RADIOACTIVE MATERIALS

TRANSPORTATION AND INCIDENT RESPONSE

FEMA

U.S. Department of Energy

Transportation Emergency Preparedness Program

Q&A About Incident Response

FEMA 358, 05/10

	Phone Number	Radio Frequency
Law Enforcement		
Fire		
Medical		
State Radiological Assistance		
Local Government Official		
Local Emergency Management Agency		
State Emergency Management Agency		
HAZMAT Team		
Water Pollution Control		
CHEMTEL (Toll-free US & Canada) 1-800-255-3924		
CHEMTREC (Toll-free US & Canada) 1-800-424-9300		
CHEMTREC (Outside US) 1-703-527-3887		
National Response Center (Toll-free US & Canada) 1-800-424-8802		
In Washington, D.C. 1-202-267-2675		
Military Shipments (DoD) Call Collect 1-703-697-0218		
Other:		
Other:		

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Q&A About Incident Response

NOTES

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INTRODUCTION

Radioactive materials are among the many kinds of hazardous substances emergency responders might have to deal with in a transportation accident. Because strict packaging requirements are used in the shipment of radioactive materials, accidental spills or releases of these substances seldom occur. Very few emergency responders have ever had to deal with transportation accidents involving radioactive materials, and these accidents will continue to be rare occurrences. Nevertheless, it is prudent for you, as an emergency responder, to know your role in responding to such an accident should one occur in your community.

Like most emergency first responders, you might have questions about these accidents and your involvement in them. This booklet was written to answer questions most frequently asked by fire fighters, law enforcement officers, and emergency medical services personnel. The booklet is not intended as a substitute for the US Department of Transportation (DOT) *Emergency Response Guidebook (ERG)* for hazardous materials incidents. Remember that some radioactive materials can also be chemically hazardous. Use the *Emergency Response Guidebook* and the appropriate guide during any transportation accident involving a hazardous material.

Note that words appearing as *italics* text with an underline are defined in the glossary at the end of this booklet

What is radiation?

Radiation is energy that comes from a source and travels through some material or through space. Light, heat, and sound are types of radiation. The kind of radiation discussed in this booklet is called *ionizing radiation* because it can produce charged particles (ions) in matter.

Ionizing radiation is produced by unstable *atoms*. Unstable atoms differ from stable atoms because they have an excess of energy or mass or both.

Unstable atoms are referred to as radioactive atoms. In order to reach stability, these atoms give off, or emit, the excess energy or mass in the form of particles or rays. These emissions are called radiation. The kinds of radiation are *electromagnetic* (like light) and particulate (i.e., mass given off with the energy of motion). Gamma radiation and *X-rays* are examples of electromagnetic radiation. Beta and alpha radiation are examples of particulate radiation. Ionizing radiation can also be produced by devices such as X-ray machines.

Radioactive material used in medicine, research, and industry

Irradiation occurs when a person is exposed to penetrating radiation. This can occur from a variety of radiation sources. Commonly encountered sources include those used in medical and industrial applications. The photos above and to the right (clockwise from top) show packages containing radiopharmaceuticals, a box containing radioactive sources used in research, and a soil density gauge used for testing the compaction of soil.

There is a "background" of natural radiation in our environment. It comes from *cosmic rays* and from naturally occurring radioactive materials contained in the earth and in living things.

Natural background radiation exposure.

What is radiation exposure?

Radiation exposure or *irradiation* occurs when all or a part of the body is exposed to radiation from an radioactive source.

Exposure to radiation alone does not make a person radioactive.

Radiation from Various Sources

Natural Background Radiation
- US Average, 100 mrem/yr (1 mSv/yr)

Natural *Radioactivity* in Body Tissue
- 50 mrem/yr (.5 mSv/yr)

Air Travel Round Trip (London-New York)
- 4 mrem (.04 mSv)

Chest X-ray
- 10 mrem per test (.1 mSv per test)

CT Scan of Abdomen/Pelvis
- 1,000 mrem per test (10 mSv per test)

Radon in the Home
- 200 mrem/yr (variable) (2 mSv/yr)

According to NCRP Report 630, the average Annual Dose in the United States from Natural and Man-made Sources is Approximately 630 mrem

Radiation is often measured in units of microR (μR) or milliR (mR) per hour. Typically, background radiation levels range from 5 to 20 μR/hour.

How can I detect radiation?

Radiation cannot be detected by human senses. A variety of instruments are available for detecting and measuring radiation.

Examples of Radiation Survey Meters

CD V-700

ADM-300

RO-20

Use the CD V-700 to measure gamma radiation. With its probe shield in the open position, this meter can detect beta radiation. This instrument can *saturate* in radiation fields that are greater than 1 R/hr.

The ADM-300 detects beta and measures gamma radiation. An external gamma probe is also available for remote area monitoring to 10,000 R/hr.

The Eberline R0-20 detects beta and measures gamma radiation up to 50 R/hr. It has various range levels making it useful for measuring areas with low to moderate radiation levels.

How is radiation measured?

Radiation is measured in units called *rads*, *rem*, or *roentgens* (R). For practical purposes, these are considered equal. Milli (m) means 1/1000. For example, 1,000 mrem = 1 rem. Micro (μ) means 1/1,000,000. One million μrem = 1 rem. "*Gray*" and "*Sievert*" are SI units (International System of Units).

1 Gray = 100 rads
1 Sievert = 100 rem

Is it safe to be around sources of radiation?

Too much radiation exposure can be harmful. The degree of radiation injury depends on the dose of radiation received. In general, the higher the dose, the greater the severity of early effects (occurring within a few weeks) and the greater the possibility of late effects such as cancer.

The BEIR V (Biological Effects of Ionizing Radiation) Committee of the National Research Council estimates that, among 100,000 people exposed to a one-time dose of 10 rem and followed over their life span, about 790 more would die of cancer than the estimated 20,000 cancer deaths that would be expected among a non-exposed group of the same size. Biological effects from a one-time, acute, exposure are shown in the table below. It is important to note that the doses producing effects listed below are consider large doses and have never been experienced in a transportation-related accident. Because of package design and safety, there has never been an injury or death resulting from the release of radioactive material in a transportation accident.

Biological Effects of Acute, Total Body Dose

Amount of Exposure	Effect
5 rem	No detectable injury or symptoms.
25 rem	A slight decrease in white blood cell count and a possible drop in blood platelet count (no detectable outward symptoms).
100 rem	May cause nausea and vomiting for 1-2 days and a temporary drop in production of new blood cells.
350 rem	Nausea and vomiting initially, followed by a period of apparent wellness. At 3-4 weeks, there is a potential for infections and bleeding due to a deficiency of white blood cells and platelets. Medical care is required.

Doses above 350 rem may be fatal.

How can I keep radiation exposure low?

Although some radiation exposure is natural in our environment, it is desirable to limit radiation exposure as much as is possible or practical. This is known as the ALARA principle (as low as reasonably achievable).

Radiation Protection Guidelines

Time: The shorter the time spent in a radiation field, the less the radiation exposure. Work quickly and efficiently. A rotating team approach can be used to keep individual radiation exposures to a minimum.

Distance: The farther a person is from a source of radiation, the lower the radiation dose. Do not touch radioactive materials. Use shovels, long-handled tools, etc., to move materials to avoid physical contact.

Shielding: Although not always practical in emergency situations, shielding offered by available barriers such as a squad car or fire truck can be used to reduce radiation exposure.

Quantity: Limit the amount of radioactive material in the working area to decrease exposure.

What guidance is available for emergency responders?

There are a number of resources available that can be used to establish recommendations towards maximum emergency responder dose. The EPA's guidance provides greater than 25 rem (0.25 Sv) for lifesaving activities or protection of large populations (EPA 400-R-92-001). There is no upper limit provided by the EPA guidance. The FEMA RDD/IND Protective Action Guidelines (PAGs) (FEMA 2008) modify the EPA 400-R-92-001 guidance slightly however, the numbers remain the same (i.e., 5, 10, 25 rem). The National Council on Radiation Protection and Measurement (NCRP) (NCRP Report No. 116), International Commission on Radiological Protection (ICRP) (ICRP Publication 96), and the Conference of Radiation Control Program Directors (CRCPD 2006) all provide 50 rem (0.5 Sv) for life-saving. Finally, the International Atomic Energy Agency (IAEA 2006) provides a recommendation of 100 rem (1 Sv) for lifesaving.

No first responder has ever been injured by radiation
in any radiation accident in the US.

What should I know about alpha, beta, and gamma radiation?

Useful Information about Alpha Radiation

1. Alpha radiation will NOT penetrate human skin.

2. Alpha-emitting contaminants can be harmful to humans if the materials are inhaled, swallowed, or absorbed through open wounds.

3. A variety of instruments have been designed to measure alpha radiation. Special training in the use of these instruments is essential for making accurate measurements.

4. Many common <u>*GM*</u> contamination survey instruments can detect the presence of radioactive materials that produce alpha radiation along with beta and/or gamma radiation.

5. Instruments cannot detect alpha radiation through even a thin layer of water, blood, dust, paper, or other material, because alpha radiation is so easily shielded by these materials.

6. Alpha radiation travels a very short distance in air.

7. Alpha radiation is not able to penetrate turnout gear, clothing, or a cover on a probe.

Useful Information about Beta Radiation

1. Beta radiation may travel several meters in air and is moderately penetrating.

2. Beta radiation can penetrate human skin to the "germinal layer," where new skin cells are produced. If beta-emitting contaminants are allowed to remain on the skin for a prolonged period of time, they may cause skin injury.

3. Beta-emitting contaminants may be harmful if deposited internally.

4. Most beta emitters can be detected with a survey instrument (such as a CD V-700) provided the metal probe cover is open. Some beta emitters, however, produce very low energy, poorly penetrating radiation that may be difficult or impossible to detect. Examples of these are carbon-14, tritium, and sulfur-35.

5. Beta radiation cannot be detected with an ionization chamber survey instrument such as a CD V-715 unless it has a "beta window" like the Eberline RO-20 does.

6. Turnout gear provides some protection against most beta radiation.

Useful Information about Gamma and X-ray Radiation

1. Gamma and X-ray radiation is able to travel many meters in air and can easily penetrate human tissue. It readily penetrates most materials and is often referred to as "penetrating" radiation.

2. Radioactive materials that emit gamma radiation and X-rays constitute both an external and internal hazard (often referred to as a "whole body" hazard) to humans.

3. Gamma radiation and X-rays are *electromagnetic radiation* like visible light, radio waves, and ultraviolet light. These electromagnetic radiations differ only in the amount of energy they have. Gamma rays and X-rays are the most energetic of these.

4. Dense materials are needed for shielding from penetrating radiation. Although turnout gear provides protection from radioactive contamination, it provides little shielding from penetrating radiation such as gamma and X-ray radiation.

5. Gamma radiation is readily detected with most survey instruments.

6. Gamma radiation or X-rays frequently accompany the emission of alpha and beta radiation.

7. Instruments designed solely for alpha detection (such as an alpha scintillation counter) will not detect gamma radiation.

8. Self-reading pocket chamber (pencil) *dosimeters*, electronic dosimeters, or TLDs can be used to measure accumulated exposure to gamma radiation.

What is radioactive contamination?

Contamination occurs when material that contains radioactive atoms is deposited on skin, clothing, or any place where it is not desired. It is important to remember that radiation does not spread or get “on” or “in” people; rather, it is radioactive contamination that can spread. A person contaminated with radioactive materials will be exposed to radiation until the source of radiation (the radioactive material) is removed.

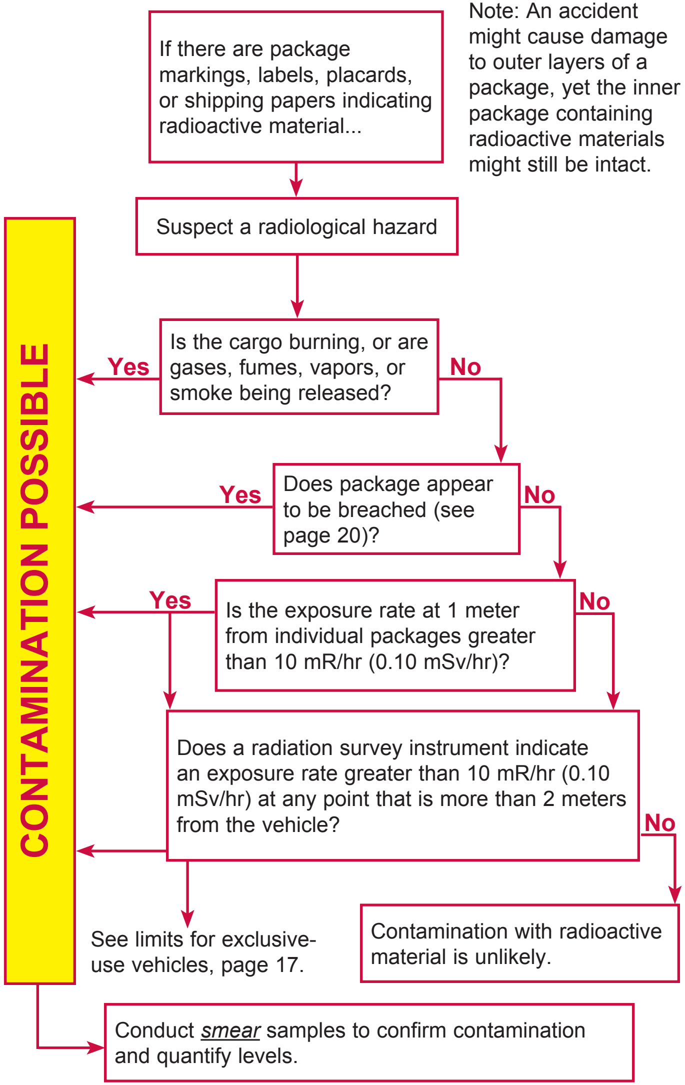
A person is externally contaminated if radioactive material is on their skin or on their clothing. A person is internally contaminated if radioactive material is ingested, inhaled, swallowed, or absorbed through wounds. The environment is contaminated if radioactive material is spread about or uncontained.

How can I work safely around radioactive contamination?

1 Avoid contact with the radioactive material.
2. Wear protective clothing (such as fire turnout gear, coveralls, gloves, and boots) that, if contaminated, can be removed.
3. Wear multiple pairs of gloves and change them frequently to avoid spreading contamination.
4. Use full respiratory protection if fire, smoke, fumes, gases, or wind-blown dusts are present.
5. Assume that all materials, equipment, and personnel have been contaminated if they were in the immediate area of the incident. Radiological monitoring is recommended before leaving the scene.
6. Do not eat, drink, smoke, chew, rub eyes, or apply cosmetics within potentially contaminated areas.
7. As an additional precaution, consider taking a shower and changing clothes after being released by the Radiation Authority.

Wearing protective clothing can help prevent personnel contamination

Is contamination possible?



How do I survey for contamination?

Smears can be taken on an object to assess for removable contamination or direct measurements can be taken using a contamination survey instrument. Removable contamination is defined as the radioactive material that can be transferred from a surface by rubbing with moderate pressure. The smear (or wipe/swipe test) is the universal method of assessing removable contamination. A small cloth, filter paper, or fiberglass disk is used to “wipe” an area or object suspected of being contaminated. A smear should cover a minimum surface area of 100 cm^2 (approximately equal to a square measuring 4” by 4”). Smears should be dry and taken using moderate pressure. Protective clothing should always be worn when taking smear samples to minimize the chance of personnel contamination.

Contamination survey instruments are very sensitive and can be used to measure the presence of radioactive contamination. Contamination survey instruments usually read out in units of counts per minute (CPM). Contamination surveys are useful for the following:

- Locating contamination on personnel and equipment
- Determining the effectiveness of decontamination
- Verifying contamination control boundaries
- Determining the extent and magnitude of a contaminated area

Contamination survey instruments typically have "pancake" style probe attached (as shown in the photo at left below) or some type of open window (as shown in the photo at right below) that allows for the detection of the contamination. Hold the detector 1/2 to 1 inch from the surface being surveyed. For guidance on how to survey a patient or person, see page 29

A Comparison of Transportation Accidents Based on Type of Contaminant

	Toxic/ Hazardous Chemicals	Radioactive Material
Is the material *immediately* threatening to the lives of rescuers and patients?	Possibly	Unlikely
Is respiratory protection (SCBA) recommended for emergency response?	Yes	Yes, if fire, fumes, smoke, or chemicals are involved or if environmental conditions could cause material to be airborne.
Is special protective clothing recommended for emergency response?	Yes	Yes. Protective clothing, turnout gear, or other clothing that covers bare skin can keep contaminants off skin.
Does contamination with material produce visible early skin injury (i.e., redness, blistering, or rash that is not due to heat or flames)?	Possibly, if corrosive or toxic.	No. If these symptoms occur, look for other causes.
Does exposure cause immediate symptoms such as coughing, choking, burning eyes, vomiting, pain, etc., or unconsciousness?	Possibly	No. If these symptoms occur, look for other causes.
Are instruments capable of detecting and measuring the hazard available?	Possibly	Yes
Can human exposure be measured at the accident scene?	No	Yes, Accumulated external radiation dose can easily be measured by using a *dosimeter*.

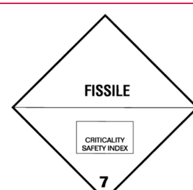
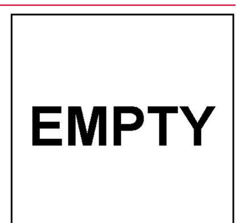
What do the markings and labels on packages of radioactive material indicate?

All shipments of radioactive material, with the exception of those containing very small quantities of radioactive material or those of *low specific activity* (LSA) or *surface contaminated objects* (SCO), will have markings on the outside of the package that give information such as the material's Proper Shipping Name and UN ID number. The photos below show a shipping cask with a close-up of the markings found on the exterior of the package.

In addition to the package markings, these packages will bear two identifying warning labels affixed to opposite sides of the outer package. Three different labels—White-I, Yellow-II, or Yellow-III—are used on the external surface of packages containing radioactive material. Package labels will specify the radioactive content or isotope (e.g., Tl-201, Ir-192, etc.) and the activity level in Becquerels (Bq). Yellow-II and Yellow-III labels also specify the transport index. The transport index is a single number, determined by the shipper, that is used to provide control over radiation exposure and establish transport controls. The transport index is determined by taking the maximum radiation level (as measured in mrem/hr) at one meter (3.3 feet) from an undamaged package. When assessing a package's integrity at an accident scene, you can use this information as a baseline for determining if damage has occurred to the package (see page 20)

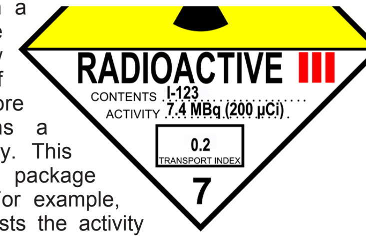
Labels Used on Radioactive Materials Packages

Standard size is approximately 4 inches x 4 inches.

Label	Label Information	Example
Radioactive White-I	Extremely low radiation levels 0.5 mrem/hr (0.005 mSv/hr) maximum on surface	
Radioactive Yellow-II	Low radiation levels >0.5 - 50 mrem/hr (0.5 mSv/hr) maximum on surface; 1.0 mrem/hr (0.01 mSv/hr) maximum at 1 meter	
Radioactive Yellow-III	Higher radiation levels >50 - 200 mrem/hr (2 mSv/hr) maximum on surface; 10 mrem/hr (0.1 mSv/hr) maximum at 1 meter Also required for *HRCQ* shipments, regardless of radiation level	
Fissle	Applied to packages that contain *fissile materials*. The Criticality Safety Index (CSI) for each package will be noted on the label. When used, the fissile label will appear adjacent to the radioactive material label.	
Empty	Applied to packages that have been emptied of their contents as far as practical but may still contain regulated amounts of internal contamination and minimal radiation levels detectable outside the package (<0.5 mrem/hr).	

How much radioactivity is in a package?

The size or weight of a package does not indicate how much radioactivity is in the package or shipment.



The amount of radioactivity in a package or container can be determined by noting how many *becquerels* or *curies* of the material are present. More becquerels or curies means a greater amount of radioactivity. This information can be found on package labels and shipping papers. For example, the label shown to the right lists the activity as 7.4 Megabecquerels which equates to 200 microcuries.

There is no direct correlation to the physical size of a material and the level of radioactivity. A large amount of material can have a very small amount of radioactivity; a very small amount of material can have a lot of radioactivity. For example, uranium-238 has 0.00015 curies of radioactivity per pound (150 microcuries), while cobalt-60 has over 500,000 curies per pound.

In the International System of units (SI), the becquerel (Bq) is the unit of radioactivity. One curie is 37 billion Bq. Since the Bq represents such a small amount, you are likely to see a prefix used with Bq, as shown on the following page:
1 MBq (27 microcuries)
1 GBq (27 millicuries)
37 GBq (1 curie)
1 TBq (27 curies)

Following is a list of prefixes and their meanings which are often used in conjunction with SI units:
micro (µ) means "one millionth of" or (0.000001)
milli (m) means "one thousandth of" or (0.001)
centi (c) means "one hundredth of" or (0.01)
kilo (k) means one thousand (1,000)
mega (M) means one million (1,000,000)
giga (G) means one billion (1,000,000,000)
tera (T) means one trillion (1,000,000,000,000)

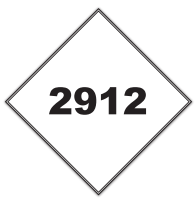
What do the placards for shipment of radioactive material indicate?

Typical Radioactive Material Warning Placard

The placard shown must be used anytime a vehicle carries one or more packages with a Radioactive Yellow-III label or if the vehicle is operating under exclusive-use provisions required for certain *SCO* and *LSA* shipments or packages with higher than normal radiation levels. The number "7" at the bottom of the placard is the UN hazard identification number for radioactive materials. Standard size is approximately 10 inches x 10 inches.

A four-digit UN ID number is often shown adjacent to the placard on an **orange panel** or on a plain white square-on-point configuration that is the same size as a placard.

The orange panel is 6.3 inches x 15.7 inches



The square-on-point configuration is 10.8 inches x 10.8 inches

There is one other type of radioactive placard that you may encounter on highway shipments. It looks like the standard placard, except that it has a white square background and a black border. This placard represents a "Highway Route Controlled Quantity" (*HRCQ*) shipment. HRCQ shipments contain higher quantities of radioactive material and require special controls during transport.

The orange panel and square-on-point configuration shown on the previous page both bear the UN identification number (UN ID) for radioactive material, LSA. This is the same four-digit ID number that must appear with the proper shipping name on the package as well as on the shipping documents. Refer to this number in the yellow pages of the *ERG* for response information.

Most shipments of hazardous materials, including radioactive material, are required to have shipping papers that provide information on the shipment contents, potential health hazards, and an emergency contact number.

Limits for Packages in Non-Exclusive-Use Vehicles

- 200 mR/hr (2 mSv/hr) at surface of package
- Individual packages cannot exceed 10 mR/hr (0.1 mSv/hr) at 1 meter

Limits for *Exclusive-Use* Vehicles

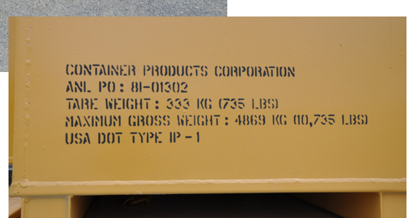
- 2 mR/hr (0.02 mSv/hr) in cab
- 200 mR/hr (2 mSv/hr) on surface of vehicle
- 10 mR/hr (0.1 mSv/hr) maximum at 2 meters
- Under certain conditions, individual packages on exclusive-use vehicles can have readings up to 1 R/hr (10 mSv/hr) on contact with package surface. Exposure levels will be significantly higher if package is breached.

What types of radioactive material packages am I likely to encounter?

There are four types of radioactive material packages that are commonly used in the United State. Each will be discussed here.

Excepted Packages contain material with extremely low levels of radioactivity and pose a very low hazard. Examples of material typically shipped in excepted packaging include consumer goods such as smoke detectors. Excepted packages are excepted (excluded) from specific packaging, labeling, and shipping paper requirements; they are however, required to have the letters “UN” and the appropriate four-digit UN identification number marked on the outside of the package.

Industrial Packages are commonly used to ship low-activity materials and contaminated objects. Most low-level radioactive waste is shipped in these packages. There are three categories of industrial packages: IP-1, IP-2, and IP-3. The higher the category, the more durable the package will be. The category of package will be marked on the exterior of the package as shown in the close-up photo below.



Type A Packages are used to transport small quantities of radioactive material with higher concentrations of radioactivity than those shipped in industrial packages. Type A packages will contain non life-endangering amounts of radioactive material. Examples of material typically shipped in Type A packages include nuclear medicines (radiopharmaceuticals), radioactive waste, and radioactive sources used in industrial applications such as the soil density gauge pictured at right below. Type A packages must meet standard testing requirements designed to ensure that the package retains its containment integrity and shielding under normal transport conditions.

Type B Packages are designed to transport material with the highest levels of radioactivity. As illustrated in the photos below, Type B packages range from small hand-held radiography cameras to heavily shielded steel casks that weigh up to 125 tons. Examples of material transported in Type B packages include spent nuclear fuel, high-level radioactive waste, and high concentrations of other radioactive material such as cesium and cobalt. These package designs must withstand a series of tests that simulate severe or “worst-case” accident conditions. Accident conditions are simulated by performance testing and engineering analysis. Life-endangering amounts of radioactive material are required to be transported in Type B Packages.

Is a package breached?

The transport index (TI), appearing on the Yellow-II and III labels, indicates the maximum radiation level (measured in mrem/hr) at 1 meter from the surface of the undamaged package. If the survey meter indicates higher readings, the package may have been breached. For example, a TI of 0.2 (as shown on the label below) would indicate that, at 1 meter from the labeled package, the radiation dose rate should be no more than 0.2 mrem/hr (0.002 mSv/hr).

CAUTION: Be aware that other radioactive material packages in the immediate vicinity may interfere with measurements, resulting in radiation levels above the indicated transport index of any particular package.

What do I do if I am the first to arrive at an accident scene?

- Assess situation, assume command, note labels and markings.
- Notify dispatcher
  - Dispatcher notifies: Law Enforcement; Fire Dept.; State Radiological Health Dept.; Special Response Groups (as necessary)
- Wear appropriate PPE as outlined in ERG guides 161-166. Perform lifesaving rescue and emergency first aid and firefighting.
- Restrict access to area.
- If possible, detain all individuals at a safe distance upwind of accident site and await arrival of other responders.
- Document all pertinent information.

What are some guidelines for incident command?

1. Approach site with caution. Position personnel, vehicles, and command post at a safe distance upwind and upslope of the site, if possible.

2. Ensure safety of responders.
   - Identify all hazards (danger of fire, explosion, toxic fumes, electrical hazards, structural collapse, etc.).
   - Identify cargo.
   - Obtain information concerning the cargo from package markings, labels, placards, shipping documents, and other immediately available sources.
   - **Consult DOT *Emergency Response Guidebook***.
   - Keep upwind of smoke, vapors, etc.
   - Follow usual protocols for respiratory protection, use of protective clothing, and turnout gear.
   - Monitor changing conditions that could create hazardous situations.

3. Locate patients and facilitate extrication, emergency care, and transportation of the injured. EMS Actions, (see page 28).

As outlined in the ERG, medical problems take priority over radiological concerns. Do not delay rescue or transport of a seriously injured, contaminated patient.

4. Communications.
   - Notify hospital of possible contamination/exposure of patient.
   - Notify state radiological assistance (emergency response center) of accident conditions.

5. Establish a *control zone* (for guidelines, see page 24).
   - Reroute traffic.
   - Mark controlled area by use of ropes or barrier tape.
   - Limit entry to rescue personnel only.
   - Order evacuation or sheltering as needed.

6. Prevent/fight fires as outlined in ERG. Radioactivity does not change flammability or other properties of materials (see page 26).

7. Ensure radiation protection and contamination control.
   - Do not allow eating, drinking, smoking, chewing, or other activities within contaminated areas that might lead to intake of radioactive material.
   - Avoid direct contact with radioactive material where possible. Utilize protective clothing and anything available for remote handling (shovels, branches, ropes, etc.).
   - Limit time near radioactive material. Rotate staff as necessary.
   - Determine radiation levels within controlled zones and monitor rescue personnel with individual dosimeters, if available.
   - Evacuate personnel who were in the immediate downwind area. Detain personnel who were in the accident area until they can be surveyed for contamination. Follow instruction of radiation authority.
   - Remove protective gear/clothing in the decon corridor.
   - Wrap, label, and isolate all clothing, tools, etc., used in the hot zone, and retain them until they can be cleared by radiation authority.
   - Determine if measures are needed to contain all accident debris in the hot zone until cleanup is achieved. Prevent unnecessary handling of incident debris.

8. Documentation.
   - Record the names and addresses of all persons involved, including those who insist on leaving the area; rescuers; those removed for medical attention; and ambulance personnel.
   - Make detailed records of the incident.

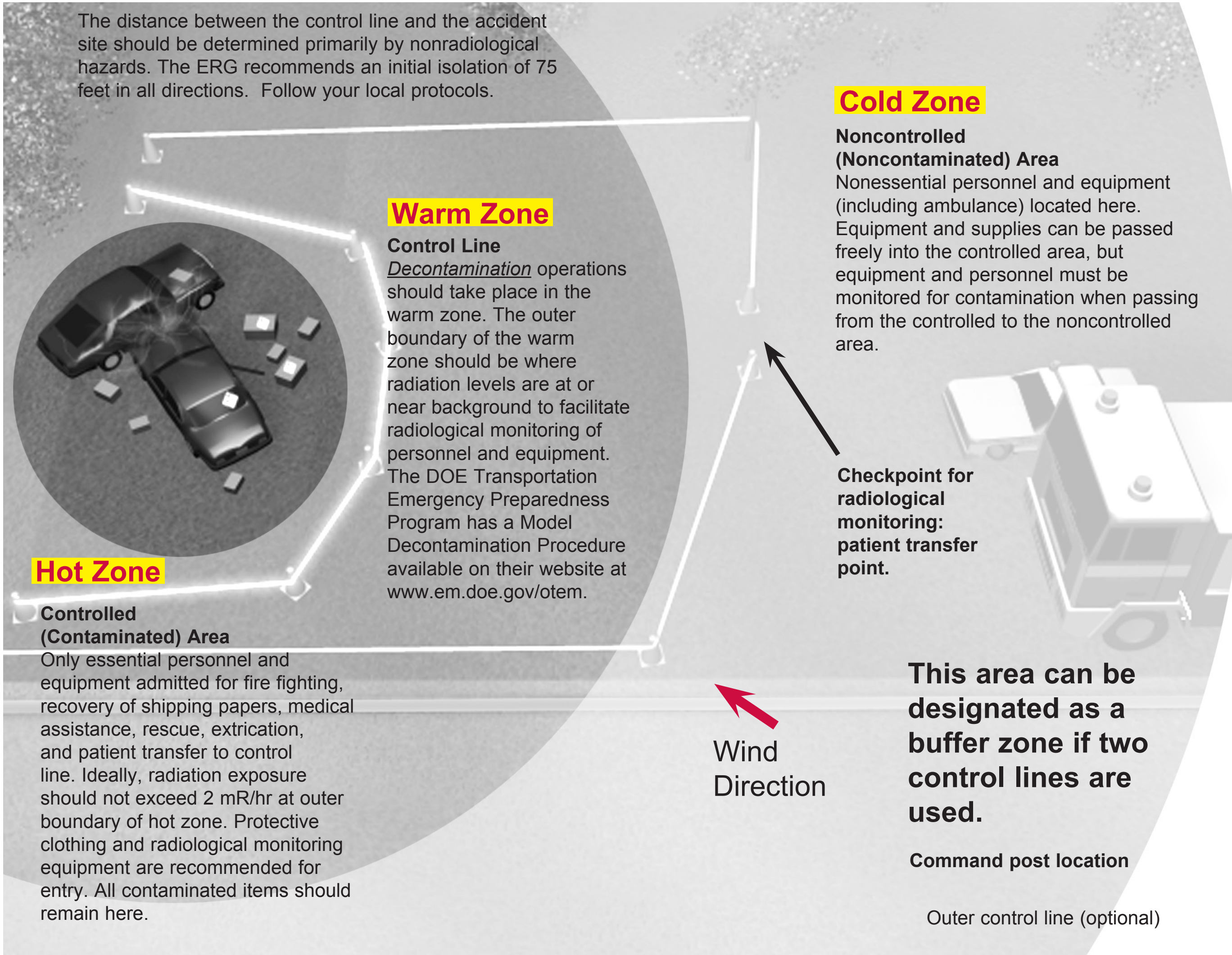
9. **Remain calm. Ensure your own safety but do not be overly concerned by the presence of radioactive material or allow it to disrupt usual emergency response activities. Because of package design and testing, it is unlikely that emergency personnel will receive radiation injury during response to transportation incidents.**

10. Delay cleanup pending instructions from radiation authority. Coordinate cleanup activities at the site with public officials.

Response actions may be performed prior to any radiation measurements. Some radioactive materials cannot be detected by commonly available instruments.

How is a control line established?

The distance between the control line and the accident site should be determined primarily by nonradiological hazards. The ERG recommends an initial isolation of 75 feet in all directions. Follow your local protocols.



Hot Zone

Controlled (Contaminated) Area

Only essential personnel and equipment admitted for fire fighting, recovery of shipping papers, medical assistance, rescue, extrication, and patient transfer to control line. Ideally, radiation exposure should not exceed 2 mR/hr at outer boundary of hot zone. Protective clothing and radiological monitoring equipment are recommended for entry. All contaminated items should remain here.

Warm Zone

Control Line

Decontamination operations should take place in the warm zone. The outer boundary of the warm zone should be where radiation levels are at or near background to facilitate radiological monitoring of personnel and equipment. The DOE Transportation Emergency Preparedness Program has a Model Decontamination Procedure available on their website at www.em.doe.gov/otem.

Cold Zone

Noncontrolled (Noncontaminated) Area

Nonessential personnel and equipment (including ambulance) located here. Equipment and supplies can be passed freely into the controlled area, but equipment and personnel must be monitored for contamination when passing from the controlled to the noncontrolled area.

Checkpoint for radiological monitoring: patient transfer point.

This area can be designated as a buffer zone if two control lines are used.

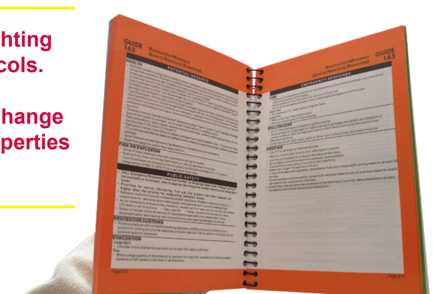
What are general guidelines for responding to a fire?*

Consult the *Emergency Response Guidebook*.

- Some materials may react with water or water vapor in air to form a hazardous vapor.
- For small fires: dry chemical, CO_2, Halon, water spray, or regular foam. Large fires: water spray, fog, or regular foam.
- Move undamaged containers from fire area if you can do it without risk. Do not touch damaged containers.
- Cool containers that are exposed to flames with water until well after fire is out. Keep to the sides of containers and away from the ends.
- Fight fire as if toxic chemicals are involved. To the extent possible, keep upwind and avoid smoke, fumes, gases, and dusts.
- For massive fire in cargo area, use unmanned hose holder or monitor nozzles; if this is impossible, withdraw from area and let fire burn.
- Stay away from ends of tanks. Withdraw immediately in case of rising sound from a venting safety device or if there is discoloration of tanks due to fire. Fight fires from maximum distance.
- Delay cleanup until radiation authority provides guidance.
- As much as possible, form a barrier to contain fire water that may be contaminated with radioactive and/or other chemicals.

Use established fire fighting procedures and protocols.

Radioactivity does not change flammability or other properties of materials.



What are general guidelines for responding to a spill or a leak?*

Consult the *Emergency Response Guidebook*.

- Shut off ignition sources; no flares, smoking, or flames in hazard area.
- Keep combustibles (wood, paper, oil, etc.) away from spilled material.
- Do not touch spilled material. Do not touch damaged containers or move anything, except to rescue people.
- Detour pedestrian and vehicular traffic.
- Detain anyone who has been in the area of the spill or area of suspected contamination (except for patients requiring emergency medical care).
- Delay cleanup until the radiation authority arrives.
- Minimize dispersal of material (by wind, rain, etc.) by covering with a tarp, plastic sheet, etc. Tie down or use weights as necessary.
- If radiation protection experts are not able to get to the scene within a reasonable period of time because of weather or other constraints and prompt action is required, do the following:

  Small spills: Cover with sand or other noncombustible absorbent material and place into containers for later disposal.

  Large spills: Build a dike far ahead of the spill to contain spilled material for later disposal.

Note: Some radioactive materials may be corrosive.

*Adapted from the DOT *Emergency Response Guidebook*.

What are the guidelines for emergency medical management?

Field Operation Protocols for Radiation Accidents

1. Approach site with caution—look for evidence of hazardous materials.
2. If radiation hazard is suspected, position personnel, vehicles, and command post at a safe distance (approximately 75 feet) upwind of the site.
3. Notify proper authorities and hospital.
4. Put on protective gear and use dosimeters and survey meters if immediately available.
5. Determine whether injured patient(s) are present.
6. Assess and treat life-threatening injuries immediately. Do not delay advanced life support if patient cannot be moved, or to assess contamination status. Perform routine emergency care during extrication procedures.
7. Move patient away from the hazard area, using proper patient transfer techniques to prevent further injury. If contamination is suspected, removing the patient's clothing (gross decon) can remove much of the contamination on patient.
8. Expose wounds and cover with sterile dressings.
9. Patient should be monitored at the control line for possible contamination only if they are medically stable. Radiation levels above background indicate the presence of contamination.
10. Move the ambulance stretcher to the clean side of the control line and unfold a clean sheet or blanket over it. Place the patient on the covered stretcher and package for transport. Do not remove the patient from the backboard if one was used.
11. Package the patient by folding the stretcher sheet or blanket over and securing him or her in the appropriate manner.
12. Before leaving the controlled area, rescuers should follow their decontamination procedures and be surveyed at the control line. If possible, the patient should be transported by personnel who have not entered the controlled area. Ambulance personnel attending to patients should wear appropriate PPE.
13. Transport the patient to the hospital emergency department. The hospital should be given additional appropriate information, and the ambulance crew should ask for any special instructions the hospital may have.
14. Follow the hospital's radiological protocol upon arrival.

15. The ambulance and crew should not return to regular service until the crew, vehicle, and equipment have undergone monitoring and necessary decontamination by the radiation safety officer.
16. Personnel should not eat, drink, smoke, chew, etc., at the accident site, in the ambulance, or at the hospital until they have been released by the radiation safety officer.

How can I tell if a patient is contaminated with radioactive materials?

Some instruments cannot detect contamination from alpha or low-energy beta radiation. It is important to know limitations of instruments before using a particular model. Therefore, if you suspect contamination with radioactive material that emits alpha or low-energy beta particles, handle the patient as contaminated and obtain assistance (see page 46). **No estimates of personal radiation dose should be made. This should be done by radiological health experts.** If contamination survey instruments are available, use the following:

1. Perform an operational check of a low-range contamination survey instrument, keeping the probe shield open. (See instructions for specific instrument model.)

2. Set range selector switch to the most sensitive scale (e.g., x1).

3. Using the proper procedure, determine the background radiation level.

4. When necessary, adjust the range of the instrument by moving the selector switch. Meter readings should not be taken when the dial indicator reads in the lower 10 percent of the scale when on the x100 and x10 ranges. Turn the selector switch to a more sensitive range to measure the count rate more accurately.

5. Holding the probe about 1/2 inch from the person, systematically survey the individual from head to toe on all sides. Avoid touching the probe to any contaminated surface. Move the probe slowly, approximately 1 to 2 inches per second. Pay particular attention to wounds, body openings, hands, and bottoms of shoes. An increase in count rate above the previously determined background level indicates the presence of contamination. Be familiar with your jurisdiction's limit (e.g., 100 cpm over backgound or 2x background).

6. Note contaminated areas to be reported to the hospital emergency department or radiation safety officer. Do not delay or hinder emergency medical care in order to survey patients for contamination. Do not move or turn a patient to perform a contamination survey if movement could further injure the patient.

How do I use radiation detection instruments?

Model CD V-700 Survey Meter

The CD V-700 is a low-range (0-50 mR/hr) radiation detection survey meter calibrated primarily to detect gamma radiation. However, it can also detect high-energy beta radiation if the probe shield is open.

PREPARE THE CD V-700 FOR USE

1. Check visually to see that fresh "D" cell batteries are in place. If not, insert them, observing the indicated polarity.

2. Turn the range selector switch to the x10 range.

3. Allow 30 seconds for warm-up time.

4. Open the probe shield and place the open area directly against the check source on the side of the instrument. There should be a deflection of the meter needle indicating that the instrument is responding to radiation. NOTE: Some instruments have been calibrated by state maintenance shops for use in peacetime radiation incidents. In this case, the specific reading obtained from the check source will be indicated on a calibration sticker on the instrument.

5. Determine the background radiation level by setting the instrument on the most sensitive scale (x1) and observing it for about 30 seconds.

Background radiation is usually less than 0.05 mR/hr, or under 50 cpm, when the selector switch is on the x1 range. The needle may jump about randomly on this setting because of erratic background radiation.

TO USE THE CD V-700

The only control on the CD V-700 is a selector switch that has an OFF position and three ranges labeled x100 (times 100), x10 (times 10), and x1 (times 1). On the x1 range, the measured radiation exposure rate is read directly from the meter. On the x10 and x100 ranges, the meter readings must be multiplied by 10 and 100, respectively, to obtain the measured rate. The maximum capabilities of the three ranges are 0.5

mR/hr on the x1, 5 mR/hr on the x10, and 50 mR/hr on the x100. Should the meter needle deflect full scale on the x1 or x10 ranges, select a higher range on the selector switch.

The CD V-700 can jam or saturate in areas where radiation exposure rates are above 1 R/hr (1,000 mR/hr), causing the meter reading to be incorrectly low or off-scale. A higher-range instrument must be used whenever radiation exposure levels exceed 50 mR/hr, the maximum that the CD V-700 is capable of measuring.

Model CD V-715 *Ionization* Chamber

The CD V-715, an ionization chamber survey meter, is a high-range instrument for measuring gamma exposure rates and should be used when high-level radiation hazards are suspected. It is not capable of detecting beta or alpha radiation. In addition, the CD V-715 can be used to monitor only high-level (>50 mR/hr) gamma radiation and is not capable of measuring low-level gamma radiation or contamination. The CD V-715 cannot be used to determine background radiation levels.

PREPARE THE CD V-715 FOR USE

1. Insert a fresh "D" cell battery in the instrument, observing polarity.

2. Turn the selector switch to the ZERO position.

3. Allow 2 minutes for warm-up time.

4. Adjust the zero control to make the meter read zero. Without proper zero adjustment, the instrument readings may have large errors.

5. Turn the selector switch to CIRCUIT CHECK. The needle should point to the area marked CIRCUIT CHECK.

6. Recheck the zero setting on all four ranges.

7. Begin survey procedures with the instrument set on the x0.1 range.

TO USE THE CD V-715

The selector switch has seven positions: CIRCUIT CHECK, OFF, ZERO, x100 (times 100), x10 (times 10), x1 (times 1), and x0.1 (times 0.1). On the x1 range, the measured exposure rate is read directly from the meter. On the x0.1, x10, and x100 ranges, the meter readings must be multiplied by factors of 0.1, 10, or 100, respectively, to obtain the measured exposure rate. The maximum measurements are 500 mR/hr on the x0.1 range, 5 R/hr on the x1 range, 50 R/hr on the x10 range, and 500 R/hr on the x100 range.

Model Eberline RO-20 Ion Chamber

The measurement range of the Eberline RO-20 Ion Chamber Survey Meter is 0-50 R/hr, with range settings of 5 mR/hr, 50 mR/hr, 500 mR/hr, 5 R/hr, and 50 R/hr. The various range levels of this meter make it useful for measuring areas with low to moderate radiation levels.

The Eberline RO-20 Ion Chamber Survey Meter is calibrated to primarily measure gamma radiation; however, it can also detect beta radiation when the shield is open.

PREPARE THE RO-20 FOR USE

1. Install fresh “C” cell batteries in the instrument, observing polarity.

2. Be careful when installing batteries; the ion chamber face is very thin and easily damaged.

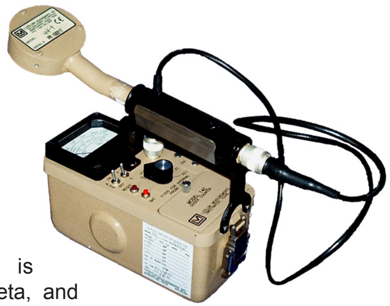
3. Check the "C" cells by turning the selector switch to the Battery 1 position. The needle should move into the green arc.

4. Check the lithium cell by turning the selector switch to the Battery 2 position. The needle should move into the green arc.

5. Rotate the selector switch to the zero position and allow 2 minutes for warm-up.

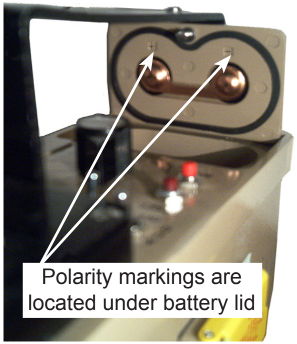
6. Adjust the zero control knob so the meter reads "0."

The Ludlum Model 3 or Model 14C Survey Meter



The Ludlum Model 3 and 14C Survey Meters are very similar with the exception that the Model 14C has an internal <u>*GM*</u> probe that operates on the X1000 scale. A variety of <u>*detectors*</u> can be attached to the survey meter via the coaxial cable. Depending on the type of external detector attached, the survey meter is capable of detecting alpha, beta, and gamma radiation. Both instruments are capable of measuring contamination up to 500,000 cpm with the proper detector attached. The Model 3 can measure radiation levels up to 200 mR/hour and the Model 14C can measure radiation levels up to 2,000 mR/hour.

PREPARE THE LUDLUM INSTRUMENT FOR USE



1. Attach the appropriate probe to the survey meter.

2. Insert fresh "D" cell batteries in the instrument, observing polarity as shown at right.

3. Check the battery strength by turning the selector switch to the BAT position or by pressing the BAT button (Model 14C). The needle should jump to the BAT TEST area.

4. Place the probe against a check source. The instrument should give a reading.

5. Move the selector switch to view an exponential reading.

6. Adjust the response control by flipping the toggle switch to F (fast) or S (slow). The response should be adjusted to get the most desirable compromise between response speed and meter fluctuation.

The Ludlum Model 2241 Digital Rate Meter

The Ludlum Model 2241-2 or 2241-3 is a portable microprocessor-based digital Scaler/Ratemeter designed for use with a variety of detector types for measurement of ionizing radiation. The data is presented on a 4 digit (6 digits while in the Scaler mode) Liquid Crystal Display (LCD) with a moving decimal point. The instrument allows for use as a RATEMETER or as a SCALER. The scaler is activated by a push-button in the handle (count time adjustable from 1 - 9999 seconds in 1 second intervals). A toggle switch (Model 2241-2) or a 5 position rotating switch (Model 2241-3) allow for quick change among external detectors. The Model 2241-2 features adjustable alarm set points for the RATEMETER and SCALER operating mode.

The instrument provides auto-ranging from 0 mR/hr to 9999 R/hr, or 0 cpm to 999 kcpm (999,000 cpm), depending on which detector is attached. Be aware that the attached detector may not have the same range as the instrument.

PREPARE THE LUDLUM 2241 INSTRUMENT FOR USE

1. Attach the appropriate probe to the survey meter.

2. Insert fresh “D” cell batteries in the instrument, observing polarity as shown on previous page.

3. Turn the instrument on, ensuring that the switch is set to the appropriate DETector position for the detector attached (DET 1, DET 2, etc.) and to the RATEMETER position if using the Model 2241-2. The display will go through a start-up sequence. The display will show all 8s with decimal points. Check to make sure all segments of each number display are functioning.

4. After the start-up sequence is complete, the unit will show the typical operating screen with the display auto ranging to the current radiation or count rate level, depending on which position the DETector select switch is in.

5. Expose the detector to an external check source. Switch the AUD ON/OFF to the ON position and confirm that the external speaker produces an audible click. Normal operating mode should be with the AUD ON/OFF toggle switch in the ON position.

6. Switch to the scaler position. Depress the count switch located in the end of the carrying handle to start the count cycle. The word “COUNTING” should be visible in the display during the count cycle and should disappear at the end of the preset count time. Count time is set during instrument calibration, and is set for 1 minute.

7. Depress and release the LIGHT switch. The backlight located behind the LCD should illuminate for 5 seconds.

8. Adjust the response control by flipping the toggle switch to F (fast) or S (slow). The response should be adjusted to get the most desirable compromise between response speed and meter fluctuation.

   <u>Use of the scaler function</u>: The pushbutton switch located in the end of the carrying handle which, when depressed, starts scaler count accumulation for the preset counting/scaling time. The switch must be in the SCALER position to start the counting cycle. Scaling time is set during instrument calibration and can be set from 0 to 9999 seconds. Depressing the count switch after a scaler ALARM will reset the scaler display to “0” and will reset the scaler alarm condition. The scaler function is often used when counting smear samples. The photo below shows the location of the scaler count switch.

The scaler count switch button is located in the end of the instrument's carrying handle

Model ADM-300 Survey Meter

This auto-range survey meter is a microprocessor-based, portable, battery-operated, digital-dose-rate meter and contamination monitor for radiological surveys and *monitoring* of personnel. An external gamma probe is also available for remote area monitoring to 10,000 R/hr.

1. Press “POWER ON” switch, and hold for 2 seconds.

2. Observe display panel to confirm unit is in operation. If LCD backlight and alarm audio is desired, press the "LIGHT" and "AUDIO" switches.

3. To observe accumulated dose, depress “MODE” switch until the DOSE mode is displayed.

NOTE: DISPLAY WILL SHOW TOTAL ACCUMULATED DOSE AS WELL AS TIME REMAINING TO ALARM AT PRESENT DOSE RATE.

4. To return to dose rate display, depress “MODE” switch until the RATE mode is displayed.

5. The unit will continue to operate until “POWER OFF” switch is depressed for 2 seconds.

6. To display Alarm Set Points, use “MODE” switch to display the proper mode as indicated by the MODE block. The default values for Rate and Dose Alarms are 600 μR/h and 100 mR, respectively.

7. A rate alarm is visually indicated by a flashing R. Dose alarm is indicated by a flashing D. Simultaneous RATE and DOSE alarms are indicated by a flashing B. Audio feedback is provided if the Audio (*) has been activated. Audio also provides a chirp for every strike (photon event) on the GM tube.

ALARM ADJUST PROCEDURE

1. Select desired mode, Rate Alarm or Dose Alarm, using the "MODE" switch. RaAlm or DoAlm is displayed in the mode block of the display window. The Digits and Units display will begin flashing.

2. Press the "SET" switch to get the Units display to flash. Use the “up arrow” switch to select the desired units on the flashing display. Press the "SET" switch to store the units information into the processor. The first digit will begin flashing.

3. Press the “up arrow” switch to select the desired digit (0-9) on the flashing display. Press the "SET" switch to store the digit information into the processor. The next digit will begin flashing.

4. Repeat Step 3 for the remaining digits. The final depression of the "SET" switch will toggle the display out of the ALARM mode and back into the RATE mode.

5. Re-enter the ALARM mode to verify that the desired alarm set-point was correctly entered into the processor.

DOSE RESET

To reset accumulated dose, press "SET" and the “up arrow” switches, respectively, for a period of approximately 3 seconds. The accumulated dose reading will start flashing and the CLEAR DOSE message will appear. At the end of the sequence, the dose will be reset to 0.00 μR and the CLEAR DOSE message will disappear.

OPERATION WITH EXTERNAL PROBES

<u>Beta Probe</u>

1. Connect the beta probe to the seven-pin probe connector at the rear of the meter. The ADM-300 Processor automatically identifies the external probe and displays external probe mode (Beta) on the LCD. The display is also changed to C/min. The processor uses the appropriate calibration factor for the external probe.

2. To monitor beta contamination, point the probe window toward the contaminated surface.

3. The beta probe mode provides automatic gamma background compensation. To provide gamma compensation, the internal low-range GM tube in the ADM-300 is kept active and the resultant internal tube counts are subtracted from the external probe counts.

4. To deactivate gamma compensation, press the “up arrow” switch once; the display mode is changed to “B + G,” indicating that both beta and gamma are being counted.

5. To activate gamma compensation, press the “up arrow” button again.

6. Press "AUDIO" to get the ADM-300 to chirp for every event.

7. "MODE" and "SET" switches are inoperative.

Gamma Probe

1. Connect the gamma probe to the seven-pin probe connector at the rear of the meter. The ADM-300 Processor automatically identifies the external probe and displays external gamma probe mode (RaGm) on the LCD. The processor uses the appropriate calibration factor for the gamma probe. The two internal GM tubes are turned off in this mode.

2. Gamma probe uses two GM tubes to cover the wide range of 10 μR/hr to 10,000 R/h. The GM tubes are automatically switched by the ADM-300 Processor to provide auto-ranging.

3. All the operations in external gamma probe are similar to operations indicated in the Operation and Alarm Adjust Procedure.

Alpha Probe

1. Connect the alpha probe to the seven-pin probe connector at the rear of the meter
.
2. Press "AUDIO" to activate chirper.

3. Press the “up arrow” switch to select the desired units for display, which are C/min, μCi/m^2.

The Ludlum Model 19 Micro R Survey Meter

The Ludlum Model 19 Micro R Survey Meter measures low-level gamma radiation. This meter allows you to measure levels from 0-500 microR/hr. It is typically used to find small, lost sources of radiation.

PREPARE THE LUDLUM MODEL 19 INSTRUMENT FOR USE

1. Install two fresh "D" cell batteries in the instrument, observing polarity.

2. Adjust the audio (AUD ON-OFF) and meter response (F/S) toggle switches as desired.

3. Select the 0-5,000 microR/hr range with the selector switch.

4. Depress the "BAT" test button. The needle should move into the "BAT TEST" area of the meter.

5. Depress the Light (L) button and check for light on the meter face.

6. Check the meter response by flipping the "F" (fast) and "S" (slow) toggle switch.

7. Check for audio with the "AUD" ON-OFF switch.

8. Check the instrument for the proper scale indication with a known source.

9. Depress the reset "RES" button and check to see that the meter needle returns to the zero position.

Who responds to an accident involving a shipment of radioactive material?

First responders cordon off contaminated areas and initiate controls to minimize further release of radioactive material. They also perform lifesaving duties, extinguish fires, clear unauthorized people from the immediate area, and control traffic in the event of an accident. Local responders usually contact state public health agencies.

These agencies have trained personnel to conduct radiological surveys at the site to determine if any radioactive material releases have occurred. Many local and state governments have emergency plans and training programs to prepare first responders for transportation accidents involving radioactive materials.

The US Department of Energy maintains nine Regional Response Centers across the country. Staffed 24-hours a day, 365 days a year, they are prepared to offer advice and assistance. Any state, tribal, local, or private sector organization needing radiological assistance can call its DOE Regional Response Center (RRC) to get information, advice, or assistance. The DOE Regional Response Coordinator decides what action is needed based upon the request. The DOE RRC also ensures that appropriate state or tribal personnel are contacted in order to affect the appropriate involvement of state or tribal officials and resources. If necessary, the RRC sends a response team to the accident site to help or advise the authorities in charge.

DOE offers training courses through the Transportation Emergency Preparedness Program that are designed to teach emergency response procedures for dealing with radioactive materials. Assistance and emergency response training are also provided by the Federal Emergency Management Agency (FEMA), DOT, NRC, and EPA. Assistance is also offered by the chemical industry through the Chemical Transportation Emergency Center (CHEMTREC). The National Response Center works closely with CHEMTREC on emergency calls and activates National Response Teams, if necessary.

Electric utilities operating nuclear power plants have voluntary assistance agreements with other utilities so that a utility near the scene of a transportation accident would respond on behalf of the utility shipping the radioactive material.

How are nuclear weapons transported and what do I do in the event of an accident?

In the United States, nuclear weapons and weapons components are safely and securely transported by the Department of Energy/National Nuclear Security Administration (NNSA) Office of Secure Transportation (OST). OST uses specially designed vehicle trailers for over-the-road transport. These vehicle trailers incorporate various deterrents to prevent unauthorized entry and removal of cargo. The tractor trailer rigs are also designed to protect the cargo against damage in the event of an accident. This is accomplished through superior structural characteristics and use of an aircraft-type cargo tie-down system. The trailers provide ballistic protection and Radio Frequency (RF) attenuation and are designed with thermal characteristics that allow the trailer to be totally engulfed in a fire without damaging the cargo. The tractors used with the trailers are standard production units that have been modified to provide the federal agent drivers protection against attack. Other vehicles in the convoy include vans or other types of vehicles. The tractors and escort vehicles are equipped with communications, electronic, and other equipment which further enhance enroute safety and security.

Armed federal agents and convoy vehicles accompany each classified shipment. Federal agents accompanying each classified shipment don't wear uniforms. They carry firearms and are authorized by the Atomic Energy Act to make arrests in accordance with federal law. They carry both a photo identification card and a shield certifying their federal agent status. The agents are responsible for driving the vehicles, providing security for the shipment, and maintaining contact with the Transportation and Emergency Control Center (TECC) located in Albuquerque, New Mexico.

The TECC monitors the status and location of shipments and maintains real-time communications 24-hours a day with every convoy. TECC is the first line in the support of convoys. If the security of the convoy is threatened in any way – such as by an accident, a group or protesters, or an actual attack – the Convoy Commander in Charge, or his designee, will notify the TECC and provide details. Through an active liaison program, DOE maintains an emergency contact directory of federal and state response organizations located throughout the contiguous United States. During a convoy emergency, an open communications line is established and maintained between TECC and the appropriate state agencies. This way a continuous update of information from the scene can be relayed to the responding units.

If an event occurs where a trailer is damaged, the federal agents in the convoy will provide information on the hazards of the material to the first arriving emergency responders or state official. This action is to warn and protect the public in the event of a hazardous release into the atmosphere. This will be accomplished by providing first responders with initial recommended protective actions as soon as possible after the incident. The Convoy Commander in Charge or his designee at the scene will give initial response protective actions to first responders.

OST has a liaison program through which it communicates with law enforcement and public safety agencies throughout the country, making them aware of the OST mission. OST has established procedures should a law enforcement officer stop an OST vehicle. The liaison program provides law enforcement officers information to assist them in recognizing one of these vehicles should it be involved in an accident and what actions to take in conjunction with the actions of the federal agents.

Through the liaison program, OST offers in-depth mission briefings. If you are interested in a briefing or have any other questions concerning OST's operations, contact the Liaison and Security Affairs Branch through the TECC at 1-800-424-0167.

Glossary

Alpha radiation: A specific particle ejected from a radioactive atom. It has low penetrating power and short range. Alpha particles will generally fail to penetrate the skin. Alpha-emitting atoms can cause health effects if introduced into the lungs or wounds. Symbol: α

Atom: The smallest piece of an element which cannot be divided or broken up by chemical means.

Becquerel: The SI unit of radioactivity, or "activity" 1 disintegration per second; 37 billion Bq=1 curie.

Beta radiation: A small particle ejected from a radioactive atom. It has a moderate penetrating power and a range of up to a few meters in air. Beta particles will penetrate only a fraction of an inch of skin tissue. Symbol: β

Control zones: An area where entry, activities, and exit are controlled to help ensure radiation protection and prevent the spread of contamination.

Cosmic rays: High-energy radiation which originates outside the Earth's atmosphere.

Contamination: Presence of radioactive material in any place where it is not desired, particularly where its presence can be harmful.

Curie: A unit of measure used to describe the amount of radioactivity in a sample of material. Symbol: Ci (SI unit is Bq, becquerel).

Decontamination: The reduction or removal of contaminating radioactive material from a structure, area, object, or person.

Detector: A device that is sensitive to radiation and can produce a response signal suitable for measurement or analysis. A radiation detection instrument such as Ludlum Model 3. The detector is attached to a survey instrument by a coaxial cable or is a part of the survey instrument. For example, a Ludlum Model 44-9 pancake GM detector can be attached to a Ludlum Model 3 or similar survey instrument.

Dose: A general term for the quantity of radiation or energy absorbed.

Dose rate: The dose delivered per unit of time. It is usually expressed as roentgen or rem per hour or in multiples or submultiples of this unit, such as millirem per hour. The dose rate is commonly used to indicate the level of hazard from a radioactive source.

Dosimeter: A small, pocket-sized device used for monitoring radiation exposure of personnel. Before use, it is given a charge, and the amount of discharge that occurs is a measure of the accumulated radiation exposure. Electronic dosimeters are battery operated and keep track of actual radiation exposure.

Electromagnetic radiation: A traveling wave motion that results from changing electric and magnetic fields. Types of electromagnetic radiation range from those of short wavelength, like X-rays and gamma rays, through the ultraviolet, visible, and infrared regions, to radar and radio waves of relatively long wavelengths.

Exposure: A quantity used to indicate the amount of ionization in air produced by X or gamma radiation. The unit used to quantify exposure is the roentgen (R). For practical purposes, 1 roentgen is comparable to 1 rem for X and gamma radiation.

Exclusive use: When a single shipper transports the material and all initial, intermediate, and final loading and unloading are carried out in accordance with the direction of the shipper or receiver.

Fissile Material: Material whose atoms are capable of nuclear fission (capable of being split). Department of Transportation (DOT) regulations define fissile material as plutonium-239, plutonium-241, uranium-233, uranium-235, or any combination of these radionuclides.

Gamma rays or gamma radiation: Electromagnetic radiation of high energy. Gamma rays are the most penetrating type of radiation and represent the major external hazard. Symbol: γ

Geiger counter or GM meter: An instrument used to detect and measure radiation such as a CD V-700.

Gray (Gy): The SI unit of absorbed dose; 1 gray=100 rad.

High-level waste (HLW): Highly radioactive waste resulting from reprocessing spent fuel (fuel irradiated in a nuclear reactor). Currently in the United States, reprocessing involves removing the plutonium and uranium from spent fuel generated by nuclear reactors.

HRCQ: Acronym for Highway Route Controlled Quantity which is a high activity shipment transported in a Type B package. The package will always have a Yellow-III label regardless of radiation level. HRCQ shipments by highway will require the standard placard on a white square background with a black border.

Ionization: Production of charged particles in a medium. The removal of an electron from an atom. This results in the formation of ion pairs.

Ionizing radiation: Electromagnetic (X-ray and gamma) or particulate (alpha, beta) radiation capable of producing ionization or charged particles.

Irradiation: Exposure to ionizing radiation.

Low-level waste (LLW): Radioactive material that results from nuclear-related research, medical, and industrial processes. The radiation level of these materials ranges from natural background levels to very radioactive.

LSA: Low Specific Activity material means the radioactive material is distributed throughout a substance to such an extent that it poses little hazard even if released in an accident. Examples would include uranium and thorium ores.

Monitoring: Determining the amount of ionizing radiation or radioactive contamination present. Also referred to as surveying.

NCRP: The National Council on Radiation Protection and Measurement. NCRP was chartered by the U.S. Congress in 1964 as the National Council on Radiation Protection and Measurements. More information can be found online at http://www.ncrponline.org/.

Rad: The unit of radiation absorbed dose. (SI unit is *gray*).

Radiation: Energy traveling through space. Some types of radiation associated with radioactivity are alpha and beta particles and gamma and X-rays.

Radioactivity: The spontaneous emission of radiation from the nucleus of an unstable atom. As a result of this emission, the radioactive atom is converted, or decays, into an atom of a different element that might or might not be radioactive.

Rem: A measure of radiation dose related to biological effect. (SI unit is Sievert).

Roentgen (R): The unit of exposure from X or gamma rays (see exposure).

Saturate: Saturation is a problem experienced in a limited number of GM-type radiation detectors. When exposed to a very high exposure rate, some instruments may show a momentary upswing of the meter needle followed by a return of the needle to a point near zero causing the user to believe it is safe when it is not. Most newer GM instruments use non-saturating detectors which are designed so that when the instrument's needle pegs high, it stays pegged and will not return to zero.

SCO: Surface Contaminated Object means a solid object which is not itself radioactive but which has radioactive material distributed on its surface. Examples would include contaminated tools and equipment.

Sealed source: A radioactive source sealed in an impervious container which has sufficient mechanical strength to prevent contact with and dispersion of the radioactive material under the conditions of use and wear for which it was designed. A radiation check source or button source used for instrument response checks would be a commonly used example of a sealed source.

Sievert (Sv): The SI unit of dose equivalent; 1 Sv=100 rem.

Smear: A smear (swipe) is the universal method of assessing removable contamination. A small cloth, filter paper, or fiberglass disk is used to “wipe” an area or object suspected of being contaminated. The smear is then checked using a contamination survey meter. If contamination is found on the smear, the smeared object is considered contaminated.

Transuranic (TRU) waste: Elements having atomic numbers greater than that of uranium are called transuranic (beyond uranium). Most TRU waste is a byproduct of weapons production, and consists of protective gear, tools, residue, debris, and other items contaminated with small amounts of radioactive elements (mainly plutonium).

Uranium tailings: Radioactive rock and soil—the by-products of uranium mining and milling.

X-rays: Penetrating *electromagnetic radiation* whose wave lengths are shorter than those of visible light.

Who should be called for assistance in accidents involving radioactive materials?

Department of Energy Emergency Operations Center
(DOE-EOC) (24-HOUR) 1-202-586-8100

Nuclear Regulatory Commission
(NRC) (24-HOUR) 1-301-816-5100

Federal Emergency Management Agency
(FEMA) (24-HOUR) 1-202-586-8100

Environmental Protection Agency
(EPA) (24-HOUR) 1-800-424-8802

Radiation Emergency Assistance Center/Training Site
(24-HOUR) 1-865-576-1005 (Ask for REAC/TS)

National Response Center
1-800-424-8802, in District of Columbia 1-202-267-2675

Military Shipments (DoD)
Call Collect 1-703-697-0218

CHEMTEL
1-800-255-3924 (Toll-free US & Canada)

Where can I get more information about the transportation of radioactive materials?

CHEMTREC
Toll free: **1-800-424-9300**
Calls outside continental US: **1-703-527-3887**

*Phone numbers verified June, 2009.

US Department of Transportation
Pipeline and Hazardous Materials Safety Administration
East Building, 2nd Floor
1200 New Jersey Ave., SE
Washington, DC 20590
1-202-366-4433
http://phmsa.dot.gov/hazmat

US Department of Energy
Transportation Emergency Preparedness Program (TEPP)
Office of Environmental Management
U.S. Department of Energy
1000 Independence Avenue
Washington, DC 20585
1-301-903-7284
http://www.em.doe.gov/otem

Office of Scientific and Technical Information
US Department of Energy
P.O. Box 62
Oak Ridge, TN 37831
1-865-576-1188
http://www.osti.gov

Health Physics Society
1313 Dolley Madison Boulevard, Suite 402
McLean, Virginia 22101
1-703-790-1745
http://www.hps.org