Lesson 11: Field Monitoring Operations

Lesson Overview

In the previous lesson, you learned about the organization of field monitoring teams. In this lesson, you will learn about how field monitoring teams operate throughout the different phases of an incident.

Upon completion of this lesson, you will be able to:

- Explain the functions of field monitoring in radiological accident assessment.
- Identify sampling techniques, establish sampling priorities, and make personnel deployment decisions for collecting field samples and data during the early and intermediate phases of an incident.
- Describe the resources and tools used for data analysis during the early and intermediate phases that guide the decision making process.

Remember you can access the glossary in one of two ways throughout this course. You can select the glossary button in the top right hand corner of each main content screen. In addition, on content screens you can select underlined words to access their definitions in the online glossary. Selecting an underlined word will take you directly to its definition in the glossary.

This lesson should take approximately **45 minutes** to complete.

Field Monitoring Operations: Early Phase

As you have learned in previous lessons, an incident can be divided into three incident phases: early (emergency or plume), intermediate (post-plume, ingestion or relocation) and late (recovery). Some aspects of field monitoring are applicable only to the early phase, some only to the intermediate phase, and others are common to all the phases. Incident phases are identified in this lesson as they pertain to applicable field monitoring team functions, operations, and data analysis. Requirements are quoted from Nuclear Regulatory Commission Regulation (NUREG-0654), unless otherwise specified.

In this lesson, you will learn about the functions, operations, and data analysis of field monitoring during the early and intermediate phase. You will begin by learning about early phase functions, operations, and data analysis.

Functions of Early Phase Field Monitoring Teams

The primary purpose of plume exposure rate verification is to provide a flexible means of correcting, verifying and expanding on initial, inaccurate dose projections. The functions of early phase field monitoring teams include:

- Defining the plume (locating the perimeter of the radioactive cloud as it moves downwind).
- Verifying projections. Local meteorological or topographical conditions, such as coastal effects, river meander, building wake and precipitation may cause the off-site radioactive plume to

behave differently from the projections made early in the accident. Field monitoring is therefore required to verify these projections.

- Collecting environmental measurements and verifying that actions taken based on projected concentrations are adequate to limit radiation exposure to members of the public. Are the protective actions in place adequate? Are the correct geographic areas protected?
- Indicating the need for further actions.
- Determining when protective actions should be terminated after the release of radioactive materials has stopped. When has the plume departed? When can those sheltering-in-place leave shelter?

Data Needed for Field Monitoring Teams

In order to dispatch teams to the appropriate locations for monitoring, field monitoring team coordinators need to be aware of:

- Wind direction: Where is the release going?
- Wind speed: How fast will it get there?
- Atmospheric stability class: What amount of dispersion is taking place?
- Meteorological and topographic conditions that may influence the transport of the plume, such as river valleys, coastlines, mountains, precipitation, and approaching fronts: What will affect the downwind concentrations?

Additionally, information about plant conditions and release composition is important. The type of release (normal coolant, gap, core melt, vessel melt-through) and containment hold-up time (which allows for a delay) significantly affect the radionuclide mix in the effluent and the potential dose. Releases containing radioiodines influence the decision on whether to administer potassium iodide. The release of certain particulates may require assigning extremely low dosimeter limits to control internal dose.

Plume-Projected Dose Verification

The plume-projected dose is verified by first traversing the plume and making the following readings:

- While traversing, determine edge and centerline (closed window)
- At centerline, at both waist and ground level:
    - Gamma only (closed window)
    - Gamma and beta (open window)

Beta plus gamma values significantly in excess of the gamma only values indicate the presence of the radioactive nuclides that are the constituents of the plume. When such values are encountered, the plume is surrounding the team. This is called immersion. When the presence of the plume is verified, air sampling for radioiodine and particulates is warranted.

Plume Direction Projections

The state, utility, NRC, and DOE may provide plume pathway projections in the incident's early phase. There are several models for projecting plume direction.

- **Straight-Line Gaussian -** The straight-line Gaussian projection model is a relatively simple plume diffusion projection. It is frequently used because it is both fast and easy. It also makes a lot of assumptions and does not take into consideration changes in wind direction downwind from the release point.
- **Variable Trajectory -** NARAC is an atmospheric modeling system based at Lawrence Livermore National Laboratory. NARAC can predict the atmospheric diffusion of a plume as influenced by local meteorological and topographical conditions using a suite of computer codes and models.

  NARAC advisories may consist of predicted concentration patterns, estimated exposure rate patterns, dose projections and predicted ingestion pathway concentrations.

  The Aerial Measuring System (AMS) is an aerial radiation surveillance program operated for the Department of Energy. Using both fixed-wing and rotary aircraft, AMS can conduct aerial surveys of deposited materials after the plume has dissipated.

  A lead time of 12 hours is desired when aerial measurements are requested. Since it is not necessary to begin foodstuff monitoring for 36 to 48 hours after a release, AMS could survey the area surrounding the site prior to sampling. This would allow authorities to concentrate the initial sampling effort in areas where greatest radioiodine deposition has occurred.

Lesson 11: Field Monitoring Operations

Every state has a designated radiological laboratory for use in nuclear incidents. The laboratory should be certified and have proper instrument calibrations. Usually, the laboratories selected are analytical laboratories that do routine environmental analysis.

During the early phase of the accident, particulate filters and iodine sample cartridges are sent to the lab. They may be many more times radioactive than the samples the lab usually handles. Procedures for handling these "hot" samples should be in place. Particulate filters should receive expedited analysis, as information about the mix will prove valuable during the intermediate phase.

Field Monitoring Operations: Intermediate Phase

Now that you have learned about the functions, operations, and data analysis of field monitoring during the early phase, you will learn about the functions, operations, and data analysis of field monitoring during the intermediate phase.

Functions of Intermediate Phase Field Monitoring Teams (1 of 2)

The initial decisions made during the early phase of a nuclear power plant accident are based on plant conditions and projections. During the intermediate phase, however, "real" data (i.e., field environmental measurements) can be gathered for use in assessing the situation accurately and implementing appropriate protective actions.

The goal of field monitoring teams during the intermediate phase includes environmental sampling to obtain data upon which to base decisions regarding:

- The ingestion pathway with an emphasis on crops near harvest: What are the contamination levels? Are contamination levels lower than acceptable standards? Can it be proven that there is no contamination?
- Relocation and reentry: Do the restricted zone boundaries need to be expanded or relaxed? Is relocation temporary or permanent in a particular area? If temporary, when may people return to their residences?
- Adjustment of protective action decisions (PADs): The actual path of the plume as established by measurements is likely to be quite different from that predicted with dispersion calculations. Sampling can determine whether areas bounded by the early-phase protective actions must be expanded or contracted.

Functions of Intermediate Phase Field Monitoring Teams (2 of 2)

Another priority during the intermediate phase is determining whether there are "hot spots." This is particularly important if there are areas measured greater than 10 mR/hr because of the 96 hours of exposure that is included in the plume (exposure) phase protective action guides (PAGs) calculations.

Depending on the nuclides that are producing the measured 10 mR/hr (or greater), any population not already evacuated warrants being evacuated based on exceeding the plume phase PAG even though the incident may have advanced to the intermediate phase.

Other priorities during the intermediate phase include determining:

- Where evacuated residents may safely return
- Areas where reentry must be limited
- Areas where decontamination activities must be conducted on exit of the reentry areas

Determining Sampling Locations

Information needed for determining appropriate sampling locations during the intermediate phase include:

- Early phase field monitoring team data: The areas where early phase measurements were obtained and would lead to the expectations of intermediate need samples.
- Source term: The particular type or amount of radionuclides originating at the source of a nuclear accident. The source term will vary depending upon the type of accident.
- Plant conditions: Indications of the source term's contents and duration of the release.

- Meteorology: Were there dispersion conditions? Was there precipitation that might increase ground concentrations? Did wind shifts occur during the release?
- Early-phase data: Laboratory analysis of iodine samples and particulate filters should be available.
- Projections: State and/or utility as well as Nuclear Regulatory Commission (NRC) projections should be available. The DOE will provide a National Atmospheric Release Advisory Capability (NARAC) projection for a serious accident.

Land Use Data

In addition to the data that you just learned about that can help determine appropriate sampling locations, land use data is also critical to prioritizing sampling locations.

The local emergency response plan generally does not include land use data because the data are constantly changing. These data are often available from the local county extension agency or other state agricultural agency. The emergency response plan should, however, note the location of a land use database.

Harvesting Data

In addition to land use data, current harvesting data is also critical to prioritizing sampling locations.

Farmers have a narrow window for harvesting crops. If an accident occurs, the crops that would be harvested within the next 30 days should be determined, and the appropriate lists of farms growing those crops and the emergency planning zone (EPZ) map showing their locations would be used to develop the monitoring plan. Sampling of these crops would be a priority since the potential loss of a crop is a critical economic issue for local farmers

Data Analysis

During the early phase, field monitoring teams will have taken air samples. The particulate filters should have undergone laboratory analysis and should have received expedited handling.

In the intermediate phase, the results of this analysis provide the first indication of the nuclide mix involved with the deposition.

Next, you will learn about milk sampling techniques used to gather further data and how contamination control is applied to samples in the intermediate phase.

Sampling Techniques

You learned about milk sample ion exchange equipment in Lesson 10. The ion exchange method involves passing a 3–4 liter sample of contaminated milk through a column of anion resin to collect the iodines present in the sample. The anion resin is the chloride form of a strongly basic ion exchanger. The iodines are retained within the resin column for analysis.

Calibration curves for the appropriate instrument system (that have been developed prior to the accident) are used to determine the activity present in the milk. The milk activity is then compared to the U.S. Food and Drug Administration (FDA) derived intervention levels (DILs) to provide a basis for determining appropriate protective actions.

Contamination Control

Field teams should employ the following techniques to prevent cross-contamination of samples and to ensure integrity of data.

- **Best practices -** All samples should be double-bagged. All sampling equipment used at a sample collection site should be decontaminated before reusing at another sampling location. Teams sampling in "cold" areas should not be sent to areas of suspected high activity.
- **Representative sample -** If deposition appears to be relatively even, fewer samples need to be taken. A high degree of variation requires more samples.
- **Labels -** All monitoring personnel should be trained to use the same system for identification of samples and data collection. The identification should be attached to all sample containers at the time of collection and should include the following information:
    - Date
    - Time
    - Type of sample (grass, soil, milk, etc.)
    - Location of sample collection point
    - Area represented by the sample
    - Identity of person or team collecting the sample
- **"Hot line" -** All samples should be accounted for and rebagged at a control line. This line, also called the "hot line," is designed to separate contaminated and noncontaminated areas.

Data Evaluation

Data evaluation in the intermediate phase yields:

- DILs: Calculated radionuclide concentrations in foodstuffs, milk and water, which, if ingested without any protective actions, would result in a projected dose commitment equivalent to the FDA PAGs.
- Buildup curves: Provide a basis for comparing milk measurements from samples taken at various times following the initial ingestion.
- Nuclide mix: The specific isotopes deposited from the particular accident.

Laboratory Use

Because of the high number of samples taken during the intermediate phase, samples are contaminated and minimum detectable levels are different from those in the materials the laboratories normally handle. Laboratories will continue to be working outside of routine conditions. Adequate planning, written procedures and training are essential for effective sampling and laboratory analysis during this phase.

Lesson Summary

Let's summarize what you learned in this lesson:

- Early Phase
  - Field monitoring team functions to define plume, verify projections, collect environmental measurements, and determine further actions.
  - The plume-projected dose is verified.
  - Plume pathway projection is provided by the state, utility, NRC, and DOE, using either straight-line Gaussian or variable trajectory models.
- Intermediate Phase
  - Function of field monitoring in this phase is to gather the data that will be used to accurately assess the situation and take appropriate actions.
  - Contamination and sampling techniques are applied.
  - Data is evaluated and yields DILs, buildup curves, nuclide mix, and summation of partial PAGs.