

Frequently Asked Questions & Suggested Answers - Radiation Emergencies

CAUTION

The answers to some of the questions below are *general* in nature and may need to be revised based on the details of the actual emergency, local conditions and response plans or other factors.

Physics

What is radiation and radioactive material?

Radiation is a form of energy that is present all around us. Different types of radiation exist, some of which contain more energy than others (e.g. low energy examples: *radio waves and visible light* and higher energy examples: *X-rays and gamma rays* emitted from radioactive material and used in diagnostic radiology and nuclear medicine. Radioactive material is comprised of atoms whose nuclei are unstable. As they spontaneously transform to a more stable state, they emit energy in the form of particles (e.g., alpha and beta particles) and/or waves (e.g. X-rays and gamma rays), referred to collectively as *ionizing radiation*. Ionizing radiation means that, (unlike non-ionizing radiation such as radio waves and microwaves) the energy in this type of radiation is high enough to strip electrons from atoms and alter their chemistry. The quantity or amount of radioactive material is referred to as *activity* and is expressed in units called becquerels, abbreviated to Bq. The dose of radiation that a person receives is measured in units called sieverts, abbreviated to Sv. People cannot see, smell, feel, hear or taste ionizing radiation. Detecting and measuring ionizing radiation requires special instruments, called radiation survey meters.

What is radiation exposure?

When a person is exposed to radiation, some or all of the radiation energy is deposited in the body. For example, when a person has a medical X-ray exam, he or she is exposed to radiation in the form of X-rays. Some of the X-rays deposit their energy in the body while some traverse and exit the body and interact with an X-ray detector to form the X-ray image of the internal anatomy. There is another, more technical, meaning of exposure, which describes the intensity of radiation.

How can exposure occur?

People are exposed to small amounts of ionizing radiation every day, both from naturally occurring sources (such as radioactive material in the soil or building materials and cosmic rays from outer space), and man-made sources (such as X-rays, certain diagnostic tests, and radiation therapy treatments), and from fallout from past nuclear weapons testing. Scientists estimate that the average person receives a dose of about 3 mSv per year. The amount of radiation to which people are exposed is usually small; a radiation emergency (such as a nuclear power plant accident or a terrorist event) could expose people to small or large doses of radiation, depending on the situation.

What is radioactive contamination?

Radioactive contamination occurs when radioactive material is deposited on, or in, an object or a person. Radioactive materials released into the environment can cause air, water, surfaces, soil, plants, buildings, people, or animals to become contaminated. A contaminated person has radioactive materials on, or inside, their body.

What is external contamination?

External contamination occurs when radioactive material, in the form of dust, powder, or liquid, becomes deposited on a person's skin, hair, or clothing. In other words, the radioactive material is on the outside of a person's body. People who are externally contaminated can become internally contaminated if radioactive material gets into their bodies through their mouth, nose or open wounds.

What is internal contamination?

Internal contamination occurs when people swallow or breathe in radioactive materials, or when radioactive materials enter the body through an open wound, or are absorbed through the skin. Some fraction of radioactive material may be deposited (i.e. concentrated) in different body organs and stay there for an extended period of time (e.g. radioactive iodine concentrates in the thyroid gland) while some fraction will be eliminated from the body in urine, feces, and sweat.

How does contamination differ from exposure?

A person exposed to radiation is not necessarily contaminated with radioactive material. A person who has been exposed to radiation has had radiation (in the form of waves and/or particles) interact with the body (e.g. like having a medical X-ray). For a person to be contaminated, radioactive material must be on or inside the body. A contaminated person is continuously exposed to radiation released by the radioactive material on, or inside, the body. An uncontaminated person can be exposed to radiation by being close to radioactive material or a contaminated person.

How can exposure or contamination happen?

Radioactive materials could be released into the environment and may cause exposure or contamination in the following ways: an accidental release from a medical or industrial device, fallout from previous nuclear weapons testing, an intentional release of radioactive material as an act of terrorism, an atomic bomb explosion, or a nuclear power plant accident.

What types of terrorist events might involve radiation?

Possible terrorist events could involve introducing radioactive material into the food or water supply, using explosives (like dynamite) to scatter radioactive materials (called a "dirty bomb"), bombing or to destroy a nuclear facility, or exploding a small nuclear weapon (atomic bomb).

Although introducing radioactive material into the food or water supply most likely would cause great concern or fear, it probably would not cause much contamination, or significantly increase the danger of adverse health effects. A meltdown or explosion at a nuclear facility could cause a large amount of radioactive material to be released. People at the facility would probably be contaminated with radioactive material and possibly be injured if there was an explosion. Those people who received a large dose might develop acute radiation syndrome. People in the surrounding area could be exposed or contaminated. Clearly, a successful detonation of even a

small nuclear weapon (atomic bomb) in a populated area would result in substantial casualties and extensive property damage. People would be killed or injured from the blast and many would be exposed and contaminated with radioactive material. Many people could have symptoms of acute radiation syndrome. After a nuclear detonation, radioactive fallout would extend over a large region far from the point of detonation, potentially increasing people's risk of developing cancer over time.

What is a dirty bomb?

A dirty bomb is a mix of explosives, such as dynamite, with radioactive material, likely in the form of a powder or pellets. When the explosive is set off, the blast spreads radioactive material into the surrounding area. A dirty bomb is *not* the same as an atomic bomb, like those dropped on Hiroshima and Nagasaki, which involves the splitting of atoms and a huge release of energy and radioactive material.

What are the main dangers of a dirty bomb?

The main danger from a dirty bomb is from the explosion, which could cause serious injuries and property damage. The radioactive materials used in a dirty bomb would probably not create enough radiation exposure to cause immediate serious illness, except maybe those people who are very close to the blast site. However, the radioactive dust and smoke spread farther away could be dangerous to health if it is inhaled. Because people cannot see, smell, feel, hear or taste radiation, you should take immediate steps to protect yourself and others as shown in the next item.

What immediate protective actions should I take?

These simple steps—recommended by doctors and radiation experts—will help protect you and others. The steps you should take depend on where you are located when the incident occurs: outside, inside, or in a vehicle.

If you are outside and close to the incident

Cover your nose and mouth with a cloth to reduce the risk of breathing in radioactive dust or smoke. Quickly go into a building where the walls and windows have not been broken. This area will shield you from radiation that might be outside. Once you are inside, take off your outer layer of clothing and seal it in a plastic bag if available. Removing outer clothes may get rid of up to 90% of radioactive dust. Shower or wash with soap and water. Be sure to wash your hair. Washing will remove most of the remaining dust.

If you are inside and close to the incident:

If the walls and windows of the building are not broken, stay in the building and do not leave. Shut all windows, outside doors, and fireplace dampers. Turn off fans and heating and air-conditioning systems that bring in air from the outside. It is not necessary to put duct tape or plastic around doors or windows. If the walls and windows of the building are broken, go to an interior room.

If you are in a car when the incident happens:

Close the windows and turn off the air conditioner, heater, and vents. Cover your nose and mouth with a cloth to avoid breathing radioactive dust or smoke. If you are close to your home,

office, or a public building, go there immediately and go inside quickly. If you cannot get somewhere safely, pull over to the side of the road and stop in the safest place possible. If it is a hot or sunny day, try to stop under a bridge or in a shady spot. Turn off the engine and listen to the radio for instructions. Stay in the car until you are told it is safe to get back on the road.

Radiation Protection Principles

How do I know if I've been exposed to radiation or contaminated by radioactive materials?

People cannot see, smell, feel, hear or taste radiation; so you may not know whether you have been exposed. Police, firefighters or other emergency response personnel, will check for radiation by using special equipment to determine how much radiation is present and whether it poses any danger in your area. Low levels of radiation exposure (like those expected from a dirty bomb situation) do not cause any clinical symptoms. Very high levels of radiation exposure may produce symptoms, such as nausea, vomiting, diarrhea, and swelling and redness of the skin. If you develop any of these symptoms, you should contact your doctor, hospital, or other sites recommended by authorities.

How do you survey someone if you suspect they are contaminated?

When conducting a radiation survey, the technician should initially conduct a scan of the face, hands, and feet using a standard radiation survey instrument. If contamination is detected, then the technician should conduct a thorough survey. The speed of the survey should not exceed 5 cm per second, and the distance between the probe and the person being scanned should be approximately 2 cm. Staff should consider covering the survey probe in plastic to prevent contamination of the instrument. The data recorded from the survey should include the instrument used, background reading (instrument reading when it is away from radioactive material), date, time and location of the survey, identity of the person surveyed, as well as the surveyor, and results of the survey with the location of any contamination noted on a map or diagram of the body.

What if internal contamination is suspected?

Arrangements for a bioassay should be made if internal contamination is suspected. A bioassay is a measurement of the amount of radioactive material inside a person's body. Body fluids used for laboratory analysis include blood, urine, feces, nasal and saliva swabs, sputum, vomitus, and wound secretions. Nasal swabs are used as the first step to examine the internal contamination.

How is radioactive contamination spread?

Radioactive material is typically attached to dust and dirt. People who are externally contaminated with radioactive material can contaminate other people or surfaces that they touch. For example, people who have radioactive dust on their clothing may spread the radioactive dust when they sit in chairs or touch other people. People who are internally contaminated can expose people near them to radiation from the radioactive material inside their bodies. The body fluids (blood, sweat, urine) of an internally contaminated person may contain radioactive materials. Coming in contact with these body fluids can result in contamination.

How can radiation exposure be reduced?

The principles of time, distance, and shielding are key. Even in treatment of the most contaminated patients from the Chernobyl nuclear power plant accident, doses to the medical staff were typically less than 10 mSv. Doses to first responders at the scene, however, can be much higher and appropriate dose rate meters must be available for evaluation. Radiation dose is reduced by reducing time spent in the radiation area (moderately effective), increasing distance from a radiation source (very effective) and using metal or concrete shielding (less practical in emergency circumstances).

What guidance is there for occupational exposure during emergency responses?

When an incident has occurred, in some circumstances it may be necessary to knowingly allow individuals to be exposed to relatively high levels of radiation. This may be necessary to perform an urgent intervention or even to save lives. Doses (whole body effective doses) recommended by the ICRP for such circumstances are:

Lifesaving measures – may exceed 500 or 1000 mSv

For other urgent rescue operations – (500 or 1000 mSv) or less

For other rescue operations – below 500 mSv

How much dose could first responders receive in order to recover persons who would otherwise die?

The consensus is more than 250 mSv and probably not a lot more than 500 mSv whole body effective dose. The rationale for this is that in this dose range there would not be acute radiation sickness, but there would be a modest increased cancer risk of less than 3%. Responders should be volunteers who have been informed of the risks of radiation exposure. Allowing persons to get over 1 Sv would likely result in mild acute radiation sickness of the responders and, given the uncertainties in an accident, may result in some responder fatalities.

Should I recommend sheltering to the public?

If field measurements or predictions are that the population is likely to receive an effective dose in the range of 5-50 mSv in 2 days, sheltering should be recommended. One should not wait until the public has received this dose to take action. Sheltering is an excellent short term but not a long term solution.

How can my home become contaminated?

People who are externally contaminated can spread the contamination by touching surfaces, sitting in a chair, or even walking through a house. Contaminants can easily fall from clothing and contaminate other surfaces.

How can I limit contamination?

Since radiation cannot be seen, smelled, felt, hear or tasted, people at the site of an incident will not know whether radioactive materials were involved. You can take the following steps to limit your contamination. Get out of the immediate area quickly. Go inside the nearest safe building or to an area to which you are directed by law enforcement or health officials.

1. Remove the outer layer of your clothing. If radioactive material is on your clothes, getting it away from you will reduce the external contamination and decrease the risk of internal contamination. It will also reduce the length of time that you are exposed to radiation.
2. If possible, **place the clothing in a plastic bag or leave it in an out-of-the-way area**, such as the corner of a room. Keep people away from it to reduce their exposure to radiation. Keep cuts and abrasions covered when handling contaminated items to avoid getting radioactive material in them.
3. **Wash all of the exposed parts of your body** using lots of soap and lukewarm water to remove contamination. This process is called **decontamination**. Try to avoid spreading contamination to parts of the body that may not be contaminated, such as areas that were clothed.
4. After authorities determine that **internal contamination may have occurred**, you may be able to take medication to reduce the radioactive material in your body.

What preparations can I make for a radiation emergency?

- Your community should have a plan in place in case of a radiation emergency. Check with community leaders to learn more about the plan.
- Check with your child's school, the nursing home of a family member, and your employer to see what their plans are for dealing with a radiation or other type of emergency.
- Develop your own family emergency plan so that every family member knows what to do.
- At home, put together an emergency kit that would be appropriate for any emergency.

The kit should include the following items:

- ◆ A flashlight with extra batteries
- ◆ A portable radio with extra batteries
- ◆ Bottled water
- ◆ Canned and packaged food
- ◆ A hand-operated can opener
- ◆ A change of clothes
- ◆ A first-aid kit and essential prescription medications
- ◆ Personal items such as paper towels, garbage bags, and toilet paper

How can I protect myself during a radiation emergency?

After a release of radioactive materials, local authorities will monitor the levels of radiation and determine what protective actions to take. The most appropriate action will depend on the situation. Tune to the local emergency response network or news station for information and instructions during any emergency.

What is “shelter in place”?

If a radiation emergency involves the release of large amounts of radioactive materials, you may be advised to “shelter in place,” which means to stay in your home or office or you may be advised to move to another location. If you are advised to shelter in place, you should: close all doors and windows, turn off fans, air conditioners, and forced-air heating units that bring in fresh air from the outside, close fireplace dampers, bring pets inside and move to an inner room or basement.

What if I am told to evacuate?

If you are advised to evacuate, follow the directions that your local officials provide. Leave the area as quickly and orderly as possible. In addition, take a flashlight, portable radio, batteries, first-aid kit, supply of sealed food and water, hand-operated can opener, mobile phone (if available), a change of clothes, 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 may not accept animals.

What should I do about my children and family?

If your children or family are with you, stay together. Take the same actions to protect your whole family. If your children or family are in another home or building, they should stay there until you are told it is safe to travel. Schools have emergency plans and shelters. If your children are at school, they should stay there until it is safe to travel. Do not go to the school until public officials say it is safe to travel.

How do I protect my pets?

If you have pets outside, bring them inside if it can be done safely. Wash your pets with soap and water to remove any radioactive dust if the contamination is suspected.

Should I take potassium iodide (KI) during a radiation emergency?

Potassium iodide (KI) should only be taken under the instruction of medical doctors in a radiation emergency that involves the release of radioactive iodine, such as an accident at a nuclear power plant. A “dirty bomb” most likely will not contain radioactive iodine. KI only protects the thyroid gland and does not provide protection from any other source of radiation exposure. Some people are allergic to iodine and should not take KI. Check with your doctor about any concerns you have about potassium iodide.

Will food and water supplies be safe?

Food and water supplies most likely will remain safe. However, any unpackaged food or water that was out in the open and close to the incident may have radioactive dust on it. Therefore, do not consume water or food that was out in the open. The food inside of cans and other sealed containers will be safe to eat. Wash the outside of the container before opening it and wash pans, dishes, and utensils before using them. Authorities will monitor food and water quality for safety and keep the public informed.

Radiation Biology

What happens when people are exposed to radiation?

Radiation can affect the body in a number of ways, and the adverse health effects of exposure may not be apparent for many years. These adverse health effects can range from mild effects, such as skin reddening, to serious effects such as cancer and death, depending on the amount of radiation absorbed by the body (i.e., the dose), the type of radiation, the route of exposure, and the amount of time over which the dose was received. Exposure to very large doses of radiation may cause death within a few days or months. Exposure to lower doses of radiation may lead to an increased risk of developing cancer or other adverse health effects later in life.

What are the effects of exposure to low levels of radiation?

In general, it is unlikely that there will be any adverse health effects from exposure to low levels of radiation. At exposures of less than about 100 mSv to the whole body, the effects are so small that they cannot be detected because any effects from the radiation (if they exist) are much smaller than the normal or background health risks. For example, the additional cancer risk following a 100 mSv radiation dose will be small (less than 0.5%) compared to normal cancer rates in the population (about 40% of the population of the U.S., for example, will develop cancer during their lifetimes and about 25% of the population will die of cancer). It is not possible to be certain whether or not a particular cancer is due to radiation exposure or would have occurred anyway due to some other cause.

At low levels of exposure, is the risk proportional to the dose? Would the risk from 6 mSv be twice that of 3 mSv?

3 mSv per year is the approximate average dose from all sources of radiation exposure to the U.S. population. Health risks (e.g., cancer) cannot be accurately determined at such low doses. Based on many epidemiological studies, health risks at doses below about 100 mSv are either zero or so low that they cannot be determined with certainty. Accordingly, while it is conservative to make this assumption for radiation protection purposes, it is not possible to prove that the risk at 6 mSv is twice the risk at 3 mSv.

What is the maximum amount of radiation an average person can receive at one time without any short-term effects?

Dose below 200 mSv would not be likely to produce any acute (occurring within days or weeks) clinical effects. At doses above 500 mSv, some acute clinical changes (e.g., changes in lymphocyte count) may be observed. After exposure to about 1000 mSv, some exposed people will begin to feel the effects of radiation sickness. These effects can include nausea, vomiting, and feelings of fatigue. This may not occur for several days or even a few weeks after exposure. Higher radiation doses will produce more severe radiation sickness and the symptoms appear more rapidly after the exposure. 5,000 mSv is the approximate dose that will lead to a 50% chance of death in 60 days.

What is prenatal radiation exposure?

The exposure of an unborn baby to radiation is referred to as prenatal radiation exposure. This can occur when the mother's abdomen is exposed to radiation from outside her body. However, since the unborn baby is shielded by the mother's abdomen, it is partially protected in the womb.

from radioactive sources outside the mother's body. Consequently, the radiation dose to the unborn baby is lower than the dose to the mother for most radiation exposure events. Also, a pregnant woman who accidentally swallows or breathes in radioactive materials may absorb that substance into her bloodstream. From the mother's blood, radioactive materials may pass through the umbilical cord to the baby or concentrate in areas of the mother's body near the womb (such as the urinary bladder) and expose the unborn baby to radiation.

Is there increased cancer risk after prenatal exposure?

Radiation exposure before birth can increase the risk of getting cancer later in life. Unborn babies are especially sensitive to the cancer-causing effects of radiation. However, the increased risk depends on the amount of radiation to which the baby was exposed and the amount of time over which the dose was received. For example, if the radiation dose to the unborn baby from a diagnostic x-ray exam was 50mSv the increase in the overall risk of childhood cancer would be approximately 0.9%.

Clinical Assessment

At what levels are radiation effects seen?

Radiation doses to people are expressed in sieverts (Sv).

An approximation of the relative hazard is:

100 mSv or less, no prompt clinical symptoms and only a very small chance of subsequent cancer;

0.1 Sv, no acute effects, subsequent additional risk of cancer about 0.5%;

1 Sv, nausea, vomiting possible, mild bone marrow depression, subsequent risk of cancer 5%;

Greater than 2 Sv, definite nausea and vomiting, medical evaluation and treatment required.

What if the patient is found to contain radioactive shrapnel?

Radioactive shrapnel may pose a substantial hazard for medical staff and patients. Some radioactive shrapnel may be a fragment of a very radioactive metallic source. These sources will likely be emitting penetrating gamma radiation and result in very high exposure rates near the source. The radiation dose to medical staff near the source (patient) in some circumstances could exceed normal (i.e., non-emergency) occupational dose limits. Metallic radioactive items should never be handled directly, only with instruments, such as tongs. If such sources are removed from the body, they should be placed in a shielded container in a secure location away from people.

Therapy

What special drugs might be needed?

Hospitals should consider keeping a supply of potassium iodide (typically available as KI tablets or super saturated potassium iodine (SSKI) "Lugol's solution) to help reduce the risk of only thyroid cancer from radioactive iodine exposure. Such exposures may arise from a nuclear power plant incident or in radioactive fallout from a terrorism event involving the detonation of a nuclear device. Hospitals should adhere to published recommendations (e.g. *Guidance: Potassium Iodide as a Thyroid Blocking Agent in Radiation Emergencies*, U. S. Department of

Health and Human Services, Food and Drug Administration, Center for Drug Evaluation and Research, December, 2001) for administration of potassium iodide. In general, the doses are: Adults and children weighing >70 kg, 130 mg/d; children 3-18 years, 65 mg/d; children 1 month -3 years, 32 mg/d; birth - 1 month, 16 mg/d.

What is DTPA and what does DTPA do?

DTPA is a chelating agent. Chelating agents work by binding to some radioactive materials and poisons that get into the body and then passed them from the body in the urine. Chelating agents help decrease the amount of time it takes to get a poison out of the body. When radioactive materials get into the body, we say that “internal contamination” has occurred. Since the 1960s, doctors have used DTPA as a chelating agent to treat internal contamination with some radioactive material. Currently, calcium and zinc DTPA are approved for chelation of plutonium, americium, and curium.

What is Prussian blue?

Pharmaceutical grade Prussian blue can speed up the removal of certain radioactive materials, specifically cesium and thallium, from people’s bodies but must be taken under the guidance of a doctor. People **SHOULD NOT** take Prussian blue artist’s dye in an attempt to treat themselves. Since the 1960s, Prussian blue has been used to treat people who have been internally contaminated with radioactive cesium (mainly Cs-137) and nonradioactive thallium (once an ingredient in rat poisons). Doctors can prescribe Prussian blue at any point after they have determined that a person who is internally contaminated would benefit from treatment.

What is acute radiation syndrome (ARS)?

Radiation sickness, known as acute radiation syndrome (ARS), is a serious illness that occurs when the entire body (or most of it) receives a high dose of radiation, usually over a short period of time. Many survivors of the Hiroshima and Nagasaki atomic bombs in the 1940s and many of the firefighters who first responded after the Chernobyl Nuclear Power Plant accident in 1986 became ill with ARS.

What are the symptoms of the acute radiation syndrome (ARS)?

The first symptoms of ARS are typically are nausea, vomiting, and diarrhea. These symptoms will start within minutes to days after the exposure, will last for minutes up to several days, and may come and go. Then the person usually looks and feels healthy for a short time, after which he or she will become sick again with loss of appetite, fatigue, fever, nausea, vomiting, diarrhea, and possibly (at very high doses) seizures and coma. This seriously ill stage may last from a few hours up to several months. People with ARS may also have some skin damage. This damage can start to show within a few hours after exposure and can include swelling, itching, and redness of the skin (like bad sunburn). There also can be hair loss. As with the other symptoms, the skin may heal for a short time, followed by the return of swelling, itching, and redness days or weeks later. Complete healing of the skin may take from several weeks up to a few years depending on the radiation dose the person’s skin received.

How can the acute radiation syndrome (ARS) be treated?

When a person has received a very high dose of radiation, damage of the bone marrow, resulting

uncontrolled bleeding and infection, is a major concern. To help the recovery of the bone marrow, growth factors that stimulate the blood cells to multiply can be used. Human granulocyte colony stimulating factor (G-CSF) is a specific type of cytokine that stimulates the growth of white blood cells. It has been used for cancer patients with bone marrow damage due to chemotherapy or radiotherapy. Treated patients have had fewer infections, less need for intravenous antibiotics, and shortened hospital stays than those who did not receive the drug. Other clinical support for this condition may include electrolytes, reverse isolation, selective use of antibiotics, parenteral nutrition, transfusions as necessary with irradiated blood to kill white cells.

Management of Radiation Casualties Outside the Hospital

How should a first responder protect themselves in the situation of responding to casualties after a deliberate release of radioactive material (e.g. a dirty bomb)?

Approach the release site with caution. Position personnel, vehicles, and the command post at a safe distance upwind and uphill of the site, if possible. Ensure your own physical safety. If radiation measuring instruments are available, place them in plastic bags to prevent their contamination and use them to map the areas leading up to the highest dose rates. Wear a mask to reduce the dose from inhalation of radioactive dust. Ideally the mask should be a full face mask with a HEPA filter, but even breathing through a wet handkerchief or cloth will help. There will be little danger from radioactive gases, so a self contained breathing mask, while effective, is not necessary unless there are other gasses or toxins present. Dust will collect on your clothing. Remove and discard (or decontaminate) it after you leave the area. Open wounds or abrasions must be protected from radioactive contamination. If running water or showers are available, full body rinsing with lukewarm water is advised. Drinking water may be necessary for people working in high temperatures with bulky protective clothing. If absolutely necessary to drink water, drink from a canteen or other closed container.

How should first responders protect those who have been injured and exposed?

Seriously injured people should be removed from the source of radiation, stabilized, and sent to hospitals first. After treatment of serious physical injuries, preventing the spread of the radioactive material or unnecessary exposure of other people is paramount. Establish an exclusion zone around the source. Mark the area with ropes or tapes. Reroute traffic. Limit entry to rescue personnel only. Detain people who were near the event in a safe area, free of significant contamination, until they can be checked for radioactive contamination, but do not delay treatment of injured people or transport to a hospital for this purpose. Take action to limit or stop the release of more radioactive material, if possible, but delay cleanup attempts until radiation protection technicians are on the scene. Tell nearby hospitals to expect the arrival of radioactively contaminated and injured people. Everyone near the scene should be checked for radioactive contamination. As soon as you can obtain radiation measuring equipment, establish a decontamination area for this purpose. Decontaminate people whose injuries are not life-threatening (broken arms, etc.) before sending them to hospitals. Do not send people without serious medical conditions or severe ARS symptoms to the hospital.

Hospital Management of Radiation Casualties

What if a patient is contaminated?

Medical staff must not allow the threat of contamination to impede the delivery of essential medical services. The right thing to do for an individual with a life threatening condition is to admit them to the Emergency Department for immediate care. It is crucial to educate staff to provide appropriate patient treatment. Staff who work in an Emergency Department are exposed to a variety of risks from physical, chemical and especially biological agents, many of which pose a more serious potential hazard than radiation exposure. Initially, hospitals should obtain as much patient history as possible, noting circumstances and situations that might indicate radiation exposure.

What should be done immediately?

In the first 48 hours, the basic premise is that physicians should conduct standard patient assessment, take care of immediately life-threatening problems, and take care of all other problems that require immediate medical attention. Emergency department staff should:

- Treat patients according to standard treatment practices and procedures.
- Take care of wounds by irrigating, debriding, and covering to the best extent possible.
- Look for the symptoms of acute radiation syndrome.
- Have a trained technician perform a radiation survey if symptoms, patient history, and situation history indicate the possibility of contamination.

How is the radiation dose to the patient assessed?

Emergency department staff can obtain complete blood counts (CBCs) with differential initially to serve as a baseline measurement. CBCs taken over the next several days can then be compared to the baseline measurements and used to assess the radiation dose received. These data are of key importance in evaluating patients for acute radiation syndrome. Screening should also include a history of where the patient was when the incident occurred and afterwards. Medical staff should also consider the time of onset (following the incident) and severity of early symptoms of ARS (e.g., nausea, vomiting, diarrhea, weakness). That information helps assess the dose of the patients.

Will excreta be contaminated?

When internal contamination is present, body excreta may contain (typically small quantities of) radioactive substances. Collection of urine and feces should be considered for those patients for radiation protection purpose as well as evaluation of internal dose. Also, swabs from body orifices should be taken for survey or analysis for radionuclides. Hospitals should identify, during their emergency planning, what agencies or laboratories the samples should go to for analysis.

What special supplies should be kept on hand?

Potassium iodide tablets and other special medications to block the uptake or remove radioactivity from the body may be kept on site depending on the size of the hospital and the ability to otherwise obtain these supplies in a relatively short period of time from other sources when needed.

Reception Centers

What about victims who are not injured?

The term “worried well” has often been used to describe patients who are not injured. Patients thus labeled may feel stigmatized and that their health concerns have not been taken seriously. Terms such as “high risk”, “moderate risk”, and “minimal risk” convey continued concern and imply continued monitoring, both of which are reassuring to patients. Where feasible, the establishment of an “Emergency Services Extended Care Center” may offer an important means of monitoring patients who remain fearful and are not reassured by negative findings. Patients with minor physical problems who cannot return home can also be referred here. In the event that a patient is misdiagnosed, the patient can be sent back to the Emergency Department. Mental Health professionals including psychiatrists should be an integral part of the teams that perform initial screening and triage.

Radiological Aspects of Decedent Affairs

What about fatalities?

If a victim is pronounced dead at the site of an incident, do not transport them to the hospital. Obtain guidance from the local coroner or a public health official as to where to transport bodies. In general, if a survey of a body is less than 300 cpm, then the body can be freely released. If, after washing the body and removing any radioactive shrapnel, the readings are less than 36,000 cpm, the body can be released for burial. If the readings of the body exceed 1 mSv/hr on contact, the body should be held in refrigeration until further assessment and procedures can be put in place. In a mass casualty incident, refrigerated trucks might be necessary for holding until thorough assessments can be made. Depending on the amount of contamination, these trucks could be staged in a location so as to minimize exposure to others.

Should autopsies be performed?

In general, autopsies should not be performed on internally contaminated bodies unless absolutely necessary. However, if the body only contains a small quantity of radioactive material and there is a compelling need, an autopsy may be permitted.

How should bodies be handled to minimize exposure?

Burial without embalming and a memorial without a viewing will minimize radiation doses to others. Embalming can be performed but assessment of the possibility of internal contamination should be made. Cremation should not be performed if the body can not be decontaminated as extensive contamination of the facility and the surrounding area is highly likely.

Post Event Public & Media Communications

General opening remarks:

I am with [*insert name of official source of information and recommendations*] and we are the official source of information concerning this emergency. We understand that you may be concerned or even frightened. It is very early in the emergency and many things are very

uncertain but I will keep you informed of any information that can help you to make responsible decisions. I may not be able to answer all your questions, either for security reasons, or because I do not yet know the answers. If I do not know the answer to a question, I will not speculate.

Answers to questions:

Who is in charge?

[Insert name] is responsible for coordinating the joint response to this emergency. The official in charge is *[insert name of official source of information and recommendations]*. For further information, the public should contact *[name and phone number or website address]*.

What can I do to ensure that my family and I are safe now?

You should follow the directions from *[name of official source of recommendations]*. Currently you are advised to *[summarize current recommendations]*. You should also be careful when considering assessments and recommendations from non official sources. In the past such assessments and recommendations have resulted in people taking actions that were not justified and have done more harm than good.

Is my family safe now? What could be the consequences for my health?

Based on experience from past emergencies, it is very unlikely that anyone, including unborn children, has been exposed to a radiation level that will result in any detectable health effects. However, in some cases, it may be necessary to conduct a further evaluation to determine if someone needs medical treatment or follow-up. Therefore some people may be asked to a medical facility for a further assessment. Being called in for such assessment is a precaution and does not mean that you are at undue risk. It is important to realize that assessing the risk from a radiological emergency is highly specialized and can only be performed by someone with experience in this area.

Why is it safe to be outside the safety boundary around the site of an emergency?

During an emergency, initial measurements are taken to determine the areas in which people can safely remain. These measurements enable us to determine the immediate effects possible from the levels of radiation present. The boundaries for any evacuation areas are established using criteria to ensure that people outside this area remain safe until further tests are performed. This includes considering children playing on the ground and pregnant women. Those living very close to such boundaries are safe from immediate effects in the short term. However, it would be prudent to *[list recommendations to the people outside the inner cordoned area]*. Over a longer period, some of the areas near the boundary may require further measures, such as decontamination or brief evacuation, to reduce the risk of longer term effects from the cumulative exposure to low levels of radiation. In order to determine whether any such measures are needed, teams may be sampling and monitoring for radioactive contamination in the area. This does not mean that the area is unsafe; ongoing monitoring provides officials with the information needed to determine whether or not further measures might be needed in the area.

What is contamination and is it dangerous? Are the food, water, milk and other products safe?

As a result of a radiological emergency, radioactive dust or liquid could get on the ground, food, in the water or even on a person. This is called contamination. The levels of contamination that could be a significant health hazard would be very high, many times the amounts of radioactive material normally found in nature. The hazard from any contamination can only be determined based on criteria developed by experts and measurements taken by trained personnel. The criteria we are using to assess contamination are established well below the levels that could result in any significant health effects. (Therefore based on our current evaluation the following *[list]* are safe. **(or)** We are currently carrying on our evaluation and will inform you immediately on the results; but until notified you should *[insert recommendation]*.)

I was monitored and contamination was found. Am I safe?

People who may have been contaminated as a result of an emergency are monitored to assess the risk. Very low levels of radioactive materials can be detected by the instruments used to monitor for contamination. The levels of contamination that would be a significant health hazard would be very high, many times the minimum amounts of radioactive material that can be detected by monitoring instruments or that are normally found in nature. The criteria used to determine if a person is contaminated to levels which warrant some actions (for example, showering and changing clothing) were established well below the levels that could result in any significant health effects. However, in some cases, it may be necessary to conduct a further evaluation to determine if someone needs medical treatment or follow-up. Therefore, some people may be asked to come in for a further assessment. Being called in for such an assessment is a precaution and does not mean that you are at undue risk. It is important to realize that assessing the risk from a radiological emergency is highly specialized and cannot be performed by anyone without experience in this area.

I am pregnant — what are the dangers for my baby?

It requires very high levels of exposure to radiation to cause even a small chance that the baby will be affected. These levels would be at least a million times what you normally receive from natural sources of radiation in an hour. Determining the risk to the baby is very complex and does not depend solely on the levels of exposure to radiation. Local officials have criteria to identify those who should be assessed. Being called in for such assessment is a precaution and does not mean that your baby or you are at undue risk. The risk to your baby can only be assessed by an expert with experience in this field.

Why are higher doses for the public acceptable in this emergency rather than during the normal operation of a nuclear facility?

Around a nuclear facility, such as a nuclear power plant, the dose limits for the public are established well below levels at which any health effects, including cancers, would be seen in anyone, including pregnant woman or children. This is done to ensure that the facility is operated safely and that an accident is unlikely to cause any health concern. During an emergency, dose criteria are established that also ensures that all members of the public are safe. The dose criteria used to decide on the actions taken during an emergency are established based on many factors such as ensuring those that are at risk in the near term are protected first.

How can I find out what dose I may have received and what it means to my health?

We recognize that everyone is concerned about their health and the health of their loved ones. It is very early in the development of the emergency situation and it will be some time before an accurate assessment of the possible health consequences of the emergency can be made. It is important to realize that assessing the health risk from a radiological emergency is a highly specialized task and the risk can only be assessed by those who have experience in the field. We know that this emergency has caused considerable anxiety and you would like definitive answers now. But we also realize that it is important that any assessment made should be as accurate as possible. Therefore, we will inform every one of their risks and actions you should take as soon as possible. In some cases, it may be necessary to conduct a further evaluation to determine if someone needs medical treatment or follow-up. Therefore, some people may be asked to come in for a further assessment. Being called in for such assessment is a precaution and does not mean that you are at undue risk.

Immediately following the emergency I was checked for contamination and I was told to change my clothes, take a shower, and listen for official instructions; what am I listening for?

The first responders screened people for external contamination using hand held instruments to determine who needed immediate decontamination to prevent serious injury. In the next phase of the response, specialists trained in radiological assessment determine the specific type, form and quantity of radioactive materials present at the scene. Based on their analysis, they may recommend that additional monitoring or evaluations be performed to better determine the dose received by specific individuals. Some people may be requested to present themselves for additional monitoring and evaluation. The request could be made by a public official using local radio or television if large numbers of people were involved, or you could be individually contacted if only a small number of people were exposed to the radiological hazard.

Long-term Medical Follow-up and Epidemiology

What is “population monitoring”?

The term “population monitoring” includes immediate monitoring after an incident and long-term monitoring for health effects from an incident. Within the first hours and days after a radiological incident, people should be monitored for contamination. Public health officials will use the information from the monitoring to find out whether people are contaminated, either inside or outside their bodies, with radioactive materials from the incident. Public health officials will also estimate the amount of radiation to which people were exposed, known as the dose, through a process called dose reconstruction. In addition, the health of people who were involved in the incident will be monitored over many years, to see whether people are having long term health effects. These health effects could include effects from the radiation exposure itself, or effects from the stress of being involved in an attack. The monitoring of people in the area is usually called “population monitoring”.