

# RADIATION EMERGENCIES

FREQUENTLY ASKED  
QUESTIONS

# How to Prepare for a Radiation Emergency

- **What preparations can I make for a radiation emergency?**  
Check with your community leaders to learn more about your community's plans and evacuation routes for a radiation emergency (they should have one). Check with your child's school, the nursing home of a family member, and/or your employer to see what their plans are for dealing with a radiation emergency. Also, you can develop your own family emergency plan so that every family member knows what to do in case of a radiation emergency. At home, put together an emergency kit that would be appropriate for any emergency.
- **Are local and state agencies in Oregon prepared for radiation emergencies?**  
Local and state agencies as well as emergency response personnel (emergency medical technicians, police, firefighters, and hospital staff) are in the process of being trained. Oregon is one of the top states in training local and state agencies and it is one of the most prepared states for dealing with radiation emergencies. Emergency plans are, or are being, created. Practice drills are being preformed.
- **How do I minimize my radiation exposure:**  
There are three components in minimizing your radiation exposure. They are time, distance, and shielding.
  - Time: By limiting the amount of time you spend near the radiation source reduces the amount of radiation exposure that you will receive.
  - Distance: The greater the distance between you and the radiation source, the less radiation exposure you will receive.
  - Shielding: The more heavy and denser the material between you and the source of the radiation the better. The shielding will block much of the radiation from reaching you.
- **What are the components of a family emergency plan?**  
List all telephone numbers, as well as e-mail addresses for everyone that you will need to notify in an emergency. Ask an out-of-state friend or relative to serve as the family contact. Make sure everyone in your family knows the name, address and telephone number of the contact person. Practice and quiz your family about the emergency plan at least once every six months. Also, work together with

neighbors and know what specialized equipment they might have, like power generators, or expertise such as medical knowledge that might help in a crisis.

- **How can I get information during a radiation emergency?**  
Tune to the local emergency response network or news station for information and instructions during any emergency. You may be advised to “shelter in place” (stay in your home or office) or you may be advised to evacuate.

## **A. Sheltering in Place**

### **1. How do I “shelter in place” at home?**

You should:

- Close and lock all doors and windows
- Turn off fans, air conditioners, and forced-air heating units that bring in fresh air from the outside.
- If you are told there is a chance an explosion may occur, close the window shades, blinds, or curtains.
- Close fireplace dampers.
- If possible, bring pets inside.
- Move to an inner room or basement.
- Keep your radio tuned to the emergency response network or local news to find out what else you need to do.

### **2. How do I shelter in place at work?**

Close the business. If there are customers, clients, or visitors in the building, ask them to stay, not leave. When authorities provide directions to shelter-in-place, they want everyone to take those steps immediately, where they are, and not drive or walk outdoors. Unless there is an imminent threat, ask employees, customers, clients, and visitors to call their emergency contact to let them know where they are and that they are safe.

Turn on call-forwarding or alternative telephone answering systems or services. If the business has voice mail or an automated attendant, change the recording to indicate that the business is closed, and that staff and visitors are remaining in the building until authorities advise you that it is safe to leave. Close and lock all windows, exterior doors, and any other openings to the outside. If you are told there is a danger of an explosion, close the window shades, blinds, or curtains. Have employees familiar with your building’s mechanical systems turn off all fans, heating and air conditioning systems.

Gather essential disaster supplies, such as nonperishable food, bottled water, battery-powered radios, first aid supplies, flashlights, batteries, duct tape, plastic sheeting, and plastic garbage bags. Select interior room(s), with the fewest windows or vents. The room(s) should have adequate space for

everyone to be able to sit in. Avoid overcrowding by selecting several rooms if necessary. Large storage closets, utility rooms, pantries, copy and conference rooms without exterior windows will work well. Avoid selecting a room with mechanical equipment like ventilation blowers or pipes, because this equipment may not be able to be sealed from the outdoors. It is ideal to have a hard-wired telephone in the room(s) you select.

Call emergency contacts and have the phone available if you need to report a life-threatening condition. Cellular telephone equipment may be overwhelmed or damaged during an emergency, so have a land line available as well. Use duct tape and plastic sheeting to seal all cracks around the door(s) and any vents into the room. Bring everyone into the room(s). Shut and lock the door(s). Write down the names of everyone in the room, and call your business' designated emergency contact to report who is in the room with you, and their affiliation with your business (employee, visitor, client, customer.)

Keep listening to the radio or television until you are told all is safe or you are told to evacuate. Local officials may call for evacuation in specific areas at greatest risk in your community.

### **3. How will schools and daycares “shelter in place”?**

You can contact the local school district or your child's daycare center and ask them for a copy of their emergency plan. Ask how they will communicate with families during a crisis. Ask if they store adequate food, water and other basic supplies. Find out where they plan to go if they must evacuate. An example emergency plan is below:

Close the school. Activate the school's emergency plan. Follow reverse evacuation procedures to bring students, faculty, and staff indoors. If there are visitors in the building, provide for their safety. Ask visitors to stay, and not leave.

Provide for answering telephone inquiries from concerned parents by having at least one telephone with the school's listed telephone number available in the room selected to provide shelter for the school secretary, or person designated to answer these calls. This room should also be sealed. There should be a way to communicate among all rooms where people are sheltering-in-place in the school. Ideally, provide for a way to make announcements over the school-wide public address system from the room where the top school official takes shelter.

If children have cell phones, allow them to use them to call a parent or guardian to let them know that they have been asked to remain in school until further notice, and that they are safe. If the school has voice mail or an automated attendant, change the recording to indicate that the school is closed,

students and staff are remaining in the building until authorities advise that it is safe to leave.

Provide directions to close and lock all windows, exterior doors, and any other openings to the outside. If you are told there is danger of explosion, direct that window shades, blinds, or curtains be closed. Have employees familiar with your building's mechanical systems turn off all fans, heating and air conditioning systems. Some systems automatically provide for exchange of inside air with outside air; these systems, in particular, need to be turned off, sealed, or disabled.

Gather essential disaster supplies, such as nonperishable food, bottled water, battery-powered radios, first aid supplies, flashlights, batteries, duct tape, plastic sheeting, and plastic garbage bags. Select interior room(s) above the ground floor, with the fewest windows or vents. The room(s) should have adequate space for everyone to be able to sit in. Avoid overcrowding by selecting several rooms if necessary. Classrooms may be used if there are no windows or the windows are sealed and cannot be opened. Large storage closets, utility rooms, meeting rooms, and even a gymnasium without exterior windows will also work well.

It is ideal to have a hard-wired telephone in the room(s) you select. Call emergency contacts and have the phone available if you need to report a life-threatening condition. Cellular telephone equipment may be overwhelmed or damaged during an emergency. Bring everyone into the room. Shut and lock the door. Use duct tape and plastic sheeting to seal all cracks around the door(s) and any vents into the room. Write down the names of everyone in the room, and call your schools' designated emergency contact to report whomever is in the room with you.

Listen for an official announcement from school officials via the public address system, and stay where you are until you are told all is safe or you are told to evacuate. Local officials may call for evacuation in specific areas at greatest risk in your community.

#### **4. How do I “shelter in place” in my vehicle?**

If you are driving a vehicle and hear advice to “shelter-in-place” on the radio, go immediately to your home, office, or a public building, if nearby, and go inside. Follow the shelter-in-place recommendations for the place you pick described above.

If you are unable to get to a home or building quickly and safely, then pull over to the side of the road. Stop your vehicle in a safe place. Turn off the engine. Close windows and vents. Listen to the radio regularly for updated advice and instructions. Stay where you are until you are told it is safe to get

back on the road. Be aware that some roads may be closed or traffic detoured. Follow the directions of law enforcement officials.

### **5. How do I prepare a shelter in my home?**

The safest place in your home during an emergency involving radioactive materials is a centrally located room or basement. This area should have as few windows as possible. The further your shelter is from windows, the safer you will be. Sheltering is up to 80% effective in reducing dose depending upon length of exposure, building design and ventilation. Store emergency supplies in this area. Every 6 months check the supplies in your shelter. Replace any expired medication, food, or batteries. Also replace the water in your shelter every 6 months to keep it fresh. Make sure that all family members know where the shelter is and what it is to be used for. Caution them not to take any items from that area. If you have pets, prepare a place for them to relieve themselves in the shelter. Pets should not go outside during a radiation emergency because they may track radioactive materials into your shelter when they come back inside.

### **6. What emergency supplies should I store my shelter's supply kit?**

The following is a list of things that you should consider storing in your emergency supplies kit. Most of these items should be stored in waterproof containers. You should also have small emergency disaster supply kits in each vehicle, as well as supplies at your workplace (water, first aid kit, flares, jumper cables, flashlight and extra batteries, etc.). You should have a portable supply kit (one per family member) as well located near an exit of your house or sheltered somewhere in your backyard to take with you if you are told to evacuate.

Food with a long shelf life – Preferably store foods that do not need cooking. Store enough food for each member of the household for at least 3 days. Make sure you also have a hand-operated can opener on hand. Include any special dietary foods that may be necessary. Examples of foods you could store:

- Ready-to-eat canned meats, fruits, and vegetables
- Protein or fruit bars
- Dry cereal or granola
- Peanut butter
- Dried fruit
- Nuts
- Crackers
- Canned juices
- Non-perishable pasteurized milk or dry milk
- Vitamins
- Water – Store bottled water or water from the tap in non-breakable containers (soft drink bottles work well). Each person in the household will need about 1 gallon per day; Plan on storing enough

- water for at least 3 days. Children, nursing mothers, and sick people may need more than 1 gallon of water per day.
- A change of clothes and shoes – Check clothing every 6 months and remove clothes that no longer fit or are unsuitable for seasonal weather. Remember to include underwear, socks, sturdy shoes or work boots, and winter or summer clothes as needed. Keep rainwear items in your supply kit as well.
  - Paper plates, paper towels, and plastic utensils – Store disposable dishware and utensils because you will not have enough stored water to wash dishes.
  - Plastic bags – Because you may not be able to leave your shelter for several days, you will need to collect your waste in plastic bags until it can be removed.
  - Bedding – Store sheets, blankets, towels, and cots and/or sleeping.
  - Battery-operated radio and batteries – A battery-operated radio will allow you to listen to emergency messages. Try to a radio that can receive the National Oceanic and Atmospheric Administration (a weather radio).
  - A portable generator
  - Medicines – Have 2-3 days' dose of current prescription medications in a childproof bottle for your shelter medical kit; label it with the name and expiration date of the medicine. Be sure to check medicines in your kit every 6 months to make sure they are not past the expiration date. Also keep prescribed medical supplies such as glucose and blood pressure monitoring equipment and supplies.
  - Toiletries – Keep a supply of soap, shampoo, toothpaste, toothbrushes, washcloths, towels, feminine sanitary products, hand sanitizer, toilet paper, deodorant, disinfectants, etc.
  - Flashlight and batteries – Electrical power may be. A flashlight will help you see.
  - A telephone or cell phone – Although cell phone or ground phone service may be interrupted, there is still a chance that you will be able to use a phone to call outside for information and advice from emergency services. Make sure you have a charger/extra batteries for the cell phone.
  - Extra eyeglasses or contact lenses and their cleaning supplies as well as hearing aids, dentures or canes
  - A tool kit
  - Scissors
  - A portable air purifier with a HEPA filter
  - Cash (at least \$50 in small bills and be sure to include change for making phone calls at pay phones if necessary or have a prepaid phone card) and credit/debit cards
  - An extra set of car keys.

- Copies of identification, valuable papers, insurance policies, medical insurance cards, Medicare/Medicaid cards, and sentimental photographs should be put into a waterproof container.
- Duct tape and heavy plastic sheeting – You can use these items to seal the door to your shelter and to seal any vents that open into your shelter for a short period of time.
- Pet food, baby formula, diapers, items needed for the elderly, etc. – If you have an infant, store extra formula and diapers. If you have pets keep a 3-day supply of pet food. If you have elderly family members store extra medical equipment that they might need.
- Games, books, magazines, toys, and other entertainment – You may be in your shelter for several days, keep items on hand to occupy your family during that time.
- Matches and a second method to light a fire (like a lighter)
- Candles and light sticks
- Sewing kit
- Bottle of potassium iodide tablets
- Whistle with neck cord (for signaling rescuers if you are trapped)
- A portable toilet
- Portable outdoor camping stove or grill with fuel supply.
- Some form of alternative heating (kerosene heat, wood heat, heating pouches)
- First aid kit - You can purchase one or prepare one yourself. Be sure to include the following items:
  - o A first aid reference book
  - o Sterile adhesive bandages
  - o Sterile gauze pads in 2 inch and 4 inch sizes
  - o Adhesive tape
  - o Soap or hand sanitizer
  - o Latex or vinyl gloves
  - o Safety pins
  - o Aspirin or aspirin free pain reliever
  - o Anti-diarrhea medication
  - o Sterile rolled bandages
  - o Scissors
  - o Tweezers
  - o Needle
  - o Thermometer
  - o Moistened towelettes
  - o Eye wash solution
  - o Antiseptic and antibiotic ointment
  - o Tube of petroleum jelly or other lubricant
  - o Laxative
  - o Antacids
  - o Syrup of ipecac to cause vomiting if advised by the Poison Control Center

- o Activated charcoal to stop vomiting if advised by the Poison Control Center

**7. Can you give me an example of a portable emergency supply kit?**

- At least a three day supply of water
- At least a three day supply of food
- Battery-powered radio and extra batteries
- Flashlight and extra batteries
- A first aid kit
- A whistle to signal for help
- A dust mask or cotton t-shirt to put over your mouth and nose to help filter the air
- Moist towelettes
- Wrench and/or pliers
- Manual can opener
- Plastic sheeting and duct tape to shelter in place
- Infant formula and diapers if you have an infant
- Garbage bags and plastic ties for personal sanitation

**8. What else do I need to know before entering a shelter?**

If you are outside when the alert is given, try to remove clothing and shoes and place them in a plastic bag before entering the house. During severe weather, remove at least the outer layer of clothes before entering the home to avoid bringing radioactive material into your shelter. Leave clothing and shoes outside. Shower and wash your body with soap and water. Removing clothing will eliminate up to 90% of radioactive contamination.

Before entering the shelter, turn off fans, air conditioners, and forced-air heating units that bring air in from the outside. Close and lock all window and doors, and close fireplace dampers.

Use duct tape and plastic sheeting to seal any doors, windows, or vents for a short period of time in case a radiation plume is passing over (listen to your radio for instructions). Within a few hours, you should remove the plastic and duct tape and ventilate the room.

Keep your radio tuned to an emergency response network at all times for updates on the situation.

**9. How long can a family stay in a sealed room?**

The Federal Emergency Management Agency recommends that individuals allow ten square feet of floor space per person in order to provide sufficient air to prevent carbon dioxide build up for up to 5 hours.

**10. Why does the government recommend duct tape and plastic sheeting?**

Duct tape and plastic sheeting or even heavy-duty trash bags can be used to create an airlock in a room to reduce the amount of radioactive materials that might get into an area. These materials provide temporary shelter for you and your family for about five hours. Once the danger or plume has passed, it is easy to remove these materials and exit.

**11. Is there a particular type (brand) of duct tape that citizens should buy?**

The Federal Emergency Management Agency recommends using duct tape with a minimum thickness of 10 millimeters (0.01 in).

**12. What is the most effective type of plastic sheeting?**

The Federal Emergency Management Agency recommends using plastic sheeting with a thickness of 0.01 inch (10 millimeters). Commercially available sheeting is typically sold at 0.7, 1, 1.2, 1.5, 2, 2.5, 3, 4, 6 and 10 millimeters thickness. But, keep in mind that any type of plastic sheeting, even heavy trash bags, can be better than nothing.

**13. Will shrink wrap plastic used for weatherproofing work?**

The Federal Emergency Management Agency does not recommend using shrink-wrap plastic. Installing shrink-wrap plastic would take more time than using plastic sheeting and duct tape due to the two steps required (adhesion to the frame using double sided tape and use of hair dryer to achieve a tight fit).

## **B. Evacuation**

**1. What do I need to do if told to evacuate?**

- Before an emergency, learn how to turn off utilities (locate the electric, gas and water shut-off valves. Keep the necessary tools near gas and water shut off valves. Teach family members how to turn off utilities. If you turn off the gas, a professional must turn it back on. Do not attempt to turn the gas back on yourself.
- Follow the directions that your local officials provide. Leave the area as quickly and orderly as possible. Listen to the radio or television for information about evacuation routes, temporary shelters, and procedures to follow.
- Before you leave, close and lock windows and doors and turn off air conditioning vents, fans, and furnace. Close fireplace dampers.
- Use your own transportation, if possible. If traveling by car, keep all windows closed and turn off the heater and ventilators. If you do not have your own transportation, the police should have you go to a designated assembly point from where a bus should pick you up and evacuate you.
- Do not attempt to pick up children from school. The school and government authorities will ensure that they are looked after.

- Take a flashlight, portable radio, batteries, first-aid kit, supply of sealed food and water, hand-operated can opener, essential medicines, and cash and credit cards.
- Take pets only if you are using your own vehicle and going to a place you know will accept animals. Emergency vehicles and shelters usually will only allow service animals inside of them. Take extra food, water, and supplies for your pet.
- Remember your neighbors and certain family members may require special assistance, especially infants, elderly people, and people with disabilities. Find out what their special needs are and plan ahead.
- If you have a car, keep a half tank of gas in it at all times.
- If time allows:
  - Call or email the “out-of-state” contact in your family communications plan.
  - Tell them where you are going
  - If there is damage to your home and you are instructed to do so, shut off water, gas and electricity before leaving
  - Leave a note telling others when you left and where you are going

## **C. People with disabilities preparations**

### **1. How do people with disabilities prepare for radiation incidents?**

Maintain a list of the following important items and store it with the emergency supplies. Give a copy to another family member and a friend or neighbor.

- Special equipment and supplies, like hearing aid batteries
- Current prescriptions names and dosages
- Names, addresses, and telephone numbers of doctors and pharmacist
- Detailed information about your medication regime

Create a self-help network of relatives, friends or co-workers to assist in an emergency.

Tell these people where you keep your emergency supplies. Give one member of your support network a key to your house or apartment. If you think you may need assistance in a disaster, discuss your disability with relatives, friends, and co-workers and ask for their help. For example, if you need help moving or require special arrangements to receive emergency messages, make a plan with friends.

Contact your local emergency information management office now. Many local emergency management offices maintain registers of people with disabilities so they can be located and assisted quickly in a disaster.

Wearing medical alert tags or bracelets to identify your disability may help in case of an emergency.

Know the location and availability of at least two medical facilities offering the care you need. For example: if you are dependent on a dialysis machine or other life-sustaining equipment or treatment.

If you have a severe speech, language, or hearing disability: You can dial 9-1-1, tap space bar to indicate TDD call. Also, store a writing pad and pencils to communicate with others. Keep a flashlight handy to signal whereabouts to other people and for illumination to aid in communication. Remind friends that you cannot completely hear warnings or emergency instructions. Ask them to be your source of emergency information as it comes over their radio. If you have a hearing ear dog, be aware that the dog may become confused or disoriented in an emergency. Store extra food, water and supplies for your dog.

Planning for Evacuation:

People with disabilities have the same choices as other community residents about whether to evacuate their homes and where to go when an emergency threatens. Listen to the advice of local officials.

If you need a wheelchair:

Show friends how to operate your wheelchair so they can move you if necessary. Know the size and weight of your wheelchair as well as whether or not it is collapsible in case it needs to be transported.

## **D. Caring for pets**

### **1. How should I prepare to care for my pets before a disaster?**

Contact your local animal shelter, humane society, and veterinarian or emergency management office for information on caring for pets in an emergency. Find out if there will be any shelters set-up to take pets in an emergency. Also, see if your veterinarian will accept your pet in an emergency.

Decide on safe locations in your house where you could leave your pet in an emergency (it is not advised to leave your pet at home unless absolutely necessary).

You will need a pet carrier that allows your pet to stand up and turn around inside. Put familiar items such as the pet's normal bedding and favorite toys inside. Train your pet to become comfortable with the carrier. Use a variety of training methods such as feeding it in the carrier or placing a favorite toy or blanket inside.

If your pet is on medication or a special diet, find out from your veterinarian what you should do in case you have to leave it alone for several days. Try and get an extra supply of medications.

Make sure your pet has a properly fitted collar that includes current license and rabies tags. Including an identification tag that has your name, address, and phone number. If your dog normally wears a chain link "choker" collar, have a leather or nylon collar available if you have to leave him alone for several days.

Keep your pet's shots current and know where the records are.

Most kennels require proof of current rabies and distemper vaccinations before accepting a pet.

Contact motels and hotels in communities outside of your area and find out if they will accept pets in an emergency.

When assembling emergency supplies for the household, include items for pets.

- Extra food stored in watertight, sturdy containers
- Kitty litter if you have a cat
- Large capacity self-feeder and water dispenser
- Extra medications if they require them

Trained Guide Dogs:

In most states, trained guide dogs for the blind, hearing impaired or handicapped will be allowed to stay in emergency shelters with their owners. Check with local emergency management officials for more information.

## **2. What should I do with my pets during an emergency?**

Bring your pets inside immediately.

Animals have instincts about severe weather changes and will often isolate themselves if they are afraid. Bringing them inside early can stop them from running away. Never leave a pet outside.

Even if your dogs and cats normally get along, the anxiety of an emergency situation can cause pets to act irrationally. Separate dogs and cats. Keep small pets away from cats and dogs as well.

If you evacuate your home, **DO NOT LEAVE YOUR PETS BEHIND!** Pets most likely will not be able to survive on their own.

Make sure identification tags are up to date and securely fastened to your pet's collar. If possible, attach the address and/or phone number of your evacuation site. If your pet gets lost, his tag is his ticket home. Make sure you have a current photo of your pet for identification purposes.

Put your pet in a secure pet carrier, or on a leash or harness for your pet so that if it panics, it cannot escape.

Consider making and taking a pet survival kit with you containing: pet food, bottled water, medications, veterinary records, cat litter/pan, can opener, food dishes, first aid kit and other supplies with you in case they're not available later.

If it is impossible to take your pet with you to temporary shelter, contact friends, family, veterinarians, or boarding kennels to arrange for care. Make sure medical and feeding information, food; medicine, medical records, and other supplies accompany your pet to his foster home. **NOTE:** Some animal shelters will provide temporary foster care for owned pets in times of disaster, but this should be considered only as a last resort.

Birds must eat daily to survive. In an emergency, you may have to take your birds with you. Talk with your veterinarian or local pet store about special food dispensers that regulate the amount of food a bird is given. Make sure that the bird is caged and the cage is covered by a thin cloth or sheet to provide security and filtered light.

If you have no alternative but to leave your pet at home, there are some precautions you must take, but remember that leaving your pet at home alone can place your animal in great danger! Confine your pet to a safe area inside -- NEVER leave your pet chained outside! Place notices outside in a visible area, advising what pets are in the house and where they are located. Provide a phone number where you or a contact can be reached as well as the name and number of your vet.

### **3. Should I do anything special with my pets after the emergency?**

If after a radiation incident you have to leave town, take your pets with you. Pets are unlikely to survive on their own.

In the first few days after the radiation incident, leash your pets when they go outside. Always maintain close contact. Familiar scents and landmarks may be altered and your pet may become confused and lost.

The behavior of your pets may change after an emergency. Normally quiet and friendly pets may become aggressive or defensive. Watch animals closely. Leash dogs and place them in a fenced yard with access to shelter and water.

## **E. Precautions that farmers should take in a radiation incident**

### **1. What disaster planning tips do you have for dealing with livestock?**

Evacuate livestock whenever possible. Arrangements for evacuation, including routes and shelter sites, should be made in advance. Alternate routes should be mapped out in case the planned route is inaccessible.

The evacuation sites/shelters should have or be able to readily obtain food, water, veterinary care, handling equipment and facilities.

Trucks, trailers, and other vehicles suitable for transporting livestock (appropriate for transporting each specific type of animal) should be available along with experienced handlers and drivers to transport them. Whenever possible, the animals should be accustomed to these vehicles in advance so they're less frightened and easier to move.

If evacuation is not possible, a decision must be made whether to move large animals to available shelter or turn them outside. This decision should be determined based on the type of radiation incident and the soundness and location of the shelter's structure.

All animals should have some form of identification that will help to make their return easier.

Your disaster plan should include a list of emergency phone numbers for local agencies that can assist you if disaster strikes -- including your veterinarian, state veterinarian, local animal shelter, animal care and control, county extension service, local agricultural schools and the American Red Cross. These numbers should be kept with your disaster kit in a secure, but easily accessible place

### **2. What other precautions should farmers take?**

Suggested actions to protect dairy animals and livestock from radiological contamination follow. It is unlikely that animals will suffer from contamination that will cause death or permanent injury, but radioactivity ingested by dairy animals can contaminate milk and milk products. Therefore, dairy animals should be provided with shelter, stored feed and protected water supplies before precautions are taken for other farm animals. If there is sufficient shelter, feed and water available, move other livestock indoors and place them on stored feed and protected water supply. The major concern for protecting dairy animals from contamination is to protect the milk and other dairy products produced for human consumption.

Water from a covered well, tank, cistern or from a freely running spring is best. To prevent contamination from radioactive particles, do not add water to

covered tanks unless the water is from a protected well or spring. Use all the water originally present in the tanks first.

Water in an exposed pond would be contaminated but, usually, the level of contamination would decrease rapidly. Such water could be used for surface irrigation. It could also be used to wash off farm buildings and unsheltered livestock. Surface water should be safe within a few days after the incident. The surface waters in ponds and rivers would tend to be safer sooner if there is no rain. Otherwise, if possible, obtain drinking water for livestock from another source.

Covered feeds are the safest feeds. Radioactive particles are like dust or dirt; a cover will prevent contamination from coming in contact or mixing with the feed.

Grain stored in a permanent bin, hay in a barn or in a covered silo can be considered safe. They can be used as feed for your dairy animals and livestock. A haystack in an open field can be protected with a tarpaulin or similar covering.

Remain alert to emergency broadcasts and other communications that will notify you of radiation levels and if animal feed growing in your area is considered harmful. As a precautionary measure, house the dairy animals and livestock and do not let them graze. In the event you have no stored feed during an emergency, you should know that animals could survive for a period of time on water alone.

State emergency personnel will be monitoring milk and milk stations, and sampling will also be done on the farms. When possible, you will be informed whether or not your milk contains radioactive materials.

Poultry is somewhat more resistant to radiation than other farm animals. Also, most poultry is raised under shelter and given feed that has been protected or stored, so they are of less concern following a radiological emergency. However, the same protective measures recommended for other livestock should be used for poultry as well.

Do not destroy any animal food products unless spoilage has made them inedible. Milk should be safe to use if it is from dairy animals that have been adequately sheltered and protected. Livestock exposed to external contamination can be used for food if the radiation level is not excessive, if they are adequately washed and if monitored by state authorities prior to slaughtering. Meat animals that have internal contamination cannot be slaughtered until the appropriate state authorities advise the owner that it is safe to do so. You will receive specific instructions from state authorities.

If milk pickups and deliveries are interrupted because of an emergency, officials concerned will be in touch with milk transport companies and will provide instructions. There may be delays in pickups, which will necessitate the holding of milk for longer than normal periods. It is possible that some milk may have to be discarded.

It is unlikely that the type and level of radioactive release would cause any animal illness. Animal's skins containing radioactive materials can be washed off with soap and water. When washing animals, protective clothing should be worn similar to that worn when applying pesticides.

It is anticipated that most affected land could be returned to normal use in several weeks after having been contaminated. The exact length of time that the land would remain unusable would depend on the amount and type of radioactive materials deposited in a given area.

Extension agents and state agricultural officials will guide farmers in determining how to use their land following a radiological emergency.

Under the worst conditions, radioactive contamination could reduce the economic productivity of your farm. As previously mentioned, you may suffer the loss of some farm and dairy items due to spoilage during the period of time that a radiological emergency is in progress. However, following an accident, radioactive contamination might reduce the competitive economic value of your farm products. This would be due to public reluctance to purchase farm products that are suspected of having been grown in an area that has been affected by a radioactive release. State authorities will advise you on the contamination level that your farm experienced and the marketability of your farm products.

Growing fruit and vegetables can become externally contaminated. Leaves, pods and fruits that are contaminated with radioactive particles can be cleaned before being eaten. Green vegetables that are contaminated should have outer layers removed. Washing is probably the most effective measure.

Roots and tubers absorb little contamination. The normal cleaning or peeling of underground vegetables such as potatoes and carrots would be adequate for removing contamination.

Fruits that are ripe at the time of a radiological accident may be lost due to a possible personal hazard to the worker. Fruits that do not have to be picked immediately can be saved and picked after the contamination has decayed.

## **F. Protective Equipment**

### **1. Should I buy a radiation detector?**

You do not need one, but if you would like to buy a radiation detector, try to find a dose rate meter that has a scale from 1 millirem/hour up to 1 Roentgen/hr. You can use this to determine if there is radiation in an area (air, a room, a field, etc.). You might also buy a contamination meter that measures dose. You can use this to see if the surface of something is contaminated (clothing, your skin, etc.). Make sure you take the time to learn how much background radiation is in your area. Also know how and when to get the instrument calibrated. If you do not understand what these terms mean, how to take a measure of radiation dose or dose rate, or what the differences between the two types of meters are, then it might not be beneficial to you to purchase them. Improper use may cause you to panic when there is no real danger.

### **2. Should I buy some sort of protective/gas mask?**

An ordinary surgical facemask provides good protection against inhaling particles. It is not recommended that you use any other type of mask. Other types of masks need to be fitted carefully for each face, and there are different kinds of masks for different types of agents. Having or using a protective mask may offer a false sense of security. They can also be unsafe for children or people with asthma. Over-the-counter N95 masks are designed to be 95% effective at blocking many particles. The N95 masks might be able to provide some protection against inhalation. But, better advice would be to stay away from the immediate area of a radiological incident, minimize the time near the area, maximize the distance between you and the source of the radiation, and place as much shielding (like a building) between yourself and the contaminated area.

## **G. Miscellaneous Planning Information**

### **1. What can I do about wildlife in the area?**

Most wildlife will evacuate an area when a loud sound, like a bomb detonation, goes off. They may panic however. If you see an injured or stranded wild animal in need of assistance, or you need help with removing a wild animal from your home, please contact your local animal control office or animal shelter.

### **2. I live in a high-rise, do I respond the same way as if I lived in a house?**

Know and practice your building's evacuation route and plan. Listen to the advice of local government officials. If advised to shelter in place, select an interior room on the floor that you are on and take refuge. If advised to evacuate, follow the advice of local government officials or building management.

**3. What radio or television stations should I listen to for information?**

All stations are required to carry “Emergency Alert System Messages” when government officials issue them.

**4. How do I stay calm?**

Know how to be prepared for emergencies. Develop a plan on how to respond with your family, including loved ones who will be concerned about you but who do not live with you. Include an emergency communications plan. If a disaster happens, follow your plan. Knowing that you know what to do and doing it is the best way to remain calm.

**5. How can I handle fears and concerns of my children?**

First it is important that parents stay calm, since children will look to your reaction for comfort. Having a family communications plan in place and talking about disasters before they occur, will give your child confidence in knowing what to do and how to contact you. Agencies like The American Red Cross have resources available that can help children deal with terrorism and tragic events. See the lessons and activities titled Facing Fear: Helping Children Deal With Terrorism and Tragic Events. These materials are available to be downloaded from

<http://www.redcross.org/disaster/masters/facingfear>

**6. Will whole house air filtration systems protect me?**

These systems are designed to reduce, but not completely remove, particulate matter in the air inside a home. A house or apartment is not completely air tight or sealed, even when doors and windows are closed.

**7. Other than Potassium Iodide, are there any other supplements or over-the-counter products, which might be helpful in a radiation incident?**

The simple answer is no. Some people have asked in the past if they should take something like large doses of calcium to protect against strontium-90 (which can accumulate in bone). Since strontium-90 is not a gas, but a particle, it would enter the body through contaminated food and drink. It is therefore easy to prevent exposure to strontium-90 by not eating or drinking anything that might be contaminated.

**8. How can I protect my family and myself from a terrorist nuclear attack?**

You should cover your nose and mouth and immediately seek shelter in a stable undamaged building. Once inside close windows and doors, turn off air conditioners, heaters or other ventilation systems if possible. Listen to local radio or television stations for national emergency-alert information. As a general rule, you can reduce the potential exposure and subsequent health consequences by limiting your time near the radiation source, increasing your

distance from the source, or keeping a physical barrier (such as the wall of a building) between you and the source.

**9. What should I do if there is a terrorist attack on a nuclear power plant near my home?**

A terrorist attack on a nuclear power plant will initiate a national emergency response that has been carefully planned and rehearsed by local, state, and federal agencies for more than 20 years. Contact the plant and ask for a copy of their emergency plan. Study these plans and be prepared to follow the instruction that local and state public health officials provide in the event of a terrorist incident involving the nuclear power plant near your home.

**10. What do I do if there is a dirty bomb explosion in or very close to the building that I am in and there is a danger the building might collapse?**

Exit the building as soon as possible. If it is not possible, take shelter against your desk or a sturdy table.

- Do not use elevators
- Check for fire and other hazards
- Take your emergency supply kit if time allows
- Find a safe place to take shelter until local authorities tell you to do otherwise.

**11. What do I do if I am in the area where a dirty bomb is exploded and there is a fire?**

- Exit the building as soon as possible
- Crawl low if there is smoke
- Use a wet cloth to cover your nose and mouth
- Use your hand to feel a door top to bottom
- If the door is hot do not open it, look for another way out.
- If the door is not hot, brace yourself against it and open it slowly
- Do not use elevators
- If you catch fire, do not run. Stop-drop-and-roll to put out the fire.
- Go to a previously designated meeting place
- Account for your family members or coworkers, carefully supervise small children
- Never go back into a burning building.
- Find a safe place to take shelter until local authorities tell you to do otherwise.

**12. What do I do if I am trapped in debris?**

- If possible, use a flashlight to signal your location to rescuers
- Avoid unnecessary movement so that you do not kick up dust.
- Cover your mouth and nose with anything you have on hand (dense-weave cotton material can act as a good filter. Try to breath through the material.)

- Tap on a pipe or wall so that rescuers can hear where you are.
- Shout only as a last resort. Shouting can cause a person to inhale dangerous amounts of dust and possibly radioactive materials.

## **H. Radiation Incidents Abroad**

### **1. What should I do if a radiation incident occurs where I am while abroad?**

In general, you should do the same things to prepare and to help yourself, as you would do at home. You probably will not have a disaster supply kit with you, however, you can still try to find shelter, stay as far away from the site of the incident as possible and minimize your time near any areas that might be radioactive.

In addition you should contact the U.S. Embassy or Consulate if you need help. Be sure to register with the U.S. Embassy or Consulate by phone, fax, or in person if possible. Monitor the U.S. Embassy and State Department's home pages. Monitor Voice of America and BBC broadcasts announcements.

When a crisis occurs abroad the State Department sets up a task force to bring together all of the people necessary to work on the event. Usually this task force will be in touch by telephone 24 hours a day with our Ambassador and Foreign Service Officers at the embassy in the country affected.

### **2. What happens if a family member is involved in a radiation incident abroad?**

Relatives will want information on the welfare of their family members and on the disaster. Despite the possibility of lack of electricity, phone lines, gasoline, etc. that could occur in a disaster, foreign service officers work hard to get information back to the State Department as quickly as possible.

As concerned relatives call in, officers of the Bureau of Consular Affairs collect the names of the Americans possibly involved in the disaster and pass them to the embassy and consulates. Officers at these posts attempt to locate these Americans in order to report on their welfare. The officers work with local authorities and may personally search hotels, airports, hospitals, or even prisons.

When an American dies abroad, the Bureau of Consular Affairs must locate and inform the next-of-kin. Sometimes discovering the next-of-kin is difficult. If the American's name is known, the Bureau's Office of Passport Services will search for his or her passport application. However, the information there may not be current.

The Bureau of Consular Affairs provides guidance to grieving family members on how to make arrangements for local burial or return of the

remains to the U.S. The disposition of remains is affected by local laws, customs, and facilities, which are often vastly different from those in the U.S. The Bureau of Consular Affairs relays the family's instructions and necessary private funds to cover the costs involved to the embassy or consulate. The Department of State has no funds to assist in the return of remains or ashes of American citizens who die abroad. Upon completion of all formalities, the consular officer abroad prepares an official Foreign Service Report of Death, based upon the local death certificate, and sends it to the next-of-kin or legal representative for use in U.S. courts to settle estate matters.

A U.S. consular officer overseas has statutory responsibility for the personal estate of an American who dies abroad if the deceased has no legal representative in the country where the death occurred. The consular officer takes possession of personal effects, such as apparel, jewelry, personal documents and papers. The officer prepares an inventory and then carries out instructions from members of the deceased's family concerning the effects. A final statement of the account is then sent to the next-of-kin. In Washington, the Bureau of Consular Affairs gives next-of-kin guidance on procedures to follow in preparing Letters Testamentary, Letters of Administration, and Affidavits of Next-of-Kin as acceptable evidence of legal claim of an estate.

In the case of an injured American, the embassy or consulate abroad notifies the task force, which notifies family members in the U.S. The Bureau of Consular Affairs can assist in sending private funds to the injured American; frequently it collects information on the individual's prior medical history and forwards it to the embassy or consulate. When necessary, the State Department assists in arranging the return of the injured American to the U.S. commercially, with appropriate medical escort, via commercial air ambulance or, occasionally, by U.S. Air Force medical evacuation aircraft. The use of Air Force facilities for a medical evacuation is authorized only under certain stringent conditions, and when commercial evacuation is not possible. The full expense must be borne by the injured American or his family.

As for evacuation, sometimes commercial transportation entering and leaving a country is disrupted during a disaster. If this happens, and if it appears unsafe for Americans to remain, the embassy and consulates will work with the task force in Washington to charter special air flights and ground transportation to help Americans to depart. The U.S. Government cannot order Americans to leave a foreign country. It can only advise and try to assist those who wish to leave.

# Potassium Iodide

## **1. What is Potassium Iodide (KI)?**

KI is a salt of iodine. KI has been approved by the FDA as a nonprescription drug for use as a “blocking agent” to prevent the human thyroid gland from absorbing radioactive iodine. However, KI may not provide people with 100% protection against all radioactive iodine.

## **2. Should I take Potassium Iodide during a radiation emergency?**

Potassium iodide (KI) should only be taken in a radiation emergency that involves the release of radioactive iodine, such as an accident at a nuclear power plant or explosion of a nuclear bomb. A person who is internally exposed to radioactive iodine may experience thyroid disease or thyroid cancer later in life. Potassium iodide will saturate the thyroid with iodine, decreasing the amount of harmful radioactive iodine that can be absorbed. Potassium iodide will only protect the thyroid and does not protect from any other radiation exposure. It must be taken prior to exposure or immediately after exposure to be effective. Potassium iodide can be dangerous to some people, so it is not recommended that it be taken unless there is a definite risk of exposure to radioactive iodine.

## **3. When should I take Potassium Iodide (KI)?**

Local emergency management officials will tell people when to take KI. If radioactive iodine is not present, then taking KI will not protect people. Taking KI will not protect people from radioactive substances that may be present other than radioactive iodine.

## **4. What forms does Potassium Iodide (KI) come in and how much should be taken?**

- KI comes in tablets of 130mg. A one-time dose at the levels recommended below is usually all that is required. Below are the usual recommended doses.
- Adults should take one 130mg tablet.
- Children between 3 and 18 years of age should take one-half of a 130mg tablet (65mg total).
- Infants from birth to 1 month of age should be given one-eighth of a 130mg tablet (16mg).
- Women who are breastfeeding should take the adult dose, and their infants should take the recommended dose above.

- Children approaching adult size (greater than or equal to 150 pounds) should take the adult dose regardless of their age.

**5. How long can KI tablets be stored?**

KI tablets can be stored for at least 5 years without losing their potency.

**6. Where can I obtain KI?**

People should talk to their pharmacists to obtain KI and instruction on taking it.

**7. Can't I just take table salt (since it is iodized) instead of Potassium Iodide (KI)?**

Iodized table salt will not provide enough iodine to protect the thyroid and should not be used as a substitute.

**8. Who should or should not take KI when the public is told to do so?**

Children are the most susceptible to the dangerous effects of radioactive iodine. The FDA and the World Health Organization (WHO) recommend that children from newborn to 18 years of age all take KI unless they have a known allergy to iodine. Women who are breastfeeding should also take KI to protect both themselves and their breast milk. Breastfeeding infants should still be given the recommended dosage of KI to protect them from any radioactive iodine that they may breathe in or drink in breast milk. Young adults between the ages of 18 and 40 have a smaller chance of developing thyroid cancer or disease from exposure to radioactive iodine than do children. However, the FDA and WHO still recommend that people ages 18 to 40 take the recommended dose of KI.

Adults over the age of 40 have the smallest chance of developing thyroid cancer or disease after an exposure to radioactive iodine. Adults over age 40 also have a greater chance of having an allergic reaction to the high dose of iodine in KI. Because of this, they *are not recommended* to take KI unless a very large dose of radioactive iodine is expected.

**9. What medical conditions make it dangerous to take KI?**

- The high concentration of iodine in KI can be harmful to some people. People should not take KI if they:
- Have ever had thyroid disease (such as hyperthyroidism, thyroid nodules, or goiter).
- Know they are allergic to iodine (If you are allergic to shellfish, ask your doctor or pharmacist about taking KI).
- Have certain skin disorders (such as dermatitis herpetiformis or urticaria vasculitis).

# Prussian Blue

## **1. What is Prussian blue?**

Prussian blue is a blue dye in used by artists and manufacturers. It is also called Radiogardase. It got its name from its use as a dye for Prussian military uniforms. Prussian blue dye and paint are still available today from art supply stores.

## **2. How is Prussian blue used to treat radioactive contamination?**

Prussian blue is used to treat people who have been internally contaminated with radioactive cesium or thallium. Prussian blue can be given at any point after doctors have determined that a person is internally contaminated. Prussian blue will help speed up the removal of cesium and thallium from the body.

## **3. How does Prussian blue work?**

Radioactive cesium and thallium, whether ingested or inhaled, will end up in the intestines. Prussian blue traps these materials in the intestines and keeps them from being absorbed by the body. The radioactive materials then move through the intestines and are excreted in bowel movements. Prussian blue reduces the time that radioactive cesium and thallium stay in the body, it helps limit the amount of time the body is exposed to radiation.

## **4. Who can take Prussian blue?**

The drug is safe for all adults, children, and infants, including pregnant women and women who are breast-feeding their babies. Prussian blue may not be recommended for people who have had constipation or blockages in the intestines.

## **5. What are the side effects of taking Prussian blue?**

The most common side effects of Prussian blue are upset stomach and constipation. These side effects can easily be treated with other medications. People will have blue feces during the time that they are taking Prussian blue

## **6. How soon after exposure to radioactive cesium or to thallium does somebody have to receive Prussian blue to avoid illness and death?**

Prussian blue should be taken as soon as possible after exposure. However, even when treatment cannot be started right away, patients should be given Prussian blue as soon as it becomes available because it is still effective even after time has elapsed since exposure.

## **7. Where you can get Prussian blue?**

Prussian blue is not routinely available. It is supplied in 500-milligram capsules that can be swallowed whole or mixed in liquid for children to drink. The amount to be taken depends on how badly a person is contaminated.

Prussian blue must be taken 3-4 times a day for up to 150 days, depending on the extent of the contamination, under the supervision of a doctor.

People SHOULD NOT take Prussian blue artist's dye in an attempt to treat themselves. This type of Prussian blue is not designed to treat radioactive contamination and is not manufactured in a germ-free area. People who are concerned about the possibility of being contaminated with radioactive cesium or thallium should go to their doctors for advice and treatment.

**8. Can my doctor write a prescription for Prussian blue for me to keep on hand?**

Prussian blue should be given only under the supervision of a physician after assessing your medical condition. It is only effective to treat contamination with radioactive cesium or thallium. The dose and duration of treatment depends on the amount of contamination a person is exposed to. Therefore, this drug should be given only when the physician has determined your need for it.

**9. How do I know that Prussian blue will be available in case of an emergency?**

The U.S. government makes sure that needed medications, especially medicines that may be needed to treat a terrorist threat, are stored in sufficient quantity to provide treatment if there is an emergency.

**10. Will Prussian blue be added to the National Stockpile?**

It is already part of the National Stockpile of drugs that can be used in an emergency situation.

## VII. Where to find more information

**Where can I go to find more information about radiation health effects and emergency response? The following are sources of information used in this text. They are also good places to find more information on radiation incidents.**

- The Nuclear Regulatory Commission (NRC) can be reached at (301) 415-8200 or at <http://www.nrc.gov>
- The Federal Emergency Management Agency (FEMA) can be reached at (202) 646-4600 or at <http://www.fema.gov/>
- The Radiation Emergency Assistance Center/Training Site (REAC/TS) can be reached at (865) 576-3131 or at <http://www.ornl.gov/reacts/>
- The U.S. Department of Energy (DOE) can be reached at 1-800-dial-DOE or at <http://www.doe.gov/>
- The CDC Public Response Source can be reached at 1-888-246-2675 or at <http://www.cdc.gov/>
- The Conference of Radiation Control Program Directors can be reached at (502) 227-4543 or at <http://www.crcpd.org/>
- World Health Organization, Radiation and Environmental Health Unit at (international call) +41 22 791-3427 and +41 22 791-4312 or at [http://www.who.int/ionizing\\_radiation/en/](http://www.who.int/ionizing_radiation/en/)
- The Humane Society of the United States, Disaster Services Program can be reached at (202) 452-1100 or at <http://www.hsus.org/ace/352>
- The International Atomic Energy Agency (IAEA) at [www.iaea.org](http://www.iaea.org)
- The Center for Technology and National Security Policy, National Defense University at <http://www.ndu.edu/ctnsp/home.html>
- The Health Physics Society at <http://www.hps.org/>
- National Terror Alert Resource Center at <http://www.nationalterroralert.com/>
- Ready.gov from the U.S. Department of Homeland Security at <http://www.ready.gov/>
- U.S. Department of State, The Bureau of Consular Affairs at <http://travel.state.gov>
- The U.S. Environmental Protection Agency at [www.epa.gov](http://www.epa.gov)
- The Department of Homeland Security at [www.dhs.gov](http://www.dhs.gov)
- The U.S. Food and Drug Administration [www.fda.gov](http://www.fda.gov) or at 1-888-INFO-FDA
- Nuclear Was Survival Skills Book online at [www.ki4u.com/free\\_book/s73p904.htm](http://www.ki4u.com/free_book/s73p904.htm)

## VIII. Glossary of Radiological Terms

### A

**Absorbed dose:** the amount of energy deposited by ionizing radiation in a unit mass of tissue.

**Activity (radioactivity):** the rate of decay of radioactive material expressed as the number of atoms breaking down per second measured in units called Becquerel or curies.

**Acute exposure:** an exposure to radiation that occurred in a matter of minutes rather than in a longer continued exposure over a period of time.

**Acute Radiation Syndrome (ARS):** Also called radiation sickness. An illness caused by receiving a dose greater than 50 rads of penetrating radiation to the body in a short time (usually minutes). The earliest symptoms are nausea, fatigue, vomiting, and diarrhea. Hair loss, bleeding, swelling of the mouth and throat, and general loss of energy may follow. If the exposure has been approximately 1,000 rads or more, death may occur within 2 to 4 weeks.

**Airborne radioactivity:** Radioactive material in any form contained or suspended in air.

**Air burst:** a nuclear weapon explosion that is high enough in the air to keep the fireball from touching the ground. Because the fireball does not reach the ground and does not pick up any surface material, the radioactivity in the fallout from an air burst is relatively insignificant compared with a surface burst.

**Alpha particle:** the nucleus of a helium atom, made up of two neutrons and two protons.. Alpha particles generally carry more energy than gamma or beta particles, and deposit that energy very quickly while passing through tissue. Alpha particles can be stopped by a thin layer of light material, such as a sheet of paper, and cannot penetrate the outer, dead layer of skin. Therefore, they do not damage living tissue when outside the body. When alpha-emitting atoms are inhaled or swallowed, however, they are especially damaging because they transfer relatively large amounts of ionizing energy to living cells.

**Atom:** the smallest particle of an element that can enter into a chemical reaction.

## **B**

**Background radiation:** ionizing radiation from the following natural sources:

1. Naturally occurring radioactive materials, which have not been technologically enhanced.
2. Cosmic sources
3. Global fallout as it exists in the environment (such as from the testing of nuclear explosive devices)
4. Radon and its daughters in concentrations or levels existing in buildings or the environment which have not been elevated as a result of current or prior activities
5. Consumer products containing small amounts of radioactive material or producing small amounts of radioactive material

**Beta particles:** electrons ejected from the nucleus of a decaying atom. Although a thin sheet of aluminum can stop them, beta particles can penetrate the dead skin layer, potentially causing burns. They can pose a serious direct or external radiation threat and can be lethal depending on the amount received. They also pose a serious internal radiation threat if they are ingested or inhaled.

## **C**

**Calibration:**

The process of adjusting or determining either:

1. The response or reading of an instrument relative to a standard or to a series of conventionally true values; or
2. The strength of a radiation source relative to a standard or conventionally true value.

**Carcinogen:** a cancer-causing substance.

**Chronic exposure:** exposure to a substance over a long period of time.

**Contamination (radioactive):** the presence of unwanted radioactive material on the surfaces of structures, areas, objects, or people (where it may be external or internal).

**Cosmic radiation:** radiation produced in outer space when heavy particles from other galaxies bombard the earth.

**Critical mass:** the minimum amount of fissile material that can achieve a self-sustaining nuclear chain reaction.

## **D**

**Daughters:** Many radioactive materials decay into other radioactive materials called 'daughter' products, which may have very different physical, chemical and radiological properties from the parent radioactive material.

**Decay, radioactive:** disintegration of the nucleus of an unstable atom by the release of radiation.

**Decontamination:** the reduction or removal of radioactive contamination from a structure, object, animal, or person.

**Dirty bomb:** a device designed to spread radioactive material by conventional explosives when the bomb explodes. A dirty bomb kills or injures people through the initial blast of the conventional explosive and spreads radioactive contamination over possibly a large area. Such bombs could be miniature devices or as large as a truck. A dirty bomb is much simpler to make than a true nuclear weapon.

**Dose (radiation):** the amount of radiation absorbed by a person's body.

**Dose Assessment:** Process of estimating radiological dose through the use of exposure scenarios, bioassay results, monitoring data, source term information and pathway analysis.

**Dose rate:** the radiation dose delivered per unit of time.

**Dosimeter:** a small portable instrument (such as a film badge, thermoluminescent dosimeter [TLD], or pocket dosimeter) for measuring and recording the total accumulated dose of ionizing radiation a person receives.

## **E**

**Electron:** an elementary particle with a negative electrical charge and a mass  $1/1837$  that of the proton. Electrons surround the nucleus of an atom because of the attraction between their negative charge and the positive charge of the nucleus. A stable atom will have as many electrons as it has protons. The numbers of electrons that orbit an atom determine its chemical properties.

**Embryo/Fetus:** Developing human organism from conception until birth. It is the same as unborn child.

**Exposure (radiation):** a measure of ionization in air caused by x-rays or gamma rays only. The unit of exposure most often used is the roentgen.

**Exposure pathway:** a route by which a radioactive material can enter the body. The main exposure routes are inhalation, ingestion, absorption through the skin, and entry through a cut or wound in the skin.

**Exposure rate:** a measure of the ionization produced in air by x-rays or gamma rays per unit of time (frequently expressed in roentgens per hour).

**External exposure:** exposure to radiation outside of the body.

## **F**

**Fallout, nuclear:** minute particles of radioactive debris that descend slowly from the atmosphere after a nuclear explosion.

**Fissile material:** any material in which neutrons can cause a fission reaction. The three primary fissile materials are uranium-233, uranium-235, and plutonium-239.

**Fission (fissioning):** the splitting of a nucleus into at least two other nuclei that releases a large amount of energy. Two or three neutrons are usually released during this transformation

**Fusion:** a reaction in which at least one heavier, more stable nucleus is produced from two lighter, less stable nuclei. Reactions of this type are responsible for the release of energy in stars or in thermonuclear weapons.

## **G**

**Gamma rays:** high-energy electromagnetic radiation emitted by certain radioactive materials. These rays have high energy and a short wave length. Gamma rays penetrate tissue farther than do beta or alpha particles. Gamma rays are very similar to x-rays.

**Geiger counter:** a radiation detection and measuring. Geiger counters are the most commonly used portable radiation detection instruments.

**Genetic effects:** hereditary effects (mutations) that can be passed on through from parent to child.

## **H**

**Half-life:** the time any substance takes to decay into half of its original amount.

**Hormesis:** All living things exist in a sea of ionizing radiation, much of which is internal. It is a general belief that low doses of ionizing radiation produce detrimental effects proportional to the effects produced by high-level radiation. Over the past decades, however, some pioneer scientists reported that low-dose ionizing radiation is not only a harmless agent but often has a beneficial effect. That is, low-level ionizing radiation may be essential for life. This idea is called hormesis.

## I

**Ingestion:** In the case of radioactive materials, swallowing radioactive materials by eating or drinking.

**Inhalation:** In the case of radioactive materials, the breathing in of radioactive materials.

**Internal exposure:** exposure to radioactive material that has entered into the body.

**Iodine:** There are both radioactive and non-radioactive types of iodine. Radioactive types of iodine are widely used in medical applications. Radioactive iodine is a fission product and is the largest contributor to people's radiation dose after an accident at a nuclear reactor.

**Ion:** an atom that has fewer or more electrons than it has protons causing it to have an electrical charge and, therefore, be chemically reactive.

**Ionization:** the process of adding one or more electrons to, or removing one or more electrons from, atoms or molecules, thereby creating ions. High temperatures, electrical discharges, or radiation can cause ionization.

**Ionizing radiation:** any radiation capable of removing electrons from atoms, thereby producing ions.

**Irradiation:** exposure to radiation.

**Isotope:** one of two or more atoms with the same atomic number but with different numbers of neutrons (or mass numbers).

## K

**Kiloton (Kt):** the energy of an explosion that is equivalent to an explosion of 1,000 tons of TNT.

## M

**Milli (m):** One-thousandth of a unit, for example millirem (mrem)

**Molecule:** a combination of two or more atoms that are chemically bonded. A molecule is the smallest unit of a compound that can exist by itself and retain all of its chemical properties.

## N

**Neutron:** a small atomic particle possessing no electrical charge typically found within an atom's nucleus. Neutrons are neutral in their charge (they are positively nor a negatively charged). A neutron has about the same mass as a proton.

**Non-ionizing radiation:** radiation that has lower energy levels and longer wavelengths than ionizing radiation. It is not strong enough to affect the structure of atoms it contacts but is strong enough to heat tissue and can cause harmful biological effects. Examples include radio waves, microwaves, visible light, and infrared from a heat lamp.

**Nuclear energy:** the heat energy produced by the process of nuclear fission within a nuclear reactor or by radioactive decay.

**Nuclear Reactor:** A device in which a fission chain reaction can be initiated, maintained and controlled.

**Nuclear Regulatory Commission (NRC):** Federal agency responsible for regulating the use of radioactive material.

**Nucleus:** the central part of an atom that is positively charged and contains protons and neutrons. The nucleus is the heaviest part of the atom and contains almost all of its mass.

## P

**Pathways:** the routes by which people are exposed to radiation or other contaminants. The three basic pathways are inhalation, ingestion, and direct external exposure

**Penetrating radiation:** radiation that can penetrate the skin and reach internal organs and tissues. Photons (gamma rays and x-rays), neutrons, and protons are penetrating radiations. However, alpha particles and all but extremely high-energy beta particles are not considered penetrating radiation.

**Photon:** discrete "packet" of pure electromagnetic energy. Photons have no mass and travel at the speed of light. The term "photon" was developed to describe energy when it acts like a particle (causing interactions at the molecular or atomic level), rather than a wave. Gamma rays and x-rays are photons.

**Plume:** the material spreading from a particular source and traveling through environmental media, such as air or ground water. For example, a plume could describe the dispersal of particles, gases, vapors, and aerosols in the atmosphere, or the movement of contamination through an aquifer.

**Plutonium (Pu):** a heavy radioactive element. Pu-239 can be used in reactor fuel and is the primary nuclear material used in nuclear weapons. The complete detonation of a kilogram of plutonium produces an explosion equal to about 20,000 tons of chemical explosive. All isotopes of plutonium are readily absorbed by the bones and can be lethal depending on the dose and exposure time.

**Prenatal radiation exposure:** radiation exposure to an embryo or fetus while it is still in its mother's womb. At certain stages of the pregnancy, the fetus is particularly sensitive to radiation and the health consequences could be severe above 5 rads, especially to brain function.

## **R**

**Rad (radiation absorbed dose):** a unit of absorbed radiation dose. It is a measure of the amount of energy absorbed by the body. The rad is the traditional unit of absorbed dose.

**Radiation:** energy moving in the form of particles or waves. Non-ionizing forms are heat, light, radio waves, and microwaves. Ionizing radiation is a very high-energy form of electromagnetic radiation.

**Radiation sickness:** See acute radiation syndrome (ARS)

**Radiation warning symbol:** a symbol prescribed by the U.S. Code of Federal Regulations. It is a magenta or black trefoil on a yellow background. It must be displayed where certain quantities of radioactive materials are present or where certain doses of radiation could be received.

**Radioactive contamination:** the deposition of unwanted radioactive material on the surfaces of structures, areas, objects, or people. It can be airborne, external, or internal.

**Radioactive decay:** the spontaneous disintegration of the nucleus of an atom.

**Radioactive half-life:** the time required for a quantity of a radioactive material to decay by half.

**Radioactive material:** material that contains unstable (radioactive) atoms that give off radiation as they decay.

**Radioactivity:** It is the process of emission of radiation from a material. The process of spontaneous transformation of the nucleus, generally with the emission of alpha or beta particles often accompanied by gamma rays.

**Radiological or radiologic:** related to radioactive materials or radiation. Radiological sciences focus on the measurement and effects of radiation.

**Radiological dispersal device (RDD):** a device that disperses radioactive material by conventional explosive or other mechanical means, such as a spray.

**Rem:** a unit of equivalent dose. Not all radiation has the same biological effect, even for the same amount of absorbed dose. Rem relates the absorbed dose in human tissue to the effective biological damage of the radiation. The rem is the traditional unit of equivalent dose.

**Risk:** the probability of injury, disease, or death under specific circumstances and time periods. Risk can be expressed as a value that ranges from 0% (no injury or harm will occur) to 100% (harm or injury will definitely occur). Risk can be influenced by several factors: personal behavior or lifestyle, environmental exposure to other material, or inborn or inherited characteristic known from scientific evidence to be associated with a health effect. Because many risk factors are not exactly measurable, risk estimates are uncertain.

**Risk assessment:** an evaluation of the risk to human health or the environment by hazards. Risk assessments can look at either existing hazards or potential hazards.

**Roentgen (R):** a unit of exposure to x-rays or gamma rays. One roentgen is the amount of gamma or x-rays needed to produce ions carrying 1 electrostatic unit of electrical charge in 1 cubic centimeter of dry air under standard conditions.

## S

**Shielding:** Any material which, when placed between a radiation source and a potentially exposed person, reduces their exposure.

**Special nuclear material:** plutonium or uranium that is usable in nuclear weapons

**Strontium:** Sr-90 is one of the radioactive fission materials created within a nuclear reactor during its operation. Strontium-90 emits beta particles during radioactive decay.

**Surface burst:** a nuclear weapon explosion that is close enough to the ground for the radius of the fireball to vaporize surface material. Fallout from a surface burst contains very high levels of radioactivity.

## T

**Thermonuclear device:** a “hydrogen bomb.” A device with explosive energy that comes from fusion of small nuclei, as well as fission.

**Terrestrial radiation:** radiation emitted by naturally occurring radioactive materials, such as uranium, thorium, and radon in the earth.

**Thyroid Blocking Agent:** A substance taken as a protective measure to reduce the uptake by the thyroid of radioactive iodine, primarily potassium iodine is used.

## U

**Unstable nucleus:** a nucleus that contains an uneven number of protons and neutrons and seeks to reach a stable state through radioactive decay.

**Uranium (U):** a naturally occurring radioactive element whose principal isotopes are uranium-238 and uranium-235. Natural uranium contains a minute amount of uranium-234.

**Uranium mill tailings:** naturally radioactive residue from the processing of uranium ore. The residues, or tailings, contain several isotopes of naturally occurring radioactive material, including uranium, thorium, radium, polonium, and radon.

## W

**Whole body exposure:** an exposure of the body to radiation, in which the entire body, rather than any one part, is irradiated by an external source.

## X

**X-ray:** electromagnetic radiation caused by deflection of electrons from their original paths, or inner orbital electrons that change their orbital levels around the atomic nucleus. X-rays, like gamma rays can travel long distances through air and most other materials. X-rays can penetrate the body and thus require more shielding. X-rays and gamma rays differ primarily in their origin: x-rays originate in the electron shell; gamma rays originate in the nucleus.