 or 5.4E5 dpm/100 cm^2 or meter off scale
Beta: 4.7E3 μCi/m^2 or 1E8 dpm/100 cm^2 or meter off scale
Dose Rate: 50 mrem/hr (5 mrem/hr if the source is Sr-90 only)

Wear electronic dosimeter and TLD.

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

This page intentionally left blank

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

3. FRMAC Monitoring Personnel	Name:	Contact Phone #(s)	Home Organization	4. Team Name
Monitoring Manager			FRMAC / NNSA / MSTS	Delta
Field Team Supervisor			FRMAC / NNSA / MSTS	(Transect plume further down)

5. Resources Assigned

Field Monitoring Team Leader	Contact Phone #(s)	Home Organization
Field Monitoring Team Member	**Contact Phone #(s)**	**Home Organization**

6. Work Assignments: Default Field Team Instructions: Collect a background survey and submit it to RAMS. Conduct a communications check before departure from parking lot. Take exposure rate measurements at 1 meter at the following locations: at each stop (**every half mile** along route). Take a contamination survey for alpha, beta, and gamma on contact for a collection time of 1 minute at the following locations: at each stop (**every half mile** along route). Collect a high-volume air sample using a filter for a sample time of 10 minutes at the following locations: once every 3 stops and only in areas < 50 mR/hr. Take a ground deposition sample (soil + vegetation) at the same locations as high-volume air samples. Try to collect the sample where the vegetation is < 6 inches. In the tablet, check this as a short-term sample. Collect a spectrum using a Detective at 1 meter for a collection time of 10 minutes at the same locations as the high-volume air samples and only in an area < 3 mR/hr. Return to Sample Receipt to turn in samples.
Locations: Perform transects of the deposition without exceeding the exposure rate turn-back limit. Start farther away from the release than Team Alpha. After the transects, and if possible, perform measurements down the deposition centerline (i.e., move away from the release site). ***See Map for route.**

7. Special Instructions / PPE: Prepare vehicle interior for contamination. At least once every hour, contact the FRMAC Field Team Supervisor with a Safety and Status check. Passenger to monitor exposure rate instrument at all times when driving. In presence of contamination, don shoe covers and disposable gloves. Don a full set of PPE when total surface contamination is greater than 100,000 dpm/100 cm^2 beta or 2,000 dpm/100 cm^2 alpha. Upon reentry to vehicle, survey hands and feet. Report to Decontamination line for whole-body survey upon exiting the Controlled / Contamination Area.
Turn-Back Limits: Exposure rate ≥ 500 mR/hr, 500 mrem per shift (immediately exit the area at these limits).
Hold Points (contact Field Team Supervisor for further instructions at these levels):

Alpha: 24 $\mu Ci/m^2$ or 5.4E5 dpm/100 cm^2 or meter off scale
Beta: 4.7E3 $\mu Ci/m^2$ or 1E8 dpm/100 cm^2 or meter off scale
Dose Rate: 50 mrem/hr (5 mrem/hr if the source is Sr-90 only)

Wear electronic dosimeter and TLD.

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

This page intentionally left blank

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

3. FRMAC Monitoring Personnel	Name:	Contact Phone #(s)	Home Organization	4. Team Name
Monitoring Manager			FRMAC / NNSA / MSTS	Echo
Field Team Supervisor			FRMAC / NNSA / MSTS	(ECAM team)

5. Resources Assigned

Field Monitoring Team Leader	Contact Phone #(s)	Home Organization
Field Monitoring Team Member	**Contact Phone #(s)**	**Home Organization**

6. Work Assignments: Default Field Team Instructions: Collect a background survey and submit it to RAMS. Conduct a communications check before departure from parking lot. Ensure that an eFRMAC specialist has properly set up the ECAM system at the FRMAC location before departing.

- Take exposure rate measurements at 1 meter at each ECAM system setup location.
- Take a contamination survey for alpha, beta, and gamma on contact for a collection time of 1 minute at each ECAM system setup location.

Locations: Set up the ECAM + EcoGamma + ATS and prepare it for continuous use at the FRMAC location. **See Map for other locations.**

7. Special Instructions / PPE: Prepare vehicle interior for contamination. At least once every hour, contact the FRMAC Field Team Supervisor with a Safety and Status check. Passenger to monitor exposure rate instrument at all times when driving. In presence of contamination, don shoe covers and disposable gloves. Don a full set of PPE when total surface contamination is greater than 100,000 dpm/100 cm^2 beta or 2,000 dpm/100 cm^2 alpha. Upon reentry to vehicle, survey hands and feet. Report to Decontamination line for whole-body survey upon exiting the Controlled / Contamination Area.
Turn-Back Limits: Exposure rate ≥ 500 mR/hr, 500 mrem per shift (immediately exit the area at these limits).
Hold Points (contact Field Team Supervisor for further instructions at these levels):

Alpha: 24 $\mu Ci/m^2$ or 5.4E5 dpm/100 cm^2 or meter off scale
Beta: 4.7E3 $\mu Ci/m^2$ or 1E8 dpm/100 cm^2 or meter off scale
Dose Rate: 50 mrem/hr (5 mrem/hr if the source is Sr-90 only)

Wear electronic dosimeter and TLD.

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

This page intentionally left blank

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

3. FRMAC Monitoring Personnel	Name:	Contact Phone #(s)	Home Organization	4. Team Name
Monitoring Manager			FRMAC / NNSA / MSTS	Foxtrot
Field Team Supervisor			FRMAC / NNSA / MSTS	(AMS Calibration Line Support)

5. Resources Assigned

Field Monitoring Team Leader	Contact Phone #(s)	Home Organization
Field Monitoring Team Member	**Contact Phone #(s)**	**Home Organization**

6. Work Assignments: Default Field Team Instructions: Collect a background survey and submit it to RAMS. Conduct a communications check before departure from parking lot. Perform the following measurements along the AMS calibration (or test) line.

- Take exposure rate measurements with an ion chamber at 1 meter for 10 minutes at each location point. Allow the ion chamber a minute to adjust to the radiation field before starting the 10-minute count.
- Collect a spectrum using a Detective at 1 meter for a collection time of 10 minutes at each location point.

***See map for location details.**

7. Special Instructions / PPE: Prepare vehicle interior for contamination. At least once every hour, contact the FRMAC Field Team Supervisor with a Safety and Status check. Passenger to monitor exposure rate instrument at all times when driving. In presence of contamination, don shoe covers and disposable gloves. Don a full set of PPE when total surface contamination is greater than 100,000 dpm/100 cm^2 beta or 2,000 dpm/100 cm^2 alpha. Upon reentry to vehicle, survey hands and feet. Report to Decontamination line for whole-body survey upon exiting the Controlled / Contamination Area.
Turn-Back Limits: Exposure rate ≥ 500 mR/hr, 500 mrem per shift (immediately exit the area at these limits). Hold Points (contact Field Team Supervisor for further instructions at these levels):

Alpha: 24 $\mu Ci/m^2$ or 5.4E5 dpm/100 cm^2 or meter off scale
Beta: 4.7E3 $\mu Ci/m^2$ or 1E8 dpm/100 cm^2 or meter off scale
Dose Rate: 50 mrem/hr (5 mrem/hr if the source is Sr-90 only)

Wear electronic dosimeter and TLD.

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

This page intentionally left blank

APPENDIX F:
MONITORING DIVISION DEFAULT GUIDANCE REFERENCES (INITIAL FRMAC MONITORING AND ASSESSMENT PLAN, INITIAL FIELD TEAM INSTRUCTION REASONING, DEFAULT TURN-BACK LIMITS FOR VARIOUS SCENARIOS)

This page intentionally left blank

Initial FRMAC Monitoring and Assessment Plan
Event Name (Exercise)

Initial Operational Period: (Date)

Pre-Deployment of Field Teams

- Instrument Operability Checks
- Communications Check
- Team Assignments
- Background measurements
- Safety Brief

If no hold points or turn-back guidance has been established, then use the following default guidance. At the Consequence Management Home Team (CMHT) or prior to field team briefing, verify these values and update as required. The default turn-back limits for the first shift (assuming no active plume) are as follows:

- Exposure rate: 500 milliRoentgen per hour (mR/hr)
- External dose: 500 millirem (mrem) per shift

The default *hold points for the first shift (assuming no active plume) are as follows:

- Alpha: 24 microcuries per square meter (µCi/m^2) or 5.4E5 disintegrations per minute per 100 square centimeters (dpm/100 cm^2) or meter off scale
- Beta: 4.7E3 µCi/m^2 or 1E8 dpm/100 cm^2 or meter off scale
- Dose rate: 50 millirem per hour (mrem/hr) (5 mrem/hr if the source is only Strontium-90 [Sr-90])

**Field team must check in with Field Team Supervisors at hold points to receive further instructions. This may be to don respirators and continue work, enact stay time restrictions, or turn back at these levels.*

- Start of the contaminated boundary: 5 times background.

All surveys and samples performed by FRMAC personnel will be done in accordance with FRMAC procedures. Any deviations will be noted on the ICS 204 field team assignment form.

All field teams will complete gamma exposure rate surveys—whenever they must travel near or in the plume—to determine they are not exceeding their turn-back limits. Any unexpected radiation levels will be reported immediately to the FTS. If performing surveys during an active plume, verify the status of the plume (active or not) at each sample location.

Planning Note: At nominal altitude, speed, and line spacing, the fixed wing can survey ~15 square miles per hour (mph) and the helicopter can survey ~4 square mph. Flights last for ~2.5 hours (from takeoff to touch down).

List of Priorities

Objective 1

Confirm the deposition model and initial first responder data, determine the isotopic mix, and begin to define the deposition boundary to determine the areas of radiological concern.

Assessment: Gather information to estimate radionuclide source term information and dispersal mechanism. Develop initial map products illustrating areas of radiological concern. Provide dose assessment and stay times for returning state, county, and city residents to their homes in affected areas. Provide assessment for return of residents for normal occupancy. Assess for the first- and second-year relocation following Environmental Protection Agency (EPA) protective action guidance. Provide map products illustrating areas of concern. Provide aerial measurements for ground concentration and exposure rate as applicable. Required measurements/samples include direct measurements for alpha, beta, exposure rate readings, air concentration levels, and radionuclide identification made with a High-Purity Germanium (HPGe) detector.

Monitoring:

AMS Responsibilities:

Characterize deposition/exposure footprint. Focus on evacuated areas and adjacent non-controlled areas. Fixed-wing aerial surveys will provide the initial data to characterize the extent of the plume deposition. The Aerial Measuring System (AMS) will conduct the fixed-wing survey at 305 meters (m) (1,000 feet [ft]) in altitude. If time is limited, a serpentine pattern will be performed. If there is time for a more complete survey, a line spacing of 500 m (1,600 ft) will be utilized. Helicopter aerial surveys, if available, will be conducted by AMS at 46 m (150 ft) altitude with 92 m (300 ft) line spacing to delineate contaminated areas (focusing on evacuation and relocation areas) to the extent practical. At the CMHT or prior to asset deployment, verify the mission parameters with the AMS Mission Manager and update as required.

Field Team Responsibilities:

Characterize deposition/exposure footprint. Perform transects of the deposition footprint. Focus on evacuated areas and adjacent non-controlled areas. Identify contaminant re-suspension and air concentration levels near the accident site and at downwind locations.

Initially, field teams will perform the standard suite of surveys and samples until enough information about the type of release can be determined. Resources will be allocated to conduct alpha, beta, and gamma contamination surveys at ground level, gamma exposure rate surveys at 1 m, and FIDLER (Field Instruments for Detection of Low-Energy Radiation) or SpecFIDLER surveys (only for a weapons scenario) at each sampling location. In situ measurements, air samples, and other samples will be collected at a periodic frequency (based either on distance or by order of magnitude change in exposure/contamination rates). A 10-minute in situ measurement at 1 m in height will be conducted in areas where the exposure rate is less than 3 milliRoentgen per hour (mR/hr). Sample collection will include: high-volume air (10 minutes), ground deposition (soil and vegetation together) and other samples, as necessary, to better define the plume footprint and contamination levels.

If evaluating for resuspension only, then perform: contamination and exposure rate surveys; a 10-minute in situ survey at 1 m in height; a 10-minute, high-volume air sample; and a ground deposition sample all at the same location.

Long-term air sample locations will be established. Locate vulnerable populations with local decision makers and deploy ECAM systems, if warranted. Perform low-volume air sampling within the evacuated/relocation area. Collect the low-volume air samples for around 24 hours. If the release has stopped, consider relocating Environmental Continuous Air Monitor (ECAM) systems for 24-hour monitoring of the area.

Objective 2

Support AMS by providing exposure rate measurements and in situ measurements along the AMS calibration line.

Monitoring:

AMS Responsibilities:

The AMS Mission Manager, or designee, is to discuss with the Monitoring Manager the appropriate location of the calibration line. Prioritize when and at what frequency the calibration line needs to be characterized by the field teams.

Field Team Responsibilities:

Perform 10-minute exposure rate surveys with the pressurized ion chamber at a height of 1 m along the identified calibration line. Allow the ion chamber 1 minute to adjust to the radiation field before starting the 10-minute count. Collect a 10-minute HPGe in situ survey at 1 m in height in areas where the exposure rate is less than 3 mR/hr.

Notes on the Default Field Team Instructions: Default ICS 204FRMAC, "Assignment List, Adapted for FRMAC Field Monitoring Teams"

Alpha Team:

- Work Assignment: Transect the plume near the release point and take exposure rate and contamination surveys. Repeat transects at other downwind locations.
- Idea: Get this team out first to collect measurements ASAP to verify plume projections and AMS data.

Bravo and Delta Teams:

- Work Assignment: Transect the plume farther away than Alpha Team. Take exposure rate and contamination surveys, high-volume air samples, ground deposition samples, and in situ gamma spectrometry. Repeat in a different transect, if time permits.
- Idea: Get these teams out ASAP to collect the standard suite of measurements and samples. This team starts farther away from the release point than Alpha Team in order to take the first in-situ spectra. The data helps verify model predictions and AMS data.

Echo Team:

- Work Assignment: Set up ECAM systems at the FRMAC and at other desirable locations. Take exposure rate and contamination surveys at the location site(s).
- Idea: This team is responsible for placement of ECAM systems. These locations may be located inside or outside the deposition footprint.

Foxtrot Team:

- Work Assignment: Take exposure rate measurements (preferably using a pressurized ion chamber) and in situ measurements along the AMS calibration line. The AMS will determine the calibration line location.
- Idea: This team is responsible for supporting AMS to get quickly a calibration line characterized with ground truth data.

Default Turn-Back Limits for Various Scenarios in the FRMAC Mission Analysis

Scenarios in this document reference the evaluated scenarios performed by the FRMAC Technical Advisory Group as documented in *FRMAC Mission Analysis Volume 1, Revision 0,* dated November 2006. Each scenario will reference any key notes, pertinent contours (if any), turn-back limits, and hold points.

For Health and Safety (H&S) purposes, turn-back limits are provided in the ICS 204FRMAC form for each team in block 7, "Special Instructions / PPE" under "Turn-Back Limits." It is assumed that the radioactive release has stopped and there is no airborne component (except re-suspended materials). A general dose turn-back limit of 500 mrem was chosen because it is 10% of the emergency responder protective action guideline and the potential for receiving a dose is plausible during the first operational shift. A default exposure rate turn-back limit of 500 mR/hr was chosen to prevent field teams from exceeding their dose turn-back level in a short timeframe. If a field team exceeds the turn-back limits, they should immediately exit the area, notify the FTS, and return to the hotline (or other designated return location).

Specific contamination turn-back limits for FRMAC mission scenarios were calculated using TurboFRMAC version 8.0.3 using a method developed by the FRMAC Assessment Division in 2018 and documented in Method 2.2.1 of the *FRMAC Assessment Manual, Volume I – Overview and Methods*. The contamination turn-back limit is defined as a contamination level that should not be exceeded to ensure the worker does not exceed their dose limit for the shift. Each evaluated scenario used the same base assumptions in the turn-back limit calculations. These assumptions are as follows:

- A 500 mrem dose limit
- A single 8-hour shift starting 12 hours after release
- Includes dose from resuspension inhalation and groundshine
- No respiratory protection
- A light exercise breathing rate of 1.5 cubic meters per hour
- A constant resuspension value of 1E-5 m^{-1}
- International Commission on Radiological Protection (ICRP)-recommended lung clearance types are used unless otherwise noted.

The Monitoring Division must ensure that the turn-back limits calculated by this method are in units that field team instruments can measure in the field.

To avoid confusing terms in the Monitoring Division, the contamination turn-back limits (calculated in accordance with the FRMAC Assessment Manual) will be viewed as hold points and denoted as such in the ICS 204FRMAC for each team in block 7, "Special Instructions / PPE" under "Hold Points."

A hold point is a value, if exceeded by field teams, which warrants further instruction from supervision to continue safely with the assigned field team task. If a field team encounters a contamination hold point, then the team should move to an area that is less than the contamination hold point and immediately contact the FTS to receive further instructions. The FTS should work with H&S and Assessment to determine a path forward for the field teams.

Possible instructions after exceeding a contamination hold point may be to don respirators and continue work, enact stay-time restrictions, or turn back at these levels.

Exceeding a hold point is not as severe as exceeding a turn-back limit, it only denotes the *possibility* of exceeding a shift dose limit if the team stays in that area for a period. However, exceeding a turn-back limit means that one has already exceeded a shift dose limit. Encountering an area of 500 mR/hr or receiving 500 mrem per shift remains a *default* turn-back limit—meaning the team must exit the area immediately.

An example to illustrate the difference between a turn-back limit and a hold point: Alpha Team arrives at the site of a suspected radiological dispersal device. Their mission is to take alpha contamination measurements and exposure rate measurements. The default turn-back limits are 500 mR/hr and 500 mrem per shift. The hold point for alpha contamination is 24 $\mu Ci/m^2$. As the team performs transects, their meter reads 25 $\mu Ci/m^2$ for alpha contamination, exceeding their *hold point*. They move to an area that is less than the hold point value and contact the FTS. In consultation with H&S and Assessment, it was determined that the field team would need to don respirators and continue performing transects. As they perform transects, a field team member's dosimeter alarms and exceeds the 500 mrem *turn-back limit*. The team immediately exits the area, notifies the FTS, and returns to the hotline.

The most conservative alpha and beta contamination hold points from the FRMAC mission scenarios—which are the RTG (Pu-238) and PWR Unmitigated scenarios, respectively—are used as hold points in the default field team instructions. For the dose rate hold point, 50 mrem/hr was chosen to represent most scenarios except for a Strontium-90 (Sr-90) only source and alpha-emitting scenarios. For an incident involving only a Sr-90 source, then the dose rate hold point is 5 mrem/hr. The figures on the following page illustrate the contamination hold points for all scenarios considered.

A table of the hold points for each scenario is provided. Each result table will contain an alpha contamination hold point, a beta contamination hold point, and a dose rate hold point. For beta and gamma emitters, the dose rate hold points should be used. For alpha emitter scenarios, the alpha contamination hold points should be used. One reason for this is that some exposure rate hold points resulted in values that are unmeasurable by field instruments.

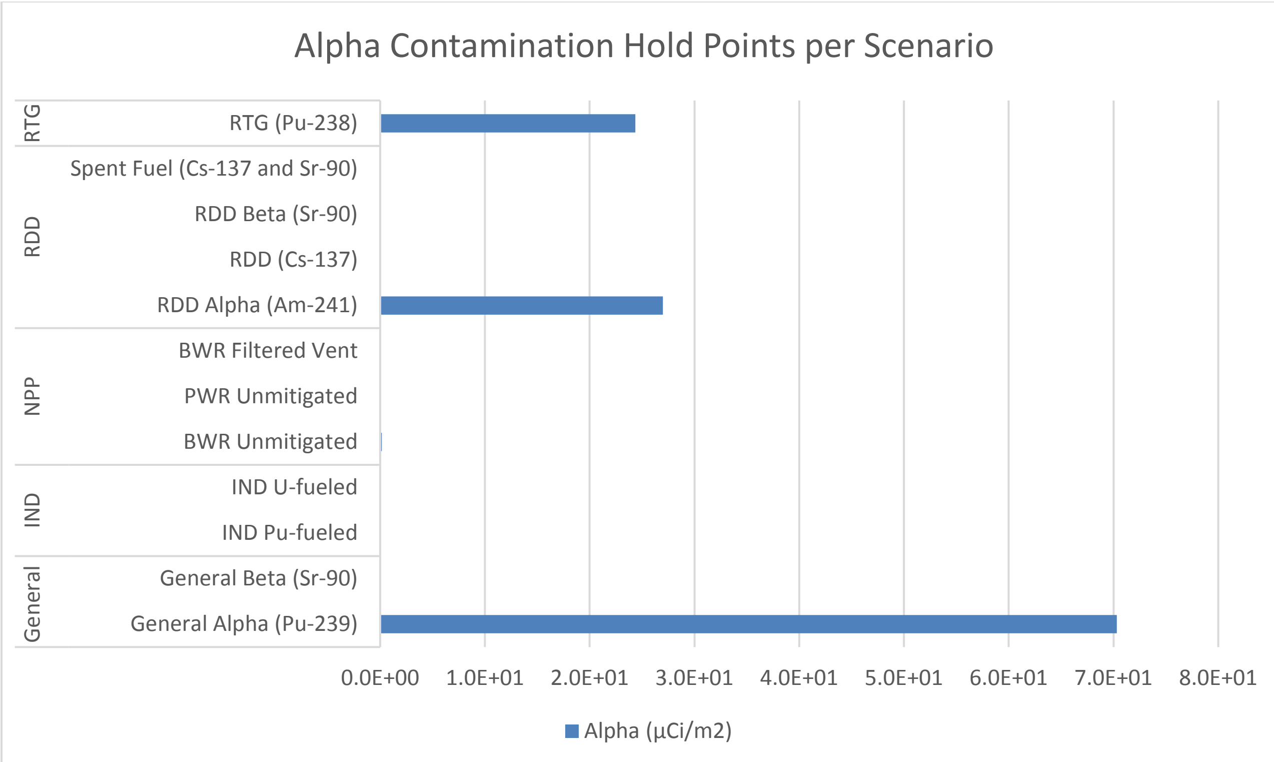


Figure 5: Alpha contamination hold points per scenario

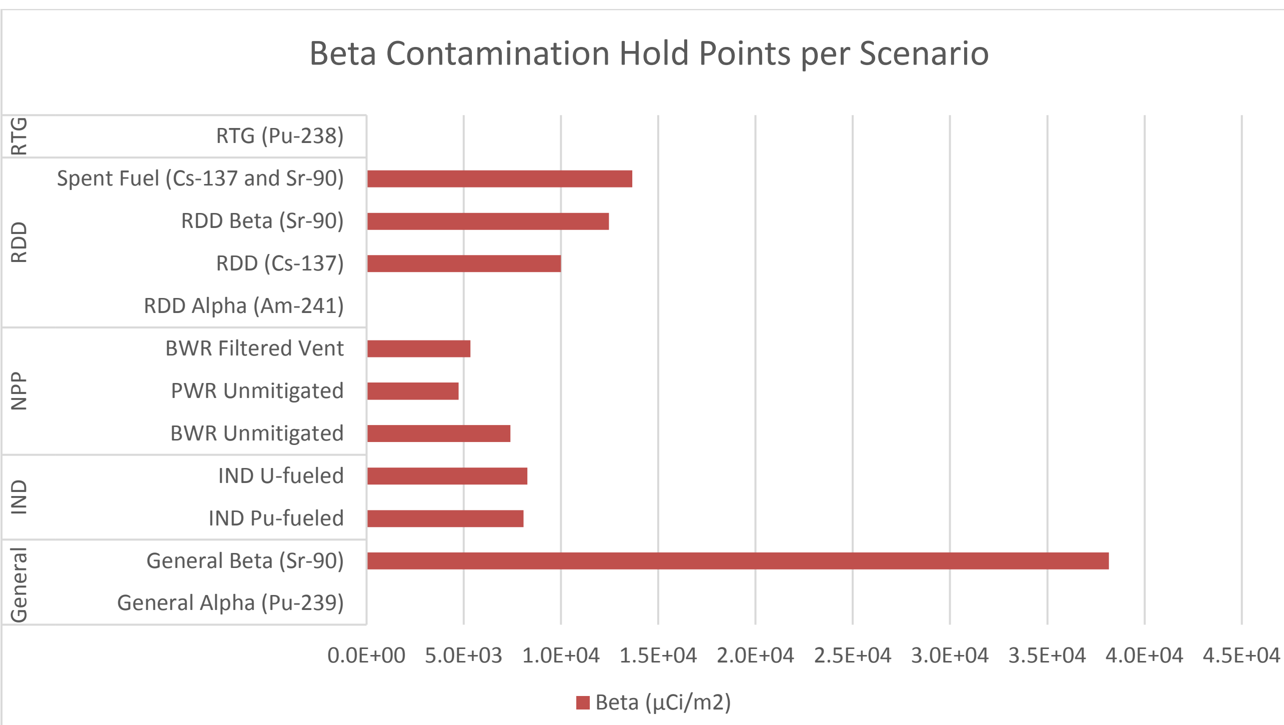


Figure 6: Beta contamination hold points per scenario

Domestic Nuclear Explosion

NOTES: The dose rate should be the primary hold point for this scenario. The beta contamination hold point would be greater than the maximum detection capability for many contamination meters. Common zone names are as follows: Dangerous Radiation Zone ≥ 10,000 mR/hr, Hot Zone > 10 mR/hr and < 10,000 mR/hr, and Cold Zone ≤ 10 mR/hr. Local Emergency Responders may have a 50 rem shift limit for lifesaving activities.

Table 2: Hold points for nuclear detonation

Hold Point	Fuel Type	
	Plutonium	Uranium
Alpha (μCi/m^2)	2.03E-02	N/A
Beta (μCi/m^2)	8.07E+03	8.27E+03
Alpha (dpm/100 cm^2)	4.51E+02	N/A
Beta (dpm/100 cm^2)	1.79E+08	1.84E+08
Dose Rate (mrem/hr)	6.21E+01	6.22E+01

Major Release from Nuclear Power Plant

NOTES: The dose rate should be the primary hold point for this scenario. The beta contamination hold point would be greater than the maximum detection capability for many contamination meters. The extent of the relocation areas could be tens of miles downwind while agricultural impacts areas could be hundreds of miles downwind. Common zone names are as follows: Dangerous Radiation Zone ≥ 10,000 mR/hr, Hot Zone > 10 mR/hr and < 10,000 mR/hr, and Cold Zone ≤ 10 mR/hr. BWR = Boiling Water Reactor. PWR = Pressurized Water Reactor.

Table 3: Hold points for nuclear power plant release

Hold Point	Nuclear Power Plant		
	BWR Unmitigated	PWR Unmitigated	BWR-Filtered Vent
Alpha (μCi/m^2)	1.48E-01	N/A	2.36E-02
Beta (μCi/m^2)	7.39E+03	4.73E+03	5.34E+03
Alpha (dpm/100 cm^2)	3.29E+03	N/A	5.23E+02
Beta (dpm/100 cm^2)	1.64E+08	1.05E+08	1.19E+08
Dose Rate (mrem/hr)	6.02E+01	6.15E+01	6.12E+01

Major Release of Alpha Sources from Radiological Dispersal Device (RDD), Failed Improvised Nuclear Device, or Radioisotope Thermoelectric Generator (RTG)

NOTES: The alpha contamination hold point should be the primary hold point for this scenario. The dose rate hold point would be indiscernible from natural background radiation for all scenarios except the RDD (Am-241). The beta contamination hold point would be indiscernible from natural background radiation for all scenarios. The alpha contamination hold point for the General Alpha (Pu-239) scenario would be close to the threshold or greater than the maximum detection capability for many contamination meters. The General Alpha (Pu-239) scenario uses a lung clearance type "S." The RDD (Am-241) scenario uses a lung clearance type "M." The RTG (Pu-238) scenario uses the ICRP-recommended lung clearance type.

Table 4: Hold points for alpha sources

Hold Point	Alpha Emitter Type		
	General Alpha (Pu-239)	RDD (Am-241)	RTG (Pu-238)
Alpha (µCi/m^2)	7.03E+01	2.70E+01	2.43E+01
Beta (µCi/m^2)	N/A	N/A	1.42E-07
Alpha (dpm/100 cm^2)	1.56E+06	5.99E+05	5.40E+05
Beta (dpm/100 cm^2)	N/A	N/A	3.16E-03
Dose Rate (mrem/hr)	2.35E-04	6.42E-03	1.60E-04

Major Release of Beta-Gamma Sources from RDD (Sr-90, Cs-137) and Decayed Spent Fuel

NOTES: The dose rate should be the primary hold point for this scenario. The beta contamination hold point would be greater than the maximum detection capability for many contamination meters. The General Beta (Sr-90) scenario uses the ICRP-recommended lung clearance type. The RDD (Cs-137) scenario uses the ICRP-recommended lung clearance type. The RDD (Sr-90) scenario uses a lung clearance type "S." The Spent Fuel (Cs-137 and Sr-90) scenario uses the ICRP-recommended lung clearance type. Common zone names are as follows: Dangerous Radiation Zone ≥ 10,000 mR/hr, Hot Zone > 10 mR/hr and < 10,000 mR/hr, and Cold Zone ≤ 10 mR/hr.

Table 5: Hold points for beta-gamma sources

Hold Point	Beta-Gamma Emitter Type			
	General Beta (Sr-90)	RDD (Cs-137)	RDD (Sr-90)	Spent Fuel (Cs-137 and Sr-90)
Alpha (µCi/m^2)	N/A	N/A	N/A	N/A
Beta (µCi/m^2)	3.82E+04	9.99E+03	1.25E+04	1.37E+04
Alpha (dpm/100 cm^2)	N/A	N/A	N/A	N/A
Beta (dpm/100 cm^2)	8.47E+08	2.22E+08	2.77E+08	3.03E+08
Dose Rate (mrem/hr)	2.33E+01	5.99E+01	7.60E+00	5.51E+01

This page intentionally left blank

APPENDIX G:
AMS HOME TEAM SCIENTIST CHECKLIST

The following checklist should be considered as the minimum requirements for this position. *Note that some of the tasks are one-time actions and others are ongoing or repetitive for the duration of the incident. Tasks may be delegated to the appropriate Unit Leader.*

✓	Task
☐	1. Obtain briefing from AMS Mission Scientist/RSL Response Manager: • Determine current aircraft/air crew status. • Determine current situation status/intelligence. • Determine current incident objectives and strategy. • Determine whether AMS Mission Scientist requires a written operations plan. • Determine time and location of first CMHT Planning Meeting. • Determine desired contingency plans.
☐	2. Activate AMS Section positions, as necessary, and notify AMS Manager of positions activated.
☐	3. Establish and maintain resource tracking system.
☐	4. Advise CMHT staff of any significant changes in incident status.
☐	5. Compile and display incident status summary information: • Forward incident status summaries to AMS Mission Scientist. • Obtain latest NARAC prediction, if applicable.
☐	6. Obtain/develop incident maps.
☐	7. Provide AMS technicians with GIS shapefiles for the aircraft acquisition systems.
☐	8. Prepare contingency plans: • Review current and projected incident and resource status. • Develop alternative strategies. • Identify resources required to implement contingency plan. • Document alternatives for presentation to AMS Mission Scientist/RSL Response Manager, and for inclusion in the written operations plan.

Rev. 2/19

- [ ] 9. Attend planning meetings according to following agenda:

Sample Planning Meeting Agenda

Agenda Item	**Responsible Party**
1. Briefing on situation/resource status.	CMHT
2. Discuss safety issues.	RSL Safety Officer
3. Set/confirm incident objectives.	Response/Monitoring Manager
4. Plot AMS survey boundaries.	Response/Monitoring Manager
5. Confirm mission parameters for each aircraft.	Mission Scientist/Monitoring Manager
6. Specify resources needed for data analysis.	Mission Scientist/Monitoring Manager
7. Discuss data analysis and products.	Monitoring/Assessment
8. Finalize/approve/implement operations plan.	Monitoring Manager/Mission Scientist

- [ ] 10. Prepare contingency plans:
    - Establish data product requirements and reporting schedules.
    - Ensure that detailed contingency plan information is available for consideration by Mission Scientist and Monitoring Manager.
    - Verify that all CMHT support and resource needs are coordinated with CMHT Response Manager.
- [ ] 11. Coordinate development of an air space clearance plan with Mission Scientist and Pilot-In-Command.
- [ ] 12. Coordinate preparation of the initial deployment hazard analysis with RSL Safety Officer.
- [ ] 13. Coordinate preparation of an AMS communications plan, if necessary.
- [ ] 14. Establish a weather data collection system, when necessary.
- [ ] 15. Ensure AMS Home Team Scientist position has adequate coverage and relief.
- [ ] 16. Attend CMHT meetings, as necessary, to ensure communication and coordination among assets.
- [ ] 17. Ensure preparation of AMS demobilization plan, if appropriate.
- [ ] 18. Ensure preparation of final AMS data packages and route to FRMAC and CMweb, if directed.
- [ ] 19. Provide briefing to relief scientist on current and unusual situations and data product status.

Rev. 2/19

APPENDIX H:
AMS MISSION SCIENTIST CHECKLIST

The following checklist should be considered as the minimum requirements for this position. *Note that some of the tasks are one-time actions; others are ongoing or repetitive for the duration of the incident.*

✓	Task
☐	1. Obtain briefing from Monitoring Manager or CMHT.
☐	2. Determine aircraft and support equipment needs and order, as necessary.
☐	3. Brief subordinate staff: • Incident and work objectives, schedules, mission requirements, priorities, time schedules, and process for briefings and debriefings. • Work site locations, status of aircraft and crews, and equipment assigned or ordered.
☐	4. Assign personnel to utilize skills and qualifications, and make adjustments, as needed.
☐	5. Establish line of authority and procedures for decision-making.
☐	6. Debrief personnel and pilots and make assignment and staffing adjustments, as necessary: • Identify safety issues and hazards, and mitigate them. • Determine aircraft status. • Identify pilot and aircraft mission capabilities. • Initiate system to monitor flight/duty hour limitations and ensure they are not exceeded.
☐	7. Collect and process incident reports, NARAC plots, points of contact: • Develop operations plan. • Complete deployment hazard analysis. • Adjust Incident Action Plan (IAP) and support needs of other sections.
☐	8. Inspect and visit areas of operation to ensure compliance with agency rules, regulations, and procedures.

Rev. 2/19

☐ 9. Provide for the safety and welfare of assigned personnel during the entire period of supervision:

- Recognize potentially hazardous situations (radiological and non-radiological).
- Inform subordinates of hazards and turn-back limits.
- Control positions and function of resources.
- Ensure that special precautions are taken when extraordinary hazards exist.
- Maintain work/rest guidelines.

☐ 10. Review data products and priorities for planning meeting (development of IAP):

- Confirm status and availability of aircraft and personnel for the next and future operational periods.

☐ 11. Participate in the planning and strategy meeting:

- Advise Monitoring Manager of capabilities and/or limitations to support the IAP.
- Determine mission priority.
- Identify start/stop times for IC/UC Aviation Operations Branch notification.
- Make assignments to carry out IAP.
- Identify mission parameters that meet the objectives of the IAP.

☐ 12. Determine what information Aviation Operations Branch needs to clear air space.

☐ 13. Coordinate with FRMAC Monitoring Unit, RNAC, and IC/UC Air Operations Branch:

- Ensure that a Temporary Flight Restriction has been initiated, if appropriate, and is in effect over the incident.
- Ensure that contact has been established with the military for special-use airspace.
- Provide current information on status of aircraft (type, tail number, FBO).
- Establish procedures for emergency reassignment of aircraft on the incident.
- Complete (or assist) ICS 220, “Air Operations Summary.”

☐ 14. Prepare demobilization schedule of aircraft, personnel, and equipment and coordinate with Monitoring Manager and Support Manager.

☐ 15. Document all activity on ICS 214, “Activity Log.”

Rev. 2/19

APPENDIX I:
FIELD TEAM SUPERVISOR CHECKLIST

The following checklist should be considered as the minimum requirements for this position. *Note that some of the tasks are one-time actions; others are ongoing or repetitive for the duration of the incident.*

✓	Task
☐	1. Obtain briefing from Monitoring Manager or Deputy: • Review the APM or ICS 201, "Incident Briefing," for incident status, if available. • Determine/confirm resources assigned to field monitoring teams, objectives, and preferred system of communication within the Monitoring Division management. • Determine necessary contingency plans. • Deliver rosters to Monitoring Manager or Deputy, if indicated.
☐	2. Organize and staff field teams, as appropriate: • Assign field team specialists. • Request other technical specialists or local escorts, as needed. • Ensure field teams have performed instrument operability checks. • Update RAMS with appropriate field team personnel and equipment. • Ensure field team tablets function properly with the MPCD and contain routes (by using the Consequence Management Center or other tool as necessary).
☐	3. Supervise field teams, as assigned (on very complex incidents, it may be necessary to assign a field team supervisor to oversee specific field teams): • Brief field team specialists on current incident status. • Assign analysis tasks. • Notify staff of timelines and format requirements. • Monitor progress. • Coordinate activities with other FRMAC Field Team Supervisors (FTSs), if applicable.
☐	4. Compile, maintain, and display incident status information for Monitoring Manager staff: • Review all data, according to Appendix C "Quality Assurance/Quality Control (QA/QC) Checklist for Monitoring," for completeness, accuracy, and relevancy in RAMS. • Sort data into required categories of information (i.e., geographic area, population, facilities, environmental values at risk, location of facilities). • Plot incident boundaries, perimeter locations, facilities, access routes, etc., on display maps in monitoring unit planning area, as necessary. • Develop additional displays (weather reports, incident status summaries, etc.), as necessary.

Rev. 2/19

☐ 5. Provide photographic services:

- Photographic services may be used to document operations and intelligence activities, public information activities, and accident investigations.
- Issue disposable or digital cameras to field team personnel, as necessary. CMRT tablets have built-in cameras.
- Ensure photographs are processed at the end of each operational period.

☐ 6. Provide situation evaluation, prediction, and analysis for monitoring manager; prepare information on alternative strategies:

- Review current and projected incident and resource status.
- Develop alternative strategies, as necessary.
- Identify resources required to implement current objectives and contingency plan.

☐ 7. Interview field team personnel coming off duty to determine effectiveness of strategy and tactics, work accomplished, and work remaining to be accomplished.

☐ 8. Request weather forecasts and spot weather forecasts, as necessary.

☐ 9. Participate in planning meetings, as required.

☐ 10. Document all activity on ICS 214, “Activity Log.”

Rev. 2/19

APPENDIX J:
FIELD MONITORING SPECIALIST CHECKLIST

The following checklist should be considered as the minimum requirements for this position. *Note that some of the tasks are one-time actions; others are ongoing or repetitive for the duration of the incident.*

✓	Task
☐	1. Obtain briefing from Field Team Supervisor (FTS)/Monitoring Manager and H&S Officer: • Identify Supervisor in organization. • Identify work location and maps, sampling routes and intervals, resources available, and expectations concerning timelines. • Confirm data units and instrument count times. • Obtain supplemental dosimetry and PPE, if required. • Attend pre-deployment and safety briefings. Confirm hold points, turn-back limits, and any non-radiological hazards. • Confirm locations of FRMAC vehicle, personnel, and sample control hotlines. • Confirm locations of traffic barricades and exclusion zone entry and exit points, if applicable. • Identify radioactive waste control procedures for used PPE and sample collection materials. • Confirm communication protocols for data transmission and for team status reports to FRMAC.
☐	2. Perform operations checks on instruments and ensure that the tablet and MPCD are functional before departing to the field.
☐	3. Participate in planning meetings, as requested.
☐	4. Provide technical expertise (timelines, instrumentation, etc.) to the FTS during the planning of field team instructions.
☐	5. Document the field team's activity on ICS 214, "Activity Log."

Rev. 1/18

This page intentionally left blank

APPENDIX K:
MONITORING DIVISION PERSONNEL QUALIFICATIONS AND RESPONSIBILITIES

POSITION	RESPONSIBILITIES	KNOWLEDGE AND SKILLS
Monitoring Manager	Reports to the FRMAC Director. Coordinates and directs FRMAC personnel, including those of the DOE, EPA, state, and participating federal agencies. Involved in aerial surveys and radiological monitoring, field monitoring, sampling, radioanalysis (mobile and fixed laboratory), and data control. Evaluates the need for field monitoring, environmental sampling, and radioanalytical data.	Detailed knowledge, expertise, and proficiency with all phases of radiological monitoring techniques, health physics instrumentation, and environmental sampling methodologies. Demonstrated ability to manage an emergency response field monitoring mission in stressful, urgent situations.
Deputy Monitoring Manager	As an assistant/alternate to the Monitoring Manager, coordinates and directs all CM/FRMAC activities. Involved in aerial radiological monitoring, field monitoring, sampling, and radioanalysis (mobile and fixed laboratories). Identifies equipment, personnel, and resource requirements and coordinates their availability.	Same as Monitoring Manager.
Field Team Supervisor	Works under the CM/FRMAC Monitoring Manager. Coordinates and directs all Field Monitoring teams. Organizes the field teams, assigns tasks, and evaluates field monitoring resources and requests for field monitoring requests and priorities. Responsible for maintaining all calibration, maintenance, and Quality Control documentation.	Knowledge, expertise, and proficiency with all phases of radiological monitoring, environmental sampling, and radioanalytical methodologies. Knowledge of sample control/hotline sample receipt methods and procedures.
Field Monitoring Specialist	Executes radiological field monitoring and environmental sampling duties according to established and documented CM/FRMAC methodologies in a safe, consistent, efficient and timely manner. Is responsible for performing Quality Control response checks on instrumentation. May provide training to local responders in field monitoring, sampling, and/or contamination control procedures.	Knowledge and expertise with broad spectrum of radiological instrumentation including alpha/beta contamination, gamma exposure rate, and gamma spectrometers. Experience in collecting environmental samples. Experience in radiological contamination control and decontamination procedures.
AMS Mission Manager/Scientist	Works under the CM/FRMAC Monitoring Manager. Coordinates and directs the fixed-wing and helicopter aerial survey missions. Ensures the initial data analysis quality and submittal. Assists in producing the aerial data survey maps with GIS and Assessment personnel.	Knowledge, expertise, and proficiency with all phases of the aerial survey missions. Ability to evaluate potential hazards during aerial missions to ensure the safety of the flight crew and aircraft with concurrence of the pilot-in-command.