APPENDIX 5

EXPOSURE VS. CONTAMINATION

External Radiation Exposure

Radiation exposure occurs when a person is near a radiation source. Persons exposed to a radiation source do not become radioactive. For example, an x-ray machine is a source of radiation exposure. However, you do not become radioactive when you have an x-ray taken.

There are three cardinal rules of radiation protection for external radiation exposure from a radiation source: *reduce* time, *increase* distance and *use* shielding.

- **TIME** — The less time you spend near the radiation source, the lower your exposure will be.

- **DISTANCE** — The greater your distance from the source, the less your exposure will be. Radiation exposure decreases with distance according to the inverse-square law. That is, if you triple your distance from the radiation source, your exposure will decrease by a factor of 9 (three squared).

- **SHIELDING** — External exposure to radiation can be partially blocked by the use of shielding. Traditionally, shielding is made of lead or concrete. However, staying behind vehicles, buildings, or other objects will also decrease exposure. In an RDD event, the radiation will likely be coming from the ground and other horizontal surfaces where the radioactive materials will have been distributed by the blast.

Internal Radiation Exposure

Internal radiation exposure comes from a person inhaling or ingesting radioactive particles. Depending on the type of radiation this can cause more damage than external exposure. During an RDD event care should be taken not to breathe particles when removing clothing over the head or entering dusty radiation zones. (Holding one's breath while removing contaminated clothing over the head will reduce the possibility of breathing radioactive particles.)

Note that it takes a considerable quantity of radioactive material, if not an alpha emitting nuclide, to result in internal contamination concerns.

Contamination

Radioactive contamination results when loose particles of radioactive material settle on surfaces, skin, or clothing. Internal contamination may result if these loose particles are inhaled, ingested, or lodged in an open wound. Contaminated people can distribute loose particles of radioactive material (dust), and should be decontaminated as quickly as possible to minimize contamination spread. However, the level of radioactive contamination on any individual(s) is unlikely to cause a health risk to another individual.

Radiation Exposure and Contamination Events

There are four types of radiation accident victims:

1. *External contamination of the body surface and/or clothing by liquids or particles.* External contamination is likely when responding to an RDD, also called "dirty bomb." In a dirty bomb event, the major hazard to health and safety is the explosion itself and/or injury from shrapnel. An exception would be when a fragment of a high activity radiation source pierces the victim. In that situation, an exposure hazard may exist.

   Patients are not likely to exhibit any symptoms related to radiological contamination. A person who is externally contaminated may have internal contamination from breathing contaminated dust/dirt/air. The amount of radioactive material expected to be on the surface of the victim is not likely to cause a radiation hazard to EMS or any first responder. In most cases, external skin contamination is not life threatening and can be usually removed with soap and water.

   Use of *Universal Precautions, also known as Standard Precautions* will help prevent the spread of contamination to emergency responders. ***Emergency responders should not delay treatment of victims due to fear of becoming contaminated with radioactive materials.*** However, the victim should be handled in a manner that will reduce the potential spread of contamination to other individuals and medical equipment (e.g., stretcher, ambulance).

2. *A person who has received a significant dose from an external source(s).* This includes an exposure to a large radiation source over a short period of time or exposure to a smaller radioactive source over a longer time frame. If the exposure is sufficiently high, symptoms may include nausea, reddening of the skin and fatigue. An extremely high exposure may result in death of the victim. These symptoms may not appear immediately; it may take several days or weeks before symptoms are observed. ***Externally exposed patients do not become radioactive and therefore do not pose a risk to EMS or other first responders. Never delay medical attention.***

3. *Internal contamination from inhalation and/or ingestion of radioactive material***.** Patients who have inhaled radioactive materials will usually have detectable body, and in particular nasal contamination; however, they are not likely to exhibit any medical symptoms related to radiological contamination. Internal contamination needs to be assessed and treated in a clinical setting such as a hospital. It is extremely unlikely that the level of internal contamination would be sufficient to cause an external exposure hazard from the patient to EMS and other first responders. A person who has inhaled and/or ingested radioactive material will almost always have external contamination. Support for medical professionals in treating internal contamination is available from the Radiation Emergency Assistance Center/Training Site (REAC/TS) in Oak Ridge, TN (**http://www.orise.orau.gov/reacts/** or 865-576-3131).

4. ***A combination of any of these types.*** In this situation, using the guidance for external contamination is warranted.

APPENDIX 6

GUIDANCE FOR ASSESSING INTERNAL CONTAMINATION

To be performed by medical personnel at the hospital

While it is not anticipated that an RDD will result in internal contamination levels that will be health significant (at least not from other than alpha emitters), it may be desirable to perform a check for potentially significant internal contamination. This can be accomplished after facial decontamination by monitoring the nostril area for deposited contamination.

- If nasal area contamination is greater than 100,000 cpm using a Pancake GM or 0.5 mR/hr (for beta/gamma emitters), a nasal swab or nasal blow can be used to determine if the contamination is in the nose and therefore has likely been inhaled.
- The assistance of local/state radiation control program staff should be sought to evaluate the significance of the inhaled radioactive material. At these levels, it is anticipated that the person may have inhaled radioactive material near the radiation worker intake limit (5 rem).
- A gamma reading of approximately 0.1 mR/hr in contact with a person's decontaminated chest may also indicate the person has inhaled radioactive Cs-137 near the radiation worker intake limit.
- Medical intervention, if needed, can be performed to reduce the deposition of radioactive materials in the body, thus reducing potential damage to the individual.
- Local/state radiation control personnel will be able to assist in these evaluations.

For nasal swab collection first moisten the swab with a small amount of clean water. These swabs may then be analyzed on-site (or in some cases, sent to an off-site laboratory for analysis). Nasal swabs are useful because of their early availability, but it may be necessary to follow-up with more definitive tests, such as urinary excretion measurements and/or *in-vivo* measurements of radionuclides in the chest or whole body.

Radiation control program staff should be consulted to evaluate the significance of nasal swabs and the desirability of more definitive tests.

Additional guidance to determine internal contamination is available from the National Council on Radiation Protection (NCRP) guidance published in *Report No. 65, Management of Persons Accidentally Contaminated with Radionuclides (NCRP 65) available from* **www.ncrp.org***, and from the REACT/s site at* **www.orau.gov/reacts**.

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.

Figure 2. General Purpose Survey Meter

Note that a survey rate meter may not be accurate unless the instrument was calibrated using the same radionuclide that is being measured, and with the 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.

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.

Figure 3. Ion Chamber

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.

Probes

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 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.

Figure 4. Pancake Probe

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%

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.

Figure 5. Alpha Scintillator

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.

Sodium Iodide Probe

A sodium iodide (NaI) probe will only detect gamma radiation. It is useful for detecting very low levels of gamma radiation, and can be used in radiation fields up to about 200 mR/hr.

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.

Figure 6. Sodium Iodide Probe

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.

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*.

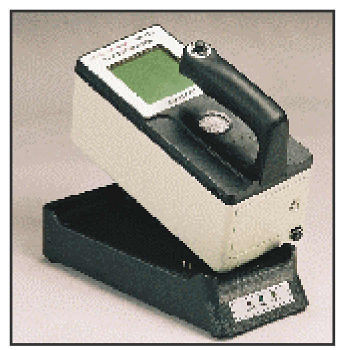

Figure 7. Radionuclide Identifier

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.

Figure 8. Electronic Dosimeters

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.

Figure 9. Direct Reading Pocket Dosimeter

Neutron Detectors/REM Ball

A REM ball is a relatively large instrument that measures neutron dose rates. They are usually only available to radiation control program staff. It is very unlikely that first responders will need to detect neutrons, because neutrons are not considered to be a significant threat in a "dirty bomb." Some radiation detection instruments also include a neutron detector; however they only provide information on whether neutron radiation is present or not, and do not provide dose rate measurements.

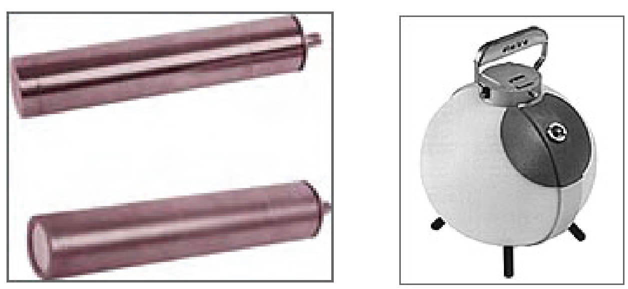

Figure 10. Neutron Detectors and REM Ball

Figure 11. Radiation Portal Monitor

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 through 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.

HOW TO PERFORM A RADIATION SURVEY FOR CONTAMINATION—INSTRUCTIONS FOR WORKERS

In performing a contamination survey with a hand-held instrument, first check to make sure the instrument is functioning properly. It is advisable to wrap the meter probe with plastic wrap to protect the probe from contamination (except if you are surveying for alpha contamination).

Make sure that the instrument has batteries and that they work. To do this, turn your instrument to battery check. If the batteries are acceptable, turn the dial to a measurement mode and use a check source to verify the instrument is operating properly.

Screening Survey

- *If a large population must be surveyed, it is acceptable to perform only a screening survey of the head, face, and shoulders, rather than a more detailed survey, since these are the most likely locations to become contaminated. You may also consider using portal monitors.*

  If only performing a screening survey, it is acceptable to hold the survey meter probe about 1-2 inches away from the body (instead of half an inch), and move it twice as fast as the normal 1-2 inches/second. (If the probe is moved too quickly, its detection capability may be reduced.) Check with state/local radiation control personnel to determine the extent of contamination survey required.

- 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.

Complete Whole Body Survey

- If feasible, perform a complete, whole body contamination survey and record the findings on the Contamination Survey Sheet. To begin a body survey, the individual should stand with their legs spread and arms extended. First holding the probe about a half-inch away from the surface to be surveyed, slowly (1-2 inches per second) move the probe over the head, and proceed to survey the shoulders, arms, and bottoms of the feet. Care must be taken not to permit the detector probe to touch any potentially contaminated surfaces.

  It is not necessary to perform the personnel contamination survey in exactly the order listed below, but a consistent procedure should be followed to help prevent accidentally skipping an area of the body. Pause the probe for about five seconds at locations most likely to be contaminated.

  1. Top and sides of head, face (pause at mouth and nose for approximately five seconds; high readings may indicate internal contamination).
  2. Front of the neck and shoulders.
  3. Down one arm (pausing at elbow), turn arm over.
  4. Backside of hands, turn over (pause at palms for about five seconds).

5. Up the other arm (pausing at elbow), turn arm over.
6. Shoe tops and inside ankle area.
7. Shoe bottoms (pause at sole and heel).

- As with the screening survey, 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.

The most common mistakes made during the survey:

- Holding the probe too far away from the surface (should be about 1-2 inches away for a screening survey or about 1/2 inch or less for a detailed survey).

- Moving the probe too fast (should be about 2-4 inches per second for a screening survey or about 1-2 inches per second for a detailed survey.)

- Contaminating the probe. Probe background should be observed and compared to initial background. If within a factor of 2, it is acceptable to continue to use probe. Otherwise, check with radiation control personnel. Wrapping the probe in plastic wrap will help prevent surface contamination.

Standard Operating Guide No. 1: Procedure for Performing a Radiation Contamination Survey

In performing a contamination survey with a hand-held instrument, first check to make sure the instrument is functioning properly. It is advisable to wrap the meter probe with plastic wrap to protect the probe from contamination (except if you are surveying for alpha contamination; see Playbook 7 to determine if alpha is present).

Make sure that the instruments have batteries and that they work. To do this, turn your instrument to battery check. If the batteries are acceptable, turn the dial to a measurement mode and use a radiation check source to verify the instrument is operating properly.

Screening Survey

If a large population must be surveyed, it is acceptable to perform only a screening survey of the head, face, hands, and shoulders, rather than a more detailed survey, since these are the most likely locations to become contaminated. You may also consider using portal monitors.

If only performing a screening survey, it is acceptable to hold the survey meter probe about 1 to 2 inches away from the body (instead of ½ inch), and move it twice as fast as the normal 1 to 2 inches per second. (If the probe is moved too quickly, its detection capability may be reduced.) If surveying for alpha radiation, hold the survey meter probe ½ inch away from the body and move it at 1 inch per second. Check with state/local radiation control personnel to determine the extent of contamination survey required.

Public that are not familiar with radiological instruments may become alarmed when they hear the “clicks” from the meter. Consider using head phones to listen to the “clicks” or turn the sound off. However, if the sound is turned off, the surveyor must look at the meter reading and watch the probe position at the same time. This will result in the surveyor taking a significantly longer time to survey an individual.

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.

Complete Whole Body Survey

If feasible, perform a complete, whole body contamination survey and record the findings on *Form No 1: Contamination Survey*. To begin a body survey, the individual should stand with their legs spread and arms extended. First holding the probe about a ½ inch away from the surface to be surveyed, slowly (1 to 2 inches per second) move the probe over the head, and proceed to survey the shoulders, arms, and bottoms of the feet. Care must be taken not to permit the detector probe to touch any potentially contaminated surfaces.

It is not necessary to perform the personnel contamination survey in exactly the order listed below, but a consistent procedure should be followed to help prevent accidentally skipping an area of the body. Pause the probe for about five seconds at locations most likely to be contaminated.

1. Top and sides of head, face (pause at mouth and nose for approximately five seconds; high readings may indicate internal contamination)
2. Front of the neck and shoulders
3. Down one arm (pausing at elbow), turn arm over
4. Backside of hands, turn over (pause at palms for about five seconds)
5. Up the other arm (pausing at elbow), turn arm over
6. Shoe tops and inside ankle area
7. Shoe bottoms (pause at sole and heel)

Standard Operating Guide No. 1 (continued)

As with the screening survey, 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.

The most common mistakes made during the survey:

Holding the probe too far away from the surface (should be about 1 to 2 inches away for a screening survey or about ½ inch or less for a detailed survey).

Moving the probe too fast (should be about 2 to 4 inches per second for a screening survey or about 1 to 2 inches per second for a detailed survey.)

Contaminating the probe. Probe background should be observed and compared to initial background. If within a factor of 2, it is acceptable to continue to use the probe. Otherwise, check with radiation control personnel. Wrapping the probe in plastic wrap will help prevent surface contamination.

Recommended procedures for on-scene responders:

1. On-scene responders should wear gloves and a gown or other protective clothing. Each responder should be provided with a personal dosimetry device.
2. Medically unstable patients should be transported to a hospital immediately.
3. A radiological survey, decontamination procedures, or steps taken to contain the contamination may be performed in the ambulance provided these actions do not interfere with more immediate medical requirements of the patient.
4. If the patient is medically stable and conditions at the site permit, limit any further exposure to radiation by moving the patient to an area of low background. The outer clothing of the individual should be removed and the patient should be wrapped in a cloth sheet or blanket to permit handling. The wrapping should be loose to avoid hyperthermia and to allow easy access to the patient by medical personnel.
5. Treat the patient's injuries (i.e., burns, cuts, etc.) sustained in the incident and, if needed, provide symptomatic treatment for the radiation illness (e.g., the use of anti-emetics).
6. If an open wound is involved, cover the wound with a clean dressing.
7. Do not release a medically stable patient to ambulance personnel before a radiological survey has been performed. If contamination is confirmed, a preliminary decontamination should be performed. Record the results of the radiological survey and proceed to decontaminate the patient.
8. Decontaminate the medically stable patient by washing the individual with tepid water to remove any radioactive contamination, beginning with the areas of highest levels of contamination. Proceed gently, mindful that this is a preliminary decontamination and that a more thorough decontamination process will be performed at a medical facility. When finished, repeat the radiation survey of the patient and record the final results. Save all clothing and bedding and all metal objects (e.g., jewelry, coins, belt buckles, etc.). A nasal swab is also recommended to detect inhalation of radioactive contaminants. However, it may be more practicable for medical personnel to perform the nasal swab.
9. Tag each item with the patient's name, location, time, and date. Save each in appropriate containers; mark containers clearly with: "RADIOACTIVE—DO NOT DISCARD."
10. Transport patient to a medical facility for further treatment. The medical facility should be given advanced warning if they are going to receive patients exposed to radiation so that the facility can institute the appropriate medical protocols. Remember, individuals suffering from radiation injury may not be radioactive, but their skin and clothing could be contaminated with radioactive material. Protection of first responders should be focused on the source of the radiation.

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(NCRP 2005, Adapted from the 1998 FBI Contingency Plan for Weapons of Mass Destruction FBI, 1998)

Standard Operating Guide No. 2: How to Distinguish Between Alpha, Beta, and Gamma Radiation Using a Pancake Geiger-Mueller Survey Meter

This instruction describes a technique using a Pancake Geiger-Mueller, and if available, a sodium iodide meter, that may be used by first responders to make a quick, initial determination of the type of radiation (alpha, beta, or gamma) present at an incident. Many studies show that the most likely radionuclide(s) to be used in a terrorism incident (like a radiological dispersal device) would be either a gamma emitter or a beta-gamma emitter. However, it is possible that the radionuclide may only emit beta such as strontium-90 or only alpha such as plutonium-239.

This methodology was developed to assist responders in making an initial determination of the type of radiation present. This determination should be used to make decisions until radiation experts arrive with more sophisticated instrumentation to verify the type of radiation and identify the radionuclide(s).

Pancake Geiger-Mueller survey meters will respond to alpha, beta, gamma, and X-rays, but have very limited response to alpha radiation. Sodium iodide survey meters will only respond to gamma or X-rays. Do not be misled into thinking that radioactive materials are not present if no radiation is detected with a sodium iodide survey meter, since it cannot detect alpha or beta radiation.

Determining the Presence of Alpha Radiation Using Only a Pancake Geiger-Mueller Meter

Materials that emit alpha are very harmful when inhaled or ingested. Therefore, it is very important to check for the presence of alpha radiation. Until the presence of alpha radiation is ruled out, responders should use appropriate respiratory protection when conducting operations and while monitoring for radiation.

Procedure

Step 1: Turn on the Pancake Geiger-Mueller meter and check that it is working properly. In an area that has not been contaminated (background area), take and record a reading (typically 30 to 100 cpm).

Step 2: Take readings at approximately 3 inches and about ½ inch (as close as possible without touching) above a smooth, hard surface with the Pancake Geiger-Mueller window (mesh covered side) facing down. If the instrument reading increases by more than a factor of three at ½ inch above the ground as compared to 3-inches above the ground, assume alpha contamination is present.

Step 3: Place a sheet of paper on the smooth, hard surface and take a reading with the window facing down at ½ inch above the paper. The alpha radiation will not penetrate the paper and the window down reading should significantly decrease to near background levels. If the window down measurement taken over the paper does not significantly decrease, the material is probably not an alpha emitter. Note that some radioactive materials that emit alpha, such as americium-241, also emit low energy gamma radiation which will not be stopped by a sheet of paper and thus will be detected by the Pancake Geiger-Mueller.

Step 4: Flip the Pancake Geiger-Mueller probe over so that the window is facing up while maintaining the detector at ½ inch above the ground. The alpha and beta radiation will be stopped by the metal backing of the probe. If the measurement taken in Step 3 at ½ inch above the paper **does not** significantly decrease, the nuclide is likely not a beta emitter. If the measurement taken in Step 3 at ½ inch above the paper **does** significantly decrease, the nuclide is likely a beta emitter.

Note that many radioactive materials emit different amounts of alpha, beta, and/or gamma radiation.

Standard Operating Guide No. 2 (continued)

Determining the Presence of Strontium-90 (or Other Pure Beta Emitters) Using Only a Pancake Geiger-Mueller Survey Meter

Strontium-90 is a pure beta emitter and will not be detected by a sodium iodide instrument or other types of gamma identification survey meters. However, strontium-90 beta radiation can be easily detected and measured with a Pancake Geiger-Mueller. Suspect the presence of strontium-90 if a Pancake Geiger-Mueller meter reads between 1,000 cpm and 10,000 cpm (20 to 200 times background), but there is no corresponding increase in readings using a sodium iodide survey meter (still reads near background).

When strontium-90 is shielded by certain materials, the beta radiation cannot be detected. However, the interaction of the beta radiation with the shielding materials can produce X-rays, which can be detected by the Pancake Geiger-Mueller, sodium iodide, and other types of gamma identification survey meters.

Procedure

Step 5: Take a measurement with the window side of the Pancake Geiger-Mueller probe (mesh covered side) facing down at approximately 6 inches from the ground in an area where the meter reading is between 500 cpm to 1,500 cpm. Then take another measurement with the window side facing up (away from the ground) at the same height.

Step 6: Compare the two measurements.

Step 7: If only strontium-90 (or another pure beta-emitter) is present, the window up reading will be near background (depending on the model of the Pancake Geiger-Mueller probe, background should be in the range of 30 cpm to 100 cpm), and the window facing down reading should be 10 or more times greater than the window facing up reading. This is because the beta radiation is not able to penetrate the back side of the metal Pancake Geiger-Mueller probe.

Step 8: If a gamma or beta-gamma emitter is present (e.g., cesium-137, iridium-192, cobalt-60), the window facing down reading at 6-inches will be approximately twice the window up reading.

Step 9: Take another measurement with the window side of the Pancake Geiger-Mueller probe facing down at approximately 3 feet from the ground in an area where the meter reading is between 500 cpm to 1,500 cpm. Then take another measurement with the window side facing up at the same height. Compare the two measurements. If a gamma emitting nuclide is present, both readings will be approximately the same.

(Adapted from CRCPD 2006)

SUGGESTED MASS DECONTAMINATION SUPPLIES LIST

- Caution line tape to mark off perimeters and areas of operation
- Survey meters
- Soap
- Disposable absorbent towels
- 5 gallon buckets
- Hazardous waste containers, bags, or drums
- Tarps (*to be used for privacy and/or wind break)*
- Redress "modesty" packs, which include a scrub or "Tyvek" type suit in varying sizes, or other available post-decontamination clothing and slippers.
- Gallon size "zip lock" bags for victims' belongings
- Indelible black markers for marking victims' belongings and hazardous waste bags
- Preprinted numbered labels for tagging victims, survey form and clothing/valuable bags
- Contamination survey forms
- Pens and pencils
- Clipboards or tables to write on
- Water diversion or collection equipment if necessary
- Point of contact listing of local and state support assets