

## GLOSSARY

**Absorbed dose:** mean energy imparted by *ionizing radiation* to an irradiated medium per unit mass, expressed in *grays* (Gy)

**Activity:** amount of radioactivity of a *radionuclide* defined as the mean number of decays per unit time

**$\alpha$ -particle:** two neutrons and two protons bound as a single particle that is emitted from the nucleus of certain radioactive *isotopes* in the process of decay or disintegration; a positively charged particle indistinguishable from the nucleus of a helium atom

**$\alpha$ -radiation:**  $\alpha$ -particles emerging from radioactive atoms

**$\alpha$ -rays:** stream of  $\alpha$ -particles

**Ankylosing spondylitis:** arthritis of the spine

**Background radiation:** amount of radiation to which a population is exposed from natural sources, such as *terrestrial radiation* due to naturally occurring *radionuclides* in the soil, *cosmic radiation* originating in outer space and naturally occurring *radionuclides* deposited in the human body

**$\beta$ -particle:** charged particle emitted from the nucleus of an atom, with mass and charge equal to those of an *electron*

**$\beta$ -rays:** stream of  $\beta$ -particles

**Brachytherapy:** method of radiation therapy in which an encapsulated source or group of sources is used to deliver  $\beta$ - or  $\gamma$ -radiation at a distance of a few centimeters, by surface, intracavitary or interstitial application

**Bremsstrahlung:** secondary *photon* radiation produced by deceleration of charged particles passing through matter

**Collective dose:** sum of individual doses received over a given time by a specified population from exposure to a specified source of radiation

**Collective dose commitment:** infinite time integral of the product of the size of a specified population and the per caput *dose rate* to a given organ or tissue for that population

- Collective effective dose equivalent:** product of the number of exposed individuals and their average *effective dose* equivalent, expressed in person-sieverts
- Committed dose equivalent:** dose to some specific organ or tissue over 50 years after intake of radioactive material by an individual
- Committed effective dose equivalent:** *committed dose equivalent* for a given organ multiplied by a *weighting factor*
- Cosmic radiation** or **cosmic rays:** radiation of very high energy reaching the earth from outer space or produced in the earth's atmosphere by particles from outer space; part of *background radiation*
- Criticality:** term used in reactor physics to describe the situation in which the number of *neutrons* released by *nuclear fission* is exactly balanced by the number being absorbed (by the fuel and poisons) and escaping the reactor core. A reactor is said to be 'critical' when it achieves a self-sustaining nuclear chain reaction, as when it is operating.
- Cumulative dose:** total dose resulting from repeated exposure to radiation
- Deterministic effect:** health effect, the severity of which varies with dose and for which a threshold is believed to exist; e.g. radiation-induced cataract (also called a non-stochastic effect) (see *Stochastic effect*)
- D<sub>0</sub>:** reciprocal of the final slope of the curve of cell survival as a function of dose, representing cell killing due to multiple events
- Dose:** a general term denoting the quantity of radiation or energy absorbed
- Dose equivalent:** quantity that expresses all kinds of radiation on a common scale for calculating the *effective absorbed dose*
- Dose fractionation:** delivery of a given dose of radiation as several smaller doses, separated by intervals of time
- Dose protraction:** spreading out of a radiation dose over time by continuous delivery at a lower *dose rate*
- Dose rate:** absorbed dose delivered per unit time
- Effective attributable risk (EAR):** reduced attributable risk, such as the fraction of total deaths from lung cancer that would be eliminated by reducing exposure to radon
- Effective dose:** sum of *equivalent doses*, weighted by the appropriate tissue *weighting factors*, in all the tissues and organs of the body
- Electromagnetic radiation:** travelling wave motion resulting from changing electric or magnetic fields; familiar types range from *X-rays* and *γ-rays* of short wavelength, through the ultraviolet, visible and infrared regions to radar and radio waves of relatively long wavelength

**Electron:** subatomic charged particle. Negatively charged electrons are parts of stable atoms. Both negatively and positively charged electrons may be expelled from the radioactive atom when it disintegrates (see also  *$\beta$ -particle*).

**Electron volt (eV):** unit of energy; 1 eV is equivalent to the energy gained by an *electron* in passing through a potential difference of 1 V.

**Equivalent dose:** obtained by weighting the *absorbed dose* in an organ or tissue by a *weighting factor* that reflects the biological effectiveness of the radiation that produces *ionization* within the tissue

**Excess relative risk (ERR):** model that describes the risk imposed by exposures as a multiplicative increment to the excess disease risk above the background rate of disease

**Fall-out:** radioactive debris from a nuclear detonation or other source

**Fast neutron:** *neutron* with kinetic energy greater than that of its surroundings when released during fission (see *Thermal neutron*)

**Fission product:** element or compounds resulting from *nuclear fission*

**Flux:** term applied to the amount of some types of particle (e.g. *neutrons*,  *$\alpha$ -radiation*) or energy (e.g. *photons*, heat) crossing a unit area per unit time; expressed as number of particles or energy per square centimeter per second

**$\gamma$ -radiation** or  **$\gamma$ -rays:** short-wavelength *electromagnetic radiation* of nuclear origin; similar to *X-radiation* but emitted at very specific energies characteristic of the decaying atoms

**Gray (Gy):** unit of absorbed dose of radiation (1 Gy = 1 J kg<sup>-1</sup>)

**Half thickness** or **half-value layer:** thickness of a specified material that, when introduced into the path of a given beam of radiation, reduces its intensity to one-half of its original value

**High-LET radiation** (see also *Linear energy transfer*): heavy, charged particles such as *protons* and  *$\alpha$ -particles* that produce dense ionizing events close together on the scale of a cellular nucleus

**Ion:** atomic particle, atom or chemical radical bearing an electric charge, either negative or positive

**Ionization:** process by which a neutral atom or molecule acquires a positive or negative charge

**Ionization density:** number of *ion* pairs per unit volume

**Ionization path (track):** trail of *ion* pairs produced by *ionizing radiation* in its passage through matter

**Ionization radiation:** radiation sufficiently energetic to dislodge *electrons* from an atom thereby causing an *ion* pair; includes *X-radiation* and *γ-radiation*, *electrons* (*β-particles*), *α-particles* (helium nuclei) and heavier charged atomic nuclei

**Isotope:** *nuclide* with same number of *protons* in its nuclei as another nuclide, and hence the same atomic number, but differing in the number of *neutrons* and therefore in the mass number

**Kerma (kinetic energy released in matter):** unit of exposure that represents the kinetic energy transferred to charged particles per unit mass of irradiated medium when indirectly ionizing (uncharged) particles, such as *photons* or *neutrons*, traverse the medium. If all of the kinetic energy is absorbed 'locally', the kerma is equal to the *absorbed dose*.

**Lineal energy:** quotient of *e* over *l* where *e* is the energy imparted to the matter in a volume of interest by an energy deposition event and *l* is the mean chord length in that volume

**Linear energy transfer (LET):** average amount of energy lost per unit of particle track length. Low LET is characteristic of *electrons*, *X-rays* and *γ-rays*; high LET is characteristic of *protons* and *α-particles*.

**Linear model (linear dose-effect model):** expresses an effect (e.g. mutation or cancer) as a proportional (linear) function of dose.

**Linear-quadratic model (linear-quadratic dose-effect model):** expresses an effect (e.g. mutation or cancer) as a function of two components, one directly proportional to the dose (linear term) and one proportional to the square of the dose (quadratic term); the linear term predominates at lower doses and the quadratic term at higher doses.

**Low-LET radiation:** light, charged particles such as *electrons* or *X-rays* and *γ-rays* that produce sparse ionizing events far apart on the scale of a cellular nucleus

**Monte Carlo calculation:** method for evaluation of a probability distribution by means of random sampling

**Neutron:** elementary particle that is a constituent of all atomic nuclei except that of normal hydrogen; has no electric charge and a mass only very slightly greater than that of the *proton*. Outside the nucleus, the neutron decays, with a half-life of 12 min, into a *proton*, an *electron* and a neutrino. Upon collision with atomic nuclei, neutrons generate *recoil protons*, which are a source of *high-LET radiation*.

**Nuclear fission:** splitting of an atomic nucleus into at least two other nuclei and release of a relatively large amount of energy. Two or three *neutrons* are usually released during this type of nuclear transformation.

- Nuclear fusion:** event in which at least one heavier, more stable nucleus is produced from two lighter, less stable nuclei. Reactions of this type are responsible for enormous releases of energy, such as that of stars.
- Nuclear medicine:** use of very small amounts of radioactive materials or radiopharmaceuticals to diagnose and treat disease
- Nuclide:** species of atom characterized by the constitution of its nucleus and hence by the number of *protons*, the number of *neutrons*, and the energy content
- Orbital electron capture:** process in which a *proton* of a nucleus is transformed into a *neutron*, by capturing an orbital *electron* accompanied by emission of a neutrino, the captured electron being replaced by one of the other shell electrons causing emission of characteristic radiation
- Phantom:** anthropomorphic representation of the human body's characteristics in terms of radiation attenuation, physical morphology and geometry; used to calibrate radiation detection systems for measuring radioactive material in the human body
- Photon:** quantum of *electromagnetic radiation* that has zero rest mass and energy equal to the product of the frequency of the radiation and Planck's constant; generated when a particle with an electric charge changes its momentum, in collisions between nuclei or *electrons* and in the decay of certain atomic nuclei and particles
- Proportional counter:** radiation instrument in which an electronic detection system receives pulses that are proportional to the number of *ions* formed in a gas-filled tube by *ionizing radiation*
- Proton:** Stable elementary particle with electric charge equal in magnitude to that of the *electron* but of opposite sign and with mass 1836.12 times greater than that of the electron. The proton is a hydrogen ion (i.e. a normal hydrogen atomic nucleus) and a constituent of all other atomic nuclei.
- Radiation shielding** (see also *Shielding factor*): reduction of radiation by interposing a shield of absorbing material between any radioactive source and a person, work area or radiation-sensitive device
- Radioactivity:** property of some *nuclides* of spontaneously emitting particle or  $\gamma$ -radiation, emitting *X-radiation* after *orbital electron capture* or undergoing spontaneous *nuclear fission*
- Radionuclide:** radioactive species of an atom characterized by the constitution of its nucleus; in *nuclear medicine*, an atomic species emitting *ionizing radiation* and capable of existing for a measurable time, so that it may be used to image organs and tissues
- Radiosensitivity:** relative susceptibility of cells, tissues, organs and organisms to the injurious action of radiation

- Recoil:** motion imparted to a particle as a result of interaction with radiation or as a result of a nuclear transformation
- Recoil proton:** product of the elastic collision of a *neutron* with an atomic nucleus; source of *high-LET radiation*
- Reference man:** person with the anatomical and physiological characteristics of an average individual which is used in calculations of internal dose (also called 'Standard man').
- Relative biological effectiveness (RBE):** factor used to compare the biological effectiveness of *absorbed radiation doses* due to different types of radiation; more specifically, the experimentally determined ratio of an absorbed dose of a radiation in question to that of a reference radiation required to produce an identical biological effect in a particular experimental organism or tissue
- Shielding factor:** ratio of the detector response at a location behind a shield on which radiation is incident to the detector response at the same location without the presence of the shield; a measure of the effectiveness of the shield
- Specific energy:** actual energy per unit mass deposited per unit volume in a given event; a stochastic quantity as opposed to the average value over a larger number of instances (i.e. the *absorbed dose*)
- Stochastic effect:** effect that occurs by chance, generally without a threshold level of dose, whose probability is proportional to the dose and whose severity is independent of the dose. In the context of radiation protection, the main stochastic effects are cancer and genetic effects.
- Target volume:** (i) volume containing those tissues that are to be irradiated to a specified *absorbed dose* according to a specified time–dose pattern. For curative treatment, the target volume consists of the demonstrated tumour(s), if present, and any other tissue with presumed tumour; (ii) volume of a discrete biological entity (i.e. chromosome strand, bacterium, gene, virus) in which the effect of radiation is primarily seen
- Telangiectasia:** dilatation of the capillary vessels and very small arteries
- Teletherapy:** radiation treatment administered from a source at a distance from the body; usually  $\gamma$ -ray beams from *radionuclide* sources
- Terrestrial radiation:** portion of natural *background radiation* that is emitted by naturally occurring radioactive materials, such as uranium, thorium and radon in the earth
- Thermal neutron:** neutron that has (by collision with other particles) reached an energy state equal to that of its surroundings, typically on the order of 0.025 eV (*electron volts*) (see **Fast neutron**)

**Thermoluminescent detector:** small device used to measure radiation as the amount of visible light emitted from a crystal in the detector when exposed to *ionizing radiation*

**Thermonuclear:** adjective referring to the process in which very high temperatures are used to bring about the fusion of light nuclei, such as those of the hydrogen *isotopes* deuterium and tritium, with the accompanying liberation of energy

**Threshold dose:** minimal *absorbed dose* that will produce a detectable degree of any given effect

**Track** (see **Ionization path**)

**Weighting factor ( $w_T$ ):** multiplier of the *equivalent dose* to an organ or tissue used for radiation protection purposes to account for different sensitivities of different organs and tissues to the induction of *stochastic effects* of radiation

**X-radiation** or **X-rays:** penetrating *electromagnetic radiation* whose wavelength is shorter than that of visible light; usually produced by bombarding a metallic target with fast *electrons* in a high vacuum; in nuclear reactions, it is customary to refer to *photons* originating in the nucleus as  $\gamma$ -radiation and those originating in the extra-nuclear part of the atom as X-radiation. Dose of X-rays is expressed in kVp, the maximum (p for peak) applied voltage (kV) that an X-ray machine can produce.