

**FEDERAL RADIOLOGICAL
MONITORING AND ASSESSMENT CENTER**

**Monitoring Manual
Volume 1
Monitoring Group Operations**

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PREFACE

In Homeland Security Presidential Directive (HSPD)-5, the President directed the development of a new National Response Plan (NRP) to align Federal coordination structures, capabilities, and resources into a unified, all-discipline, all-hazards approach to domestic incident management.

The NRP is built on the template of the National Incident Management System (NIMS), which provides a consistent doctrinal framework for incident management at all jurisdictional levels, regardless of the cause, size, or complexity of the incident. The activation of the NRP and its coordinating structures and protocols—either partially or fully—for specific Incidents of National Significance provides mechanisms for the coordination and implementation of a wide variety of incident management and emergency assistance activities. Included in these activities are Federal support to state, local, and tribal authorities; interaction with nongovernmental, private donor, and private-sector organizations; and the coordinated, direct exercise of Federal authorities, when appropriate.

The Nuclear / Radiological Incident Annex to the NRP addresses the response of Federal agencies to terrorist incidents involving nuclear or radioactive materials (Incidents of National Significance), and accidents or incidents involving such material that may or may not rise to the level of an Incident of National Significance.

In the event of a potential or existing major radiological incident, the U.S. Department of Energy's National Nuclear Security Administration Nevada Site Office (NNSA/NSO) has been charged with establishing and managing the Federal Radiological Monitoring and Assessment Center (FRMAC). The FRMAC provides coordinated federal assistance in the off-site areas to the impacted state(s) and the Coordinating Agency responsible for regulation and/or operation of the accident site.

This manual was written for those personnel who will be called upon to provide technical data, input, and decisions. Overall, this manual provides general guidance and some specific diagrams and forms. However, it is understood that site and event specific operational decisions and procedure parameters will need to be established and documented at the time of an emergency event. It is also understood that FRMAC Monitoring Division activities may be operating in an integrated or coordinated environment with other agencies and jurisdictions, including state or local agencies. This manual is intended to provide enough guidance for stand-alone use without limiting FRMAC's ability to integrate the work with other partners or stakeholders. Note that the some of the titles of management positions within the FRMAC have been changed in order to comply with the structure of the Incident Command System (ICS) under NIMS.

The NNSA/NSO has the overall responsibility for maintaining the master copy of all FRMAC manuals. Please provide comments on this manual to:

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ACKNOWLEDGEMENTS

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

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ACRONYM LIST

AGL	Above Ground Level
ALARA	As Low as Reasonably Achievable
AMS	Aerial Measuring System
Anti-C	Anti-contamination
APM	Advance Party Meeting
CA	Coordinating Agency
CM	Consequence Management
CM/FRMAC	Consequence Management/FRMAC Response
CMO	Consequence Management Official
CMRT	Consequence Management Response Team
CMRT I	Consequence Management Response Team Phase I
CMRT II	Consequence Management Response Team Phase II
DHS	U.S. Department of Homeland Security
DOE	U.S. Department of Energy
DQO	Data Quality Objective
EPA	U. S. Environmental Protection Agency
ERDS	Emergency Response Data System
ES&H	Environmental Safety and Health
FBI	Federal Bureau of Investigation
FEMA	Federal Emergency Management Agency
FRMAC	Federal Radiological Monitoring and Assessment Center
GPS	Global positioning system
HSOC	Homeland Security Operations Center
JFO	Joint Field Office
LN	Liquid nitrogen
MDA	Minimum Detectable Activity
MDC	Minimum Detectable Concentration
NARAC	National Atmospheric Release Advisory Center
NNSA	National Nuclear Security Administration
NRP	National Response Plan

NRC	U.S. Nuclear Regulatory Commission
NSO	Nevada Site Office
PAG	Protection Action Guide(s)
PFO	Principle Federal Official
PPE	Personal Protective Equipment
QA	Quality Assurance
QC	Quality Control
RAP	Radiological Assistance Program
RSL	Remote Sensing Laboratory
SEO	Senior Energy Official
TLD	Thermoluminescent Dosimeter
TOC	Technical Operations Center

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1.0 INTRODUCTION

The Monitoring group coordinates and directs:

- Aerial measurements to delineate the footprint of radioactive contaminants that have been released into the environment,
- Monitoring of radiation levels in the environment,
- Sampling to determine the extent of contaminate deposition in soil, water, air and on vegetation by radioactive contaminants,
- Sample analyses to quantify soil concentrations or depositions; and
- Environmental and personal dosimetry, during a Consequence Management Response Team (CMRT) and Federal Radiological Monitoring and Assessment Center (FRMAC) response.

The Monitoring Manager works closely with the FRMAC Operations Manager and the Assessment Manager to determine the need for field measurements, sampling and radio analyses. The Monitoring group's operations are then prioritized accordingly. The Monitoring Manager is responsible for ensuring that the quality of radiation measurements, environmental samples, and results from analyses is acceptable so that judicious and scientifically defensible decisions can be made 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 coordination to minimize duplication of efforts and assuring compatibility of results if these entities choose to conduct separate operations.

Monitoring and sampling techniques used during Consequence Management (CM) / FRMAC operation 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, space vehicle reentries, or contamination from a radiological dispersal device.

Figure 1 shows the organization of the FRMAC Monitoring group. Complete FRMAC organization charts are available in the *FRMAC Operations Manual*.

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

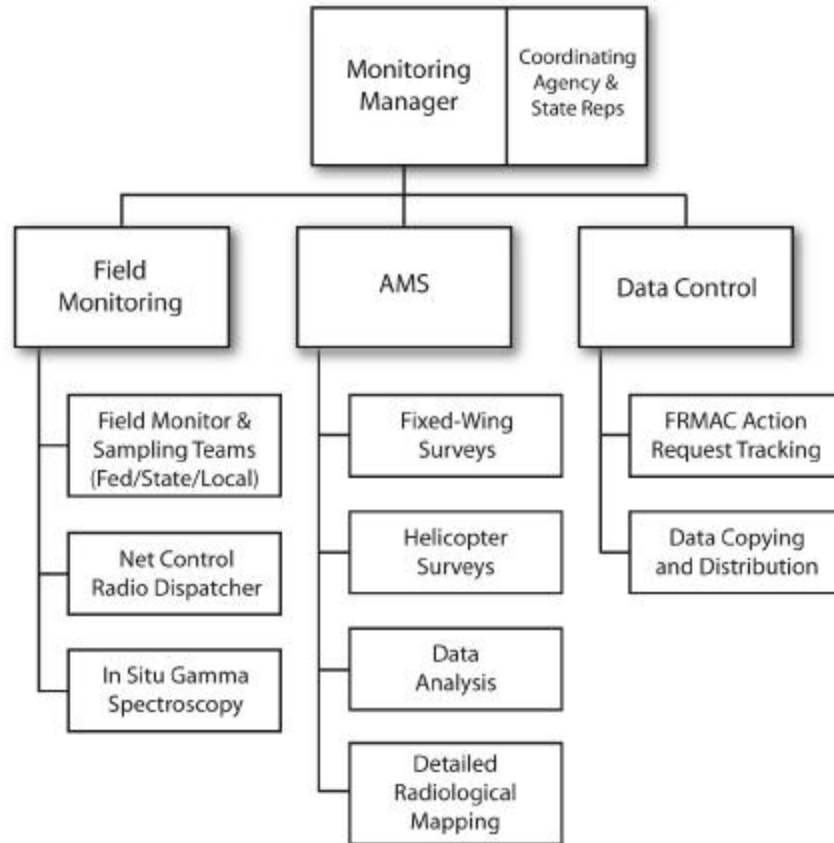


FIGURE 1. ORGANIZATION OF THE FRMAC MONITORING GROUP

2.0 INITIAL MONITORING ACTIVITIES

To allow quicker field team deployment, the initial team deployments will be handled by the Field Team Leader while the Monitoring Manager is participating in the Advance Party Meeting (APM) or coordination activities. To best implement this plan the Monitoring Manager and Field Team Leader should travel together and use the National Atmospheric Release Advisory Center (NARAC) plots and other available data to preplan field monitoring and sampling routes for use upon arrival.

The teams will receive a safety briefing containing default turn back limits and other key related topics. The Field Team Leader will brief the teams on all available information about the release and then inform each team about their route assignments and activities.

The plan is to survey for alpha, beta, and gamma radiation and to use one survey site to collect a re-suspension sample to allow the assessment personnel to work from real data instead of default levels. At this re-suspension site the team will take alpha, beta, and gamma surveys and collect an in-situ spectrum (if possible), a high volume air sample (normally one hour), and a soil sample.

Once the Monitoring Manager returns from the APM, the Monitoring and Sampling Plan, the Implementation Plan, and new field team routes are developed. The deployed field teams will be recalled if necessary or the next shift will work from these approved plans and routes.

3.0 ADVANCE PARTY MEETING

The APM is extremely important, not only because it initiates large-scale response activities to characterize the extent of the radiation in the offsite area, but also because it sets the tone for interaction between the various response agencies. Whether it is decided to integrate resources or coordinate activities, it is important to open effective lines of communication and to understand the needs of all the agencies involved to allow a relationship of cooperation to be established early.

The APM should take place as soon as practical upon arrival at the response scene. The FRMAC Director, Operations Manager and other technical resource specialists such as the Assessment Manager, Monitoring Manager, possibly the Health and Safety Manager, a representative from local response organizations, the Coordinating Agency and the deployed RAP Team Leader meet at the APM. The Monitoring Manager participates in the APM, establishes communication with the various Federal, state and local response organizations, and assists in setting sampling and monitoring priorities and strategy for responding to the radiological event. Although every event is different, data from the same kinds of measurements are used to resolve issues; for example, dose and exposure rates, etc. Appendix A contains a checklist to be used by the Monitoring Manager to collect data helpful to developing the Monitoring and Sampling Plan.

3.1 Priorities and Activities

Following an event that releases radioactive material into the environment, the priorities generally focus on determining:

- The extent of the release;
- If the release has been terminated;
- If secondary processes are still dispersing the radioactive material out to a wider area;
- How the release is effecting the population;
- What areas have been evacuated;
- What areas are safe to transport people through; and
- How long before people sheltered-in-place can be relocated from a contaminated area.

Following the APM and considering all the priorities listed above as well as the answers to the questions addressed at the APM, the Monitoring and Sampling Plan will generally contain some or all of the following points or priorities:

- Access the footprint to determine the area of radiological concern;
- Access radioactive contamination run-off/deposition (movement of the material);
- Identify location of and characterize access control points;

- Identify contaminated areas from where people have not yet been evacuated;
- Perform surveys to determine if main transportation corridors can be reopened;
- Characterize drinking water sources/facilities; and
- Characterize food, drug, and agriculture facilities outside of the Emergency Planning Zone.

The FRMAC is there to assist the requesting agency and organization with characterizing the event and providing the data needed to make recommendations to mitigate the circumstances. It is therefore important that the requirements of the customer be established at this meeting. In this meeting, there must be open discussion of the Coordinating Agency and state, local, and tribal concerns and their views regarding the highest initial priorities that need to be addressed in the Monitoring and Sampling Plan.

During the APM the following activities will take place:

- Identify the Coordinating Agency and state advisors to the Monitoring Division.
- Identify counterparts and liaisons.
- Determine the status of the radiological incident.
 1. Is a plume still being generated?
 2. Is there any information on the radiological constituents?
 3. What are the size and locations of exclusion zones around the incident?
 4. What is the location of first responders (e.g., RAP team, HAZMAT, etc.)?
- Identify the protective actions that have taken place or are taking place in the off-site area (the Monitoring Division requires a hard copy, including an illustrative map, especially for the evacuated and sheltered areas).
- Identify the ongoing monitoring and sampling activities that will be completed by the time FRMAC is operational (offsite and onsite).
 1. What analyses are the samples undergoing?
 2. What is the estimated time before sample analyses results will be available?
 3. Can FRMAC obtain copies of the monitoring and sampling data – when and how?
 4. What is the status of the fixed-wing AMS mission and data, if applicable?
- Identify and obtain adequate maps (for field teams and the Monitoring Division status map coordinator).
- Identify the location of pre-established state, local, and facility offsite monitoring locations.
- Identify local populated areas and critical facilities such as hospitals, nursing homes, and prisons.
- Identify locations of surface drinking water supplies and open-air water treatment facilities.
- Determine if state, local, and/or facility monitoring personnel will integrate their resources with the FRMAC:
 1. If they will not integrate with the FRMAC, determine who the state contact is for coordinating monitoring, sampling, and analytical activity.

2. If state, local, and/or facility monitoring personnel integrate with the FRMAC, determine allowable exposure levels and dose commitments. These values, which may be much different from FRMAC values, must be respected. This is also applicable to local individuals provided to drive monitoring vehicles.
 3. Ideally, a FRMAC monitoring team will be comprised of three members: one participant who is trained in FRMAC procedures and equipment, one participant who is familiar with radiological activities, and one participant who is familiar with the local area (that may or may not have technical training in radiological activities).
- Determine if, when, and how Federal first responders will be folded into the FRMAC. If earlier assigned duties take precedence over integrating with the FRMAC, all parties will still be contacted and updated on activities.
 1. RAP team (status and location).
 2. Fixed-wing AMS airplane (status and location).
 - Determine the transportation issues for CM/FRMAC monitors to travel in and out of evacuated areas in order to perform monitoring duties.
 1. Location of roadblocks/checkpoints.
 2. Authorizations or badges required for entry into areas, facilities, military bases, etc.
 3. Traffic flows and estimated travel times.
 - Identify local and/or facility personnel, familiar with the area, who are available to drive CM/FRMAC monitoring vehicles.
 - Prioritize the monitoring and sampling activities that have been requested by the various agencies.

3.2 Interaction with State, Local, Tribal, Other Federal Agencies

The Monitoring Manager will need to establish contacts with the first responders on the scene to learn the extent of surveys and monitoring activities that have been completed. These first responders may integrate with the FRMAC or continue separate but coordinated activities as the event unfolds. Other key contacts will be local law enforcement and/or state officials that may be needed to escort field teams to various offsite 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 communications to allow the coordination of activities among the groups. For example:

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

3.3 List of Integrated Priorities

There will be times, particularly in the early stages of the emergency response, when the need for information and assistance may exceed the FRMAC resources. Setting the priorities for monitoring and assessment will be directed by the needs of the Coordinating Agency and the state. Important considerations for the initial priorities will also be based on the actions taken thus far by onsite personnel or other local or regional first responders. General priorities to consider are:

- Assess the footprint to determine the area of radiological concern.
- Assess contamination run-off/deposition (movement of radioactive material).
- Identify location of and characterize access control points.
- Survey main transportation corridors to determine if they can be reopened.
- Identify areas that have not been evacuated but where early health effects are possible (e.g., 100 rem in four days).
- Identify areas that have not been evacuated, but where the Protective Action Guide (PAG) for evacuation may be exceeded (greater than 1 rem in four days)
- Determine the isotopic ratios following a deposition.
- Establish air sampling stations to measure resuspension and future plume releases.
- Monitor institutions, facilities, and/or residences located in the evacuated zone which were not evacuated or where people must reenter

3.4 Site Selection and Set-up

The CM Home Team and the CMRT I will coordinate with the local officials who will provide the most assistance in selecting a site or sites for the response. In most instances, a facility will be selected and setup ready to begin by the time the CMRT I team arrives with equipment. Much of the setup will be directed by the CMRT I Operations staff.

Important factors to consider when setting up are the placement of Monitoring group assets in the facility and the space needed to perform the work of the divisions. The table below reflects suggested area allocation for various functions of the group.

Table 1. Suggested Area Allocation for Various Functions

General floor space for FRMAC facility	10,000 ft ² to 20,000 ft ²
Field Team Activities	1500 ft ²
Activity Requirements	Floor Space
Forward Hotline	500 ft ²
Sample Storage and Supplies	500 ft ²
Sample Receipt	500 ft ²
Contaminated Vehicle Storage	250 ft ²
Status Map and Net Control	250 ft ²
Data Control	100 ft ²
LN, Equipment Storage, Setup	300 ft ²

In addition to the space requirements, adequate table, desk space, phone support, and power is needed. The Monitoring group should be near an exit (preferably a large dock area) near the parking area. This will allow outside resources to be near the group so field monitoring team preparation, sample receipt, hotline activities, and contaminated equipment storage can be addressed. An area to store and dispense liquid nitrogen (LN) will be needed to support the *in-situ* units. The LN area must have adequate ventilation.

Some of the outside resources such as sample receipt and the hotline will be set up by Monitoring group personnel provided to support the Health and Safety group. Set-up will be determined by the area available and will vary based on factors such as traffic/personnel flow, mobile lab placement, and other organizational needs.

4.0 DEVELOPING AND IMPLEMENTING THE MONITORING AND SAMPLING PLAN

Initial event information could come from several sources including AMS, NARAC, RAP, onsite monitoring resources, and other state/local teams already on scene. The Monitoring Manager must collect all of this information, work with all the parties present at the APM, and devise a plan for the situation. The plan will be based on the priorities agreed to with the Coordinating Agency, state, local, and tribal representatives.

The Monitoring and Sampling Plan is a generic plan that will provide a path for completing the priorities set down during the APM. The plan will list the equipment and generically describe the techniques that will be used to accomplish the priorities listed.

The Monitoring and Sampling Plan will outline the types of survey (e.g., contamination vs. exposure rate) and radiation types such as alpha, beta, gamma, and neutron. The plan will list the types of samples to be collected and a frequency for collecting those samples. Samples will be collected at pre-determined trigger levels based on the expected survey results that will be given by the Assessment Division.

The finalized, approved Monitoring and Sampling Plan will seldom change during the response unless conditions change drastically enough to cause a re-evaluation of the response. The Monitoring and Sampling Plan provides the guidance used to develop daily Implementation Plans that more precisely direct the monitoring and sampling group to characterize the radiological incident. These plans will include AMS flight operations. However, in many cases the first flight will be planned and approved by the CM Home Team and DOE/NNSA since the CMRT will probably be en-route as this planning takes place. Once the AMS assets arrive they will check in with the Monitoring Manager to be incorporated into future plans

The Operations Manager will direct which agencies have approval authority for the plan. At a minimum the Operations Manager and the Senior Energy Official (SEO) will approve the plan. If the response includes representatives from the Coordinating Agency, the state(s), or tribal representatives, they may be included in the plan approval.

4.1 Rationale of Methodology Based on Event

Factors to consider when developing the Monitoring and Sampling Plan are driven by the priorities set down during the APM and the resources available to the FRMAC. It is important to remember that resources become available in a phased manner to the FRMAC and that the priorities need to be addressed with those resources available.

To accomplish the priorities, the following strategies should be considered:

1. Monitoring Aircraft

- a. If aircraft are on-scene prior to plume release (helicopters plus fixed-wing aircraft), the following actions will be performed:
 - Maintain the fixed-wing aircraft in a readiness mode at a nearby airport.
 - To detect an unmonitored release, periodically fly a helicopter, at a safe distance, in a fixed, repeatable pattern above the incident site.
 - Upon detection of a significant plume release, replace the helicopter with the fixed-wing aircraft. The fixed-wing aircraft will be used as follows:
 - 1) Track the plume.
 - 2) Determine plume height, size, and direction.

This will be determined by the Consequence Management Official (CMO) on a case by case basis.
- b. By tracking the plume with aircraft, invaluable information is obtained for positioning monitoring personnel downwind and for identifying areas for possible initiation of protective actions.

2. Plume or Waterborne Releases

- a. If possible prior to plume release, place gamma monitors with telemetry, air samplers, and thermoluminescent dosimeters (TLDs) (all three at the same location) at representative locations between the fence line and populated areas. Emphasis should be given to the prevailing wind direction if it exists.
- b. Place gamma monitors, air samplers, and TLDs at representative populated areas.
- c. Based on information received from the monitoring aircraft and the meteorological conditions, deploy monitoring teams to travel roads in the vicinity of the incident site looking for the plume.
- d. 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 teams should proceed as follows:
 - 1) Notify the FRMAC when the plume is detected.
 - 2) Proceed through the plume until maximum radiation is detected (always being aware of radiation turn-back levels).
 - 3) Stop, exit the vehicle, and make beta/gamma open- and closed-window measurements at waist height and at ground level.

- 4) If the waist-high, open-beta-window measurement ($\beta+\gamma$) is significantly greater than the waist-high, closed-beta-window measurement (γ), the monitor is probably in the plume and should collect a 5-minute, high-volume air sample using a filter medium and a silver zeolite or similarly treated charcoal cartridge.
 - 5) Proceed through the plume noting when the plume is exited.
 - 6) In a background area, analyze the charcoal cartridge for the presence of radioiodines.
 - 7) Report the radioiodine results to the FRMAC.
- e. Teams monitoring water pathway should obtain appropriate and representative water samples. These samples should be obtained from streams, rivers, estuaries, bays, and other bodies of surface water.

3. Deposition

Identify isotopic mix and verify deposition models by taking appropriate radiation measurements using roadways and the monitoring aircraft to traverse the predicted footprint. The chosen roadways and flight paths should intersect a representative number of predicted radiation contours. Depending on the radiological release, if applicable, *in situ* gamma spectrometry systems are the preferred field-team instrument to be used with an exposure rate meter. Also as a rule of thumb, soil and vegetation samples should be collected at every order-of-magnitude change in measured radiation levels.

4. Deposition Measurements by Aircraft

Upon arriving at the location of a radiological emergency where deposition has occurred, the radiological monitoring aircraft will fly a serpentine pattern traversing the predominant plume footprint and a circle with a radius of 16 kilometers (10 miles) around the emergency site. The mission for this initial flight is to determine the following:

- a. Direction and approximate exposure rates along the deposition center line.
- b. Outline of contamination footprint.

Following the initial flight, detailed radioactive deposition mapping is performed. The flight plan is dependent on radiological conditions, weather, terrain, and priorities. Depending on the magnitude of the release, the size of the deposition footprint, and monitoring requirements, the aircraft's altitude and the distance between the parallel flight lines will vary. Normally, the helicopter flies at an approximate altitude of 46 meters (150 feet) and a speed of 36 meters per second (70 knots). Parallel flight lines are separated by approximately 76 meters (250 feet). Flying at an altitude of 46 meters (150 feet) provides a monitoring window on the ground of about 92 meters (300 feet) in width. In this manner, the helicopter can map the ground deposition at a rate of approximately 10 square kilometers per hour (4 square miles per hour). Products available from aerial mapping include:

- Isodose and exposure contours calculated to 1 meter (3 feet) above the ground.
- Soil deposition determinations of specific radionuclides.
- Total activity inventories of radionuclides of interest.
- Gamma-ray energy spectra.

The monitoring aircraft provides a very rapid and exhaustive method for radiologically mapping an area, and it should be used to complement the monitoring performed by field teams. In concert with the principle of as low as reasonably achievable (ALARA), the aircraft should be utilized instead of ground field teams for monitoring in the more highly contaminated areas. Also, the aircraft can be used to monitor where road access is limited. Sufficient overlap between the monitoring aircraft and the field monitoring activities provides comparability of the radiological data.

5. Monitoring Where People Reside

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. Continue monitoring for 360 degrees. 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 windrose. The following types of facilities usually have electrical power available and are “good” 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.

6. Monitoring Institutions, Facilities, and Residences Located in the Evacuated Areas Which Were Not Evacuated or Where People Must Reenter in the Near Future

The monitoring of these areas must be coordinated with state and/or local officials. When approaching non-evacuated residences, monitoring teams should be accompanied by local uniformed police or firemen. It is necessary to monitor the exteriors of the structures as well as the interiors. Interior monitoring will include the acquisition of swipes from representative surfaces. Environmental TLDs should be placed inside and outside of each occupied structure. Representative individuals at each location should be assigned a TLD to wear. 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.

7. Characterization

For monitoring and sampling activities, the Monitoring group will use the U.S. Nuclear Regulatory Commission (NRC) sector divisions of the off-site area (16–22.5-degree sectors). If the FRMAC response is to other than an NRC-related incident, the Monitoring

group can create 22.5-degree sector/distance maps oriented about the incident site by using FRMAC geographical information system capabilities. To characterize the area and to identify hot spots, at least one monitoring team should be assigned to each sector. If practical, monitoring activities should be initiated at a distance well beyond the deposition footprint and moved in toward the incident center. As the monitoring progresses, a serpentine pattern will be followed throughout the sector as closely 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 at each order-of-magnitude change in the radiation field measurements or 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.

8. Drinking Water

In coordination with state and/or local officials, drinking water samples should be collected from surface supplies and open-air water treatment facilities located in the affected areas.

9. 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. 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 group resources (contamination is ensured because of their location and, therefore, their products are not immediately marketable).
- Farms outside of the deposition footprint will be monitored in order of the perishability of crops.
- Milk, food, and animal feed processing facilities outside the evacuated area will be monitored and sampled in order of their “importance.”

The Monitoring and Sampling Plan must be written to address the response elements required to meet the priorities established at the APM. Always plan for what is needed for the response, not what assets might be available. Think of the resources as unlimited since this plan will guide actions throughout the response as more and more resource do become available. An example Monitoring and Sampling Plan is included as Appendix B.

4.2 Develop Daily Implementation Plan

Once the Monitoring and Sampling Plan is completed and approved, a plan must be devised to implement it. The Implementation Plan is completed daily and describes in greater detail the techniques and resources that will be used to characterize the event. The Implementation Plan will address each of the priorities and the techniques listed and explain how the Monitoring Division will complete the task.

Many things will affect the daily plan and change the response. New priorities may be introduced based on survey data that is collected during the previous day's activities. Various agencies will refine their requests for information or priorities will shift due to public concerns and the Implementation Plan needs to be flexible enough to accommodate those shifting priorities. An example Implementation Plan is included as Appendix C.

4.3 Interaction with AMS

One emergency response asset available to the Monitoring Manager is the use of AMS aircraft to perform flyover surveys of the event site. AMS has both fixed wing and helicopter mounted survey equipment that can fly over a deposition site at various distances to determine ground deposition area and levels. Often AMS will be requested very early in a response and may have already acquired data that will be beneficial to the Monitoring group. The AMS group will often write, review, and get approval for the initial mission plan at the Remote Sensing Laboratory (RSL) located on Nellis Air Force Base, Las Vegas, Nevada, and Andrews Air Force Base in Maryland. Subsequent mission plans will be developed by the FRMAC AMS scientist before review and approval by the Monitoring Manager and Health and Safety Manager. The mission plans can then be incorporated into the Implementation Plan.

4.4 Specify Monitoring and Sampling Activities

The Implementation Plan will be the guide for selecting monitoring team makeup and provide guidance for performing the actual monitoring and sampling to the teams. The plan 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.

The plan will specify where and when samples will be collected, the duration of air samples, and the location of environmental thermoluminescent dosimeter (TLD) placement. The plan will outline the equipment requirements for the teams and the support that will be provided to the other sections of the FRMAC such as Sample Receipt and Health and Safety support.

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 further away. One major reason for the close spacing is to reduce the chance of the team missing a turn-back level and receiving a higher than necessary dose. Another reason is the possibility of missing 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.

Initially surveys should be structured to cover all types of radiation. Even in a known event there may be surprises, especially in the early phase of an event. It is better to document some negative data than to rush into an unexpected hazard. Once the initial surveys prove the absence of a type of radioactive constituent such as alpha emitters, modify the Implementation Plan to address the actual hazards. Remember many first responders have been issued gamma exposure rate instruments only. They may not be capable of surveying for alpha/beta contamination.

In the first hours of the response, the emphasis will be on establishing the type and amount of radioactive contamination in the area and 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 event release. These will include NARAC plots and AMS fly over 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 verify the NARAC models to define the edges of the deposition and to begin define evacuation routes or shelter-in-place locations for the public. Additionally routes will be developed that collect air, soil, water, and vegetation samples at locations throughout the affected area.

As part of the Implementation Plan, personnel and resources may be assigned that do not perform monitoring and sampling duties. Personnel may be assigned to support the Health and Safety Division by setting up a hotline at the facility or to staff check points in the field. Decontamination stations may be required at various locations and these would be managed by the Implementation Plan. Personnel may also be assigned to support the facility or the field teams as runners for sample recovery or to distribute needed supplies to the field.

Teams are dispatched with maps, equipment, and instructions on how to accomplish the tasks outlined in the plan. 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 Implementation Plan or prompt other agencies to request additional survey or monitoring information. The Monitoring Manager will be required to look at these evolving needs and incorporate them into the Implementation Plan.

The prescribed tool for other agencies to make requests to the Monitoring group is the FRMAC Action Request shown below in Figure 2. Action Requests are submitted to the FRMAC Operations Manager and prioritized for distribution to the appropriate division 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 Implementation Plan unless it can easily be incorporated into current activities or covered by a team that completes their planned activities. The Monitoring Manager must look at the request and see how it can be rolled into the current Implementation Plan and redirect the resources necessary to do that.

FRMAC ACTION REQUEST	
Reference No. _____	
Reported By: _____	Priority _____
Organization _____	1. Emergency
Name _____	2. Urgent
Date _____ Time _____	3. Routine
	Authorization _____
NATURE OF REQUEST <i>(usually handwritten)</i>	
<i>DO NOT WRITE BELOW THIS LINE — FOR FRMAC USE ONLY</i>	
FRMAC Response Action Group(s) _____	FRMAC Priority _____
Organization _____	1. Emergency
Name _____	2. Urgent
Date _____ Time _____	3. Routine
	Authorization _____
REPLY/RESOLUTION	
Distribution: _____	For Tracking Use Only
	Received By _____
	Date/Time _____
<small>Goldenrod (Originator) Pink (File) Green (Response Group) Yellow (Originator Retain) White (FRMAC Retention)</small>	

FIGURE 2 FRMAC ACTION REQUEST

4.4.1 Sampling Frequency

1. Air Sampling

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

2. TLDs

The lower levels of detection for personnel and area TLDs are approximately 10 mrem and 10 mRad, respectively. The TLDs should be deployed for a sufficient length of time so that meaningful data that meet FRMAC objectives are produced.

3. 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 approximately three 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. 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. Water Sampling

Community surface drinking water supplies and open-air water treatment facilities located within the deposition footprint should be sampled following passage of the plume and re-sampled daily. Daily sampling should continue until usability of the water is determined (i.e., does it meet drinking water standards or is it a non-flowing body of water sufficiently contaminated that it cannot be used as a drinking water supply for some period of time). Community surface drinking water supplies located outside of the deposition footprint but in the proximity should be sampled daily for a minimum of three days or until acceptable levels are achieved. Sediment samples will be collected from surface drinking water supplies located within the deposition footprint and re-sampled as required.

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.

4.4.2 Modify the Daily Implementation Plan

The Implementation Plan is a fluid document and will change almost daily. As field teams complete or expand surveys in one area or additional requirements are placed on the division the plan will change. A new Implementation Plan is completed for each day's activities. Each new plan will still be guided by the original Monitoring and Sampling Plan but will include the new information gathered, the new requests made, modify the survey routes, and redirect resources as needed to complete the mission. As each plan is modified, reports will be generated for the FRMAC Operations Manager explaining the tasks that have been completed, what is still incomplete, and what priorities are being established for the incomplete tasks.

4.5 Field Team Development and Coordination

Actual deployment of personnel and resources will be dependent on the severity of the event. During a CMRT I deployment only ten 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.

One of those ten technicians functions as the Field Team Leader. He/she 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. He/she also ensures that paperwork is complete and given to the Emergency Response Data Systems (ERDS) group prior to deployment.

With additional resources, more teams become available. If arrangements were made during the APM, state, local, and regional personnel should be available to the Monitoring Division. As stated earlier a three person team is considered ideal with one member from DOE/NNSA, one from RAP or another organization with technically trained personnel, and one local person who knows the area. Two person teams are capable of completing assigned tasks but could be hampered by trying to navigate through new areas, watch the road for hazards, and keep an eye on instrumentation when in or near the plume 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. A listing of Monitoring Team positions and the required knowledge and skills is presented in Appendix D. Also, it is important to remember that different organizations may have different as low as is reasonably achievable (ALARA) 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 home organization would need to grant approval or a different team will be used to complete the task.

In a CMRT II deployment, a team will typically consist of the following personnel:

- Field Team Leader
- Team Member/Information Recorder
- Navigator/Escort (local, state, or tribal representative)
- In-situ operator, if required

An advantage to mixing local and regional personnel on a FRMAC team is to have a local person that is familiar with the area assist to save valuable time. Also many regions of the country use different instrumentation and sometimes slightly different terminology to perform surveys and having a mix of people will aid in communication.

If the event of a CMRT III response, additional field monitoring personnel will deploy from the national laboratories and RAP regions to the incident site bringing their own equipment.

4.6 Equipment and Logistics

Equipment for the FRMAC is also deployed in three phases. The table in Appendix E lists the instrumentation and personal protective equipment (PPE) that is available in each phase. All of this equipment is inspected, maintained, and calibrated on a regular basis. All equipment will arrive ready for immediate use.

An important consideration is that other agencies may also be responding to the radiological emergency and would be incorporated into the FRMAC. Due to 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 as quickly as reasonable.

The Logistics and Support section of the FRMAC will make vehicle arrangements for the field teams. When possible these vehicles will be SUVs (sports utility vehicles) or vans to accommodate the field teams' equipment. Each team will consist of a minimum of two members plus equipment, but may include additional members such as an *in-situ* team. The vehicle should be configured to minimize the spread of contamination by covering the seats and floorboards with plastic. The back 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 Field Team Leader will need to ensure that the teams have checked out this equipment for proper operation and logged all the equipment on the appropriate forms so that the data they transmit back can be matched to the teams and the equipment they are using.

Field teams will need maps of the area to complete their mission. Try to secure as many maps as are available in the local area upon landing. Local airports and car rental agencies would be a good source for securing local maps. These local maps will be used plot routes for the teams and to track the progress of teams back at the Technical Operations Center (TOC). Additionally predictive maps of plume deposition should be available prior to sending out field teams. When available, these maps need to be given to the teams since one of the primary missions is to verify the legitimacy of the predictive model.

As the event progresses additional maps will be created from the data collected by the FRMAC. These maps, as well as maps that list roadblocks, check points, decontamination stations, and

evacuated areas may all be helpful to various teams in the field and should be given to field teams when practical.

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 group with a brief explanation of the form's use. Instructions for completing the forms are included on the back of each form and also in Volume II of the Monitoring and Sampling Manual.

- Team, Instrument, and Equipment Information Log: Used to collect team information such as personnel assignments, instrumentation, radios, ground positioning system (GPS), and vehicles used by Field Teams.
- Field Monitoring Log: Used by Field Teams to record data collected in the field.
- 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.
- FRMAC Action Request: Used by all agencies to make requests of the FRMAC for tasks.
- Local Area Monitoring TLDs: Used to record pertinent information of Environmental TLDs used in the field.
- Data Acquisition Log: Used by Net Control to record data called in by Field Teams. This form matches the Field Monitoring Log

5.0 FIELD TEAM BRIEFINGS

Field teams will be briefed on a daily basis prior to the start of work. A representative of the Health and Safety Division will conduct part of the briefing. The Monitoring Manager or Field Monitoring Leader will complete the briefing, and all field team personnel for each shift are required to attend. The type of information to be included in the briefing follows.

5.1 Health and Safety

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
- Monitoring in vehicles

- Personnel surveys
- *In situ* measurements

5.1.1 Conditions of the deployment location

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

Existing radiological, chemical, biological, or other hazards need to be communicated to monitoring teams. It allows them to be prepared for encountering any expected or possible circumstances such as:

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

5.1.2 Personal Protective Equipment (PPE)

Field teams will be briefed on PPE requirements prior to potential exposure. Teams will be briefed on the PPE to be used for each hazard, as well as when to don and doff PPE, such as anti-contamination (anti-C) clothing and/or respiratory protection. Appendix E contains a listing of potential PPE that could be used.

5.1.3 Dosimetry

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

- Whole body dosimetry
- Supplemental dosimetry
- Neutron dosimetry
- Extremity dosimetry
- Bioassay
- Personal air sampling

5.1.4 Special Hazard Mitigation Requirements

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, etc.). Traffic conditions and roads to be avoided based on traffic, climate, hazardous and/or radiological conditions should also be noted.

5.1.5 Hold points/turn-around points

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

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

5.1.6 Emergency Procedures

All personnel need to be made aware of emergency response procedures. This includes general reporting of fires or accidents and any unusual activities. Monitoring teams also need to understand proper handling of contaminated victims or materials.

5.1.7 Debriefing

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

5.2 Monitoring Group

Event Information: This will cover the status of the event such as duration and type of release, radioactive constituents if known, and data gathered by on-site or first responders.

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 event (contamination control, sample methods, changes, etc.).

Communication Protocols: The devices, protocols, and frequency for relaying data back to the TOC.

Public Affairs Information: What and how to communicate with the general public concerning the functions they are performing in the field, and who the public can contact for further information.

5.3 Interactions Within the FRMAC

The Monitoring Manager must work closely with the Health and Safety Manager to share information, personnel, and resources. The Health and Safety group is responsible for:

- The operation of the Hotline.
- FRMAC facility surveys.
- Assistance with Health and Safety at Check Points.
- Population assembly areas which require FRMAC assistance.

The Monitoring group provides the technicians to operate these resources. When team members are selected for tasks some will be assigned to support the Health and Safety group.

All the logistical needs of the Monitoring group should be handled through the FRMAC chain of command. Communications, vehicles, and facilities are all handled by the Support Manager.

The Health and Safety group provides for the safety and security of the field teams, so it is important they be kept up to date on information gathered in the field in order to make informed decisions. The Health and Safety Manager may come directly to the Monitoring Manager for specific clarification of data turned into the FRMAC or to request additional personnel and resources to fulfill its mission.

The Assessment group uses the data collected in the field to plot potential PAG level boundaries and to provide decision makers and the Advisory Team information needed to make recommendations. The Assessment group is also responsible for providing the Monitoring group with requests for the types of surveys and samples they require. As with all data collected in the field it is first reviewed by the Monitoring Manager and then handed over to Data Control for dissemination to the rest of the FRMAC. Data Control will make copies of all data, file it, and provide the Monitoring Division copies for working up new routes and plans.

The Monitoring Manager will also be required to provide situation reports to the Operations Manager during the response. The report will typically include status of monitoring activities.

The quality of the data used as a basis for protective actions is of paramount importance. The resources devoted to quality assurance depend largely on the stage of the emergency. In the early stages of a radiological emergency when the impact on public health and safety is not well defined, the number of FRMAC resources devoted to quality assurance will be sufficient to ensure that data of acceptable quality is available in a timely manner. As the emergency stabilizes, the resources dedicated to quality assurance will increase to approximately 20 percent.

5.3.1 Federal Roles

The Coordinating Agency is the federal agency that owns, authorizes, and regulates the facility or material, or is otherwise deemed responsible for the facility or radiological activity causing the emergency and has authority to take on-site action. When it is necessary for a federal agency to assume the Coordinating Agency role and to deploy to the site, the Coordinating Agency will manage federal actions on-site; assist in developing, evaluating, or recommending off-site protective actions to be taken by the state(s) based on federal PAGs; provide advise on issues such as reentry; and help implement those actions if requested by the state(s).

Role of U.S. Department of Homeland Security (DHS)

The National Response Plan (NRP) established the Homeland Security Operations Center (HSOC) at DHS headquarters to integrate and provide overall steady-state threat monitoring and situational awareness for domestic incident management on a 24/7 basis. It also mandates a Principle Federal Official (PFO) represent the DHS secretary at the incident. The NRP identifies what federal entities will be integrated into a Joint Field Office (JFO) whenever possible. The NRP replaces the Federal Response Plan (FRP) and the Federal Radiological Emergency Response Plan (FRERP).

Role of the Federal Emergency Management Agency (FEMA)

FEMA's primary responsibilities in Federal emergency response are to immediately notify participating Federal agencies and to serve as a focal point for coordinating the Federal, non-radiological, response activities at the national level and at the emergency site.

Role of the U.S. Department of Energy (DOE)

Because the DOE transports nuclear materials and operates national laboratories and facilities, the DOE is the Coordinating Agency for radiological emergencies involving DOE-owned nuclear materials. In addition, the DOE would provide direct assistance and advice to the DoD for the Federal Bureau of Investigation (FBI), if requested regarding certain on-site activities.

Role of the Environmental Protection Agency (EPA)

The EPA shares the major responsibility with DOE for managing Federal resources provided for off-site, radiological monitoring, and assessment activities associated with the FRMAC. Initially, EPA assists DOE during the emergency phase and then assumes responsibility for managing the FRMAC during the intermediate and recovery phases.

5.3.2 Transfer of FRMAC to EPA

The immediate emergency condition must be stabilized and:

- Offsite releases of radioactive material have ceased, and there is little or no potential for further unintentional offsite releases

- The offsite radiological conditions have been characterized and the immediate consequences have been assessed
- An initial long-range Monitoring and Sampling Plan has been developed in conjunction with the affected States and appropriate Federal agencies and,
- EPA has received adequate assurances from the other federal agencies that they will commit the required resources, personnel, and funds for the duration of the federal response.

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APPENDIX A

FRMAC MONITORING MANAGER CHECKLIST

Federal Radiological Monitoring and Assessment Center (FRMAC) Monitoring Manager Checklist

Status of Emergency

1. Type of event: _____
 - a. Time? _____
 - b. Duration? _____
 - c. What is estimated source term(s)? _____
 - d. What are dominant isotopes? _____
 - e. What was the meteorology during each release? _____
 - Wind speed and direction: _____
 - Precipitation: _____
 - Stability class: _____
2. What actions have been taken to stop and/or mitigate the release(s)? _____
3. Is the situation stable? _____

4. Are current problems likely to affect areas outside of the exclusion zone? _____
 - a. How? _____
 - b. When? _____
5. Status of Emergency Operations Centers (state, local government) _____

Ongoing Emergency Response Activities

1. What protective actions have been taken and/or are pending?
 - a. Estimate of population directly effected. _____
 - b. Evacuations in progress/ordered. _____
 - c. Shelter locations. _____
 - d. Location of decontamination facilities. _____
 - e. Status of hospitals. _____

2. Are the protective action guides in use the same as those for U.S. Environmental Protection Agency/U.S. Department of Agriculture/U.S. Food and Drug Administration? _____
3. Are maps delineating the protective actions available? _____
4. Are atmospheric prediction plots available? _____ Types? _____
5. What is the current status of monitoring and sampling activities? _____
6. Is any radio analytical data available? _____
7. What monitoring/sampling results are available? _____
8. Identify un-evacuated local special needs populations such as hospitals, nursing homes, and prisons. _____
9. Identify institutions, facilities, and residences located in the evacuated areas which were not evacuated or must be re-entered. _____
10. Identify locations of surface drinking water supplies and open-air treatment facilities. _____

Establishment of Communications and Liaisons

1. Identify:
 - a. Primary state radiological decision-maker _____
 - b. State/local advisor(s): _____
 - Monitoring _____
 - Health and Safety _____
 - Assessment _____
2. Are federal responders operating prior to an operational FRMAC (i.e., RAP) to be integrated into the FRMAC? _____
 - a. When? _____
 - b. How? _____
 - c. Who is the contact? _____

- 3. Are local personnel available to drive monitoring vehicles? _____
- 4. What procedures are in place to allow FRMAC vehicle and personnel to pass through road blocks? _____

Integration of Response

- 1. Will state/local personnel join the FRMAC? _____
 - a. If YES, identify state/local personnel radiation turn back levels and dose commitment limitations. _____
 - b. If NO, identify state/local contact for coordinating monitoring and analytical activities. _____
- 2. Identify state/Coordinating Agency/local personnel to aid in development of initial FRMAC Monitoring and Sampling Plan. _____
- 3. Identify state/local and Coordinating Agency personnel to work with FRMAC Dose Assessment. _____
- 4. Identify state/local and Coordinating Agency personnel to work with FRMAC Health and Safety. _____
- 5. Determine placement needs for liaison personnel _____

Integrated Priorities (prioritize state, county, and local concerns)

Potential Priorities (for consideration during planning)

Assess the footprint to determine the area of radiological concern.

- Determine re-suspension factors
- After deposition, determine isotopic ratios
- Identify hot spots
- Establish air sampling stations to measure re-suspension and future plume releases
- Provide a measure of the validity for the dispersion models in use
- Identify location of and characterize access control points.

Perform surveys of special facilities (Hospitals, Nursing Homes, Prisons, Schools, Food, Drug, Agricultural, etc)

- Identify contaminated areas where people have not relocated and non-contaminated areas where the population can return.
- Identify areas that have not been evacuated, but where early health effects are possible (100 rem in four days; i.e., 1 rem/h).
- Identify areas that have not been evacuated, but where the federal protective action guide (PAG) for evacuation may be exceeded (greater than 1 rem in four days; i.e., without knowing isotopic ratios, 10mrem/h).
- Monitor close to evacuated areas where people are located.
- Provide monitoring data to allow decision makers to identify evacuated areas where the public can return.

Perform surveys to determine if the main transportation corridors can be reopened. (This includes highways, surface roads, railroads, water transport, etc.)

Sample surface drinking water supplies and open-air water treatment facilities.

- Assess contamination run-off/deposition (movement of radioactive material.)

Support reentry, cleanup, and mitigation activities

- Support monitoring and decontamination of Emergency Workers and Equipment
- Support monitoring and decontamination efforts for the population
- Support reentry efforts

APPENDIX B

MONITORING AND SAMPLING PLAN

Monitoring and Sampling Plan

Weapons Dispersal Accident

(Example from Dingo Dawn Exercise)

1. Assess the footprint to determine the area of radiological concern where EPA Protective Action Guidelines (PAGs) are exceeded. Measured activity levels of Am-241 will be used to assess the doses to the population.
 - a) Field teams will collect one hour high-volume air samples in order to determine resuspension factors over the long term. Resources will be concentrated on populated areas near the boundaries where PAGs could be exceeded (isopleth line). Accurate measurements of the resuspension factor will provide much better estimates of doses to the population over the long term (1 year or more). High-volume air sampling systems will be set up at a sampling rate of 10-40 cubic liters per minute (depending upon dust loading).
 - b) Based upon the calculated doses and anticipated time inside the contaminated area, it is not anticipated that face/breathing protection will be necessary of emergency worker activities. However, face/breathing protection is suggested for any extended remediation activities within highly contaminated areas.
 - c) Field teams will take ground deposition measurements using Violinist III systems and High Purity Germanium *in situ* spectrometers sensitive to plutonium and americium contamination. Field monitoring measurements of approximately 15 minute (900 seconds) duration are required in order to reach a Minimal Detectable Activity (MDA)s below 100 nCi/m² (Violinist III) and 30 nCi/m² (HPGe *in situ* system). Resources will be prioritized to provide ground-truth measurements for the aerial data, and to provide improved deposition data near the boundaries where the EPA PAGs may be exceeded. The *in situ* measurements will also be used to verify the assumed mix of the dispersed isotopes.
 - d) Field soil sampling measurements will be taken in the affected area in order to verify the deposition levels measured with the aerial and field monitoring equipment. Soil samples of 100 cm² will be collected in accordance with the FRMAC Monitoring and Sampling manual.
 - e) Rotary wing aerial measurement equipment will conduct aerial survey operations over the affected area to determine activity levels. Mission parameters will be 150 foot altitude above ground level (AGL) and a 250-foot line spacing at a speed of 70 knots. One helicopter and the associated aviation and technical personnel can be deployed to the incident site and can cover an area of approximately 20 square miles per day.

Initial surveying of the affected area will give a Minimum Detectable Activity (MDA) of approximately 100 nCi/m² which is sufficient for delineation of the area affected by the EPA PAGs.

2. Special request locations (i.e.; hospitals, nursing homes, Indian reservations, etc.) will be surveyed and characterized as needed. Violinist III, alpha probes, *in situ*, and air sampling will be used as appropriate to characterize these locations.
 - a) North Kitsap High School surveyed for contamination to allow potential use as a receiving center for evacuated personnel.
 - b) Survey the Navy Hospital and Harrison Hospital in Bremerton and Harbor View Hospital in Seattle and as necessary potentially contaminated personnel.
3. Identify location of, and characterize access control points. Based upon plume modeling and initial radiation monitoring data, the location of access control points will be determined. Radiation Control Technicians and Health Physicists will provide survey support at the control points. The intended location of the control points will be surveyed with alpha survey instrumentation (Nuclear Research Corporation Health Physics kits) to a level of 20 dpm/100 cm² (DOE release level).

MONITORING & SAMPLING MANAGER: _____

LOCAL CONCURRENCE: _____

STATE CONCURRENCE: _____

TRIBAL CONCURRENCE: _____

COORDINATING AGENCY CONCURRENCE: _____

FRMAC DIRECTOR CONCURRENCE: _____

SEO CONCURRENCE: _____

APPENDIX C

MONITORING AND SAMPLING IMPLEMENTATION PLAN

Monitoring and Sampling Implementation Plan

Weapons Dispersal Accident

(Example from Dingo Dawn Exercise)

Day 2 of Event

1. Assess the footprint to determine the area of radiological concern where EPA Protective Action Guidelines (PAGs) are exceeded. Measured activity levels of Am-241 will be used to assess the doses to the population.
 - a) Two teams will be assigned to transverse the plume to verify the ground deposition identified by the ARAC/SNL plots. One team will start at the Bangor Subbase boundary and the other will start in the area of the Port Madison Indian Reservation. These teams will take alpha probe measurements and 15-minute (900 second) Violinist III ground deposition measurements, which will provide a minimal detectable activity (MDA) below 100 nCi/m^2 .
 - b) A third team will start in the area of Poulsbo and will also take alpha probe measurements and 15-minute (900 second) Violinist III ground deposition measurements, which will provide MDAs below 100 nCi/m^2 . This team will be equipped with a High Purity Germanium *in situ* spectrometer, which will provide MDAs below 30 nCi/m^2 for 15-minute (900 second) measurements. One *in situ* measurement will be taken at approximately Sherman Hill Road and Viking Way NW if alpha probe measurements are above 300 dpm. The *in situ* measurement will be used to verify the assumed mix of the dispersed isotopes. In the area of Viking Way NW and Liberty Road, this team will establish an air sampling station and collect a one hour high-volume air sample (sampling rate of approx. 30 cubic liters per minute), complete ground surveys using an alpha probe and Violinist III, collect another *in situ* measurement, and collect a soil sample. This information will be used to determine resuspension factors.
 - c) Based upon the calculated doses and anticipated time inside the contaminated area, it is not anticipated that face/breathing protection will be necessary for emergency worker activities. However, face/breathing protection is suggested for any extended remediation activities within highly contaminated areas.
 - d) Rotary wing aerial measurement equipment will be deployed and conduct aerial survey operations over the affected area to determine activity levels starting at daylight.

Helo Survey

DAY 2 AM

Flight #1

Goal: First flight will under-sample the area, but should provide a good definition of deposition extent.

Reasoning: Based on width of ACRID Set 3 prediction, use 9-mile long lines => 10 minutes per line
2 ½ hour flight time => 30 lines
Want to cover approximately 20 miles from GZ
Use 5,000-foot line spacing

Flight parameters: 150 foot AGL
5,000-foot line spacing
Flight lines oriented North-South
Start at water's edge west of GZ
Lines are centered N-S on GZ
Stop when no land is under flight lines

Helo Survey

DAY 2 Noon

Flight #2

Goal: Begin detailed mapping of deposition

Flight Parameters: 150 foot AGL
250-foot line spacing
Flight lines oriented North-South
Start about 4 lines (1000 feet) west of GZ
Lines are centered N-S on GZ
Length of lines: 6 miles
Total number of lines flown => 20 lines
(about 1 mile along deposition)

Helo Survey

DAY 2 PM

Flight #3

Goal: Continue detailed mapping of deposition

Flight Parameters: Same as Flight #2, except that the length of lines will be determined from data analyzed from Flight #1

- e) Special request locations (i.e.; hospitals, nursing homes, Indian reservations, etc.) will be surveyed and characterized as needed. Violinist III, *in situ*, and air sampling will be used as appropriate to characterize these locations.
- f) A fourth team will survey North Kitsap High School for contamination to allow potential use as a receiving center for evacuated personnel. Violinist III and alpha probe measurements will be taken and a one hour high volume air sample collected.
- g) A fifth team will deploy to the Harbor View Hospital, Harrison Memorial Hospital, and Navy Hospitals in Bremerton and survey the facility and personnel, as necessary, for contamination. ADM 300 alpha probes will be used for personnel contamination surveys and appropriate Violinist III and alpha probe measurements taken to determine potential contamination levels of these facilities and associated parking areas and driveways.
- h) Identify location of, and characterize access control points for evacuating personnel and reentry. As a team becomes available it will be deployed to assess contamination at the access control points. Radiation Control Technicians and Health Physicists will provide survey support at the control points. The intended location of the control points will be surveyed with alpha survey instrumentation (Nuclear Research Corporation Health Physics kits) to a level of 20 dpm/100 cm² (DOE release level).

MONITORING & SAMPLING MANAGER: _____

LOCAL CONCURRENCE: _____

STATE CONCURRENCE: _____

TRIBAL CONCURRENCE: _____

COORDINATING AGENCY CONCURRENCE: _____

FRMAC DIRECTOR CONCURRENCE: _____

SEO CONCURRENCE: _____

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APPENDIX D

Monitoring Division Personnel Qualifications and Responsibilities

POSITION	RESPONSIBILITIES	KNOWLEDGE AND SKILLS
Monitoring Manager	Reports to the Operations Manager and will coordinate and direct 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. Evaluate 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 is involved in aerial radiological monitoring, field monitoring, sampling and radioanalysis (mobile and Institutional laboratories). Identifies equipment, personnel, and resource requirements and coordinates their availability.	Knowledge and proficiency with radiological monitoring techniques, Health Physic instrumentation and environmental sampling methodologies.
Documentation Specialist	Will document and track the status of all CM/FRMAC requests, priorities and activities for support including resources and data products. Will ensure that all documented activities, correspondence, situation reports, action requests, lesson learned, is archived in an accountable, secure and retrievable form.	Knowledge in the package and preparation of the CM/FRMAC equipment. Working knowledge and experience in CM/FRMAC missions, resources, capabilities, objectives, and operations.
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 Spectroscopy. Experience in radiological contamination control and decontamination procedures.

POSITION	RESPONSIBILITIES	KNOWLEDGE AND SKILLS
Field Team Leader	Works under the CM/FRMAC Monitoring Manager coordinates and directs all Field Monitoring Teams, Net Control and Status Map activities. Organizes the field teams, assigns tasks and evaluates field monitoring resources and requests for field monitoring request 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.
Aerial Measurements Scientist/Mission Scientist	Works under the CM/FRMAC Monitoring Manager. Coordinates and directs the fixed-wing and helicopter aerial survey missions. Performs the initial data analysis and 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.
In-situ Gamma Spectroscopy Scientist	Responsible for the overall in-situ gamma spectroscopy support that the Remote Sensing Laboratory provides for the deployed CM/FRMAC.	MS or Ph.D. in Nuclear Physics, Nuclear Engineering, Health Physics or equivalent experience.
Net Control Radio Dispatcher	Responsible for recording and documenting all monitoring and sampling data and information transmitted by the field monitoring teams via the two way radios system or telephones.	Knowledge of field monitoring procedure, techniques tasks, instrumentation, data produced and the units associated with the data

APPENDIX E

Monitoring, Health and Safety Instruments

Model Name	Description	Phase 1	Phase 2	Total
NRC KIT: ADM-300	Exposure Rate Meter - Part of NRC Kit	6	14	20
NRC Kit: BGP-100	Exposure Rate Meter - Part of NRC Kit	The BGP-100, BP-100, and the AP-100 are Smart Probes that are part of the NRC Kit.		
NRC Kit: BP-100	Beta/Gamma Contamination Probe - Part of NRC Kit			
NRC Kit: AP-100	Alpha Contamination Probe - Part of NRC Kit			
Garmin	GPS Unit	6	14	20
TSA	Violinist III	6	14	20
Canberra	HPGe <i>In situ</i> Systems	1	5	6
PD-10i	Electronic Pocket Dosimeter	30	40	70
TLDs	TLDs	35	475	510
BZA	Breathing Zone Air Sample Pump	6	16	22
Styplex	High Volume Air Sample Pumps	2	8	10
	Hi-Vol A/S Pumps 4 inch Sample Holder	2	8	10
	Hi-Vol A/S Pumps 8x10 inch Sample Holder	N/A	8	8
	Low Volume Air Sample Pumps	N/A	9	9
	Lo-Vol A/S 2 in Sample Paper (boxes)	N/A	11	11
	Lo-Vol A/S Silver Zeolite Cartridges	N/A	80	80
Radeco	Grab Sample Air Sample Pumps	N/A	4	4
Ludlum 2929	Alpha/Beta Swipe Counters	N/A	3	3
PPM-2000	Personnel Portal Monitors	N/A	2	2
PID	Photo Ionizing Detector	N/A	2	2
	Sample Collection Kits	1	20	21
Drager	Gas Detector Hazmat Kit	N/A	1	1
Quest	Heat Stress Monitor	N/A	2	2
Quest	Sound Level Meter	N/A	2	2
	Portable Shower	N/A	1	1
Generators	Generators, Internal Combustion Engines	N/A	22	22
	Fire Extinguishers	N/A	22	22

Personnel Protective Equipment (PPE)

	Description	Phase 1	Phase 2	Total
	Tyvek Coveralls XXXL	2	55	57
	Tyvek Coveralls XXL	8	200	208
	Tyvek Coveralls XL	4	205	209
	Tyvek Coveralls L	1	60	61
	Shoe Covers XL (pair) (Disposable)	18	350	368
	Gloves, Latex XL (pairs)	60	500	560
	Gloves, Cotton (pairs)	10	168	178
	Full Face Respirator L w/P-100 HEPA	3	10	13
	Full Face Respirator M w/P-100 HEPA	2	12	14
	Full Face Respirator S w/P-100 HEPA	0	3	3
	P-100 Ultra Filter Particulate (HEPA) cartridge (additional)	0	20	20
	GMR-I-P-100 Canister (for Iodine)	0	10	10
	First Aid Kits	4	0	4
	Safety Glasses	1	6	7

CM Comsec				
	Description	Phase 1	Phase 2	Total
	Laptops (with Classified Hard Drives)	2	0	2
	Cellular STUs	2	or 2	2
	Secure Fax	1	or 2	1

