GLOSSARY

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

Absorbed fraction: the fraction of the photon energy (emitted within a specified volume of material) that is absorbed by the volume. The absorbed fraction depends on the source distribution, the photon energy, and the size, shape, and composition of the volume.

Absorption: the process by which radiation imparts some or all of its energy to any material through which it passes

Activity: the number of nuclear transformations occurring in a given quantity of material per unit time (see ***Curie***, ***Becquerel***)

Activity median aerodynamic diameter (AMAD): the diameter of a unit-density sphere with the same terminal settling velocity in air as that of the aerosol particle whose activity is the median for the entire aerosol

Acute radiation sickness: the complex symptoms and signs characterizing the condition resulting from excessive exposure of the whole body (or a large part of it) to ionizing radiation. Five Sv is fatal 50 percent of the time. The earliest of these symptoms are nausea, fatigue, vomiting, and diarrhea and these may be followed by loss of hair (epilation), hemorrhage, inflammation of the mouth and throat, and general loss of energy. In severe cases, where the radiation dose is relatively high, death may occur within two to four weeks. Those who survive six weeks after exposure of a single high dose of radiation may generally be expected to recover.

α-decay: *radioactive decay* in which an *α-particle* is emitted. This lowers the *atomic number* of the nucleus by two and its *mass number* by four.

α-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

α-track: the track of ionized atoms left in any matter by an α-particle that has traveled through the matter

Annihilation radiation: the electromagnetic radiation emitted as a result of the combination and disappearance of an electron and a positron. Two γ-rays of 0.511 MeV energy are emitted in most cases.

Atom: the smallest particle of an element that cannot be divided or broken up by chemical means. It consists of a central core called the nucleus, which contains protons and neutrons and an outer shell of electrons.

Atomic mass (*u*): the mass of a neutral atom of a *nuclide*, usually expressed in terms of atomic mass units. The atomic mass unit is one-twelfth the mass of one neutral atom of carbon-12, equivalent to 1.66054×10^{-27} kg.

Atomic number (*Z*): the number of protons in the nucleus of a neutral atom of a nuclide

Atomic mass number (*A*): the number of *nucleons* (protons and neutrons) in the nucleus of an atom

Atomic weight: the weighted mean of the masses of the neutral atoms of an element expressed in atomic mass units

Auger electron: electron ejected from the surrounding shells due to the return to the ground state of an atom, ionized in an inner shell

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

Becquerel (Bq): SI unit of activity; equals that quantity of radioactive material in which one transformation (disintegration) occurs per second (1 Bq = 1 disintegration per second = 2.7×10^{-11} Ci).

β-decay: *radioactive decay* in which a β-particle is emitted or in which orbital *electron capture* occurs.

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

Biological half-time: The time required for a biological system, such as that of a human, to eliminate by natural processes half of the amount of a substance (such as a chemical substance or radioactive material) that has entered it

Body burden, radioactivity: the amount of radioactive material present in the total body

Boiling water reactor (BWR): a reactor in which water, used as both coolant and moderator, is allowed to boil in the core. The resulting steam can be used directly to drive a turbine and electrical generator, thereby producing electricity (see ***Light water reactor***).

Bone seeker: a radioisotope that tends to accumulate in the bones when it is introduced into the body. An example is strontium-90, which behaves chemically like calcium.

Bone surface: bone surface is the surface of bone as seen in a light microscope. It includes the endosteal and periosteal surfaces of *cortical bone*, the surfaces of *haversian canals*, the surfaces of resorption cavities, and the surfaces of trabeculae. It does not include the surfaces of lacunae or canaliculi. It should not be confused with the surfaces of the sub-microscopic bone crystals.

Burial: disappearance of pre-existing radioactive deposits from bone surfaces due to the continued deposition of new bone onto the contaminated surface

Bystander effect: the induction, by low levels of radiation, of genetic changes in cells that in themselves received no direct radiation exposure

Collective dose: the sum of the individual doses received in a given period of 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 (see ***Radiation weighting factor***, ***Tissue weighting factor***)

Compact bone: internal bone architecture consisting mainly of calcified tissue with small spaces (canals) occupied by blood vessels (see ***Trabecular bone***)

Cortical bone: bone tissue belonging to the cortex (the outer shell of a bone) and in which the arrangement of one canal with bone surrounding it is called a haversian system or osteon

Curie (Ci): the basic unit used to describe the intensity of radioactivity in a sample of material. The curie is equal to 3.7×10^{10} disintegrations per second, which is approximately the activity of 1 gram of radium. A curie is also a quantity of any radionuclide that decays at a rate of 3.7×10^{10} disintegrations per second. It is named for Marie and Pierre Curie, who discovered radium in 1898.

Decay chain or decay series: a sequence of radioactive decays (transformations) beginning with one nucleus. The initial nucleus, the parent, decays into a daughter nucleus that differs from the first by whatever particles were emitted during the decay. If further decays take place, the subsequent nuclei are also usually called daughters or progeny (see ***Decay product***)

Decay constant: see ***Disintegration constant***

Decay product: a new *isotope* formed as a result of radioactive decay. A nuclide resulting from the radioactive transformation of a *radionuclide*, formed either directly or as the result of successive *transformations* in a radioactive series. A decay product (daughter) may be either radioactive or stable.

Decay, radioactive: the decrease in the amount of any radioactive material with the passage of time due to the spontaneous emission from the atomic nuclei of either α- or β-particles, often accompanied by γ-radiation

Decorporation therapy (also: ***Chelation therapy***): procedure used to remove an internally deposited radionuclide from a person's body by administration of a metal-chelating agent to enhance excretion of the radionuclide. The chelating agent used most commonly today is a salt of diethylenetriaminepentaacetic acid, DTPA.

Depleted uranium: uranium having a percentage of ^{235}U smaller than the 0.7 percent found in natural uranium. It is obtained as a by-product from uranium isotope separation (see ***Enrichment***).

Deterministic effects (also: ***Non-stochastic effects***): the health effects, the severity of which varies with the dose and for which a threshold is believed to exist. Radiation-induced cataract formation is an example of a deterministic effect (see ***Stochastic effects***).

Disintegration constant (also: ***Decay constant***): the fraction of the number of atoms of a radioactive nuclide which decay in unit time; is the symbol for the decay constant in the equation $N = N_0e^{-t}$, where N_0 is the initial number of atoms present, and N is the number of atoms present after some time (t).

Disintegration, nuclear: a spontaneous nuclear *transformation* (radioactivity) characterized by the emission of energy and/or mass from the nucleus. When large numbers of nuclei are involved, the process is characterized by a definite half-life (see ***Transformation, nuclear***).

Dose rate: *absorbed dose* delivered per unit time

Effective dose: sum of *equivalent doses*, weighted by the appropriate *tissue weighting factors*, in all the tissues and organs of the body

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 **β-*particle***).

Electron capture: a mode of radioactive decay involving the capture of an orbital electron by its nucleus. Capture from a particular electron shell is designated as 'K-electron capture', 'L-electron capture', etc.

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.

Enriched material: (1) material in which the relative amount of one or more isotopes of a constituent has been increased; (2) uranium in which the abundance of the ^{235}U isotope is increased above normal

Enrichment, isotopic: An isotopic separation process by which the relative abundance of the *isotopes* of a given element is altered, thus producing a form of the element that has been enriched in one or more isotopes and depleted in others. In uranium enrichment, the percentage of uranium-235 in natural uranium is increased from 0.7 percent to > 90 percent in a gaseous diffusion process based on the different thermal velocities of the constituents of natural uranium (^{234}U, ^{235}U, ^{238}U).

Equilibrium, radioactive: In a radioactive series, the state that prevails when the ratios between the activities of two or more successive members of the series remains constant

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

γ-radiation: short-wavelength electromagnetic radiation of nuclear origin

Genomic instability (radiation-induced): a type of genome-wide instability in mammalian cells which is transmissible over many generations of cell replication and can lead to the enhancement of the mutation rate at multiple, unrelated loci

Gray (Gy): SI unit of absorbed dose, J/kg (1 Gy = 1 J/kg = 100 rad)

Half-life, radioactive: the time in which one half of the atoms of a particular radioactive substance disintegrates into another nuclear form. Measured half-lives vary from millionths of a second to billions of years. Also called physical or radiological half-life

Half-life, biological: the time required for the body to eliminate one half of the material taken in by natural biological means

Half-life, effective: the time required for a radionuclide contained in a biological system, such as a human or an animal, to reduce its activity by one-half as a combined result of radioactive decay and biological elimination

Haversian canals: cavities within mineralized bone in which run the blood vessels, lymph vessels and nerves. The canals are lined with connective tissue, the endosteum.

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

Heavy water moderated reactor: a reactor that uses heavy water as its moderator. Heavy water is an excellent moderator and thus permits the use of unenriched uranium as a fuel.

Hot particle: a discrete radioactive fragment that is insoluble in water and is no larger than approximately 1 mm in any dimension

Hyperthyroidism (thyrotoxicosis): functional, metabolic state caused by excessive thyroid hormone

Hypothyroidism: functional, metabolic state caused by inadequate amounts of thyroid hormone

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

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

Ionizing 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

Isobars: nuclides having the same *mass number* but different *atomic numbers*

Isotopes: atoms with the same number of protons, but different numbers of neutrons in their nuclei. Thus, carbon-12, carbon-13, and carbon-14 are isotopes of the element carbon, the numbers denoting the approximate atomic weights. Isotopes have very nearly the same chemical properties, but often different physical properties (for example, carbon-12 and -13 are stable, carbon-14 is radioactive).

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*.

Light water reactor: a term used to describe reactors using ordinary water as coolant, including boiling water reactors (BWRs) and pressurized water reactors (PWRs)

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

Lung clearance class (days, D; weeks, W; years, Y): a classification scheme for inhaled material according to its rate of clearance from the pulmonary region of the lungs to the blood and the gastrointestinal tract. Also used are classes of F (fast), M (medium), and S (slow) clearance.

Mass Number (*A*): See ***Atomic mass number***

Mastoid process: conical prominence of the temporal bone of the human skull, situated behind the ear. It commonly becomes infected in cases of suppurative otitis media. The inner ear adjoins the hollow, spongy spaces within the mastoid process so that infection of the ear easily spreads to that area, causing pain and swelling. Surgical drainage of pus and injection of antibiotics usually eliminate mastoid infection and prevent its spread to nearby areas of the brain.

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*.

Non-stochastic effects: see ***Deterministic effects***

Nucleon: common name for a constituent particle of the nucleus. Applied to a *proton* or *neutron*.

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

Parent: a *radionuclide* that, on *disintegration*, yields a specified nuclide either directly or as a later member of a radioactive series

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

Pressurized water reactor (PWR): a power reactor in which heat is transferred from the core to an exchanger by high-temperature water kept under high pressure in the primary system. Steam is generated in a secondary circuit. Many reactors producing electric power are pressurized water reactors (see ***Light water reactor***).

Progeny: the decay product or products resulting after a radioactive decay or a series of radioactive decays. The progeny can also be radioactive, and the chain continues until a stable nuclide is formed.

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.

Rad (rad): the unit of absorbed dose equal to 0.01 Gy or J/kg in any medium (see ***Absorbed dose***)

Radiation, external: radiation from a source outside the body

Radiation, internal: radiation from a source within the body as a result of deposition of radionuclides in body tissues

Radiation track (see ***Ionization path***)

Radiation weighting factor (W_R): multiplier of the *absorbed dose* in an organ or tissue to account for the different biological effectiveness of the charged particles that produce the ionization within the tissue

Radioactivity: spontaneous nuclear transformations accomplished by emission of α- or β-particles from the nucleus (*radioactive decay*) or by the capture of an orbital electron. Each of these reactions may or may not be accompanied by emission of a photon.

Radioisotope: an unstable isotope of an element that decays or disintegrates spontaneously, emitting radiation. Approximately 5,000 natural and artificial radioisotopes have been identified.

Radionuclide: a radioisotope or radioactive nuclide characterized by the constitution of its nucleus

Reaction (nuclear): an induced nuclear disintegration (i.e., a process occurring when a nucleus interacts with a photon, an elementary particle, or another nucleus). In many cases the reaction can be represented by the symbolic equation: $X + a \rightarrow Y + b$ or, in abbreviated form, X(a,b)Y. X is the target nucleus, a is the incident particle or photon, b is an emitted particle or photon, and Y is the product nucleus.

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

SI units: the International System of Units as defined by the General Conference of Weights and Measures in 1960. These units are generally based on the meter/-kilogram/second units, with special quantities for radiation including the *becquerel*, *gray*, and *sievert*.

Sievert (Sv): the SI unit of any of the quantities expressed as equivalent or effective dose. The equivalent dose in sieverts is equal to the *absorbed dose*, in grays, multiplied by the *radiation-weighting factor*. The *effective dose* is the equivalent dose multiplied by the *tissue-weighting factor*.

Specific activity: radioactivity per unit mass of a radionuclide

Stochastic effects: effects that occur 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 (see ***Deterministic effects***).

Tissue 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

Trabecular bone: internal bone architecture consisting mainly of calcified trabeculae with relatively large spaces between, occupied by loose connective tissues and blood vessels (see ***Compact bone***)

Transformation, nuclear: the process by which a nuclide is transformed into a different nuclide by absorbing or emitting a particle.

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 γ-radiation and those originating in the extranuclear 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.

Working level (WL): any combination of short-lived radon daughters in one liter of air that will result in the emission of 1.3×10^5 MeV of potential α energy.

Working-level month (WLM): a unit of exposure to air concentrations of potential α energy released from radon daughters. One working-level month is defined as the exposure to an average of 1 WL for a working month of 170 hours or 3.5×10^{-3} Jh/m³.