Radiation

February 2012

Radiation is a form of energy. There are several types of radiation: heat, light, microwave and nuclear. The common characteristic of nuclear radiation is that it is so energetic that it can destroy molecules. Heat and sunlight are unable to do such damage.

Radioactive substances emit nuclear radiation (from here onwards, radiation refers to nuclear radiation). These substances are made of non-stable atoms that disintegrate into stable atoms. During disintegration the atom emits energy in the form of radiation. This process is also called radioactive decay.

The radioactivity of a substance is the indicator for the amount of disintegrations of atoms in the substance. Substances with high radioactivity are very radioactive for two reasons:

- The substance has many of radioactive atoms within it; and
- The radioactive atoms in this substance decay very quickly.

The most radioactive substances are a combination of both.

Nuclear radiation is divided into three types of radiation: gamma, beta and alpha. Most radioactive elements send out a combination of these three types of radiation. Gamma radiation is a 'wave', just like light, but with more energy. Beta radiation consists of small particles (electrons) travelling at an incredible speed. Alpha radiation consists of big particles (two protons, two neutrons altogether), also travelling with incredible speed.

An important difference is the 'destructive power': alpha radiation has the most 'destructive power' and gamma radiation the least. Radiation with the greatest 'destructive power' loses energy rapidly and does not travel far. For example, alpha particles do not penetrate skin, or even a piece of paper.

Effects of nuclear radiation

The risk of radiation exposure can come from external radiation from radioactive elements outside of the body, or from internal contamination of the body with radioactive elements that enter the body or from both sources. Radiation can destroy molecules in our body, such as DNA molecules in cells.

Exposure to radioactivity has been linked to genetic mutations, birth defects, cancer, leukaemia and disorders of the reproductive, immune, cardiovascular and endocrine systems. High doses of radiation (> 1 sievert) can result in immediate health effects and even death. The health effects of low doses of radiation will only become visible over the longer term. Internal contamination with radioactive materials often results in significant radiation exposure because the substances can stay trapped in the body for long periods of time and continue to emit radiation.

Radiation dose

A radiation dose is the amount of energy that radiation gives to the body. The dose is the indicator of the risk: a high dose is a high risk. When radiation travels through the body and hits cells and organs, a person receives a radiation dose.

Since alpha radiation doesn't penetrate skin, alpha-emitting atoms are not dangerous outside of the body. But, if an organ takes up an alpha-emitting atom, the large particles of alpha radiation it gives off will create significant damage in the body. The radiation can have an impact on everything (DNA, cell membranes) it encounters and, therefore, result in a relatively high dose.

Gamma radiation travels right through your body, but since the chances of it 'hitting' something are quite small it does not deliver such high doses. However, all gamma-emitting atoms – whether inside or outside of the body – add to the radiation risk.

Radioactive contamination

A person or an object becomes contaminated when radioactive elements are present on it (external contamination) or in it (internal contamination). Radioactive elements behave like all elements: they can end up anywhere: in dust, food, furniture, humans etc. Like normal 'dirt', most of the external contamination can be washed away, after which the person/material is called decontaminated. Internal contamination is a bigger problem because it's more difficult to remove.

No safe dose

There is no safe dose of radiation. Radiation doses need to be kept as low as possible. Internationally accepted limits are set for members of the public for doses that are in addition to background or natural radiation. The limit is set at one millisievert a year. For nuclear workers, this limit is 20 millisieverts a year. To compare, the global average for natural radiation doses is 2.4 millisieverts a year.

Terminology

Dose = total amount of energy from radioactivity absorbed by the body over a certain period.

Measuring units:
– microsievert (μSv)
– millisievert (1 mSv = 1000 μSv)
– sievert (1 Sv = 1000 mSv).

Dose rate = the amount of radioactivity absorbed per hour, expressed in

Measuring units:
– microsievert an hour (μSv/h)
– millisievert an hour (mSv/h =1000 μSv/h)

Routes of radiation exposure

In the case of a major accident at a nuclear plant, a radioactive cloud can cause direct and indirect radiation exposure. People who encounter a radioactive cloud will be directly at risk from the external radiation dose of the cloud and from inhaling radioactive particles. Indirectly, there is a risk of inhaling radioactive particles that were deposited and re-suspended, and of ingesting radioactivity spreading in the food chain.

Radioactive materials are also spread by water. Contamination can end up in ground water, rivers and oceans. In addition, rainwater causes radioactive materials to travel, often causing an accumulation of radioactivity where water collects. Radioactive materials in water can be taken up by the food chain, for example by animals and fish or through the roots of plants and trees.

The exposure to radiation and the resulting health risks depend on many factors. For children (especially at a young age) and pregnant women, the potential health risks are higher because of the sensitivity of the reproducing human cells in their bodies. It is of paramount importance that this group takes all necessary precautions.

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