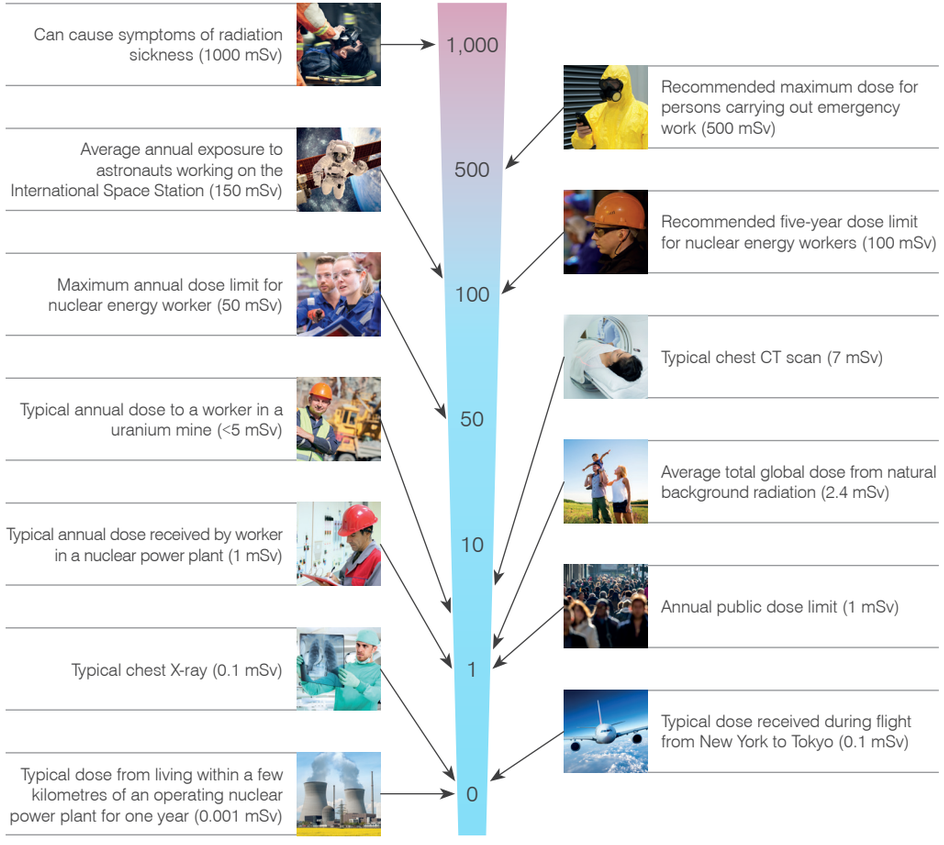
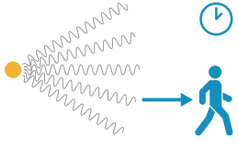
Some comparative whole-body radiation doses

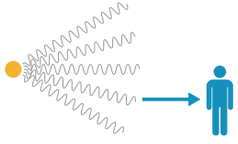


Protection against radiation

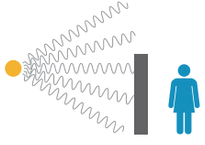
Radiation has always been present in the environment and in our bodies. However, we can and should minimise unnecessary exposure to significant levels of man-made radiation. Radiation can be very easily detected. There are a range of simple, sensitive instruments capable of detecting minute amounts of radiation from natural and anthropogenic sources. There are three ways in which people can be protected from identified radiation sources:



Time: Dose is reduced by limiting exposure time.



Distance: The intensity of radiation decreases with distance from its source.



Shielding: Barriers of lead, concrete or water, give good protection from penetrating radiation such as gamma rays.

The International Commission for Radiological Protection has developed a system for protection with three basic principles:

Justification: No practice involving exposure to radiation should be adopted unless it produces a net benefit to those exposed or to society generally.

Optimization: Radiation doses and risks should be kept "as low as reasonably achievable" (ALARA), economic and social factors being taken into account.

Limitation: The exposure of individuals should be subject to dose or risk limits, above which the radiation risk would be deemed unacceptable.

These principles apply to normal exposures. A similar system applies for accidental exposures but where it is not possible to limit doses, a target 'reference' level is suggested instead.

Underlying these principles is the application of the 'linear hypothesis' based on the idea that any level of radiation dose, no matter how low, involves the possibility of risk to human health. However, the weight of scientific evidence has never established any cancer risk or other health effects at doses below 50 mSv in a short time or at about 100 mSv/yr.

Nuclear accidents and radiation release

The exposure levels during normal operation of civil nuclear facilities are very low. However, there have been some serious accidents, which received extensive public attention and whose consequences have been reviewed by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR).

- A 2008 report from UNSCEAR concluded that apart from increased thyroid cancers in children affected in the region, "there is no evidence of a major public health impact attributable to radiation exposure" from the April 1986 Chernobyl accident in Ukraine. Thyroid cancer is usually not fatal if diagnosed and treated early.
- In May 2013, UNSCEAR reported that radiation exposure following the March 2011 accident at Fukushima Daiichi plant in Japan "did not cause any immediate health effects" and "it is unlikely to be able to attribute any health effects in the future among the general public and the vast majority of workers."

WORLD NUCLEAR ASSOCIATION

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Pocket Guide

Radiation

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What is radiation?

Radiation is energy being transmitted through space. Visible light, ultra-violet light and transmission signals for TV and radio communications are all forms of radiation that are common in our daily lives. There are two types of radiation: 'ionizing' and 'non-ionizing'. Ionizing radiation is electromagnetic radiation with sufficient energy to remove tightly bound electrons from atoms, thereby creating ions capable of breaking chemical bonds, thus causing ionization of the matter through which it passes. Non-ionizing radiation has sufficient energy to move atoms but not create ions.

Types of ionizing radiation

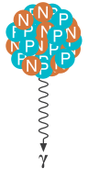
Alpha (α) particles

- Particles (helium nuclei) consisting of two protons and two neutrons.
- Emitted from naturally-occurring heavy elements such as uranium and radium, as well as from some man-made unstable elements (formed artificially by neutron capture and possibly subsequent beta decay).
- Densely ionizing but can be readily stopped by a few centimetres of air, a sheet of paper, or human skin.
- Only dangerous if alpha-emitter is inhaled or ingested and released inside the body at high exposures.
- Alpha-emitters can be safely stored in a sealed container.
- Measurement of exposures from alpha particles requires special detector systems.

Beta (β) particles

- Either electrons or positrons emitted by many radioactive elements.
- Can be stopped by wood, aluminium or glass a few millimetres thick.
- Can penetrate into human skin but generally less so than gamma radiation.
- High exposure produces an effect like sunburn, but which is slower to heal.
- Can be safely stored in appropriate sealed containers.
- Measurement of exposures from beta particles requires special detector systems.

Gamma (γ) rays



- High-energy beams similar to X-rays.
- A form of electromagnetic radiation.
- Emitted during radioactive alpha and beta decays.
- Very penetrating so need dense materials such as water, glass, lead, steel or concrete to shield them.
- Poses the main hazard to people when a container holding radioactive materials becomes unsealed.
- Gamma activity can be measured with a scintillation detector or Geiger counter.
- Doses can be assessed by the small badges worn by workers handling radioactive materials.

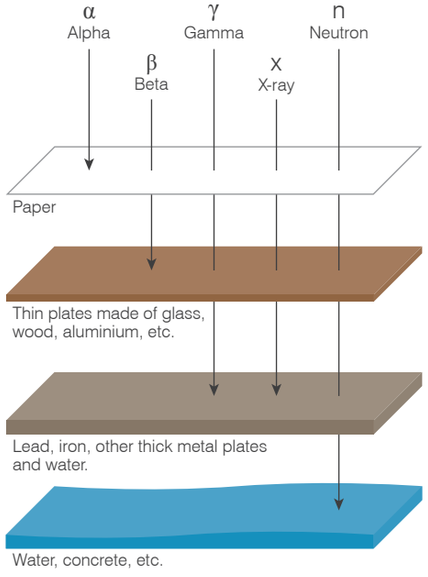
X-rays

- Similar to gamma rays, but originate from the electron cloud.
- A form of electromagnetic radiation.
- X-ray photons carry enough energy to ionize atoms and disrupt molecular bonds.
- Higher energy X-rays can traverse relatively thick objects without being absorbed or scattered much.

Neutrons

- A free neutron usually emitted as a result of spontaneous or induced nuclear fission.
- Can be shielded by light atoms, particularly those containing hydrogen.
- Indirectly ionizing and hence can be destructive to human tissue.
- Can be slowed down (or 'moderated') by graphite or water.
- Measurement of exposures from neutrons requires special detector systems.

Types of radiation and penetration



Measuring radiation

The becquerel (Bq) is the SI derived unit of radioactivity. One becquerel is defined as the activity of a quantity of radioactive material in which one nucleus decays per second. A kilogram of granite might have 1000 Bq of activity.

The amount of ionizing radiation absorbed in tissue can be expressed in grays (Gy): 1 Gy = 1 joule per kilogram. Since neutrons and alpha particles cause more damage per gray than gamma or beta radiation, another unit, the sievert (Sv), is used in setting radiological protection standards. Total dose is measured in sieverts: as this unit is so large, millisieverts (mSv) and microsieverts (μSv) are often used. One gray of beta or gamma radiation has one sievert of biological effect; one gray of alpha particles has a 20 Sv effect; and one gray of neutrons is equivalent to around 10 Sv (depending on their energy).

Background radiation

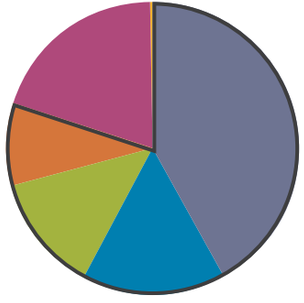
Everyone is exposed to often low levels of ionizing radiation. Naturally-occurring background radiation resulting from radioactive materials in the ground (mainly radon gas), cosmic rays and natural radioactivity in our bodies - is the main source of exposure for most people. Annual doses typically received range from about 1.5 to 3.5 mSv, but can be more than 50 mSv.

Natural radiation contributes about 80% of the annual dose to the population. The remaining 20% come from a range of medical, commercial and industrial activities. The most familiar of these sources of exposure is medical X-rays. The nuclear power industry accounts for less than 0.1% of man-made radiation.

Key points

- Radiation exists naturally everywhere at widely varying levels. Places exist where people live with over 10 times higher than average background from the ground.
- Mankind has evolved in a world with strongly differing background radiation without developing a sense to detect it.
- Radiation has always been around and is now well understood. It has been used and studied for more than 100 years.
- Radiation resulting from the use of nuclear energy accounts for only a minute fraction of background radiation.

Sources of exposure to radiation



- 20% Medicine
- <0.1% Nuclear Industry
- 42% Radon
- 16% Soil
- 13% Cosmic
- 9% Food and Drinking Water
- 80% Natural Radiation

Source: UNSCEAR

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