EPA Facts About Radium

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What is radium?

Radium is a naturally occurring radioactive metal that exists as one of several isotopes. It is formed when uranium and thorium decay in the environment. In the natural environment, radium is found at low levels in soil, water, rocks, coal, plants, and food.

What are the uses of Radium?

In the early 1900's, radium was erroneously used to treat rheumatism and mental disorders, and as a general tonic. Radium was also used to make luminous paints for watch dials, clocks, glow in the dark buttons, and military instruments. Because of the health hazards from these types of exposures the use of radium for these purposes was discontinued. Radium has also been widely used in medical therapy to irradiate cancerous cells in the body, but this use has largely been replaced by other radioactive materials or methods. Radium-226 has also been used in medical equipment, gauges, and calibrators, and in lightening rods. Alpha emitters such as radium and plutonium can be used as components of a neutron generator.

How does radium change in the environment?

Radium is not a stable element. As radium decays, it releases radiation and forms decay products. Like radium, many of these decay products also release radiation and form other elements. The decay process continues until a stable, nonradioactive decay product is formed.

Radiation is released during the decay process in the form of alpha and beta particles, and gamma radiation. Alpha particles can travel only short distances and cannot penetrate human skin. Beta particles are generally absorbed in the skin and do not pass through the entire body. Gamma radiation, however, can penetrate the body.

Isotopes of radium decay to form radioactive isotopes of radon gas. Radium-224, radium-226, and radium-228, the most common isotopes of radium, have half-lives of 3.5 days, 1,600 years, and 6.7 years respectively, after which each forms an isotope of radon. Radon is known to accumulate in homes and buildings.

How are people exposed to radium?

Since radium is present at relatively low levels in the natural environment, everyone has some level of exposure from it. However, individuals may be exposed to higher levels of radium and its associated external gamma radiation if they live in an area where there is an elevated level of radium in soil. In addition, radium is particularly hazardous because it continually produces radon which can diffuse into nearby homes.

An individual can be exposed to radium if one comes into contact with waste from 20th century ore at radium processing facilities, former radium dial facilities, or radium dials. In addition, exposure from radium can occur if radium is released into the air from the burning of coal or other fuels, or if drinking water taken from a source that is high in natural radium is used. Individuals may also be exposed to higher levels of radium if they work in a mine or in a plant that processes ores. Phosphate rocks which can contain relatively high levels of uranium and radium are also a potential source of exposure. The concentration of radium in drinking water is generally low, but there are specific geographic regions in the United States where higher concentrations of radium may occur due to geologic sources.

Radium exposure therefore can be from gamma radiation from radium decay products, lung exposure from radon gas and its decay products, and inhalation and ingestion exposure.

How does radium get into the body?

Radium can enter the body when it is inhaled or swallowed. Radium breathed into the lungs may remain there for months; but it will gradually enter the blood stream and be carried to all parts of the body, with a portion accumulating in the bones.

If radium is swallowed in water or with food, most of it (about 80%) will promptly leave the body in the feces. The other 20% will enter the blood stream and be carried to all parts of the body. Some of this radium will then be excreted in the feces and urine on a daily basis; however, a portion will remain in the bones throughout the person's lifetime.

Is there a medical test to determine exposure to radium?

Urine and bone biopsy tests are sometimes used to determine if individuals have ingested or swallowed a source of radioactivity such as radium. Radon, a decay product of radium, can also be measured in air that is exhaled from the body. Another technique, gamma spectroscopy, can measure the amount of radioactivity in portions of the body. These tests require special equipment and cannot be done in a doctor's office. There is no test that can detect external exposure to radium's gamma radiation alone.

How can radium affect people's health?

Exposure to radium over a long period may result in many different harmful effects. If inhaled as dust, or ingested as a contaminant, risk is increased for several diseases including, lymphoma, bone cancer, and hematopoietic (blood-formation) diseases, such as leukemia, and aplastic anemia. These effects take years to develop. If exposed externally to radium's gamma radiation, risk of cancer is increased in essentially all tissues and organs, though to varying degrees. However, in the environment, the greatest risk associated with radium is actually posed by it's direct decay product radon. Radon has been shown to cause lung cancer.

What recommendations has the Environmental Protection Agency made to protect human health?

Please note that the information in this section is limited to recommendations EPA has made to protect human health from exposure to radium. General recommendations EPA has made to protect human health, which cover all radionuclides including radium, are summarized in the Introduction section of this booklet.

For uranium mill tailing sites with radium contamination, EPA has established a radium level of 5 picocuries per gram (pCi/g) above background as a protective health based level for the cleanup of soil in the top 15 centimeters. These regulations under 40 CFR Part 192.12 are often ARARs at Superfund sites. The EPA OSWER Directive 9200.4-25, "Use of Soil Cleanup Criteria in 40 CFR Part 192 as Remediation Goals for CERCLA sites" provides guidance regarding when of 5 pCi/g is an ARAR or otherwise recommended cleanup level for any 15 centimeters of subsurface radium contaminated soil other than the first 15 centimeters.

If regulations under 40 CFR Part 192.12 are an ARAR for radium in soil at a Superfund site, then Nuclear Regulatory Commission regulations for uranium mill tailing sites under 10 CFR Part 40 Appendix A, I, Criterion 6(6) may possibly be an ARAR at the same site. Criterion 6(6) requires that an estimate be made of the level of radiation, called a "benchmark dose," that an individual would receive after that site was cleaned up to the radium soil regulations under 40 CFR Part 192.12. This benchmark dose then becomes the maximum level of radiation that an individual may be exposed to from all radionuclides, except radon, in both the soil and buildings at the site. The EPA OSWER Directive 9200.4-35P "Remediation Goals for Radioactively Contaminated CERCLA Sites Using the Benchmark Dose Cleanup Criterion 10 CFR Part 40 Appendix A, I, Criterion 6(6)" provides guidance regarding how Criterion 6(6) should be implemented as an ARAR at Superfund sites, including using a radium soil cleanup level of 5 pCi/g in both the surface and subsurface when estimating a benchmark dose.

EPA has established a Maximum Contaminant Level (MCL) of 5 picocuries per liter (pCi/l) for any combination of radium-226 and radium-228 in drinking water. EPA has also established a MCL of 15 pCi/l for alpha particle activity, excluding radon and uranium, in drinking water. Radium-226 would also be covered under this MCL.

For more information about how EPA addresses radium at Superfund sites, please contact either:

EPA's Superfund Hotline
1-800-424-9346 or 1-800-535-0202
or EPA's Superfund Radiation Webpage
http://www.epa.gov/superfund/resources/radiation