Radiation Safety

Facts About Radiation

Radiation and radioactivity occur naturally in the physical world. All living beings require some kinds of radiation just to live. Light and heat, for example, are two basic forms of radiation necessary for all life on Earth. Radiation is a form of energy. Radioactivity is the *spontaneous* emission of energy from certain elements, and from other elements under special conditions, in the form of particles or electromagnetic waves.

All matter is made up of atoms. Atoms are particles held together by electrical charges and internal forces. When an atom loses the delicate balance among the forces holding its center, or nucleus, together, it tries to regain its balance by giving off energy — radiation — in a process called radioactive decay. An atom that emits radiation is called a radioisotope or radionuclide. Over time, radioactive elements decay to gain balance: some in a few minutes, some in a few days or years, and some in thousands or millions of years. The length of time needed for half the atoms of a radioactive substance to decay is called its half-life.

Nature is source of 80% of exposure

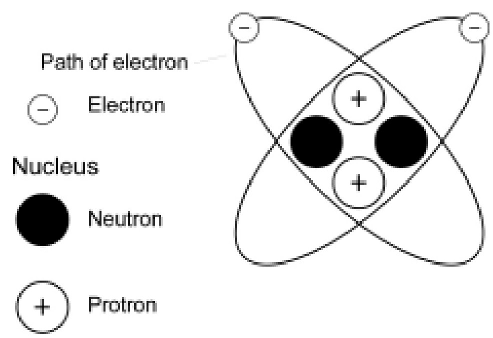
More than 80 percent of the radiation we are exposed to comes from such natural sources as sunlight, soil, and certain types of rocks. Cosmic rays filtering down through the atmosphere, and radon gas filtering up through the soil, are sources of natural radiation. This radiation is called background radiation. It is present everywhere, all the time and varies greatly depending on our geographical location.

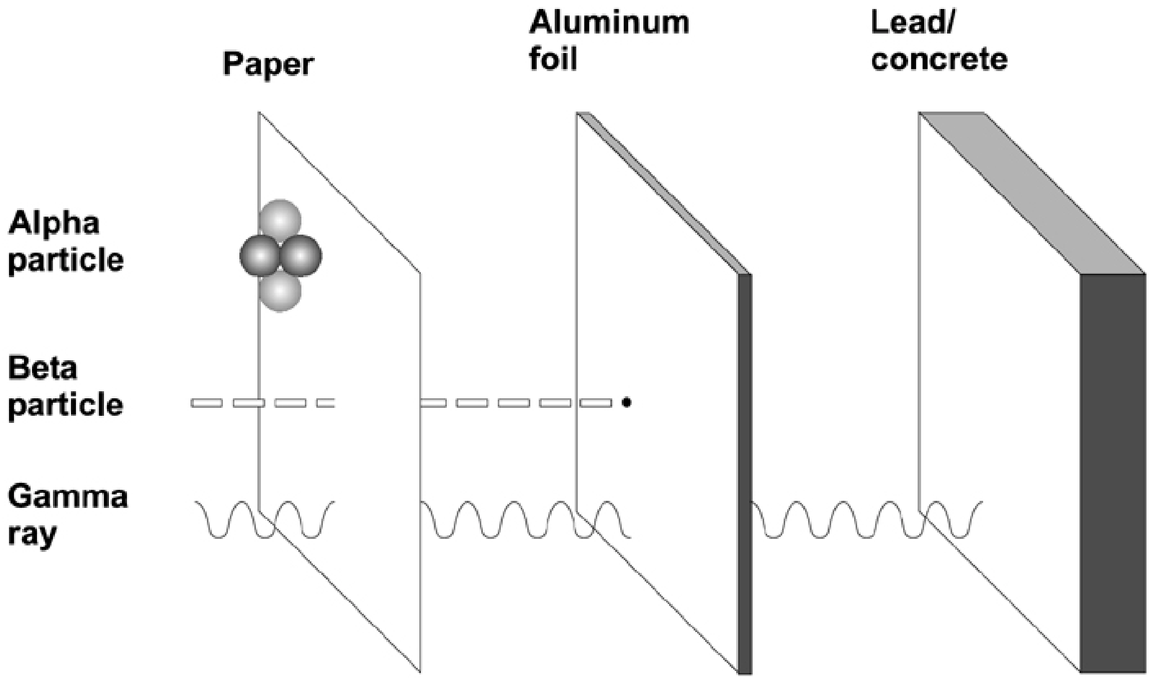
In addition, people are exposed to radiation from man-made sources such as color televisions, smoke detectors, computer monitors, and X-rays. These sources account for less than one-fifth of our total radiation exposure. But, there is no difference between natural radiation and its effects and man-made radiation and its effects.

Radioactivity

The study of radioactivity begins with the atom. Tremendous amounts of energy are stored in the center, or nucleus, of an atom. Scientists have learned how to split atoms in a controlled process to capture the energy stored in them. When atoms are split, heat and radioactivity are produced. The intense heat produced when an atom is split can be used to turn water into steam to run turbines that produce electricity. This is the basis for nuclear power production.

The helium atom





The radiation produced from radioactive atoms is emitted in several forms, most commonly, alpha and beta particles, and gamma rays. Alpha particles have the shortest range among these three types of radiation. They can travel only a few inches in the air and can be stopped easily by a sheet of paper or the outer layer of a person's skin. Alpha particles are harmful only if the radioactive source material is swallowed, inhaled, or absorbed into a wound.

Beta particles are more penetrating than alpha particles. They can travel through the air for several feet, but their penetrating power, too, is limited. Although they can pass through a sheet of paper, materials such as a thin sheet of aluminum foil or glass can stop them. Like alpha particles, they cause their most serious effects if swallowed or inhaled. Some radioactive material that emits beta particles could, for example, be attached to dust we might breathe in, or cling to food we might eat. In such cases, some of the material would leave the body through natural elimination processes. Some, however, may be retained in various organs where chemicals in living cells would be ionized and potentially damaged when the beta particles are emitted.

Unlike alpha or beta particles and their relatively short ranges, gamma rays are electromagnetic energy, with much greater penetration power. They are more energetic than X-rays. This type of radiation requires shielding with such materials as concrete, lead, steel, or water. Water is used to shield workers from radiation emitted by spent nuclear fuel assemblies at nuclear power plants.

Measuring radiation exposure and average exposures

A person's exposure to radiation is measured in units called *millirem*. A millirem measures the effects of radiation on the human body much as degrees measure temperature. In the United States, a person's average exposure to radiation is about 360 millirem per year. Roughly 300 millirem come from natural sources of radiation, and 60 millirem come from man-made sources, primarily medical procedures.

Location and lifestyle contribute to exposure

Where people live, as well as their lifestyles, can play a part in how much radiation they receive. The natural or background radiation exposure a person receives can vary depending on how high above sea level he or she lives and on the radioactive content of the soil and rocks in the vicinity. People who live at higher altitudes receive more exposure to radiation that comes from space.

Background radiation in the United States varies considerably from state to state. For instance, a person living on the Atlantic Coast, on average, receives about 55 millirem per year from the ground and space. A person living on the Colorado Plateau receives, on average, 140 millirem per year from the ground and space. The background radiation exposure on the Colorado Plateau is higher because of the higher altitude and radioactive particles from uranium that occur in the soil. The atmosphere at higher altitudes is thinner, allowing more radiation from space to penetrate

People living in the northwest region of Washington state receive about 240 millirem per year, on average, from natural and man-made sources, whereas residents in the state's northeast region receive doses of about 1,700 millirem per year, most of it from radon that occurs naturally in the rock and soil.

Because of other factors, it is not uncommon for a person to receive far more than the average 360 millirem per year. Things that can affect a particular person's annual radiation exposure level include airplane travel, dental and medical X-rays, and occupation.

Some examples of exposure

- A person taking a cross-country flight would receive about two to five additional millirem of radiation per roundtrip, depending on flight altitude and shielding on the airplane. Due to the thinner atmosphere at the altitudes involved in cross-country flights, a traveler is exposed to more cosmic radiation. Because of their occupations, airline pilots and flight attendants routinely are exposed to higher levels of radiation than many other workers. Airline crew members and frequent flyers receive annual doses on the order of between 500 and 600 millirem.
- A person undergoing a full set of dental X-rays would receive about 10-39 additional millirem per set.
- A person working in a nuclear power plant would receive approximately 300 additional millirem per year (the Nuclear Regulatory Commission's limit is 5,000 millirem per year for occupational exposures).
- A person living directly outside a nuclear power facility would receive approximately one additional millirem per year.
- Transportation casks are constructed with multiple layers of dense metal designed to protect public health and safety during transportation and shield people from radiation. A person standing 30 meters (100 feet) from a vehicle transporting spent nuclear fuel, moving 15 miles per hour, would receive a radiation dose of approximately 0.0004 millirem. If the same person were standing the same distance from all potential shipments (approximately 50,000 truck shipments over 24 years), he or she would receive a total whole-body dose of about 20 millirem. During the same 24-year timeframe, that same person would receive over 7,000 millirem from natural background radiation.

EPA sets exposure limits

The Environmental Protection Agency is responsible for establishing exposure limits to protect public health and safety and the environment for a repository. Federal law has directed the agency to consider recommendations by the National Academy of Sciences, and, through a rulemaking process, to establish environmental standards for a repository. The rulemaking process allows for public input into how these environmental standards are developed and instituted. The Nuclear Regulatory Commission will then incorporate the results into its criteria for licensing a repository.

U.S. Department of Energy
Office of Civilian Radioactive Waste Management

YUCCA MOUNTAIN
SITE CHARACTERIZATION
PROJECT

P.O. Box 30307
North Las Vegas, NV 89036-0307
1-800-225-6972
http://www.ymp.gov

DOE/YMP-0403
June 2000