US Army Corps of Engineers®

FUSRAP Fact Sheet
Radiation

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The Formerly Utilized Sites Remedial Action Program (FUSRAP) was initiated by the Atomic Energy Commission in 1974 to identify and clean up contaminated sites used in the early years of the nation's atomic energy program. Management of the program was transferred to the U.S. Army Corps of Engineers from the U.S. Department of Energy in October 1997. This is one in a series of fact sheets that provide information about regulatory, technical, and other issues considered in decision making within the Formerly Utilized Sites Remedial Action Program (FUSRAP). This fact sheet discussed low-level radiation: what it is and how it is measured.

What is radioactivity?

Simply put, radioactivity is a process in which an atom's nucleus spontaneously disintegrates, or "decays," and releases energy. The rate of decay is called the "activity," and is measured as the number of disintegrations per second.

Many isotopes in nature are stable, which means they never change. Other isotopes — both natural and manmade — are radioactive, meaning that they are unstable and can change into another form. For example, uranium is composed of two main isotopes that have mass numbers of 235 and 238. Uranium-238 decays to thorium-234 and an alpha particle. And Radium-226 decays to radon-222 and an alpha particle.

The decay of radium to radon is one step in a long radioactive process, starting with Uranium-238 and ending, ultimately, with lead. The rates of decay vary, ranging from a fraction of a second to billions of years, depending on the isotope. It is measured in half-lives, or the time it takes for half of the radioactive atoms in a radionuclide to decay to another form. Radium-222, for example, has a half-life of 1,599 years. Radon-222, though, has a half-life of 3.82 days.

What are the types of radiation?

The term "radiation" is very broad, and includes visible, infrared and ultraviolet light and radio waves. However, it is most often used to mean "ionizing" radiation: radiation that changes the physical state of atoms it strikes, causing them to become electrically charged or "ionized." In some circumstances, the presence of such ions in living tissues can disrupt normal biological processes. Ionizing radiation may therefore represent a health hazard to man.

There are various types of ionizing radiation, and each has different characteristics:

- *Alpha radiation* consists of heavy positively charged particles emitted by atoms of elements such as uranium and radium. Alpha radiation may just penetrate the surface of the skin, and it can be stopped completely by a sheet of paper. However, if alpha-emitting materials are ingested or inhaled, they can expose internal tissues directly and be a potential hazard.
- *Beta radiation* consists of electrons. These are more penetrating than alpha particles, requiring a sheet of aluminum a few millimeters thick to stop them completely. Tritium, which is present in fallout from nuclear tests, is a source of beta radiation.
- *Gamma rays* are a form of electromagnetic radiation, similar to X-rays, light and radio waves. They can be very penetrating, and can pass right through the human body. But they are almost completely absorbed by one meter of concrete.
- *X-rays* are a more familiar form of electromagnetic radiation, with limited penetrating power. X-rays generally are focused into a beam, and lead stops their penetration.
- *Neutrons,* which are released during processes such as the splitting of atoms in the fuel of nuclear power plants, also can be very penetrating. But efficient shielding against neutrons can be provided by water.

Some exposure to ionizing radiation cannot be avoided. Exposures can be natural or man-made. Natural sources include cosmic rays and naturally-occurring radionuclides in the earth and air, and are considered “background” radiation. Man-made sources include medical X-rays and coal-fired power plants. Other sources of radiation include fallout from nuclear explosives testing and radionuclides emitted from nuclear installations in the course of normal operation.

What is a radiation dose?

The term “dose” describes the amount of radiation or energy transmitted to cells. Sunlight, for example, feels warm because its energy is absorbed by the body. The amount of radiation and the type absorbed are easily measured using instruments, and the biological effect of absorbing a given amount of radiation varies, depending on its type.

Dose equivalent is the term used to express the amount of effective radiation received by an individual. A dose equivalent considers the type of radiation, the amount of body exposed, and the risk of exposure. It is measured in Roentgen equivalent man units (or rems) to measure the amount of damage to human tissue from a dose of ionizing radiation.

How do we protect against radiation exposure?

Radioactive particles can enter the body by ingestion – by eating, drinking and breathing. When a particle of radiation penetrates the human body and passes through and out without interacting with bodily tissue, no damage is inflicted. It is when the particles deposit some of their energy in tissue that damage could occur. To protect against a radiation hazard, it is necessary to isolate the source of radioactivity or to render it harmless. At present there is no way to eliminate radioactivity through treatment, but there are measures that can be taken.

To provide protection against radiation that is external to the body, three factors can be used: *distance, time,* and *shielding.* A person is safer the farther from the source of radiation, the shorter the time of exposure and the thicker the shielding. Exposure to radiation from wastes is prevented by using protective containers and shielding, and by isolation of the radioactive material.

Approaches to radiation protection are similar throughout the world because most governmtnes have accepted the recommendations of the International Commission on Radiological Protection, an independent group of experts. One of the commission’s priciples is “As Low as Reasonably Achievable” (ALARA), which is the practice of keeping all doses as low as possible. In recommending maximum dose limits, the commission also recoginzes two categories of people: adults exposed throught their work and members of the public.

In this country, these exposure limits are found in Code of Federal Regulations 10 Energy, Part 20. The document, which is reissued annually, includes regulations of the Nuclear Regulatory Commission, which are based on specifications of the U.S. Environmental Protection Agency.

The maximum occupational dose is 5 rems per year, although somewhat higher limits are allowed for the lens of the eye and the skin, hands, and feet (15 and 50 rems per year, respectively). For the general public, the limits are 0.1 rem (100 millirems) per year.

How do I get more information?

For more information about radiation or other FUSRAP issues, please contact the FUSRAP Public Information Center at **(716) 879-4438**. Or call the 24-hour, toll-free telephone number. An answering machine records comments or questions, and all calls are returned. The number is **1-800 833-6390**.

Or visit the FUSRAPhomepage on the World Wide Web at: ***http://www.fusrap.usace.army.mil***

References and Further Reading

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Facts About Low-Level Radiation, American Nuclear Society, 1989
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Toxics A to Z: A Guide to Everyday Pollution Hazards, John Harte, Cheryl Holdren, Richard Schneider and Christine Shirely, University of California Press, 1991