What is Radiation?

Nevada Test Site

Introduction

Radiation is energy in the form of wave particles. Although radiation is around us every day, you cannot see, hear, or smell it. Radiation is detected by measuring the activity of the energy released as it decays. It comes from natural and man-made sources as unstable atoms decay to form more stable atoms.

Different Types of Radiation

Alpha particles travel only a few inches in the air and lose energy almost as soon as they encounter an obstacle such as a sheet of paper or the outer layer of a person's skin. Alpha particles are hazardous only when they are inhaled or swallowed.

Beta particles can travel in the air for a few feet and can be stopped by a sheet of aluminum foil or glass. Beta particles can damage skin, but are most hazardous when swallowed or inhaled.

Gamma rays are waves of pure energy and are similar to x-rays. They travel at the speed of light through air or open spaces. Concrete, lead, or steel must be used to block gamma rays. Gamma rays are an extreme external hazard.

Neutrons are small particles that have no electrical charge. They are released during nuclear fission and can travel long distances in the air. Water or concrete are the best shielding against neutrons. Like gamma rays, neutrons can present an extreme external hazard.

Measurements of Radiation

Radiation is measured in different ways:

Rad (radiation absorbed dose) is the amount of energy actually absorbed by human tissue.
Roentgen describes the amount of radiation energy, in the form of gamma or x-rays, in the air.
Rem (Roentgen equivalent man) measures the biological damage (dose) of radiation. A millirem is one one-thousandth of a rem.

The average individual receives approximately 300 millirem of radiation per year from natural background sources. The legal radiation exposure limit for an 18-year old male, whose profession allows or permits exposure, is five rem per year; and 500 millirem for a woman during pregnancy.

Sources of Radiation:

Radiation may be found everywhere, be it naturally occurring or from man-made sources. Natural sources of radiation include:

The human body. About 39 millirem (11%) of the average person's total exposure emanates from within the body itself. Potassium-40 and other radioactive isotopes found in the air, water and soil are incorporated into the food we eat, then into body tissue.

Terrestrial sources. Radon is the largest source of radiation exposure (200 millirem or 55% per year) in the United States. In addition, rocks, soil and building materials derived from the earth’s crust, like granite, account for an additional 28 millirem per year.

Cosmic rays. The average person receives about 28 millirem per year (8%) of their total exposure from cosmic radiation from outer space. Cosmic radiation increases with altitude, roughly doubling every 6,000 feet.

Radiation Source	Dose (millirems)
Chest x-ray	10
Mammogram	30
Cosmic rays	31 (annually)
Human body	39 (annually)
Household radon	200 (annually)
Cross-country airplane flight	5

Man-made radiation sources include:

X-rays and nuclear medicine procedures. The average American receives about 45 millirems (15%) this way.

Consumer products. The average American receives about 9 millirem (3%) of their total exposure to radiation from consumer products. Exposure comes from smoke detectors, building materials, and television sets. Lawn fertilizer can also expose an individual to radiation. Fertilizer contains trace amounts of potassium-40, a naturally radioactive material.

Individuals are exposed to tiny amounts of radiation--less than one percent of total exposure--from a variety of other sources, including fallout from past testing of nuclear weapons, and from the generation of electricity in nuclear, coal-fired, and geothermal power plants.

Radiation's Effects on Humans

The nature and extent of damage caused by ionizing radiation depends on the amount of exposure, the frequency of exposure, and the penetrating power of the radiation to which an individual is exposed. There are two main types of radiation effects on humans:

Deterministic radiation occurs at the cellular level. Deterministic effects have definite threshold doses, and the effect is not seen until the absorbed dose is greater than the threshold level. Once above that level, the severity of the effect increases with dose. Effects are usually manifested soon after exposure. Examples include radiation skin burning, blood count effects, and cataracts.

In contrast, *stochastic radiation* effects are caused by more subtle radiation-induced cellular changes (usually DNA mutations) that are random in nature and have no threshold dose. The probability of such effects increases with dose, but the severity does not. Cancer is the only observed clinical manifestation of radiation-induced stochastic effects. Not only is the severity independent of dose, but there is a substantial delay between the time of exposure and the appearance of the cancer. Stochastic radiation can also damage the germ cells (ova and sperm) to produce hereditary effects.

Protection

To protect your self from radiation, there are three basic concepts to keep in mind: time, distance, and shielding. The amount of radiation exposure increases and decreases with the amount of time spent near the source of radiation, the distance from the radiation, and the shielding between you and the source of radiation. The less time spent near the source, at the greatest distance, with the greatest shield will result in the *least* exposure.

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