

## What is radioactivity?

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Radioactivity (radioactive decay) is the ability of some nuclei to spontaneously (self-induced process) change its nuclide structure and/or energy state. The measure of volatility of a radioactive substance is its half-life – the time required for the decay of half of the atoms of the radioactive substance under consideration. For example, the half-life of cesium-137, a fission product present in large quantities in spent nuclear fuel (SNF) is 30 years. This means that after 30 years there will be half of its initial quantity, after 60 years - half of the remaining half (1/4), and after 90 years - 1/8, and so on.

The half-life is strictly specific: it cannot be artificially changed. For some nuclei, it is enormous. For example the half-life of uranium-235 is 710 million years and that of thorium-232 – 14 billion years.

In practice, the only radioactivity types that are accompanied by the irradiation (emission) of ionizing radiation – alpha and beta decay – are significant. Alpha radiation is the emission of alpha particles (helium-4 nuclei) having a velocity of about 107 m/s. It is characteristic of the heaviest nuclei of the periodic table – including uranium, thorium and plutonium. The penetrative power of alpha radiation is low, a layer of air few centimetres thick - for example, a sheet of paper fully absorbs it. Beta radiation is the emission of electrons, often at very high (near-light) speed. It is typical for nuclei of all masses, where the ratio between the number of neutrons and protons is different from the most favourable in terms of energy release (for light nuclei - about 1, for heavy nuclei - about 1.5).

The majority of radioactive fission products of uranium, as well as some natural radionuclides represent beta emitters. The penetrating ability of beta radiation is much higher than that of alpha particles; meters of air or a few millimetres of aluminium or plexiglas are required to stop it.

In the course of the radioactive decay of nuclei, electromagnetic (quantum) radiation is usually formed with a very short wavelength – gamma radiation. It possesses a very high penetrating power: tens of centimetres, and sometimes meters of dense medium are needed to stop it. The best protection against gamma radiation is heavy materials (e.g. lead).