Ionizing radiation protection

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The main objective of radiation protection is to keep the exposure of the population as low as possible with the use of technologically and economically affordable methods.

The aim of protection against ionizing radiation is to **prevent**, or significantly **reduce**, the **radiation damage** of exposed individuals, their descendants and humanity as a whole. At the same time we should be able to the sources of ionizing radiation to our benefit. Radiation protection technology uses biological, chemical and physical approaches.

Biological protection lies in the improvement of nutrition and nonspecific mechanisms of improving the immune system as a whole. This for example achieved by increasing the intake of vitamins and antioxidants.

Chemical protection uses the administration of radio protective substances, which protect the organism against direct and indirect effects of ionising radiation. The mechanism of protecting against direct effects lies in masking the sensitive chemical groups by binding the cell receptors or enzymes with radio protective substances, and by preventing the migration of energy. Radio protective substances are aimed against the indirect effects. They block the influence of free radicals and can also cause cell hypoxia, which prevents the origin of radiolysis products, and inhibits their harmful effects.

Physical protection against external exposure uses three main factors: *distance*, *time* and *shielding*.

The significance of protection by **distance** is obvious from the rule stating that the decrease of dose is proportional to the square of the distance of the source of ionising radiation. The simplest application of this principle is the use of tweezers and pliers, which was a usual practise in the times of a pioneering work with ^{226}Ra.

In order to reduce the **time** spent in the field of ionizing radiation, it is important to set proper administrative measures and to rehearse the more difficult tasks outside the area of ionizing radiation. For example, concerning enclosed gamma emitters there are inactive mock-ups available.

The application of the **shielding** principle has a very wide application in radiation protection. Every radiation protection worker needs to be introduced to the basic physical principles that the shielding is based on. This method of protection also uses the knowledge about different ways of interaction between ionizing radiation and absorbent medium.

Alpha radiation protection

Alpha radiation particles possess the range of couple of cm in the air. In the tissues and water the range is reduced to several tens of micrometres. Due to this fact the protection against external exposure is very simple. Usual clothing, paper, and thin Plexiglas sheet all provide a sufficient amount of protection.

Beta radiation protection

The energy spectrum of β-emitters is continuous. The range of β-particles in absorbent medium is not always the same. The maximum range of β-particles is usually described using the substance of absorbent material that completely absorbs all of the electrons emitted by the given source. In **air**, the range of β-particles reaches *several meters*, and in **water** it is *several centimetres*. In the **soft human tissues** the range of β-particles reaches *millimetres*. The most commonly used products for of shielding are usually of thin and light materials, such as *Plexiglas* or *aluminium*. These generate less bremsstrahlung X-radiation. Thin layer of 3-5mm aluminium sheet, followed by 5 cm lead sheet are considered to be sufficient protection from most of the β emitters used in medicine. The lead sheet is used in order to protect from the bremsstrahlung X-rays generated in aluminium.

Bremsstrahlung can also originate in soft tissues, provided there is a β-particles source distributed within. Due to its very low effective proton number (for example for muscle $Z \sim 7{,}6$), the intensity of such bremsstrahlung is very low. For the purposes of calculating the radiation dose received from β emitters, the energy loss represented by bremsstrahlung is ignored.

Gamma radiation and X-rays protection

The application of the **shielding** principle is most commonly associated with the assessment of the effectiveness of protection against photons, ionizing gamma radiation, and X-radiation. The materials used for radiation shielding are characterised by high proton numbers, such as *lead*, *steel* etc. Another commonly used material is *concrete*, produced with barite aggregate.

Radiation shields can be installed right over the source of radiation, which is the case of X-ray tube housing or of enclosed emitters. The execution of radiation shielding is usually obtained by the use of shielding walls and curtains. Most commonly the radiation protection is implemented in the materials and the spatial arrangement of the room itself. Personal protection based on the shielding principle is carried out with the use of lead rubber aprons and gloves, and lead radiation glasses.

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