Radiation Fact Sheet

What is radiation?

Radiation is any form of energy propagated as rays, waves, or energetic particles that travels through the air or a material medium.

Radioactive materials are composed of atoms that are unstable. An unstable atom gives off its excess energy until it becomes stable. The energy emitted is radiation. The process by which an atom changes from an unstable state to a more stable state by emitting radiation is called radioactive decay or radioactivity.

Radiation is often divided into ionizing and non-ionizing radiation. Radiation that has enough energy to move atoms in a molecule around or cause them to vibrate, but not enough to change them chemically, is referred to as "non-ionizing radiation." Examples of this kind of radiation are radio waves and visible light.

We take advantage of the properties of non-ionizing radiation for common tasks:

- Microwave radiation - telecommunications and heating food
- Infrared radiation - infrared lamps to keep food warm in restaurants
- Radio waves - broadcasting

Radiation that falls within the "ionizing radiation" range has enough energy to actually break chemical bonds. This is the type of radiation that people usually think of as “radiation.” We take advantage of its properties to generate electric power, to kill cancer cells, and in many manufacturing processes.

Ionization is the process in which a charged portion of a molecule (usually an electron) is given enough energy to break away from the atom. This process results in the formation of two charged particles or ions: this leaves the atom with a net positive charge, and the free electron with a negative charge. Compared with other types of radiation that may be absorbed, ionizing radiation deposits a large amount of energy into a small area.

People receive some natural or background radiation exposure each day from outer space, radioactive elements in the soil and rocks, household appliances (such as television sets and microwave ovens), and medical and dental X rays. Even the human body itself emits radiation. These levels of natural and background radiation are normal. The average American receives 360 millirems of radiation each year, an amount that varies significantly due to residence location, type of employment, and travel patterns. (A rem is a unit of radiation exposure.) Nuclear radiation above normal levels can be a health and safety concern because of its ability to damage human and other cells biologically. How harmful low levels of extra radiation is remains a subject of debate. At levels comparable to the normal levels, effects are difficult or impossible to detect. At very high levels, say a thousand times normal levels, the effects of radiation are deadly.

Radioactive materials—if handled improperly—or radiation accidentally released into the environment can potentially be dangerous because of the harmful effects of certain types and activity levels of radiation on the body. The longer a person is exposed to radiation and the closer he/she is to the radiation, the greater the risk.

How are Americans exposed to radiation?
According to the National Council on Radiation Protection and Measurements, of the approximately 360 millirems of radiation the average American receives in a year, approximately:

- **71 percent** comes from natural background radiation (radon is the major contributor of this type of radiation, providing 55 percent of all sources of radiation)
- **15 percent** is the result of medical irradiation (11 percent from medical X rays, 4 percent from nuclear medicine procedures)
- **11 percent** comes from the human body
- **3 percent** can be attributed to consumer products
- **0.5 percent** comes from miscellaneous sources
- **0.2 percent** is the result of occupational exposure
- **0.05 percent** comes from releases from the nuclear industry

How do these types of radiation differ?
From the perspective of a radiological emergency, there are three basic types of ionizing radiation:

Alpha radiation is a positively charged particle emitted from the unstable nucleus of a radioactive isotope when the neutron-to-proton ratio in the nucleus is too low. Alpha particles are highly ionizing, but the particles travel short distances in air (4 centimeters) before being absorbed. Alpha particles have a very low ability to penetrate objects; thus, they can be stopped by a sheet of paper or the outer layer of (dead) skin. The external hazard from alpha particles is minimal, while the internal hazard when they are inhaled or absorbed may be significant.

Beta radiation is an energetic electron emitted from the unstable nucleus of some radioactive atoms. Beta particles are more penetrating than alpha particles. They can travel about 2 meters in air and can pass through an inch of water or human tissue, but they can be stopped by a thin sheet of aluminum. Beta particles generally constitute an external radiation hazard, such as skin burns.

Gamma radiation is electromagnetic radiation emitted from the nucleus of a radionuclide. It travels a greater distance in air than either alpha or beta particles do before being absorbed. Gamma-ray radiation is similar to X rays, and dense shielding material, such as lead, is needed to absorb it. Gamma-ray radiation is the most common external radiation hazard encountered in a radiation incident. Because of their high penetrating power, high-energy gamma rays can irradiate the entire human body almost uniformly, and they pose a serious external and internal hazard.

It is important to distinguish between direct and indirect exposure to radiation and exposure through radiological contamination. A person exposed to a medical X ray receives direct radiation, but the body is not radioactively contaminated. Radioactive contamination occurs when radioactive particles are deposited on a person's skin and can be absorbed through the skin or by inhalation or ingestion. These considerations form the basis of emergency planning as well as the protective actions taken to ensure the health and safety of the public after an accidental radiological release.

What can I do to minimize radiation exposure?
There are three factors that affect your body's exposure to radiation: time, distance, and shielding.

Time - All radioactivity loses its strength with time: some of it within days or less, some of it over years. Limiting the time spent near the source of radiation reduces the amount of radiation exposure you will receive. Following an accident, local authorities will monitor any release of radiation and determine the level of protective actions and when the threat has passed.

Distance - The more distance between you and the source of the radiation, the less radiation you will receive. In the most serious nuclear power plant accident, local officials will likely call for an evacuation, thereby increasing the distance between you and the radiation.

Shielding - The heavy, dense materials between you and the source of the radiation will provide shielding from the radiation and reduce exposure to the radiation. This is why local officials may advise you to remain indoors if an accident occurs. Buildings protect from radioactive fallout by isolation (like an umbrella "shields" us from rain) and ensure distance between you and the radioactive materials.

Sources:
Federal Emergency Management Agency
Environmental Protection Agency
National Council on Radiation Protection and Measurements

More information on nuclear terrorism including additional fact sheets, backgrounders and reports is available on the CISAC website, http://cisac.stanford.edu.