Recognize: Radioactive Material

Radiation is the invisible energy emitted by certain types of unstable (or radioactive) atoms. This energy travels through the air, but cannot be seen, felt, smelled, or tasted. Some types of radiation can penetrate through packaging materials, vehicles, and building walls. When radiation energy reaches a person, the person is exposed to radiation. The amount of radiation energy absorbed by a person is the dose the person received. A small dose of radiation (for example, from a dental x-ray) has a very low risk of health effects. A high dose of radiation (such as sitting near an industrial radiography source for several hours) has a high risk of health effects, including nausea, vomiting, diarrhea, burns, and possible death. Terrorists may use radiological material as WMD to injure or kill people, or to create fear among the public.

The four types of radiation emitted by radioactive material are alpha, beta, gamma, and neutron radiation. The radiation travels from the radioactive material in all directions (including upwind) and the distance it can travel ranges from ¼ inch to hundreds of feet, depending on the specific type of radioactive material. The further the radiation travels, the weaker (and less hazardous) it becomes. The Emergency Response Guidebook (ERG) Guide 163 recommends isolating a spill, leak, or damaged container of radiological material for at least 25 to 50 meters (80 to 160 feet) in all directions.

Radioactive material is material containing unstable (radioactive) atoms that emit radiation. Radioactive material may be a solid, liquid, or gas. Many of the types of radioactive material released into the public by terrorists may be in the form of dust or powder. Even when this radioactive material is properly contained, it still emits radiation and may be a hazard. The radioactive material is not considered to be contamination until is released from its container. Some radioactive materials only emit small amounts of radiation, and are little threat to responders or the public. Other types of radioactive materials are highly radioactive and emit large, dangerous amounts of radiation.

Radioactive contamination is radioactive material in an unwanted place, particularly where its presence may be harmful. Some types of contamination may be readily spread from one surface to another. Some contamination may be suspended in the air. In a deliberate release of radioactive material by terrorists, this contamination may be in the form of radioactive dust (ceramic or powder).

Even if used as a terrorist weapon, most of the radioactive sources (devices or items with radioactive material) in use in the U.S. do not meet the definition of a WMD, as defined in Title 18, U.S.C. 2332a, because they do not “release radiation or radioactivity at a level dangerous to human life.” Examples of radioactive sources that do not emit life-endangering amounts of radiation are smoke detectors, tritium night sights on firearms, vials of radiopharmaceuticals (radioactive drugs), lantern mantles, tungsten welding rods, industrial moisture/density gauges (also called portable nuclear gauges), and most radioactively-contaminated medical waste. As explained in ERG Guide 163, packages (cartons, boxes, drums, articles, etc) identified as “Type A” by marking on packages or by shipping papers contain non-life- endangering amounts of radioactive material.

Radioactive sources that can be life-endangering may be found at:

- Hospitals and cancer treatment facilities: blood irradiators, sterilizers, cancer treatment irradiators
- Industrial and construction sites: radiography cameras, food irradiators
- Nuclear power plants: used (or spent) fuel rods from the nuclear reactor
- In transit: material inside metal containers identified as “Type B” (ERG Guide 163)

Exposure Versus Contamination

External Exposure—The radiation, but not the radioactive material, reaches the person. The source of radiation (radioactive material) is not on the person and not inside the person, therefore, the person is not contaminated. This person is NOT radioactive. This person does not emit radiation and cannot be a hazard to him/herself or anybody else around, including medical personnel. External exposures are either local (such as the hands) or total body. Receiving a dose (exposure) of radiation energy is somewhat like receiving a dose of solar ultraviolet (UV) energy from the sun. The solar energy results in a sunburn, but the person receiving the sunburn is not contaminated by the sun, does not emit UV energy, and does not cause other persons to receive a sunburn.

Receiving a small dose of radiation is a very low risk to victims and responders. Receiving a massive dose of radiation constitutes a significant risk to the victims and responders.

External Contamination—An externally contaminated person has radiological material physically attached to his or her skin and/or hair. Everyone and everything near the release of radioactive material must be treated as potentially externally contaminated. This includes victims, responders, equipment, papers, and evidence. Externally contaminated victims rarely have enough radioactive material on their bodies to create radiation levels dangerous to responders. An externally contaminated person is receiving an external exposure of radiation as long as the radioactive material remains on the individual.

Internal Contamination and Internal Exposure—Occurs when unprotected people ingest, inhale, or are wounded by radioactive material. Open wounds can be a pathway for internal contamination. Internally contaminated victims present a minimal risk to responders. The internally contaminated victim may also be externally contaminated. The skin, mouth, and nose are the most obvious routes to internal contamination. Internally contaminated persons also receive an internal exposure. In general, internal contamination is more dangerous to the victim than external contamination.

Radioactive material can enter the body by four methods:

- Inhalation—Gaseous or airborne particles, dust particulates, and matter with radioactive material may enter the body through the lungs.

- Ingestion—Internal radioactive contamination may enter the body through the gastrointestinal tract by way of contaminated food, drink, and swallowing contaminated mucous from the nasal area.

- Absorption—Radioactive material may be absorbed through the skin or mucous membranes.

- Puncture or injection—Radioactive material can penetrate the body through cuts, wounds, and punctures in the skin.

Physiological Signs and Symptoms of Exposure

Acute Radiation Syndrome

- Victims who receive a large dose of radiation may suffer from Acute Radiation Syndrome (ARS) or "radiation sickness."

- Key symptoms are nausea, vomiting, and diarrhea.

- Symptoms may not develop for hours after the exposure.

- If the victims are nauseous and vomiting immediately after the release of WMD, the cause is probably not radiation exposure; many other factors besides radiation can cause nausea, vomiting, and diarrhea.

- The larger the dose of radiation a victim receives, the quicker the symptoms appear and the more severe the reaction; if a victim who starts to feel nauseous six hours after the radiological WMD event, but never vomits, probably received a lower dose than the victim who became nauseous and started vomiting several hours after the event.

- If the dose of radiation is high enough, the victim may die in days to weeks, but proper medical attention may save many victims if the dose was not too high.

- Victims and individuals who receive lower doses of radiation may have no symptoms, and have only a very small increase in their risk of developing cancer.

- Some victims may also receive high enough doses of radiation to increase their risk of developing cancer in the future, but not high enough to suffer from any of the symptoms

of Acute Radiation Syndrome (ARS).

- No proven cases of genetic damage to people (caused by radiation) passed on from parents to children, but there is a very small risk that it might occur.

- Another indicator of ARS is the victims may seem to recover, but then the symptoms reappear hours to days later and the symptoms are more severe than before.

Radiation Burns

- Skin exposed to high doses of radiation may turn red and look "puffy"; burns may not appear for hours after exposure. Skin may also turn a bronze color similar to a suntan.

- Lack of radiation burns immediately after a detonation or release of material does NOT mean the person did not receive a serious dose of radiation, and does not mean the person is not contaminated.

- Victim with burns appearing immediately after the release of the WMD agent are probably not radiation burns, but more likely thermal or chemical burns.

- Radiation burns are not painful while the damage is occurring. After burns to the skin start to develop, the skin may start to itch and become painful. Radiation burns may seem to heal, then return a day more later with more severe pain, blistering, and swelling. This is another difference from thermal or chemical burns.

- In some cases where persons have found or stolen industrial radioactive sources and taken the containers apart, they suffered burns on their hands. If suspects have burns on their hands, they may have been handling, transporting, or building a Radiological Dispersal Device.

Recognize: Radiation Exposure Device

A radiation exposure device may take many different forms, but the energy radiated or transmitted in the form of rays, waves, or particles serves the particular purpose of the terrorist. Terrorists may place a stolen industrial radiation source in a building or public location, irradiating (but not contaminating) individuals in the immediate area every day until the device is discovered, or the victims begin to show recognizable symptoms.

A radiation exposure device is a radiation source placed to expose victims to high levels of radiation. Terrorists may place a stolen industrial radiation source in a building or public location. This would irradiate, but not contaminate, individual victims every day until the device is discovered, or until the victims start to show recognizable symptoms.

- According to Nuclear Regulatory Commission (NRC) spokesman Victor Dricks, as reported by The Washington Times, said: “There are about 2 million radioactive sources across the United States. Radioactive sources are located at hospitals, medical facilities, construction sites, industrial manufacturing facilities, university and research labs, in transport (road, rail, waterways, and air), nuclear power plants, and government facilities. Cases in which radioactive material is lost or misplaced are infrequent. More common, are situations where devices containing radioactive material are stolen from jobs or work sites, or are abandoned. For the years 1998–2002, there has been an average of 300 such cases per year.”

The slide shows an industrial radiography source (gamma ray source) placed in a business office. The source is housed in a small metal capsule (about one-quarter-inch diameter, one-half-inch long) at one end of a short, flexible cable (about six inches) called a “pig tail.”

- The stainless steel cylinder, pictured on the slide, is a capsule containing a small amount of material that emits neutrons and gamma radiation. This stainless steel source configuration is commonly about one-quarter-inch in diameter and about three-quarter-inch to one-inch long. Many industrial sources are manufactured in the shape of disks about the size of a quarter (about one inch diameter by one-quarter-inch thick) and made of steel or plastic.

- Radiation sources often do not have the radiation symbol on them, although the original containers for dangerous sources usually do. The figure, on the slide on the lower right, shows two source containers for industrial gamma sources. They are about six inches in diameter by 10 inches high and weigh 40 to 80 pounds each, due to the lead shielding.

- Any package, container, backpack, etc. that seems to weigh much more than it normally should may contain lead or depleted uranium being used to shield (or block) the radiation from a dangerous source.

Recognize: Radiological Dispersal Device (RDD)

- A Radiological Dispersal Device (RDD) or “dirty bomb” is a conventional explosive or bomb containing radioactive material.

- The conventional bomb is used as a means to spread radioactive contamination. It is not a nuclear bomb and does not involve a nuclear explosion.

- Any type of radioactive material could be used in a dirty bomb, but in general, these devices would be unlikely to cause serious health effects beyond those caused by the detonation of conventional explosives, according to the U.S. Nuclear Regulatory

Commission.

- Radioactive material may also be dispersed by methods other than explosives.

- An RDD may be as simple as a pipe bomb or explosives attached to a shipping container of radiological material, as shown on the slide in the figure on the left. Because of the wide availability of radiological material throughout the world and the ease of building simple explosives, the probability of the use of an RDD is much higher than that of a nuclear weapon.

- The probable effects of a dirty bomb detonation would be

  — potential for panic in the general public

  — contamination areas near the RDD blast site

  — probably not lethal radiation dose levels

  — huge numbers of people think they are contaminated

  — small number seriously contaminated

  — may need regional decontamination sites to handle thousands

  — limited radiation detectors and trained personnel would add to the problem

- The figure (upper right) on the above slide depicts an industrial radiography source container (simulated) breached by gunfire. This container uses depleted uranium as the shielding material. Even if the source capsule itself is not breached, the breached container may have released some of the depleted uranium, which is a source of beta and gamma radiation.

- The figure on the slide on the upper right shows a vial of radiopharmaceuticals (the radioactive material injected into patients for medical testing and treatment) broken open on a public street, are often transported, stored, and administered in liquid form and kept in small glass vials. Radiopharmaceuticals may also be in solid or gas form. Even though breaking open these vials may not create life-threatening radiation hazards, it may generate a response, news reports, and a public fear level greater than the actual hazard warrants.

Recognize: Nuclear Weapons

The use of a nuclear device by a terrorist would produce devastating effects, including thermal (heat) impulse, blast wave, penetrating neutron and gamma radiation, and radioactive fallout with radiological contamination, and would have a tremendous psychosocial impact on the community and the entire country.

- There is a lower probability terrorists will detonate a nuclear weapon than an RDD. A nuclear weapon uses the energy from splitting the atoms (fission) of special nuclear material (such as certain types of uranium or plutonium).

- Terrorists may attempt to build a nuclear weapon or attempt to steal or buy one from a nation in possession of them. Note that there is "no direct evidence that any [Russian nuclear weapons] have been stolen. Russia and the U.S. monitor these activities [security of nuclear weapons]" according to a Dale E. Klein, Assistant to the Secretary of Defense Nuclear, Chemical, and Biological Programs.

- The size of a nuclear explosion may be much larger than conventional explosives. The size of nuclear explosions is measured in kilotons (kt). The energy of one kiloton is equivalent to the explosion of one thousand tons of trinitrotoluene (TNT) high explosives.

- Nuclear weapons have been made small enough to be carried by one person. Although a nuclear device with a yield similar to the atomic bombs used in World War II (16 to 23 kilotons) may devastate the center of a city, a "small" nuclear detonation of less than one kiloton may be mistaken for a large truck bomb. The area of destroyed buildings may be less than a city block.

- A mushroom-shaped cloud will not appear with every nuclear explosion. In the slide on the proceeding page, notice that the color of the smoke column is light brown (vaporized soil). The smoke column from ground zero is vertical and the white or light brown "smoke" is not spread out like a conventional explosion. The white "smoke" is caused by condensed water vapor in the cloud and ice that may form on the top of the mushroom. Conventional explosions and fires usually have black or dark brown smoke.

- The upper figure on the slide shows the smoke column from a 24-kiloton nuclear explosion (equivalent to 24,000 tons of TNT) held at the Nevada Test Site on March 24, 1953. The lower two photos—the house, located 3,500 feet from ground zero is illuminated by the blast from a 16-kiloton nuclear explosion. The only source of light was from the detonation. Victims in the basement of the house could have survived the blast. The car behind the house was also tested the day after the blast. The car started and could be driven.

Avoid: Radiological Materials

Individuals should use the principles of time, distance, and shielding to avoid radiological materials.

- Time—Minimize time spent near a radioactive source or radioactive contamination. Limit the time near a source of radiation, and leave the area as quickly as possible. The less time exposed to source of radiation, the lower the dose received. For example, if one spends only two minutes near the radioactive material instead of four minutes, radiation exposure is reduced by 50%. Conduct the work quickly and efficiently, but do not rush. Get out and stay out until the all clear signal is given.
- Distance—Maximize the distance from a radioactive source or radioactive contamination. Keep as much distance as possible between oneself and the source of radiation. The farther one is from the source, the lower the dose received. Exposure will always be greatly reduced when moved away from radioactive material. If distance away from the radioactive material is doubled, the radiation dose is reduced 75%. For example, if an individual moves back from 20 feet to 40 feet, exposure drops by 75% (or to one fourth of what was received at 20 feet). If an individual backs up again to 80 feet from the radioactive material, exposure rate drops another 75% (down to only about 6% of what was received at 20 feet). The ERG 163 recommends staying at least 25 to 50 meters (80 to 160 feet) from the suspected radioactive source.

- Shielding—Use shielding where practical. Keep as much protection between oneself and the source as possible. If other material can be placed between oneself and the radiation source, one will receive a lower dose. Like distance, the more heavy, dense materials between oneself and the source of the radiation, the better. The more dense a material, the greater its ability to stop the passage of radiation. Position oneself to place a vehicle (engine block), mound of dirt, concrete walls, or heavy equipment between oneself and the radiation source. Remember, the thin walls of many buildings provide very little shielding to gamma or neutron radiation.

Because of the large amount of materials required for effective shielding, it is not always practical to build shielding walls around a radioactive source. Do not delay emergency procedures to search for shielding materials.

Isolate: Radiological Materials

Control Zones

Control Zones—The designation of areas at the hazardous materials incident based on safety and the degree of hazard. Many terms are used to describe the zones involved in a hazardous materials incident.

- Hot Zone—The area immediately surrounding a hazardous materials incident, which extends far enough to prevent adverse effects from hazardous materials releases to personnel outside the zone. This zone is also referred to as the exclusion or restricted

zone.

- Warm Zone—The area where personnel, equipment, decontamination, and hot zone support takes place. It includes control points for the access corridor, and thus assists in reducing the spread of contamination. It is also referred to as the decontamination, contamination reduction, or limited access corridor.

- Cold Zone—Contains the command post and other support functions deemed necessary to control the incident. If it is suspected that radioactive material has been released or spilled, the type of radioactive material is not known, see the Department of Transportation's Emergency Response Guidebook (ERG), Guide 163 Radioactive Materials (low to high level radiation) for initial guidance on isolation and evacuation.

Isolate spill or leak area immediately for at least 25 to 50 meters (80 to 160 feet) in all directions. For a large spill (a single large container of more than 55 gallons or 200 liters or multiple smaller containers) consider initial downwind evacuation for at least 100 meters (330 feet).When a large quantity of this material is involved in a major fire, consider an initial evacuation distance of 300 meters (1,000 feet) in all directions.

Notify: Radiological Materials

One must follow local protocols for notifying emergency services and emergency support personnel.

- What happened
- Where it happened
- When it happened
- Special hazards associated with the event
- Any protective measures taken
- Facilities and locations affected

Advantages/Disadvantages of Using Radiological Materials as WMD

Advantages

- Available
- Tie up resources

- Psychological impact
- Difficult to prepare for
- Next level of escalation

Disadvantages

- Heavy containers
- Delayed health effects, if any, to victims
- Theft, manufacturing, and deployment hazardous to terrorist
- Requires numerous difficult steps to make devices likely to cause mass casualties
- Very expensive to procure materials

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