RADIOLOGICAL INFORMATION

Frequently Asked Questions

Radiation Information

A. Radiation Basics

1. What is radiation?

Radiation is a form of energy. It is all around us. It is a type of energy in the form of particles or electromagnetic rays that are given off by atoms. The type of radiation we are concerned with, during radiation incidents, is "ionizing radiation". Radiation is colorless, odorless, tasteless, and invisible.

2. What is radioactivity?

It is the process of emission of radiation from a material.

3. What is ionizing radiation?

It is a type of radiation that has enough energy to break chemical bonds (knocking out electrons).

4. What is non-ionizing radiation?

Non-ionizing radiation is a type of radiation that has a long wavelength. Long wavelength radiations do not have enough energy to "ionize" materials (knock out electrons). Some types of non-ionizing radiation sources include radio waves, microwaves produced by cellular phones, microwaves from microwave ovens and radiation given off by television sets.

5. What types of ionizing radiation are there?

Three different kinds of ionizing radiation are emitted from radioactive materials: alpha (helium nuclei); beta (usually electrons); x-rays; and gamma (high energy, short wave length light).

- Alpha particles stop in a few inches of air, or a thin sheet of cloth or even paper. Alpha emitting materials pose serious health dangers primarily if they are inhaled.
- Beta particles are easily stopped by aluminum foil or human skin. Unless Beta particles are ingested or inhaled they usually pose little danger to people.
- Gamma photons/rays and x-rays are very penetrating. They pose a large danger to people because of they are able to penetrate, or even pass completely through, the human body. Gamma rays and x-rays can go through many feet of air or many inches of lead shielding.

6. Can radioactivity be neutralized?

Currently there is no way in which we can neutralize radioactivity. The best we can do is transfer radioactive material to some place safe and then wait for it to decay.

7. What is radioactive decay?
It is the process where radioactive materials disintegrate as they release radiation.

8. What is half-life?
Half-Life is the amount of time it takes for half of the atoms in a sample of radioactive material to decay. For example, a sample of 1000 atoms of a radioactive material with a half-life of one year will have only 500 atoms of the material left after one year and by the end of the second year there will only be 250 atoms of the material left.

B. Radiation Exposure

1. What is radiation exposure?
When a person is exposed to some types of ionizing radiation the energy can penetrate the body. For example, when a person has an x-ray, they are exposed to radiation.

2. How can an exposure occur?
People are exposed to small amounts of radiation every day. This radiation comes from both naturally occurring sources and man-made sources.

3. What types of exposure occur?
Exposures can be either internal or external. Internal exposures are when radioactive material is taken into the body through breathing, eating, drinking, absorption through the skin, or through cuts in the skin. External exposure refers to radioactive material that is deposited anywhere (except internally) that it is not supposed to be, such as on an object or on a person's skin.

4. What happens when people are exposed to radiation?
Radiation can affect the body in many ways, and the health effects may not be apparent for many years. These effects include mild symptoms, such as skin reddening, to serious effects such as cancer and death. These effects are dependant upon the amount of radiation absorbed by the body (the dose), the type of radiation, whether or not the exposure was internal or external, and the length of time the person was exposed. Any living tissue in the human body can be damaged by ionizing radiation. The body attempts to repair the damage, but sometimes the damage is too severe or widespread. Mistakes can also be made in the body's natural repair process as it tries to repair the damage caused by the radiation (mutations).

5. What is prenatal radiation exposure?
It is the exposure of an unborn baby to radiation. This can occur when the mother's abdomen is exposed to radiation, either externally or internally. Also, radioactive materials may enter the mother's bloodstream if a pregnant woman accidentally swallows or breathes in radioactive materials. From the

mother's blood, radioactive materials may pass through the umbilical cord to the baby.

Unborn babies are less sensitive during some stages of pregnancy than others. However, unborn babies are particularly sensitive to radiation during their early development, between weeks 2 and 15 of pregnancy. The health consequences can be severe, even if radiation doses are too low to make the mother sick. Such consequences can include stunted growth, deformities, abnormal brain function, or cancer that may develop sometime later in life. The radiation dose to the unborn baby is usually lower than the dose to the mother for most radiation exposure events.

Pregnant women should consult with their doctors if they have any concern about radiation exposure to their unborn baby.

6. How are radiation exposure victims medically treated?

Treatment of a victim within the first six weeks to two months after exposure is vital. Treatment is determined by what types of radioactive materials to which the victim was exposed.

Medical personnel will treat victims for hemorrhage and shock. Open wounds are usually cleaned to remove any bits of radioactive materials that may be in them. Amputation of limbs may occur if a wound is highly contaminated and recovery of its function is not likely.

If radioactive material is ingested, treatment is given to reduce absorption into the body and enhance body's natural elimination processes (excretion and elimination). It can include stomach pumping or giving the victim laxatives or aluminum antacids.

If radioactive material has gotten into internal organs and/or tissues, treatment includes giving the patient blocking and diluting agents, such as potassium iodide, to decrease absorption into the body. Other chemicals such as ammonium chloride, diuretics, expectorants and inhalants are given to a patient to force the body to release the harmful radioactive materials. Other treatments involve chelating agents, which, when ingested, bind with some radioactive metals to form a stable material that is more easily removed from the body through the kidneys.

7. Is any amount of radiation safe?

Some scientists believe that low levels of radiation are beneficial to health (known as hormesis). However, there do appear to be thresholds of exposures for various health effects, for example: at 50 rem nausea occurs, at 70 rem vomiting occurs, at 400 rem death occurs.

C. Sources of Radiation

1. What are naturally occurring sources of ionizing radiation?
They include elements in the soil, naturally occurring radon, uranium mill tailings, and cosmic rays from the sun.

2. Where do man-made sources of ionizing radiation come from?
The sources include medical sources (x-rays, treatments), and from nuclear weapons testing. Some consumer products that contain radioactive materials include: smoke detectors, some watches and clocks (especially older radium dial type), some ceramics (such as old orange-red glazed Fiesta ware), some glass (especially antique glassware with a yellow or greenish color), fertilizer, food, gas lantern mantles, and antique 'quack' radioactive medical curative devices.

3. What is the most commonly occurring radionuclide in the human body?
Potassium-40 is the most common. It is found in potassium-rich foods such as bananas.

D. Radiation's Health Effects:

1. What is radiation sickness?
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.

People exposed to radiation will get ARS only if:

- The radiation dose was high
- The radiation was able to reach internal organs
- The person's entire body (or most of it) received the dose
- The radiation was received in a short time, usually within minutes

The first symptoms of ARS typically are nausea, vomiting, and diarrhea. These symptoms will start within minutes to days after the exposure. These symptoms will last for minutes 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 even seizures and coma. This stage may last from a few hours up to several months.

People with ARS usually have some skin damage that can start to show within a few hours after exposure. This damage can include swelling, itching, and redness of the skin (like a bad sunburn). There can also be hair loss, nausea, and diarrhea. 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 or up to a few years depending on the radiation dose to the skin.

The chance of survival for people with ARS decreases with increasing radiation doses. Most people who do not recover from ARS will die within several months of exposure. The cause of death in most cases is the destruction of the person's bone marrow, which results in infections and internal bleeding. For the survivors of higher doses, the recovery process may last from several weeks up to 2 years.

If a radiation emergency occurs that exposes people to high doses of radiation in a short period of time, they should immediately seek medical care from their doctor or local hospital.

2. How do we know radiation causes cancer?

Basically, we have learned through observation. Scientists didn't understand that there were any health effects associated with radioactive materials when people first began working with them. As the use of radioactive materials and reports of illnesses became more frequent, scientists noticed a pattern to the illnesses. People working with radioactive materials and x-rays developed particular types of uncommon medical conditions. Among the best-known long-term studies are those of Japanese atomic bomb blast survivors, other populations exposed to nuclear testing fallout (natives of the Marshall islands for example), and uranium miners.

3. Aren't children more sensitive to radiation than adults?

Yes, because children are growing more rapidly, there are more cells dividing and a greater opportunity for radiation to disrupt the process. Fetuses, depending on their stage of development, can also highly sensitive to radiation.

4. What are the possible health effects that an unborn baby could experience when exposed to ionizing radiation?

During the first 2 weeks of pregnancy, the radiation-related health effect of greatest concern is the death of the baby. Of the babies that survive, few will have birth defects related to the exposure, regardless of how much radiation they were exposed to.

Large radiation doses to the unborn baby during the stages of development (between weeks 2 and 15 of pregnancy) can cause birth defects, especially to the brain. Babies exposed to the atomic bombs dropped on Hiroshima and Nagasaki during the 8 to15 week stage of pregnancy were found to have a high rate of brain damage that resulted in lower IQ and even severe mental retardation. They also suffered stunted growth (up to 4% shorter than average people) and an increased risk of other birth defects.

Between the 16th week of pregnancy and birth, health effects due to radiation exposure are unlikely unless the unborn baby receives an extremely large dose of radiation. In the 16 to 25 week stage of pregnancy, health consequences similar to those seen in the 8 to 15 week stage could occur, but only when the doses are extremely large (more than the equivalent of about 5,000 chest x-rays received at one time). At this dose level, the mother could be showing signs of acute radiation syndrome.

After the 26th week of pregnancy, the radiation sensitivity of the unborn baby is similar to that of a newborn. Unborn babies exposed to radiation during this stage of pregnancy are no more sensitive to the effects of radiation than are newborns. This means that birth defects are not likely to occur, and only a slight increase in the risk of having cancer later in life is expected.

5. Do chemical properties of radioactive materials contribute to radiation health effects?

The chemical properties of a radionuclide can determine where health effects occur. To function properly many organs require certain elements. They cannot distinguish between radioactive and non-radioactive forms of the element and will accumulate one as quickly as the other. For example:

- Radioactive iodine concentrates in the thyroid. The thyroid needs iodine to function normally. As a result, radioactive iodine contributes to thyroid cancer more than any other types of cancer.
- Calcium, strontium-90, and radium-226 have similar chemical properties. The result is that strontium and radium tend to collect in calcium rich areas of the body, such as the bones and teeth. The strontium-90 and radium-226 can contribute to bone cancer.

6. What is the cancer risk from radiation? How does it compare to the risk from other sources?

Currently estimates are that overall, if each person in a group of 10,000 people exposed to 1 rem of ionizing radiation, in small doses over a life time, we would expect 5 or 6 more people to die of cancer than would otherwise. In this group of 10,000 people, we can expect about 2,000 to die of cancer from all non-radiation causes.

7. What are the risks of other long-term health effects?

There is the possibility of mutations in fetuses and genetic effects in children and adults.

8. What are the possible genetic effects due to radiation exposure?

Genetic effects are mutations that can be passed from parent to child or mutations that occur in the person exposed.

E. Contamination:

1. What is radioactive contamination?

Radioactive contamination is when a person or object has radioactive material either internally or externally. Radioactive materials released into the environment can cause air, water, surfaces, soil, plants, buildings, people or animals to become contaminated.

2. What is external contamination?

External contamination on humans occurs when radioactive material, in the form of dust, powder, or liquid, comes into contact with a person's skin, hair, or clothing.

3. What is internal contamination?

Internal contamination occurs when people swallow or breathe in radioactive materials or when these materials enter the body through an open wound or are absorbed through the skin. Some types of radioactive materials stay in the body and are deposited in different body organs. Other types are eliminated from the body in blood, sweat, urine, and feces.

4. How does contamination differ from exposure?

A person can be exposed to radiation and not become contaminated. Radioactive contamination emits radiation. If a person is contaminated, they will continue to be exposed to radiation until the contamination is removed.

5. How can exposure or contamination happen?

Radioactive materials could be released into the environment in the following ways:

- A nuclear power plant accident
- An atomic bomb explosion
- An accidental release from a medical or industrial device
- Nuclear weapons testing
- An intentional release of radioactive material as an act or terrorism

6. How is radioactive contamination spread?

People who are externally contaminated with radioactive material can contaminate other people or surfaces that they touch. 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 can contain radioactive materials. Coming in contact with these body fluids can result in contamination and/or exposure.

7. How could your 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. Homes can also become contaminated with radioactive materials in body fluids from internally contaminated people.

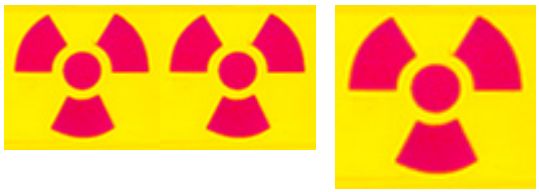
8. How is radioactive material contamination cleaned up?

Techniques include sandblasting buildings to remove the layers of contamination and removing the layers of contaminated soil and trucking it away to a radioactive waste disposal site. We cannot eliminate radioactivity. We can only transfer radioactivity from one place to another. Then we must wait until the radioactive materials decay.

9. How can I limit the chances of becoming contaminated?

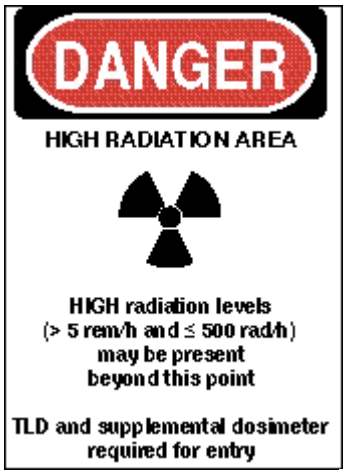
- Get out of the immediate area of the radiation incident quickly. Go inside the nearest safe building or to an area to which law enforcement or health officials direct you.
- Remove the outer layer of your clothing. If radioactive material is on your clothes, getting it away from you will reduce the external contamination and decrease the risk of internal contamination. It will also reduce the length of time that you are exposed to radiation.
- Place the clothing in a plastic bag or leave it in an out-of-the-way area. 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.
- Wash all of the exposed parts of your body using lots of soap and water to remove contamination.
- If medical authorities determine that internal contamination may have occurred, you may be able to take medication to reduce the radioactive material in your body.
- Be on the lookout for information. Once emergency personnel can assess the scene and the damage, they will be able to tell people whether or not radiation was involved in the incident.

III. Radiation Signs and Symbols



The symbol above is called a tri-foil and it is the international symbol for radiation. The symbol can be magenta or black, on a yellow background. This sign is posted where radioactive materials are handled, where radiation-producing equipment is used, or where a radiation exposure is possible. This sign is used as a warning to protect people from being exposed to radioactivity or contaminated by radioactive material.

Some examples of signs using this tri-foil symbol are shown below. You might see the radiation symbol in a hospital where radioactive medicine is used, or in a university, or research facility. In a radiation incident, the signs would be posted where radioactive materials have been found and a site clean up is taking place.




Caution
Radioactive
Material Area


CAUTION
RADIOACTIVE MATERIAL


RADIATION
CONTAMINATED
AREA


RADIATION
CONTAMINATED
MATERIAL


RADIATION
CAUTION
HIGH RADIATION
AREA


CAUTION
HIGH
RADIATION
AREA

VII: 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. Stronium-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.