Guidelines for Handling Decedents Contaminated with Radioactive Materials

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April 26, 2007

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Summary

Detonation of a nuclear weapon or activation of a radiological dispersal device could cause radioactively contaminated decedents. These guidelines are designed to address both of these scenarios. They could also be applicable in other instances where decedents' bodies are contaminated with radioactive material (e.g. reactor accidents, transportation accidents involving radioactive material, or the discharge of a decedent from a hospital after injection or implantation of a radiopharmaceutical). These guidelines suggest ways for medical examiners, coroners, and funeral directors to deal with loose surface contamination, internal contamination, or shrapnel on or in decedents' bodies.

Introduction

There are several scenarios involving accidents, terrorist attacks, or medical treatments that could result in radioactively contaminated fatalities. Examples include a transportation accident involving radioactive material, a reactor accident, activation of a radiological dispersal device, detonation of a nuclear weapon, or release of a body injected with a radiopharmaceutical or brachytherapy seeds from a hospital.

Although there are laws regulating radioactive material in live patients (1) or in industrial materials (2), there are no federal regulations regulating radioactive material in human remains. There is some published guidance on special cases of radioactively contaminated decedents, such as from medical sources (3), transportation accidents (4), or the military (5). There are state regulations or common carrier policies for shipment of decedents; and federal regulations for shipment of radioactive material (6)

There have been very few exercises in recent years involving radioactively contaminated fatalities, and those generally end with remains recovery at the scene without involving medical examiners, coroners, or funeral directors.

At the same time that work on these guidelines was in progress, the National Association of Medical Examiners (NAME) was preparing its own guidelines (7) for dealing with contaminated decedents and the National Council on Radiation Protection and Measurements (NCRP) was revising its report on handling contaminated persons (8) to include a chapter on fatalities. The authors of these three documents worked together to ensure all three final guidelines would be consistent.

Key Concepts

Radiation as used in this paper includes the charged particles or electromagnetic rays emitted from the nuclei of unstable atoms. Contamination is the presence or radioactive material in an inappropriate place.

Contamination can be external, internal, or shrapnel. 90% of the external contamination on a person can be eliminated by removing clothing (9) and the rest by washing. Internal contamination is radioactive material which entered the body through inhalation or ingestion.

When a person inhales or ingests radioactive material, it is resident in the lungs or gastrointestinal tract for a while. It will be slowly absorbed by the blood and eventually become resident in an organ or tissue. At any given time the amount in the blood is miniscule. This internal contamination cannot be removed but will not emit enough radiation to be hazardous to anyone else (10).

Small pieces of radioactive material embedded in tissue by the force of an explosion could emit enough radiation to cause emergency responders or medical examiners to exceed regulatory limits or experience deterministic effects (10). They can be surgically removed.

The terms dose and dose rate are used to explain the hazards of working with radioactive material. Dose is the amount of energy from radiation absorbed in tissue. The dose rate at a given location is the amount of energy per unit time a person standing at that location would absorb (11).

Radiation has two effects on health, deterministic and stochastic. A deterministic effect is a clinically observable symptom, such as hair loss, nausea, or changes in lymphocytes in the blood. The severity of a deterministic effect is directly proportional to the dose. Time duration from exposure to manifestation of symptoms is inversely proportional to the dose. (12) A stochastic effect is a long term effect that may or may not happen, like cancer. The risk of a stochastic effect is proportional to the dose, but the severity of the effect is independent of dose.

Federal regulations limit the annual radiation dose to a worker or to a member of the public (2), or the dose a member of the public can receive from a nuclear medicine patient (1). Regardless of the regulatory limit, it is good practice to keep any radiation dose as low as reasonable achievable. (ALARA is a well-known acronym in the nuclear industry.)

Any radiation dose should be avoided unless there is some benefit from that dose. It is useful in explaining doses to people who are not health physicists to compare their doses to doses from familiar sources like chest radiographs or airline flights. (Table 3)

For more information on these concepts readers may refer to CDC's on line glossary of terms (11) at http://www.bt.cdc.gov/radiation/glossary.asp.

Scenarios

Detonation of a Nuclear Weapon

The energy from detonation of a nuclear weapon is released as blast (50%), extreme heat (35%), prompt radiation (5%), and delayed radiation in fallout (10%). (13) This energy comes from the splitting of plutonium or uranium atoms into smaller fission product atoms. The fission product atoms are the source of most of the radiation.

When a nuclear weapon detonates, everything inside the fireball vaporizes. The fireball rises rapidly, pulling debris up under it. This creates the mushroom cloud associated with a nuclear detonation. As the fireball cools, the vaporized material condenses into small particles. The condensing particles trap fission products, making them highly radioactive. The mushroom cloud contains about 90% of the radioactive fallout and the stem about 10% (13).

Within 5 minutes after the explosion, the mushroom cloud stabilizes and starts to move downwind. The particles within it begin to settle to earth. Persons downwind from the explosion could be exposed to enough radiation from fallout to cause sickness or death within a few days.

The mixture of fission products in fallout decays rapidly. The dose rate after a detonation can be precisely calculated using the following formula (13):

$$\text{Dose rate} = \text{Initial dose rate} \times t^{-1.2}$$

These dose rates can be estimated using the Rule of Seven, which states that the dose rate decreases by a factor of 10 for each sevenfold increase in time following a fission detonation. (Table 1). This rule is valid for only the first 2 weeks after a detonation. Rain accelerates the decrease in dose rate in an area.

Table 1. Rule of Seven for Radiation Dose Rates

Elapsed Time	Percentage of Initial Radiation Dose Rate Remaining
0 hour	100%
7 hours	10 %
49 hours (2 days)	1%
343 hours (14 days)	0.1%

Deaths Caused by Detonation of a Nuclear Weapon

The detonation of a nuclear weapon would produce both initial and delayed deaths. Initial deaths would include persons at or near ground zero killed by blast, heat, or flying objects. Delayed deaths would include persons who died because of injuries sustained in the initial blast, persons who died from acute radiation syndrome, and persons who died from a combination of injuries and acute radiation syndrome. (One deterministic effect is suppression of the immune system, making burn victims more difficult to treat.)

Persons who die immediately because of the blast could have external contamination on their skin and clothes. They will not have internal contamination if they died before they had time to inhale or ingest radioactive material. Because everything inside the fireball is vaporized, radioactive shrapnel is not likely.

Persons who die hours or days later might have inhaled or ingested radioactive material. Their internal contamination cannot be eliminated, but the dose rates from this source of contamination will be too low to pose a health risk for other persons in the vicinity of the body. (10)

Activation of a Radiological Dispersal Device

A radioactive dispersal device is designed to spread radioactive material and contaminate humans and the environment. Material can be spread by mechanical means (e.g. a spray plane) or through the use of high explosives (a "dirty bomb"). A dirty bomb will consist of one or two longer lived isotopes (14), so measured dose rates may persist for days or weeks. The explosion from a dirty bomb would not be as powerful as that from a nuclear weapon, and it would not release as much radioactivity because the splitting of atoms does not occur.

Deaths Caused by a Radiological Dispersal Device

Immediate deaths from a dirty bomb would be caused by the blast itself, not the radioactivity. The decedents might have external contamination or shrapnel. Delayed fatalities could be caused by injuries suffered in the blast, by acute radiation syndrome, or a combination of the two. These decedents could have internal contamination.

Radioactive Source in a Public Place

A high-level radioactive source in a public place (e.g. movie theater or city bus) could expose a large number of persons to enough radiation to cause deterministic effects. The symptoms of acute radiation syndrome (e.g. skin burns, influenza-like symptoms) could take days or weeks to develop. Many persons could develop symptoms of acute radiation syndrome before the first deaths.

A person exposed to a radioactive source does not become radioactive. No special precautions are required for handling the remains of persons killed by exposure to an external radiation source.

Objectives

As stated above, there are no specific laws regulating the treatment of radioactively contaminated decedents, nor is there a specific right or wrong procedure. Medical examiners, coroners, funeral directors and health physicists will have to devise working procedures for each situation. The objectives, in priority order, are:

No one will suffer a deterministic effect. If workers keep their exposures below the annual limit for a radiation worker (2) they will not incur any deterministic effects (Table 3).

Medical examiners or coroners will perform a professional medicolegal investigation in order to identify decedents scientifically and determine the cause and manner of death. Medical examiners will receive some radiation exposure in order to perform their work both at the scene and in the morgue.

Human remains will be treated with dignity and respect. Human remains will be processed as expeditiously as possible and released to the families. If bereaved family members want a funeral with a viewing or the religious practice of the decedent calls for a ceremonial washing, this will be allowed even though it causes some additional radiation exposure.

Medical examiners will minimize the spread of contamination. Decedents will be transported to a field morgue with clothing and personal effects intact, even though this may spread contamination. However, the practices employed in the morgue will prevent any further spread.

Radiation exposures will be kept as low as reasonably achievable. No one should receive a radiation exposure unless there is some benefit. Conducting a proper investigation is a benefit, and respecting the religious or emotional needs of the bereaved family is a benefit.

Instruments

It is not possible to work safely in the presence of radiation without instruments to measure that radiation. Instruments are expensive, they require annual calibration, and operators must be trained in their use. If medical examiners, coroners, or funeral directors do not want to purchase their own equipment they should partner with nearby nuclear facilities, hospitals with nuclear medicine departments, or their state radiation control program directors.

Different instruments are required for area surveys for safety, checking people or equipment for contamination, and dosimetry. Organizations who want to obtain their own equipment can find additional information in the Conference of Radiation Control Program Directors' Handbook for Responding to a Radiological Dispersal Device (15), or they can contact their own state radiation control program director.

For general area surveys an omnidirectional instrument is required. These may be a Geiger Counter (Figure 1) or a sodium iodide detector (Figure 2). The team needs detectors that can detect normal background radiation. However, some low range instruments saturate and show zero readings in high dose rate fields, so a combination of instruments will be required.

Figure 1

Figure 2

For checking people or equipment for contamination a directional probe should be used (Figure 3) to ensure the radiation measured is from the surface being checked. It may become necessary to remove contaminated decedents or equipment from the scene. In this case they will be placed in bags. It is not possible to check the outside of the bag for contamination with a pancake probe because it will sense the radiation from inside. The equipment on hand should include swipes. Swipe the exterior of the bag with absorbent material, then put the swipe down away from the source and count it.

Some manufacturers sell emergency response kits that contain one meter that works with all the probe types described above (Figure 4).

Figure 3

Figure 4

When using a probe to check a surface for contamination, the user needs to determine 3 parameters from the manufacturer – speed of the probe, height above the surface, and distance between consecutive surveys.

These guidelines use FEMA guidance developed for a mix of fission products from a reactor accident (Table 2).

Table 2:

Recommended Parameter Values for Detecting Contamination on Individuals[a]

[a]These values are based on the ability to detect 0.1 µCi of contamination on a small spot of skin in background gamma radiation levels up to 0.1 mR/h, except as noted. Refer to Table 4 of the Background Information Document for more detailed information.

Instrument/ Detector Combination	Parameter Values for Detecting Spot or Widespread Contamination on Individuals			Calculated Time Needed to Monitor an Adult (minutes)
	Probe Speed (inches/second)	Height of Probe (inches)	Path Width (inches)	
CD V-700 with side window detector[b]	4	0.25 to 0.5	0.6	19
CD V-718 with cnd window detector	3	0.5 to 1	1	12
All tested instruments with pancake detectors, except the Victoreen 190	6	1 to 3	2	3.9
Victoreen 190 with pancake detector[b]	6	1 to 4	3	2.6

[b]Audible detection is not possible in a background gamma radiation level of 0.1 mR/h. Values are for use in background levels of 0.02 mR/h or lower.

It is necessary to measure and record each individual's dose. Normally a self reading dosimeter (Figure 5) is used for this purpose. At the scene of emergencies electronic dosimeters that read both dose rate and cumulative dose can be used.

Figure 5

When transporting a contaminated decedent in a body bag or contaminated personal effects in an evidence bag, it is necessary to ensure the exterior of the bag is not contaminated. Surveying the surface of the bag is not possible because the detector would register the radiation emanating from the interior of the bag. The surveyor can swipe or smear the exterior of the bag with a small piece of absorbent paper and count the smears with a pancake probe. A radiation survey equipment kit should contain swipe papers in addition to the survey instruments.

Decedent Operations

Medical Examiner/Coroner Normal Scene Operations

Firefighters, policemen, and emergency medical technicians must act as needed to protect property and save lives. Medical examiners and coroners do not operate with the same urgency. A death scene investigation conducted in the presence of hazardous materials will require the development of a plan of operation, including appropriate safety precautions. These guidelines will only address additions or modifications to this plan of operation that would be required for working with radioactive materials.

The medico-legal investigative team will typically consist of three people – a medico-legal investigator, a photographer, and a scribe. (Figure 6) The photographer will provide photo documentation of the decedent and scene as required. The medico-legal investigator will dictate to the scribe the appearance of the decedent, clothing, wounds, and any other relevant information. To preserve the integrity of the victim's identification personal property must not be removed or disturbed in the field. Only after this investigation is complete will the body be placed in a body bag and removed from the scene.

Medical Examiner/Coroner Radiation Protection Precautions at the Scene

The incident commander should designate a radiation safety officer to oversee the radiological precautions, select the instruments to be used, and establish administrative limits on radiation doses for all workers. The annual limit on dose to a radiation worker is 5 rem (2).

If the cause of death was detonation of a nuclear weapon, consider delaying remains recovery operations for one or two days to allow the fission products to decay. If the cause of death was a dirty bomb, there is no benefit to delaying operations.

In addition to the normal protocols for human remains removal, the radiation safety officer should cordon off the area and designate a person to control entry and egress. In a nuclear power plant this person is called the "control point watch" and his station the "control point." The control point watch will record the name, time in, dosimeter serial number, dosimeter reading in, time out, and dosimeter reading out for each person entering the scene.

All people working in the controlled area should carry two dosimeters. They should have a thermoluminescent dosimeter (TLD) inside their protective clothing and a self-reading dosimeter (Figure 7) outside the protective clothing where they can read it. The TLD reading will eventually constitute the legal record of exposure. The electronic dosimeter is for safety, but in an emergency it can be used as the legal record of exposure.

Figure 6

Figure 7

Before the human remains removal team enters the area, two people should enter and conduct an initial survey using an omnidirectional probe. To prevent contamination of the instrument, the probe and the meter should be wrapped in clear plastic. Observe the instrument during the entry to ensure it does not saturate.

The two people should stay in sight of one another for safety. One person will move around the scene pausing to measure and announce dose rates. The other person will remain in a low dose rate area and record the dose rates on a map or sketch of the area (Figure 8). The map showing locations of the bodies and dose rates in the area will be used by the remains recovery team to plan their operations.

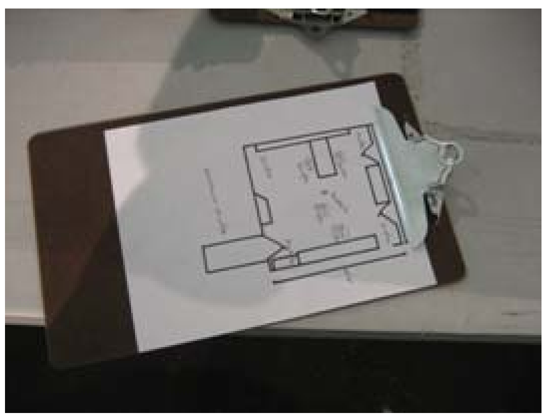

Figure 8

In addition to the normal safety briefing, the radiation safety officer should establish an administrative limit on worker doses based on the area dose rate and the time required to do the job. This should be well below the annual limit of 5 rem for a radiation worker (2). For example, suppose there are 2 bodies requiring ½ hour each to process and the highest dose rate in the area is 100 millirem per hour.

100 mrem/hr x 0.5 hrs/body x 2 bodies = 100 millirem

In order to stay below this limit, workers should frequently check their dosimeters and move to a low dose rate area when not working. When possible, employ a policy of “one person at a time.” For example, when the photographer is working, the investigator and the scribe can move to a low dose rate area; and they can use the map to select a route to that area that avoids the high dose rate area.

When the investigation at the scene is complete, they will place the body into a body bag. Some jurisdictions use plastic remains containers for the body bags (Figure 9). This is recommended, because the team can transport the body bag out of the area and lower it into the plastic container. The exterior of the container is clean and can be transported out of the controlled area without spreading contamination.


Figure 9

The body inside the body bag is emitting radiation, so the body bag or container cannot be frisked at the control point. Swipe the container with a piece of tissue, place the swipe paper on a clear surface away from the body, and check it with the pancake probe to ensure the exterior of the body bag is free of contamination. If there is no possibility of alpha- or beta-emitting isotopes, wrap the pancake probe in plastic to prevent its contamination.

There should be a table outside the cordoned off area at the control point, divided into a clear and a contaminated section. When the initial survey team exits the area, each piece of equipment – survey instrument, radio, dosimeter, etc – should be surveyed the by control point watch or another team member wearing gloves and using a pancake probe. The surveys should be done in accordance with FEMA guidelines (Table 3) (16) or vendor’s instructions for the instrument in use. Place clean or contaminated items on the appropriate side of the table.

Normal Procedures in the Morgue

In a disaster involving multiple fatalities, the medical examiner or coroner may establish a field morgue near the scene particularly if the possibility exists of hazardous material contamination. A typical field morgue consists of an initial triage area and an examination table where evidence and personal effects can be recovered and documented. (Figure 10) X-rays if required can also be accomplished in the field through the usage of portable X-ray equipment.

Figure 10

The field morgue staff is typically comprised of a pathologist, a morgue technician, a scribe, an anthropologist, medico-legal investigator, evidence collection and law enforcement personnel, and a photographer. During the initial examination the investigator will check for identification (e.g. credit cards, driver's license) or jewelry. He will dictate his observations to the scribe. He will remove one layer of clothing at a time, describing them for the record; as the photographer documents each step of the process. Personal effects will be laid out on the evidence table, photographed, documented and placed into evidence bags and tagged.

The decedent, now undressed will undergo an examination by the pathologist. A law enforcement agent will take fingerprints and photographs; and a pathologist or other qualified staff may aquire a small biopsy or saliva swab for DNA.

Radiation Protection Precautions in the Morgue

Establish a triage station outside the control point, with a table for the remains containers and body bags and a technician equipped with gloves and a survey meter. The radiation technician should perform the triage. Survey each body. If a body reads greater than 100 millirem per hour with the probe 1 inch away, that body should be moved to a refrigeration unit at least 30 feet from the work area. This will prevent the morgue staff from exceeding their dose limits on the first few decedents; it will allow the morgue staff to consult with a health physicist and devise a special work plan; and if the source of the radiation is a mix of short-lived isotopes it will allow radioactive decay to decrease the dose rate.

Decedents that have no contamination (15) can be transported to the city morgue or to an uncontaminated field morgue for further processing. These are the only bodies that require a complete survey – front and back, inside the remains container, and inside the body bag.

Bodies that have measurable contamination below 100 millirem per hour should be sent to the field morgue. Prior to beginning processing the radiation safety officer should establish administrative limits on workers' doses based on the measured dose rates from the decedents and the number to be processed. This could be a total cumulative dose, such as 200 millirem for the entire operation; or if the number of expected decedents is not yet known it may be a limit like 25 millirem per decedent.

Workers in the morgue can minimize their doses by moving away from the work area when not doing something. This is an appropriate place for the "one person at the table at a time" rule. If available, use of remote cameras can reduce the number of people required at the scene.

If the decedent contains radioactive shrapnel, consider surgically removing it as early as practicable in the process without hampering the investigation. Do not touch the shrapnel with the hands. Place a specimen jar in a bucket. Remove the shrapnel with forceps and place it in the specimen jar. Place the bucket 30 feet or more from the work area.

After the forensic examination and victim identification process is complete decontaminate the decedent. This could be done in the final examination area, or the decedent could be moved to secondary decontamination area. Use of a dry vacuum with a HEPA filter is acceptable if none of the contaminants are volatile. This minimizes runoff. A spray and wet wipe is also effective. Washing with soap and water is a last resort. Decontaminate the body until it meets the FEMA standards (Table 2; 16).

Survey the decedent. Any area reading above the FEMA recommendations (Table 2) should be decontaminated again. Surgically remove any shrapnel. If the decedent is still contaminated consider the contaminant internal contamination. Tag the decedent with the dose rate, distance of the probe, date, and time; and release the decedent to the funeral home.

Normally the medical examiner or coroner will return personal effects to the family unless they have some forensic value. In this case consider returning only personal effects that have monetary or sentimental value and are easily decontaminated (e.g. watches or rings).

Autopsy

An autopsy normally entails extensive handling of internal organs by gloved hands. An autopsy may result in fairly high doses to the pathologist's hands. Also, an autopsy disrupts the circulatory system, so an embalmer will have to work longer in close proximity to a body that has been subjected to an autopsy. Do not perform an autopsy if there is internal contamination, unless it is absolutely necessary.

Normal Procedures in the Funeral Home

Embalming is not required unless a decedent is to be shipped by a common carrier or if there is to be a funeral service with a viewing. Many states require a certificate of embalming for shipment by common carrier. The Defense Department ships decedents in body bags in shipping containers with ice without embalming. Embalming is required for esthetic reasons if there is to be a viewing; most funeral directors will not allow bereaved family members to view an unembalmed body.

In the preparation room at the funeral home, the embalmer will place the body on a preparation table (Figure 11). This is a tilted metal or plastic table with grooves in the side and a drain hose at the bottom. The embalmer inserts a canula (Figure 12) into the carotid artery and uses a compressor to pump embalming fluid. The blood is drained via another canula onto the table, out the drain, and into the sewage system.

Figure 11

Figure 12

Figure 13

Next the embalmer uses a trocar (Figure13) to remove body fluids from the gastro-intestinal tract and lungs, then uses the same instrument to pump in cavity fluid. After completing cosmetic work as required the body is ready for a viewing.

Procedures for Radioactively Contaminated Decedents in the Funeral Home

If radioactive contamination is suspected and the medical examiner cannot certify that he has complied with CDC's guidelines, the funeral director should consider rejecting the decedent. If this is not feasible, find a radiation technician who can conduct a survey of the body and provide dose rate information. Do not attempt to embalm or work near a decedent with an unknown dose rate.

Recommend to the family that they bury the decedent immediately and conduct a memorial service without a viewing. If this is not acceptable for emotional, cultural, or religious reasons then embalming is required. The funeral director will have to estimate the exposures to the person performing the embalming and to the family members.

Medical examiners should have provided a tag indicating the dose rate from the decedent and the distance from which it was measured. Dose rate decreases with the square of the distance, so encourage family members and friends to minimize their time next to the decedent.

Sample calculation:

> Dose rate at 1foot = 10 millirem / hour
> Dose rate at 3 feet = 10 x $(1/3)^2$ or 1.1 millirem / hour
> A person standing 3 feet from the decedent for ½ hour would receive 0.5 millirem.

Avoid the use of adjectives like “safe” or “dangerous.” Compare the estimated dose to a familiar source like chest radiographs, airline flights, or dental radiographs (Table 3).

Table 3. Examples of Radiation Doses

Examples of Radiation Doses	Dose in millirad
1 year of gas range use	4
1 hour airline flight above 30,000 feet	0.3
1 year living in Maryland	15
1 year living in Colorado	65
1 chest X-ray	20
1 year exposure to naturally occurring radioactive material in the human body	40
1 year of exposure to background radiation (all sources)	300
1 year regulated limit to a member of the public	500
1 year regulated occupational limit	5,000
Threshold for acute radiation syndrome	50,000
50% Fatality dose	500,000

The embalmer can use the canula to inject fluid and drain the blood. No special precautions are required for this step. Do not perform the aspiration step with the trocar. Inject cavity fluid without first aspirating the lungs and gastrointestinal tract.

Cremation

Do not cremate a decedent whose body contains man-made radioactive material. When a decedent is cremated all volatile materials escape up the refractory. After completion of cremation the crematory staff will manually pulverize the ashes before returning the remains to family members. Non-volatile radioactive material poses an airborne respiratory hazard to the crematory staff plus a risk of contaminating the crematorium.

Shrapnel or brachytherapy seeds will not be destroyed in the process of cremation. If cremation is desired and the source is shrapnel, brachytherapy seeds, or some other discrete source, surgically remove it.

Burial

Select a burial container that will delay the release to the environment as long as practicable. Wooden caskets are not sealed. Metal caskets have a seal that will release pressure from inside the casket, but will retard the entry of ground water. Place the body in a metal casket, not a wooden one, and place the casket in a concrete vault lined with plastic. Use the type that has a lid with a rubber gasket with a tongue in groove seal (Figure 14). In the cemetery, place the lid on the vault above ground where it can be inspected for a tight fit before lowering into the grave.

Figure 14

If the dose rate on the exterior of the vault exceeds 100 counts per minute above background or exceeds 2 x background, burial in the ground and not in an above ground mausoleum is recommended.

Sometimes buried bodies must be exhumed because of natural disasters or urban expansion. A discreet radiation warning label on the exterior of the vault indicating dose rate from the body and date and time of the measurement would be prudent.

Transportation

Prior to release of the decedent for transport, medical examiners should meet the same standards as for release to a funeral home – no loose surface contamination or shrapnel. The carrier should require the medical examiner to certify that he has met this standard prior to accepting contaminated human remains.

Decedents are normally transported in sealed containers. The standards imposed by the airlines or by states for transport of uncontaminated remains are more than adequate. The presence of radioactive material imposes no additional requirements for the shipping container.

Internal contamination is not volatile. Once a person dies, whatever radioactive material is in the body will stay there until it is eliminated by natural radioactive decay. Dose rates outside a body with internal contamination will be small (7).

US Department of Transportation regulations for shipment of radioactive sources assume a known number of curies (6). The dose rate external to the decedent can be measured, but the number of curies will not be known for the victim of a terrorist attack. It would be prudent to place a DOT warning label (6) on the exterior of the container displaying dose rate and the date and time of the measurement even though the amount of radioactive material is not known.

Additional Resources

Medical examiners, coroners, and morticians can contact the radiation control program director of the state in which they operate for more information. The directory of the Conference of Radiation Control Program Directors is available at http://www.14.org or (502) 227-4543.

CDC has posted useful material on radiation emergencies at http://www.bt.cdc.gov/radiation/index.asp. CDC also has a 24-hour telephone number at 1-800-CDC-INFO.

The Department of Energy's Radiological Emergency Assistance Center / Training Site (REAC/TS) at Oak Ridge can provide medical advice during a radiological emergency. Call 875-577-1005 and ask for REAC/TS.

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