UNIT TWELVE

RADIOLOGICAL HAZARD AREA CONTROL

Once the radiological responder has collected available information at the incident scene, the problem must be defined in terms of potential harm to people within the affected area. After defining the problem, the radiological responder's next task is to control the problem (reducing or eliminating contamination and/or exposure risk).

This unit will cover the components of radiological problem definition and the methods available for exposure and contamination control. Some of this information has been addressed in prerequisite FEMA courses and will be considered a review. Other concepts are introduced here and should be carefully studied. The sections of the unit are organized into topics that can be developed into a generic checklist for controlling a radiological hazard area.

GATE FRAME QUESTION

What important factors must be considered in defining a radiological problem?

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ANSWER

Your answer should include the adjacent information.

- What is the external hazard in terms of exposure rate readings?
- What are the internal hazards—any ways radioactive material might be inhaled, ingested, or absorbed?
- What are the hazards to personnel (victims, on-site public, and emergency workers) in terms of injuries, exposure, contamination, or anticipated risks?

If your answer included all or most of the above points, you should be ready for the Summary Questions at the end of this unit. Turn to page 12-21.

If your answer did not include these points, it would be advisable for you to complete the programmed instruction for this unit. Turn to page 12-3.

DEFINING THE PROBLEM: EXTERNAL HAZARDS

Using the hazard assessment information available from package types, labels, placards, and shipping papers, the nature of the exposure problem may be identified. However, actual exposure rates can only be determined using radiation detection instruments. In order to provide accurate and timely information, the radiological responder must be able to operate and read the available radiation monitoring instruments.

State response teams have access to a variety of radiation survey instruments. These include scintillation counters, Geiger-Mueller counters, and ionization chambers.

- *Scintillation counters* detect beta, x, and gamma radiation, with typical ranges of 0.02 mR/hr to 20 mR/hr.
- *Geiger-Mueller (GM) counters* detect beta, x, and gamma radiations from 0.2 to 20 mR/hr or 800 to 80,000 counts/minute.
- *Ionization chamber instruments* also detect beta, x, and gamma radiation from 3 mR/hr to 500 R/hr.

These instruments are useful for hazard assessment purposes only if the personnel have some knowledge of the instrument's ability to detect the radionuclides potentially present. A methodology for evaluating the response of survey instruments was developed and applied to the widely available CD V-700 and CD V-715 survey meters distributed by the Federal Emergency Management Agency (FEMA). The results are published in a document titled *Response of Radiation Monitoring Instruments to Normalized Risk Quantities of Radionuclides*, available from the Department of Transportation Research and

Special Programs Administration and reprinted in FEMA's SM 320, *The Fundamentals Course for Radiological Monitors*.

Entry to a scene with both low and high level instruments may be appropriate. The team members assigned to the radiological monitoring task survey first for high-level radiation exposure rates using high-range radiation instruments such as the CD V-715 and maintaining a safe distance from the source. If the high-range instruments do not detect the presence of radiation, a low-range instrument such as the CD V-700 may be used to detect lower radiation levels. The data from these surveys are the basis for determining the external hazards.

The following question will help you assess your understanding of methods used to determine external radiation hazards.

QUESTION

Circle the correct answer

Available information about the cargo of a damaged tractor trailer indicates that it is carrying solid cobalt-60 sources for industrial radiography use in Type B packages. This information is

a. enough to determine the external exposure hazard.

b. a good basis for determining the type of survey instrument to use in the area survey.

Turn the page to check your answer.

ANSWERS

a. No. Unless the area is surveyed to determine radiation levels, the existence of and extent of any problem cannot be determined.

Try the next problem.

b. Correct.

Move on to the next section.

QUESTION

Circle the correct answer

For initial area survey of an accident involving a high-level spent fuel shipment, the radiological responder should select

a. a CD V-715 (ionization chamber).

b. a CD V-700 (GM counter).

Turn the page to check your answer.

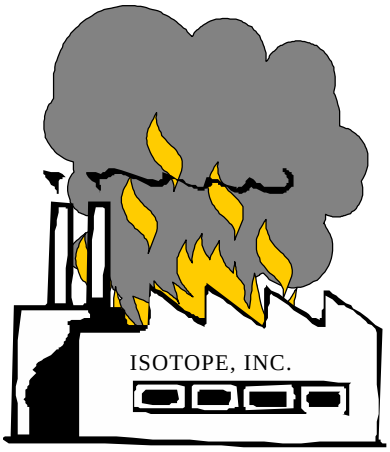
ANSWERS

a. That's correct. You remembered that the CD V-715 is a high-level monitoring instrument appropriate for use with a high-level radiation source.

Proceed to page 12-7.

b. No. The CD V-700 measures radiation levels up to about 50 mR/hr and may malfunction due to saturation of the GM detector under high exposure rates. For an incident with the possibility of higher radiation levels, a higher range instrument, such as the ionization chamber, should be selected where a choice is available.

Reread this section before proceeding to page 11-7.



DEFINING THE PROBLEM: INTERNAL HAZARDS

Radioactive contamination can get inside the body through inhalation, ingestion, absorption, and open wounds. Accidents involving radioactive materials may create conditions where contamination can be breathable—from smoke, gaseous release, or particulate release. It is necessary to take downwind air samples to determine the presence of radioiodine and particulate radiation. Direct radiation measurements can determine the exposure from noble gasses.

If an air sample for radioiodine and particulates was taken and no significant amount of radioactivity was found on either the radioiodine or particulate filter, but measurable amounts above background of gamma radiation were present, it would indicate one of three possible conditions:

- Particulate radioactivity or radioiodines are not present in measurable quantities;
- Measurements are being made just outside or beneath the radioactive smoke or plume; or
- The gamma measurements are being obtained from sources on the ground and there is no airborne radiation at that location.

If subsequent air samples from different locations do indicate measurable amounts of radioactivity, it may be assumed that the first readings were taken near to but not in the radioactive cloud. If survey meter readings taken closer to a source on the ground increase and the airborne readings remain negative, the radiation is probably not airborne.

Spreadable contamination from dispersion of a particulate source such as yellowcake (U_30_8) is determined using radiation survey instruments.

QUESTION

Circle the correct answer

Internal radiation hazards are detected using

a. downwind air-sampling and radiation instruments.

b. high-range gamma detectors.

Turn the page to check your answer.

ANSWERS

a. Correct.

Proceed to page 12-11.

b. No, high range gamma detectors may detect external radiation hazards and contamination hazards, but may not detect airborne radioactive gasses and/or particulates.

Try another problem.

QUESTION

Circle the correct answer

Two Type A packages with Radioactive White I labels containing vials of liquid iodine-131 have failed, spilling the contents on the side and shoulder of a highway. The contaminated area is detected using

a. downwind air sampling equipment.

b. low-range GM counter radiation detection instrument.

Turn the page to check your answer.

ANSWERS

a. No. This radioisotope is in liquid form spilled on the ground. Airborne contamination is unlikely.

Review page 12-7 before moving on to the next section.

b. Yes—the low range survey meter was indicated by the form of the material and the White I labels, indicating a low-level exposure hazard.

Proceed to page 12-11.

DEFINING THE PROBLEM: HAZARDS TO PERSONNEL

The emergency responder's job is to save lives and protect people from injury. Those people include accident victims, onsite public, and emergency workers.

An accident involving radioactive materials may involve hazards other than radiation. These other hazards could include potential bodily injury sustained in the accident itself, exposure to nonradioactive but toxic materials released in the accident, and exposure to radioactive materials that also are chemically toxic.
Radiological response team members identify all possible hazards to people, not just radiation hazards. *Lifesaving first aid is given priority over radiation protection.* Non-radiological hazards can be immediately life threatening and should never be ignored because of radiological hazards. The information about all personnel hazards is collected and recorded on paper and through photos, audio, and videotape. Due to the lack of general knowledge about radiation hazards, it is important to document all actual or potential hazards for legal reasons.

To check your understanding answer the following question.

QUESTION

Circle the correct answer.

Uranium hexaflouride (UF_6) is a hazardous chemical in a gaseous state that requires special handling because it reacts rapidly with water to form the irritating, noxious gas hydrogen fluoride. Because of its low level of radioactivity it is classified as an LSA material. This material would be considered

a. a chemical and radiological hazard.

b. a chemical hazard only.

Turn the page to check your answer.

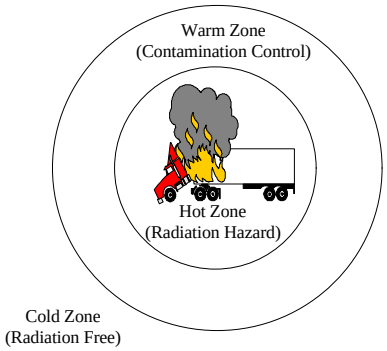
ANSWERS

a. Correct.

Proceed to page 12-13.

b. No. While the chemical toxicity may be the more immediate hazard, the low-level radiation presents possible internal exposure and contamination hazards.

Review page 12-11 before moving on to the next section.



CONTROLLING THE PROBLEM: EXTERNAL AND INTERNAL HAZARDS

If it is determined that a radiation hazard exists at an incident site, appropriate exposure control measures should be initiated. Where an external radiation hazard from unshielded radioactive material is indicated, isolate the hazard area, or *hot zone*, and prohibit entry. The physical boundaries of the hot zone are determined by the exposure rate readings taken with radiation survey instruments. Two mR/hour is a generally accepted perimeter. Response actions should be limited to shortest possible entry time into the hot zone. All persons entering the hot zone should wear appropriate dosimetry and protective clothing.

The *warm zone* is a marked area around the *hot zone* where personnel and equipment decontamination and hot-zone support takes place. It includes control points for the access corridor that help reduce the spread of contamination. Other terms for the warm zone are decontamination, contamination reduction, or limited access zones.

The *cold zone* is a marked area around the warm zone that contains the command post and other support functions necessary to control the incident. The zone is also called the clean or support zone.

If exposure rates are very high, some shielding may be necessary if lifesaving or other operations in the hot zone are imperative. Recommendations of shielding procedures should involve careful comparison of the exposure saved by shielding with the exposure added due to increased time needed to shield the area. Shielding material could include barrels, boards, vehicles, or whatever else is immediately available. Because it may take valuable time to fabricate this shield, rotation of response personnel to perform the necessary operations may be a viable alternative for exposure control.

Exposure to breathable internal radiation hazards also may be controlled by remaining at least 150 feet upwind of the hazard and possibly greater distances downwind, or through the use of self-contained breathing apparatus (SCBA). Air sampling procedures should be continued.

Exposure to spreadable contamination is limited by controlling exit and entry to the hot zone. Clothing and equipment with suspected contamination should be isolated and contamination clean-up delayed until the Radiation Authority has been consulted.

Answer the following question.

QUESTION

Circle the correct answer

Brief external exposure to a low-level contained radiation source

a. may be of less concern than an internal exposure hazard.

b. requires the same exposure control methods as an airborne exposure hazard.

Turn the page to check your answer.

ANSWERS

a. Yes. Radiation exposure inside the body is in most cases more hazardous than external exposure to low-level radiation.

Move on to page 12-17.

b. No. Controlling airborne radiation requires air sampling and a larger hot zone.

Try the next problem.

QUESTION

Building a barrier is an example of controlling

Circle the correct answer.

a. internal exposure.

b. external exposure.

Turn the page to check your answer.

ANSWERS

a. No. Internal exposure is controlled by staying upwind of the problem and air sampling.

Review page 12-13 before moving on to the next section.

b. Correct. Shielding will decrease exposure from an ionizing radiation source.

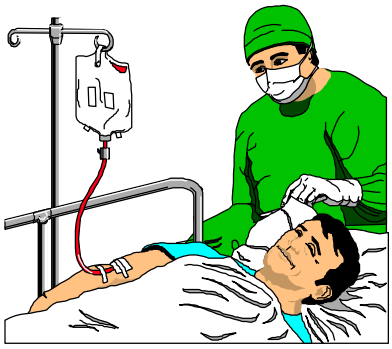
Move on to the next section.

CONTROLLING THE PROBLEM: HAZARDS TO PERSONNEL

The goal of radiological emergency response is to keep radiation exposure to all people as low as possible. The EPA's Protective Action Guides and the NCRP's guides for population exposure provide the radiological emergency responder with information about levels of exposure that should not be exceeded. After finding out what hazards exist, predictions about exposure and contamination risks can be translated into procedures for controlling the problem.

- These procedures are found in the *North American Emergency Response Guidebook* under Guides 161-66. The specific guide to follow is determined by the radioactive material involved.

EMERGENCY ROOM



Accident victims should be treated according to the nature of the injury. If it will not affect the injury, prevent exposure by moving the victim away from the source. If the injury is not affected, remove and isolate suspected contaminated clothing and shoes; wrap the victim in a sheet or blanket before transporting. Advise medical personnel that the victim may be contaminated with radioactive material.

If there is no injury to *onsite public* and they are not contaminated, remove them from the area to prevent radiation exposure and possible contamination. If contamination of uninjured onsite public is suspected, remove and isolate suspected contaminated clothing and shoes. Assist persons to shower with soap and water and notify the Radiation Authority of the action taken.

Emergency workers can reduce exposure and contamination using the *hot-team/cold-team* concept. Perimeters are established as close as practical to victims based on estimated stay times for team members, and equipment is staged accordingly.

- Hot-team members enter the hot zone and treat the patient.

- Cold-team members stand by to receive and transport the patient. This allows the cold-team members to remain free of contamination and maintain some distance from the source of radiation.

A positive pressure SCBA and structural firefighter protective clothing will provide limited protection. In the absence of fire or chemical hazards, disposable coveralls, gloves, and shoe coverings limit contamination of workers and their protective equipment. Before leaving the warm zone, emergency workers remove and isolate suspected contaminated clothing and shoes. If contamination remains, emergency workers shower with soap and water and notify the Radiation Authority of actions taken.

To check your understanding of these concepts, answer the following question.

QUESTION

Circle the correct answer

Protective clothing provides protection from

a. gamma radiation exposure.

b. contamination.

Turn the page to check your answer.

ANSWERS

a. No, gamma radiation penetrates protective clothing.

Try another problem.

b. Correct. Contaminated protective clothing is removed before leaving the warm zone.

Proceed to the Summary Questions.

QUESTION

Circle the correct answer.

For guidance on response actions in a radiological emergency, refer to

a. the *North American Emergency Response Guidebook.*

b. the EPA *Manual of Protective Action Guides.*

Turn the page to check your answer.

ANSWERS

a. Correct.

Proceed to the Summary Questions.

b. No. The *Protective Action Guides* provide exposure guidelines and recommendations on overall protective actions. The *Emergency Response Guidebook* recommends specific emergency response actions.

Review this section before proceeding to the Summary Questions.

SUMMARY QUESTIONS

QUESTION

Circle the correct answer.

1. You are a member of a radiological response team called to an incident on a ship at a busy harbor. A load of pipe being off-loaded was dropped back into the ship's holding area, damaging a Type B container marked radioactive. The shipping papers indicate that it contains three sealed cesium-137 sources. There is no fire and nothing appears to be spilled. In order to define the external radiation hazard, you

   a. survey the area using radiological instruments.

   b. survey the downwind area using an air sampling device.

Turn the page to check your answer.

ANSWERS

a. That's correct. This scenario provides no reason to suspect an airborne radiation hazard

b. No. There is no apparent reason to take air samples in scenario, but it is necessary to survey the area in order to determine the external exposure hazard.

Return to page 12-7 and review before moving on to the next Summary Question.

QUESTION

Circle the correct answer.

2. You are called to assist first responders in handling an incident in which an industrial radiographer was knocked unconscious by falling factory equipment while attempting to radiograph a pipe weld. A radiological survey shows readings of 20 mrem/hr 1 yard from the victim. Your advice to emergency medical personnel is

   a. immediately treat the victim's injuries and move him away from the source if doing so will not affect his injury.

   b. move and decontaminate the victim before treating the head injury.

Turn the page to check your answer.

ANSWERS

a. That is correct. Lifesaving first aid takes precedence over exposure control.

Proceed to the final examination.

b. No. First aid is applied according to the nature of the injury and then exposure control of the patient is initiated.

Review page 12-11 before proceeding to the final examination.