The Mississippi Radiation Response Volunteer Corps

Sponsored by:
Mississippi State Department of Health
National Medical Reserve Corps
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medical reserve corps

The Volunteer Training Program

OVERVIEW

- If you are assigned to work as a monitor in the reception center, generally, you will assist in screening and surveying persons for radiation contamination. You will either assist persons through the portal monitor, or survey them with a survey meter if the portal monitor detects contamination.
- Guidelines that follow provide a description of your primary duties and procedures to perform them.

Virtual Community Reception Center

Click to be taken to the *Virtual Community Reception Center*

Monitoring Procedures for Evacuees Upon Arrival

Vehicles arriving at the Reception Center will be considered contaminated and will be secured in the vehicle parking area until monitored. Vehicle monitoring will be performed after all evacuees have been monitored.

1. All vehicles arriving at the Reception Center will be logged in using the Vehicle Monitoring Log (REP-8).

2. Radiological monitors should be sure passengers are received from their vehicles as described below:

   a. Passengers are to open their doors, swinging their feet out into the air. Do not allow them to touch their feet on the ground.
   b. Have evacuees place booties, provided them, over their feet before stepping from the vehicle.
   c. Passengers are escorted directly to the Entry Station, and onto the Portal Monitor at the Contamination Check Station.
   d. Instruct the driver to remain in the vehicle to be directed to the designated parking area.
   e. The driver should be removed from the vehicle using instructions in a & b above. The driver will then be escorted to the Entry Station, and on to the Portal Monitor in the contamination Station.

The Contamination Detection Station

Monitoring of individuals for detection and measurement of contamination using radiation instruments that incorporate a movable beta-gamma detector is a four-step process as follows:

1. A speaker or earphone(s) attached to the instrument is used to audibly announce the presence of contamination as the detector, with the beta shield open, is passed over the potentially contaminated surface at a specified: probe speed, distance between the probe and the contaminated surface, and distance between passes of the probe (path-width).
2. When contamination is detected, the earphone(s) or speaker is used to find either, the location of spot(s) of contamination, or the location of the highest concentration(s) of widespread contamination.
3. A meter reading is then taken with the detector in a fixed position at the location of the highest audible response, and at a specified distance (one inch) from the monitored surface.
4. The meter reading is compared to the decontamination decision criteria.

The Contamination Detection Station (cont)

Of course, step 1 above (detection) takes place at the reception center established for this purpose. Steps 2, 3 and 4, also take place at the reception center, in which case only those with contamination equal to, or greater than the decontamination criteria would be sent to the decontamination station while others found to be not contaminated would be released. Alternatively, those with detectable contamination would be sent to decontamination prior to steps 2, 3, and 4. After decontamination they would be monitored again to determine whether the decontamination was successful.

Provisions should also exist to separate contaminated and uncontaminated individuals, provide changes of clothing for individuals whose clothing is contaminated, and store contaminated clothing and personal belongings to prevent further contamination of evacuees or facilities. In addition, for any individual found to be contaminated, procedures should be discussed concerning the handling of potential contamination of vehicles and personal belongings.

The Contamination Detection Station (cont)

1. A monitor will receive evacuees into the reception center and, the monitor will keep a running log of evacuees waiting in the portal monitor line by name and social security number.

2. The monitor should keep the line of persons waiting for the portal monitor at least 10 feet back from the monitor. Also keep the sides of the portal monitor covered with saran wrap to prevent contamination from getting on the portal monitor detectors.

3. The monitor will have the individual step into the portal monitor and wait 5 seconds.

The Contamination Detection Station (cont)

4. If the “contamination” alarm on the portal monitor sounds, then have the person step back and then step into the portal monitor to be scanned again (the first alarm may be a false alarm). If the “clean’ signal sounds then the person is clean and the first alarm was a false alarm. If the contamination alarm sounds again, then have the person move to the Decontamination Station.

5. If the “clean” signal sounds then give the evacuee a reception center pass and have them remove their booties using proper contamination control techniques. Dispose of removed booties in marked trash containers and proceed to the reception center registration area for further instructions.

The Decontamination Station: After a Portal Monitor Alarm

1. Before and after each survey, note the background reading of the meter on the Evacuee Evaluation and Monitoring Form (REP-6).
2. Have the individual stand with their legs spread slightly apart and with their arms straight out from their body.
3. Place the survey meter probe (shield open) about 1 inch from the person's body, being careful not to make physical contact.
4. Survey the individual carefully. Starting at the top of the head, move downward along the left side of the head, neck, collar, shoulder, out along the arm, wrist, hand, back under the arm, armpit, down the side of the body, leg, to the top of the shoe.
5. Monitor the insides of the legs and on to the other side of the body in reverse sequence working up toward the head.
6. Monitor the front and back of the body, then have the person lift one foot at a time, remove booties and monitor the bottom of the shoes.
7. Again, note the background reading on the survey meter. If the background readings before and after monitoring are significantly different, the individual should be monitored again.

The Decontamination Station: After a Portal Monitor Alarm (cont)

8. If the individual is clean, have them step off the monitoring area onto a clean surface. Complete an Evacuee Evaluation and Monitoring Form (REP-6). Give the evacuee copy along with a Reception Center Pass (REP-12) to the individual. Direct them to the reception area for registration.

9. Return the probe to its holder on the meter when finished. *Do not set the probe down on the ground*. The probe should be placed in the holder with the sensitive side of the probe facing to the side or facing down so that the next person to use the meter can monitor his/her hands without handling the probe or allowing contamination to fall onto the probe surface.

10. If the contamination limits are met or exceeded, have the individual put on booties. The booties will reduce the spreading of contamination as they walk to the decontamination station washing area. Complete an Evacuee Evaluation and Monitoring Form (REP-6) indicating on the form those areas of contamination.

The Decontamination Station: After a Portal Monitor Alarm (cont)

11. Place the completed Evacuee Evaluation and Monitoring Form (REP-6) in a large plastic baggie. Give the baggie to the individual going into the decontamination washing area. Instruct the individual that when he/she gets to the decontamination washing area, to open the baggie wide by pulling the sides of the baggie apart. The personnel in the decontamination area may reach inside (wearing a glove) and pull the report out, touching only the report, so they don’t touch the baggie and possibly become contaminated. Have the individual throw the baggie in the contaminated trash container.

WASHING & DECONTAMINATION STATION

1. Individuals who are contaminated need to be decontaminated. Only the area on the individual where contamination is found needs to be decontaminated. If only the hands are contaminated, then the individual needs only to wash the hands and be monitored again. Shoes, shirt, pants, etc., if contaminated need to be removed, and the area under these articles should be monitored.

2. Collect the plastic bag with the Evacuee Evaluation and Monitoring form in it, from the person . Be careful as you take the person's survey form out of the bag, so that you do not contaminate yourself. Have the individual throw the bag in the contaminated trash container.

3. Have the individual remove their personal articles (i.e., wallet, watch, keys, rings, etc.) and lay them on a flat surface. Monitor these articles. Avoid mixing contaminated articles with clean ones. Return the articles to the individual after he/she is clean and the articles have been monitored and decontaminated, if necessary. Inventory the articles on a Personal Property Form (REP-5). Have the individual sign the inventory sheet for their property. Place contaminated articles in a plastic bag and tag outside of the bag with REP-5 Form.

WASHING & DECONTAMINATION STATION (cont)

4. Use masking tape, or equivalent, to lift contamination off the surface will be a good method for a mustache, beard, and small areas on the arms and legs.

5. Removal of articles will be a good method for shoes, shirt, pants. In general, articles of clothing whatever method is used to decontaminate the individual, they must be monitored again to ensure that the contamination has been removed.

6. After decontamination has been successfully completed, fill out the rest of the Evacuee Evaluation and Monitoring Form (REP-6). Give the evacuee a copy along with Reception Center Pass (REP-12) to the individual. Maintain the report for permanent record. The report should be forwarded to the registration desk at the reception center.

7. Any clothing that is contaminated should be removed, placed in a heavy-duty garbage bag, which is labeled with a radiation caution sign/label. Label the bag with the REP-5 Form and notify Team Leader. It is the responsibility of GGNS to arrange for the proper disposal of contaminated clothing/materials.

RADIATION DETECTION DEVICE BASICS

As a volunteer responder there are several concepts that are important for you to learn before using a radiation detection device:

- Natural background radiation
- Measurement units and scales
- Calibration
- Limitations of the device
- Efficiency and units

Understanding these concepts will allow responders to properly use radiation detection devices and to interpret the readings correctly.

Natural Background Radiation

Background radiation varies in different parts of the world, but almost every radiation detection device will indicate that radiation is present whenever (and wherever) it is operating. Over the course of a year, United States citizens are, on average, exposed to approximately 360 millirems of radiation, 80% - 90% of which is from background sources. Therefore, many radiation detection instruments, particularly those such as microR meters, and pancake probes used to measure low levels of radiation, will indicate that radiation is present whenever they are operating.

To accurately detect an increase in the amount of radiation (and radioactive contamination) in an environment, it is important that responders turn on the radiation detection device (instrument) and establish and record a reading before beginning a survey. Take background radiation measurements in an area that you know is far from the radioactive source, and is free of contamination. For example, you may take a background reading at your base station before you leave, or even in your vehicle en route to respond.

Units

Radiation detection devices may provide readings in a number of different units, including counts per minute (cpm), Roentgen per hour (R/hr), milliRoentgen per hour (mR/hr), microRoentgen per hour (μR/hr), or millirem per hour (mrem/hr). These units and prefixes are defined in the Primer on Radiation Measurements section.

Since some radiation detection devices may have more than one scale on their faceplate, it is important to be aware of which set of measurements, or scale, you are reading. For emergency response purposes, the differences between rem and Roentgen (R) may be ignored. For the purposes of this document, assume 1 Roentgen (R) = 1 rad= 1 rem. Prefixes are important, however. Make sure you know whether the readings are in Roentgen (R), milliRoentgen (1/1000 Roentgen or mR), or microRoentgen (1/1,000,000 Roentgen, or μR).

Calibration

All instruments used to measure radiation, should be routinely calibrated, or checked, to determine the accuracy of their readings. To use a simple illustration, think of calibration as a way of making sure that your radiation detection device registers a reading of “five units” when you, in fact, have five units worth of exposure. Calibration of radiation detection devices can be done by the manufacturer or other licensed calibration facility and is usually performed at least annually. Calibration frequency increases the confidence level in the reliability of the equipment.

Radiation instruments are generally quite reliable over long periods of time.
A method for determining that an instrument is reasonably calibrated is to perform a field check of basic instrument operation using a small radioactive source, also known as a “check source,” every time the instrument is turned on. The check source response should have been recorded shortly after calibration, but even if it was not, the field check will ensure the instrument is capable of detecting radiation. It is far better to have a simple instrument that indicates a potential presence of radiation, even if it doesn’t accurately “measure” it, than to have no instrument at all.

Limitations of the Device

A variety of physical factors may limit the ability of your radiation detection device to provide accurate, consistent, and reproducible readings of the amount of radiation in a given environment. Examples of some of these limitations are described below.

A pancake probe can only measure up to approximately 400 mR/hr (0.4 R/hr), and a sodium iodide (NaI) probe can only measure up to about 200 mR/hr (0.2 R/hr). When these probes are used in higher radiation fields, the instrument indication may “peg” (go off-scale), or may even indicate zero radiation. Be very cautious if a radiation detection device indicates there is no radiation present.

Most routine ion chambers will measure to a maximum of 50 R/hr; more specialized equipment is required to measure higher exposure rates.

Limitations of the Device (cont)

Check the instrument manual or contact the manufacturer to find out how to operate the instrument in high radiation fields.

Most instruments are calibrated using a Cs-137 source, so if Cs-137 is the nuclide being measured in the environment, the measurement provided by your radiation detection device would be the most reliable for that nuclide. If another nuclide is being measured, the measurement may be quite inaccurate. For example, a 1” x 1” NaI probe calibrated to a Cs-137 source may:

- Under measure the amount of radioactive cobalt 60 by about 50%;
- Over measure the amount of iodine 131 by about 500%; and
- Over measure the amount of thallium 201 by about 1000%.

Efficiency

Radiation detection instruments consist of two parts: the meter and the probe. Probes, which are held near the suspected source of radiation, vary in size and shape, as well as in the type of radiation they detect. Some probes detect particular radionuclides better than others.

No instrument detects all the radioactivity present; one must therefore correct the instrument reading using an “efficiency factor” in order to estimate the true amount of radioactivity present.

The efficiency of a probe is the percentage of the radioactivity present that the probe is likely to detect. For example, if the efficiency of a pancake probe for cesium-137 (Cs-137) is 15%, that probe is only detecting 15% of the Cs-137 that is present. In an initial response situation, responders may only be looking to map contamination or to grossly locate a radioactive source.

Efficiency (cont)

Therefore, knowing the instrument efficiency may not be necessary, and an instrument with even a 15% efficiency can be very effective in mapping or locating radiation.

The efficiencies given in the next section are typical for the type of probe noted, and apply to measurements made under “ideal” conditions; actual detection efficiency will likely be less for field measurements. Individual manufacturers can provide efficiencies for their probes for measuring various radionuclides under "ideal" conditions.

Efficiency and Units

The use of disintegrations per minute (dpm) (rather than counts per minute – [cpm]) is preferred, because actual activity (quantity) of the radioactive material present can be calculated from dpm.

Many radiation detection instruments read in cpm. As the cpm reading varies from probe to probe, depending upon the efficiency, you may need to convert a cpm reading to dpm to accurately communicate radiation information outside your organization.

In any case, it is very important to indicate if the readings are in cpm or dpm to allow radiation control personnel to better understand the amount of radioactive material present.

Efficiency and Units (cont)

We illustrate below how to convert cpm into dpm and then calculate microcuries (μCi*) of activity from dpm.

dpm = cpm ÷ Instrument Efficiency

Activity (microcuries) = dpm ÷ 2.22 x 10^6

One (1) microcurie = 2.2 x 10^6 dpm

For example, if the efficiency for a Cs-137 source using a pancake probe is 15%:

dpm = cpm ÷0.15 and *μCi = dpm ÷ 2.22 x 10^6

{*where μCi denotes microCuries (1/1,000,000 Curies (Ci)}

RADIATION DETECTION INSTRUMENTS

Note that illustrations of a particular make or model instrument in this document are not to be construed as either an actual or implied endorsement of that instrument. Illustrations are offered simply to provide examples of what an instrument or probe may look like.

Meters
General Purpose Survey Meter

Some instruments allow various probes, including those shown in this section, to be attached to a general-purpose survey rate meter to allow them to measure different types of radiation. Some have an internal fixed detector. The scale of an instrument may read in milliRoentgen (mR), Roentgen (R), milliSievert (mS) or Sievert (S) per unit of time (typically per minute or second), or it may read in counts per minute (cpm or c/m). Some rate meters may have more than one scale. Note that a survey rate meter may not be accurate unless the instrument was calibrated using the same radionuclide that is being measured, and withthe same detector probe used during calibration. An instrument that can be used for measuring exposure rate without concern for compensating for the source used in calibration is the ion chamber described below.

RADIATION DETECTION INSTRUMENTS (cont)

Ion Chamber or Energy Compensated Geiger-Mueller (GM)

The ion chamber is the most accurate instrument for measuring radiation fields for radiation protection purposes. However, both an ion chamber and an energy compensated GM are good instruments for measuring exposure rates, because both are relatively insensitive to different radionuclide energies. This makes them a better choice than the pancake GM or Sodium Iodide (NaI) detector for measuring mR/hr. However, they are not as sensitive as a rate meter equipped with a pancake GM or NaI probe for detecting low exposure rates, and this makes them less desirable as a contamination monitoring instrument for individuals. *The ion chamber is the instrument of choice for setting up boundaries, and will measure gamma, x-ray, and beta if equipped with a beta window.* A typical ion chamber will measure up to 20-50 R/hour, although there are also ion chamber instruments designed for very high radiation levels. An energy compensated GM is typically capable of measuring a broad range of radiation levels.

RADIATION DETECTION INSTRUMENTS (cont)

Pancake Probe (Pancake GM)

A Geiger Mueller (GM) pancake probe can detect alpha, beta, or gamma radiation, and is very efficient at detecting beta radiation. The probe begins to be less accurate as the count rate increases above 100,000 cpm, and around 400,000 cpm. They will respond low by a factor of about three, making their use at count rates greater than 400,000 cpm inadvisable.

The pancake probe is best used for detecting low levels of radioactive contamination on people or on surfaces. When it is used to detect gamma radiation using a mR/hr scale, it is possible to use it in a way that discriminates whether beta radiation may also be present. This is accomplished by taking a measurement with the open window, then turning the probe over and positioning its back toward the surface being monitored. Gamma radiation can penetrate the metal back of the probe, but the beta will be shielded, and a substantial difference between the two readings will indicate the presence of a mixed beta/gamma field. A GM pancake probe is not energy compensated, meaning that it will only read mR/hr accurately for the radionuclide with which it was calibrated (normally Cs-137), but may be inaccurate by up to a factor of five for other radionuclides. Typical background readings made with this probe will vary, but are generally in the range of 25-75 cpm. Under ideal conditions, and with the face of the uncovered probe held ½ to 1 inch from the surface being measured, some efficiencies for the probe used with the radionuclides shown are approximately:

Cesium 137	15%	Iridium 192	15%
Cobalt 60	10%	Strontium 90	30%

RADIATION DETECTION INSTRUMENTS (cont)

Alpha Scintillator

An alpha scintillator probe is used for detecting alpha radiation and is preferred over a Geiger Mueller pancake probe when alpha radiation is suspected. This is because a pancake probe has a much lower efficiency for alpha emitters and is of limited use. For americium 241, under ideal conditions, an alpha scintillator probe will only detect about 20% of what is present, and a pancake probe will be about 10 times less efficient. An important note with respect to alpha radiation is that the measurement must be made as close as possible to a contaminated surface making sure that the probe is not in contact with the surface. Ideally, a measurement must be made with the probe surface held no more than about ⅛ to ½ inch away from a dry, relatively clean surface. This is because alpha particles will lose energy as they travel, and most will only travel a maximum of one to two inches. Alpha particles are easily shielded from measurement by a piece of paper, air, or wet, damp and dust laden surfaces.

RADIATION DETECTION INSTRUMENTS (cont)

Sodium Iodide Probe

The sodium iodide probe is useful for detecting the presence of low-level gamma radiation and for locating radioactive sources. In some cases, it is useful for surveying people, property, and the environment. Background radiation can vary significantly from location to location, and these variations can be further impacted by the size of the sodium iodide crystal used in the probe. The range of “typical”background readings will depend on location and size and thickness of the crystal in the probe. Some examples of background measurement variation due to crystal size are:

- 1” x 1” crystal: 1,000-5,000 cpm
- 2” x 2” crystal: 5,000-25,000 cpm
- 1” x 1 mm crystal: 200-400 cpm.

While a pancake GM probe is better able to detect low levels of contamination on people and surfaces than a NaI probe, the NaI probe will nonetheless be a useful tool for contamination monitoring in an RDD event due to the anticipated levels of contamination that may be encountered.

RADIATION DETECTION INSTRUMENTS (cont)

Other Instruments

Radionuclide Identifier

A radionuclide identifier (also known as a multi-channel analyzer or MCA) can identify the gamma emitting radionuclide(s) present. It accomplishes this identification by analyzing characteristic energy peaks from a radionuclide and comparing it to a library of stored information. However, great caution is advised, because no identifier is correct 100% of the time, and further analyses may be necessary for proper identification of a source. Several radioisotopes emit gamma rays with energies that are similar or overlapping, or the radionuclide may not be available for comparison in the library. These are delicate instruments that are sensitive to abrupt changes in temperature and humidity. Additionally, radionuclide identifiers cannot identify a pure alpha or beta emitting radionuclide unless there is an associated gamma emitter from one of its decay products. Consequently, radionuclide identifiers may sometimes misidentify the radioisotope.

RADIATION DETECTION INSTRUMENTS (cont)

Electronic Dosimeters

Electronic dosimeters, also called personal dosimeters, or “pagers,” can be used to measure an individual’s exposure to radiation. They can also be used, to a limited extent, for detecting and measuring radiation. Generally, they may have a small sodium iodide, GM or solid state detector inside. Most can be used in either an exposure rate mode, which gives exposure per unit time, or in an integrated exposure mode, which will measure the accumulating exposure to the device until it is turned off or reset. Often they have an alarm that can be set to alert the user to a preset radiation level or a cumulative exposure. Note that many of these devices have limitations when worn in a high radiation field.

RADIATION DETECTION INSTRUMENTS (cont)

Direct Reading Pocket Dosimeter

The direct reading pocket dosimeter is a charged ionization chamber designed to measure a total dose received from moderate to high levels of gamma radiation. These instruments use a small quartz fiber electroscope as an exposure detector and indicator. An image of the fiber is projected onto a film scale and viewed through the eyepiece lens. These are small simple devices that allow the user to effectively track their dose provided the dose(s) is recorded, the chamber is properly re-charged prior to its use, and is frequently monitored during use to avoid full discharge.

RADIATION DETECTION INSTRUMENTS (cont)

The Radiation Portal Monitor

A radiation portal monitor is a system designed for rapid screening of people in the event of a radiation incident. They are similar to the portal monitors that people walk at airports, but these are designed to detect low levels of radiation. They are constructed so people can walk through them, or be in a wheelchair or on a stretcher. Some come with a vehicle adapter so vehicles can be driven through. They often use long plastic scintillation detectors that can generally detect less than one microcurie of cesium 137. The use of a portal monitor can significantly decrease the time needed to survey large numbers of people.

References

1. Mississippi Emergency Management Agency, Mississippi Radiological Emergency Preparedness Plan, Volume III 2010.

2. Conference of Radiation Control Program Directors, Inc; Handbook For Responding To A Radiological Dispersal Device, September 2006.