

## GLOSSARY

### ***Absolute lethal dose (of radiation)***

a radiation dose killing all the irradiated individuals.

### ***Absorbed dose***

the amount of radiation energy absorbed per mass unit of any substance.

### ***Accident***

any unintended event, including operating errors, equipment failures or other mishaps, the consequences or potential consequences of which are not negligible from the point of view of protection or safety.

### ***Accidental medical exposure***

any therapeutic treatment delivered to either the wrong patient or the wrong tissue, or using the wrong pharmaceutical, or with a dose or dose fractionation differing substantially from the values prescribed by the medical practitioner or which may lead to undue acute secondary effects; any diagnostic exposure substantially greater than intended or resulting in doses repeatedly and substantially exceeding the established guidance levels; any equipment failure, accident, error, mishap or other unusual occurrence with the potential for causing a patient exposure significantly different from that intended.

### ***Activity***

the quantity or amount of a radionuclide in a given time, defined as the expectation value of the number of spontaneous nuclear transformations of radionuclide per time unit.

### ***Acute exposure***

exposure received within a short period of time. Normally used to refer to exposure of sufficiently short duration that the resulting doses can be treated as instantaneous (e.g. less than an hour). Usually contrasted with chronic exposure and transitory exposure.

### ***Acute radiation dermatitis (radiation skinburns)***

an acute radiation injury of the skin that occurs after irradiation at a dose of 30–50 Gy. It is characterized by several stages: primary erythema, latency, height, resolution and consequences. Epidermitis should be distinguished as a manifestation of radiation skin reaction that can heal independently without serious treatment.

### ***Acute radiation sickness (ARS)***

a set of specific clinical syndromes, which appear sequentially after general uniform

external exposure as accumulation of pathological changes in affected tissues, organs and systems.

***ALARA (as low as reasonably achievable)***

see *optimization of protection (and safety)*.

***Alpha-decay***

decay of a radioactive atom with emission of an alpha-particle by a nucleus.

***Alpha-particle***

a particle consisting of two neutrons and two protons emitted from the nucleus of a radioisotope.

***Apoptosis***

the process of programmed cell death (PCD) that may occur in multicellular organisms. Biochemical events lead to characteristic cell changes (morphology) and death. These changes include blebbing, cell shrinkage, nuclear fragmentation, chromatin condensation, and chromosomal DNA fragmentation. Unlike necrosis, apoptosis produces cell fragments called apoptotic bodies that phagocytic cells are able to engulf and quickly remove before the contents of the cell can spill out onto surrounding cells and cause damage.

***Artificial radioactivity***

radioactivity of artificial radionuclides with this property.

***Assessment***

the process, and the result, of analyzing systematically and evaluating the hazards associated with sources and practices, and associated protection and safety measures.

***Atrophic or hypertrophic dermatitis***

the skin lesion characterized by hypersensitivity of the affected area to any outside influences. It is typically more often observed in the form of dry skin atrophy. Often there are cracks accompanied by itch and hyperesthesia.

***Attenuation***

a reduction in intensity of radiation passing through matter due to processes such as absorption and scattering.

***Average lifetime of nuclei radionuclide ( $\Theta$ )***

which is determined using the equation:  $\Theta = 1.44 \times T_{1/2}$ .

***Background***

the dose or dose rate (or an observed measure related to the dose or dose rate) attributable to all sources other than the one(s) specified.

***Background radiation***

radiation exposures from naturally occurring radioactivity and extraterrestrial cosmic radiation.

***Becquerel (Bq)***

the SI unit of activity, equal to one transformation per second. It supersedes the non-SI unit *curie (Ci)*.  $1 \text{ Bq} = 37 \text{ pCi}$  ( $3.7 \times 10^{-11} \text{ Ci}$ ) approximately.  $1 \text{ Ci} = 3.7 \times 10^{10} \text{ Bq}$ .

***Beta minus decay***

the nuclear process in which a neutron is converted to a proton with emission of an electron and an antineutrino.

***Beta-particle***

an electron or a positron emitted from a nucleus during beta decay.

***Beta plus decay***

nuclear process in which a proton is converted to a neutron with emission of a positron and a neutrino.

***Biological half-life***

time required to biologically clear one half of the amount of a stable material in an organ or tissue. See *half-life*.

***Bremsstrahlung radiation***

general or “braking radiation” x-ray produced when electron loses energy.

***Characteristic radiation***

x-ray photon of characteristic energy emitted from an atom when an inner shell vacancy is filled by an outer shell electron.

***Chromosomal aberrations***

the DNA structural damage from effects of ionizing radiation which become the main cause of *reproductive cell death*.

***Chronic exposure***

exposure persisting in time. The adjective ‘chronic’ relates only to the duration of exposure, and does not imply anything about the magnitude of the doses involved.

Normally used to refer to exposures persisting for many years as a result of long lived radionuclides in the environment. Exposure that is too protracted to be described as acute exposure, but does not persist for many years, is sometimes described as transitory exposure.

***Chronic radiation sickness (ChRS)***

the result of long-term (months, years) systematic external, internal, or combined exposure to relatively low doses, but significantly higher (10–15 times) for the set limits.

***Chronic radiation ulcer of the skin***

a wound which appears on the irradiated skin area in terms of 6 months to several years. Long before its emergence there appears hyperpigmentation, pruritus, telangiectasia, skin erosion cells, which is eventually covered with laminated flakes, soldered to the underlying tissues. Later a crust forms, which gradually becomes layered as a scab. Usually, peel is stored for many months with no tendency to branch. During treatment peel is separated, opening the bottom of the ulcer covered with necrotic yellowish-white masses.

***Coherent scattering***

photon scattered by an atom without suffering any energy loss, also known as Raleigh scattering.

***Collective dose***

the total *radiation dose* incurred by a population. This is the sum of all of the *individual doses* to members of the population. If the *doses* continue for longer than a year, then the *annual individual doses* must also be integrated over time. Unless otherwise specified, the time over which the *dose* is integrated is infinite; if a finite upper limit is applied to the time integration, the *collective dose* is described as 'truncated' at that time. Unless otherwise specified, the relevant *dose* is normally the *effective dose* (see *collective effective dose* for the formal definition. Unit: man-sievert (man-Sv). This is, strictly, just a *sievert*, but the unit man-sievert is used to distinguish the *collective dose* from the *individual dose* which a dosimeter would measure (just as, for example, 'person-hours' are used to measure the total effort devoted to a task, as opposed to the elapsed time that would be shown by a clock). Contrasting term: *individual dose*.

***Compton interaction***

photon interaction with an outer shell electron resulting in a scattered electron and photon of lower energy.

**Contamination**

*Radioactive substances* on surfaces, or within solids, liquids or gases (including the human body), where their presence is unintended or undesirable, or the *process* giving rise to their presence in such places.

**Cosmic rays**

the charged elementary particles of ultrahigh energy (up to  $10^{18}$  eV) from interstellar space; they consist of protons, alpha-particles and light elements nuclei.

**coulomb (C)**

the SI unit of electric charge.

**coulomb per kilogram (C/kg)**

the SI unit of exposure dose.

**Counter rays**

a device that serves as a detector of a radiometer.

**Critical group**

a group of members of society which is reasonably homogeneous with respect to its exposure to a given radiation source and is typical of individuals receiving the highest effective dose or equivalent dose (as applicable) from the given source.

**Crust radiation**

consists of gamma rays of radioactive elements: uranium-235, uranium-238, thorium-232, and their decay products, including radium-226, radium-224, rubidium-87.

**curie (Ci)**

the unit of activity equal to  $3.7 \times 10^{10}$  Bq (exactly). Superseded by the becquerel (Bq). Activity values may be given in Ci (with the equivalent in Bq in parentheses) if they are being quoted from a reference which uses that unit. Originally, the activity of a gram of radium.

**Dangerous source**

a source that could, if not under control, give rise to exposure sufficient to cause severe deterministic effects. This categorization is used for determining the need for emergency response arrangements and is not to be confused with categorizations of sources for other purposes.

**Decay constant ( $\lambda$ )**

for a radionuclide in a particular energy state, the quotient of  $dP$  by  $dt$ , where  $dP$  is

the probability of a given nucleus undergoing a spontaneous nuclear transition from that energy state in the time interval  $dt$ .

***Decontamination***

the complete or partial removal of contamination by a deliberate physical, chemical or biological process.

***Decorporation***

see *decontamination*

***Deterministic effect of radiation***

a health effect of radiation for which generally a threshold level of dose exists above which the severity of the effect is greater for a higher dose. Such an effect is described as a severe deterministic effect if it is fatal or life threatening or results in a permanent injury that reduces quality of life. Deterministic effects are also referred to as 'harmful tissue reactions'. The level of the threshold *dose* is characteristic of the particular *health effect* but may also depend, to a limited extent, on the exposed individual. Examples of *deterministic effects* include erythema and acute *radiation* syndrome (*radiation* sickness). The term ***non-stochastic effect*** is used in some older publications, but is now superseded. Contrasting term: *stochastic effect*.

***Diagnostic reference level (DRL)***

a level used in medical imaging to indicate whether, in routine conditions, the dose to the patient or the quantity of radioactive material administered in a specified radiological procedure is unusually high or low for that procedure.

***Direct biological effect (of ionizing radiation)***

the transfer of energy by x-rays, gamma-rays and uncharged particles directly to critical targets in the cells which can start a chain of events that end with biological consequences.

***Direct ionization***

ionization of atoms by means of direct contact with them.

***Directly ionizing radiation***

charged particles, such as electrons, protons, and alpha particles, which can directly ionize atoms.

***Disaster***

a serious disruption of society causing widespread human, material and environmental losses which exceed the ability of affected society to cope its own resources.

***Dose***

a measure of the energy deposited by radiation in a target.

***Dose and dose rate effectiveness factor (DDREF)***

the ratio between the risk or radiation detriment per unit effective dose for high doses and/or dose rates and that for low doses and dose rates. Used in the estimation of risk coefficients for low doses and dose rates from observations and epidemiological findings at high doses and dose rates. Supersedes the dose rate effectiveness factor (DREF).

***Dose equivalent (H)***

the product of the absorbed dose at a point in the tissue or organ and the appropriate quality factor for the type of radiation giving rise to the dose. Expressed in sievert (Sv) or rem.

***Dose assessment***

assessment of the dose(s) to an individual or a group of people.

***Dose limit***

the value of the effective dose or the equivalent dose to individuals from controlled practices that shall not be exceeded.

***Dosimetry***

the branch of physics dedicated to problems of measuring absorbed radiation energy in different materials, especially in human tissues.

***Early effect (of radiation)***

a radiation-induced health effect that occurs within months of the exposure that caused it. All early effects are deterministic effects; most, but not all, deterministic effects are early effects.

***Early radiation ulcer***

an acute radiation injury of the skin. Itching and acute painfulness appear in the irradiated area of the skin, there is redness, inflammatory edema and swelling with a serous discharge. After rupture of swellings there open ulcerous-necrotic areas, whose formation is accompanied by pain increase, general indisposition, fever, insomnia, decreased appetite, headache.

***Effective dose (E)***

conceptually similar to the dose equivalent but obtained using the International

Commission on Radiological Protection Publication 60 organ weighting factors ( $W_T$ ). The sum of dose equivalent products ( $H_E$ ) for separate organs and tissues on organ weighting factors ( $W_T$ ); expressed in sievert (Sv).

***Effective half-time*** ( $T_{ef}$ )

half-time of a radioactive material in an organ.

***Electron***

fundamental constituent of matter — the elementary particle with 511 keV of the repose mass and  $-1$  of the charge.

***Electron capture***

nuclear process in which a proton is converted to a neutron by capturing an electron and emitting a neutrino.

***Emergency***

a non-routine situation that necessitates prompt action, primarily to mitigate a hazard or adverse consequences for human health and safety, quality of life, property or the environment. This includes nuclear and radiological emergencies and conventional emergencies such as fires, release of hazardous chemicals, storms or earthquakes. It includes situations for which prompt action is warranted to mitigate the effects of a perceived hazard.

***Emergency exposure***

exposure received in an emergency. This may include unplanned exposures resulting directly from the emergency and planned exposures to persons undertaking actions to mitigate the consequences of the emergency. Emergency exposure may be occupational exposure or public exposure.

***Emergency plan***

a description of the objectives, policy and concept of operations for the response to an emergency and of the structure, authorities and responsibilities for a systematic, coordinated and effective response. The emergency plan serves as the basis for the development of other plans, procedures and checklists.

***Emergency preparedness***

the capability to take actions that will effectively mitigate the consequences of an emergency for human health and safety, quality of life, property and the environment.

***Emergency response***

the performance of actions to mitigate the consequences of an emergency for human

health and safety, quality of life, property and the environment. It may also provide a basis for the resumption of normal social and economic activity.

**emergency worker**

Any person having a defined role as a worker in an *emergency* and who might be exposed while taking actions in response to the *emergency*.

Emergency workers may include those employed by registrants and licensees as well as personnel from responding organizations, such as police officers, fire-fighters, medical personnel and drivers and crews of evacuation vehicles.

***Endomitosis***

replication of cells without division resulting in formation of giant cells.

***Environmental monitoring***

the measurement of external dose rates due to sources in the environment or of radionuclide concentrations in environmental media.

***Equivalent dose***

used for radiation protection and occupational purposes; the unit of equivalent dose is sievert (Sv).

***Evacuation***

rapid, temporary removal of people from an area to avoid or reduce shortterm radiation exposure in an emergency.

***Event***

in the context of reporting and analysis of events, an event is any occurrence unintended by the operator, including operating error, equipment failure or other mishap, and deliberate action on the part of others, the consequences or potential consequences of which are not negligible from the point of view of protection or safety.

***Event scale***

a simple scale, designed for promptly communicating to the public in consistent terms concerning the safety significance of events at nuclear facilities.

***Excess relative risk***

the ratio of the excess risk of a specified stochastic effect to the probability of the same effect in the unexposed population, i.e. the relative risk minus one. In theory, this should be equal to the attributable risk from the exposure received by the exposed group, but excess relative risk is normally used in the context of observed numbers of

effects, whereas attributable risk normally refers to a figure calculated on the basis of a known or estimated exposure.

***Excess risk***

the difference between the incidence of a specified stochastic effect observed in an exposed group to that in an unexposed control group.

***Excited state***

any energy level above the lowest energy ground state in an atom or nucleus.

***Exposure***

the act or condition of being subject to irradiation. See also: *Acute exposure, Chronic exposure, Exposure dose, Exposure pathway, External exposure, Medical exposure, Normal exposure, Occupational exposure, Public exposure,*

***Exposure assessment***

see *dose assessment*.

***Exposure dose***

measured by charge liberated in the air in roentgen (R).

***Exposure pathway***

a route by which radiation or radionuclides can reach humans and cause exposure.

***External exposure***

exposure to radiation from a source outside the body.

***Facilities and activities***

a general term encompassing nuclear facilities, uses of all sources of ionizing radiation, all radioactive waste management activities, transport of radioactive material and any other practice or circumstances in which people may be exposed to radiation from naturally occurring or artificial sources.

***Gamma rays***

high energy electromagnetic radiation produced by nuclear processes.

***Gastrointestinal syndrome***

develops after exposure to doses of 8–30 Gy, which usually leads to death of the victim, because at this level of exposure there are permanently affected stem cells of the mucous membrane of crypts of the intestine. Without these cells it is impossible to replenish the pool of functional cells of the intestinal mucosa, which normally rapidly

regenerates, because its cells have a short life cycle.

***Genetically significant dose (GSD)***

a population dose indicator that estimates the genetic significance of radiation exposures by taking into account the child expectancy of exposed individuals.

***gray (Gy)***

the SI unit of absorbed dose, equal to 1 J/kg.

***Ground shine***

gamma radiation from radionuclides deposited on the ground.

***Half-attenuation layer***

absolute value of the thickness of the layer material that provides attenuation of radiation beam twice.

***Half-life***

1, For a radionuclide, the time required for the activity to decrease, by a radioactive decay process, by half.

2. The time taken for the quantity of a specified material (e.g. a radionuclide) in a specified place to decrease by half as a result of any specified process or processes that follow similar exponential patterns to radioactive decay.

See also: *Biological half-life, Effective half-life.*

***Health authority***

the governmental entity (at the national, regional or local level) responsible for policies and interventions, including the development of standards and provision of guidance, aimed at maintaining or improving human health, and has the legal power of enforcing compliance to such policies and interventions.

***Health effects (of radiation)*** See *Deterministic effect, Early effect, Hereditary effect, Late effect, Severe deterministic effect, Somatic effect, Stochastic effect.*

***Health screening program***

a program in which a test or examination for the early detection of disease is performed on people.

***Hematologic syndrome***

inhibition of the bone marrow after irradiation at doses 1–6 Gy with following pancytopenia.

### ***Hereditary effect (of radiation)***

a radiation-induced health effect that occurs in a descendant of the exposed person. The less precise term *genetic effect* is also used, but hereditary effect is preferred. Hereditary effects are usually stochastic effects. Contrasting term: *somatic effect*.

### ***High doses and doses rate***

that exceed the level at which most biological events deviate from the linear dependence of irradiation. The limit between low and high doses of accepted values is a dose of 200 mSv. High dose rate is defined as the capacity in which repair of radiation damage (about 100 mSv/h) is impossible (Publication 116 NCRP USA, 1993).

### ***Hormesis***

a concept which can be traced back to the ancient Greeks, who believed that too much of anything can be deadly. Conversely, substances that are harmful in large amounts can be beneficial to life in small amounts. To put it in another way, 16<sup>th</sup> century natural philosopher Paracelsus said, 'The dose makes the poison'. Surely, high doses of many substances found on Earth can be life-threatening, but low doses of the same substances often have the opposite effect. Take vitamins, for example. Typical vitamins include small concentrations of substances such as iron, magnesium, and zinc, which are necessary to good health if not essential to life. In large, naturally-occurring concentrations, these minerals are deadly toxins. It seems *hormesis* occurs with radiation, as well. Dr. Luckey discovered that doses below 50 rem produced no harmful effects at all, and there was a lethal threshold of about 100 rem.

### ***Incidence***

the number of new cases of a disease each year.

### ***Indirect biological effects***

the transfer of the energy by x-rays, gamma rays, charged or uncharged particles to water molecules resulting in their radiolysis with formation of oxidative radicals which become factors of cell macromolecules damage.

### ***Indirect ionization***

ionization of atoms under the influence of secondary particles (orbital electrons or nuclear particles) which move away from the atom at the first interaction of uncharged radiation.

### ***Indirectly ionizing radiation***

uncharged radiation that produces ionization by way of intermediate charged particles such as photoelectrons (for x-rays) and recoil protons (for neutrons).

***Individual dose***

the dose incurred by an individual. Contrasting term: *collective dose*.

***Individual monitoring***

monitoring using measurements by equipment worn by individual workers, or measurements of quantities of radioactive material in or on their bodies.

***Integral dose***

a measure of the total amount of energy imparted to a patient during a radiological examination.

***Internal exposure***

exposure by incorporated radioactive substances; internal exposure is usually combined with exposure of the skin by the same pollution radionuclides.

***International Commission on Radiological Protection (ICRP)***

international radiation protection agency founded in 1928 that issues recommendations regarding radiation safety.

***International organization***

international intergovernmental organization in particular specialized UN agencies and organizations, and also programs, offices and departments of the UN; do not include non-governmental organizations.

***Interphase***

the time interval between two mitotic cell divisions.

***Interphase cell death***

the loss of cell viability followed by its collapse; comes before beginning mitosis after too high dose exposure.

***Iodine prophylaxis***

the administration of a compound of stable iodine (usually potassium iodide) to prevent or reduce the uptake of radioactive isotopes of iodine by the thyroid in the event of an accident involving radioactive iodine.

***Ionization***

production of electrons and positive ions following the absorption of radiation energy.

***Ionization chamber***

the special chamber filled with air for radiation dosimetry (dosimeter detector).

***Ionization density***

The number of ionized atoms per unit of length of ionizing particles or photons travel.

***Ionizing radiation (IR)***

can ionize matter either directly (charged particles: electrons, protons, alpha-particles and heavy ions) or indirectly (neutral particles: photons (x-rays and gamma-rays), neutrons).

***Irradiation installation***

a structure or an installation that houses a particle accelerator, x-ray apparatus or large radioactive source that can produce high radiation fields. Irradiation installations include installations for external beam radiation therapy, installations for sterilization or preservation of commercial products and some installations for industrial radiography.

***Isotope***

the nuclides with the same number of protons.

***joule (J)***

the SI unit of energy.

***Justification***

1. The process of determining whether a practice is, overall, beneficial, as required by the International Commission on Radiological Protection's System of Radiological Protection, i.e. whether the benefits to individuals and to society from introducing or continuing the practice outweigh the harm (including radiation detriment) resulting from the practice.
2. The process of determining whether a proposed intervention is likely, overall, to be beneficial, as required by the International Commission on Radiological Protection's System of Radiological Protection, i.e. whether the benefits to individuals and to society (including the reduction in radiation detriment) from introducing or continuing the intervention outweigh the cost of the intervention and any harm or damage caused by the intervention.

***Late effect (of radiation)***

a radiation-induced health effect that occurs years after the exposure that caused it. The most common late effects are stochastic effects, such as leukemia and solid cancers, but some deterministic effects (e.g. cataract formation) can also be late effects.

***Latent period***

the interval between exposure and appearance of signs of radiation damage.

***Lead equivalent***

thickness of the layer of lead, which weakens the flow of photon radiation as much as a layer of reused material.

***Length of ionizing radiation in matter***

the average total path that may be taken by an elementary particle or photon in the environment.

***Lethal dose (LD)***

the dose of radiation expected to cause death to 50 percent of an exposed population within 30 days (LD 50/30). Typically, the LD 50/30 is in the range from 400 to 450 rem (4 to 5 sieverts) received over a very short period.

***Lethal radiation effects***

the loss of cell ability to proliferate (formation of clones); it is actually reproductive cell death which is the most common form of radiation cells inactivation.

***Linear attenuation coefficient***

the fraction of photon lost from an x-ray beam in traveling of distance of 1 cm.

***Linear energy transfer (LET)***

energy absorbed by the medium per unit of length traveled, measured in keV per  $\mu\text{m}$ .

***Local radiation damage***

the lesion of skin or organs coming into being after local exposure by high level dose with typically receive affection signs and without significant manifestation of common reaction.

***Luminescent dosimeter***

an apparatus with scintillator detector (single crystal NaI, special plastic) for measurement of radiation dose.

***man-sievert (man-Sv)***

the unit of collective dose.

***Medical exposure***

exposure incurred by patients as part of their own medical or dental diagnosis (diagnostic exposure) or treatment (therapeutic exposure); by persons, other than those occupationally exposed, knowingly while voluntarily helping in the support and comfort of patients; and by volunteers in a program of biomedical research involving

their exposure.

***Medical radiation facility***

a facility in which radiological procedures are carried out.

***Medical radiation technologist***

a health professional, with special education and training in medical radiation technology, competent to carry out radiological procedures, on delegation from the radiological medical practitioner, in one or more of the specialties of medical radiation technology.

***Medical radiological equipment***

radiological equipment used in medical radiation facilities to perform radiological procedures that either delivers an exposure to a person or directly controls or influences the extent of such exposure. The term applies to radiation generators, such as an x-ray machine or a medical linear accelerator; to devices containing sealed sources, such as cobalt-60 teletherapy units; and to devices used in medical imaging to capture images, such as a gamma camera, an image intensifier, or a positron emission tomography scanner.

***Metastable state***

transient unstable energy state of an atom.

***Minimal lethal dose***

a dose at which there is loss of 1–5 % of exposed individuals; the minimum lethal human dose is 1.5 Gy total external photon irradiation. This means minimal lethal dose is that level of exposure when one observes only isolated cases of death of victims if they were not given treatment.

***Mitosis (M)***

the process of cell division.

***Modification of radiosensitivity***

the weakening or strengthening of radiosensitivity of cells, tissues or whole organism by chemical or physical factors.

***Monitoring***

The measurement of derived operational quantities used in the System of Radiological Protection that relate to the assessment of dose or to the control of exposure to radiation or radioactive material, and the interpretation of the results. See also *Environmental monitoring*, *Individual monitoring*, *Workplace monitoring*.

***Natural background***

the *doses, dose rates* or *activity concentrations* associated with *natural sources* or any other *sources* in the environment that are not amenable to *control*.

***Natural source***

a naturally occurring source of radiation, such as the sun and stars (sources of cosmic radiation) and rocks and soil (terrestrial sources of radiation), or any other material whose radioactivity is for all intents and purposes due only to radionuclides of natural origin, such as products or residues from the processing of minerals; but excluding radioactive material for use in a nuclear installation and radioactive waste generated in such an installation.

***Neurocirculatory radiation syndrome (NRS)***

an acute radiation injury after total external irradiation at a dose of 30 Gy and above leads to a fatal outcome within the first 72 hours usually in the range of 24–48 hours before clinical signs of gastrointestinal or bone marrow injury manifest themselves. Such high dose exerts a significant direct effect on the structure of cells and molecules, in addition, induces excessive formation of free radicals in cell and basement membrane of microvessels. As a result among other injuries there is a massive output of plasma electrolytes in the extravascular space resulting in vascular collapse, edema, increased intracranial pressure and cerebral anoxia.

***Neutron (n)***

uncharged elementary nuclear particle (nucleon) with 940 MeV of the repose mass.

***Nonspecific reduction of life***

in experiments on small animals there was found phenomenon called ‘radiation aging’. Specimens were irradiated in sublethal doses and survived, blood tests returned to normal, gastrointestinal disorders signs disappeared, and weight returned almost to normal, however the life expectancy of these animals decreased and the animals behaved as though they lost their youth.

***Normal exposure***

exposure that is expected to occur under the normal operating conditions of a facility or activity, including possible minor mishaps that can be kept under control, i.e. during normal operation and anticipated operational occurrences.

***Nuclear accident***

any accident involving facilities or activities from which a release of radioactive material occurs or is likely to occur and which has resulted or may result in an inter-

national transboundary release that could be of radiological safety significance for another state.

***Nuclear facility***

a facility (including associated buildings and equipment) in which nuclear material is produced, processed, used, handled, stored or disposed of, if damage to or interference with such facility could lead to the release of significant amounts of radiation or radioactive material.

***Nuclear installation***

a nuclear fuel fabrication plant, research reactor (including subcritical and critical assemblies), nuclear power plant, spent fuel storage facility, enrichment plant or reprocessing facility.

***Nuclear security***

prevention and detection of, and response to, theft, sabotage, unauthorized access, illegal transfer or other malicious acts involving nuclear material, other radioactive material or their associated facilities.

***Nucleon***

a general name for one of two nucleus particle — proton and neutron.

***Nuclide***

a single isotope of a chemical element; the terms *isotope* and *nuclide* are usually used as synonyms.

***Occupational exposure***

Exposure of workers incurred in the course of their work.

***Optimization of protection (and safety)***

the process of determining what level of protection and safety makes exposures, that is, the magnitude of individual doses and the number of people (workers and the public) exposed, and the probability and magnitude of potential exposures, “as low as reasonably achievable, economic and social factors being taken into account” (ALARA), as required by the System of Radiological Protection. For medical exposures of patients, optimization of protection and safety is the management of the radiation dose to the patient commensurate with the medical purpose.

***Orphan source***

a radioactive source which is not under regulatory control, either because it has never been under regulatory control or because it has been abandoned, lost, misplaced,

stolen or otherwise transferred without proper authorization.

***Oxygen effect***

the phenomenon of amplification of radiation injury in the presence of oxygen.

***Pair production***

an electron and positron pair produced in the atomic nucleus field by a high- energy photon ( $> 1.022$  MeV).

***Photodisintegration***

disintegration of a nucleus after absorbing a high-energy photon (greater than 15 MeV).

***Photoelectric effect***

a photon is absorbed by an atom and a photoelectron is emitted from an atom.

***Photon***

a bundle of electromagnetic radiation that can behave like a particle and has an energy proportional to frequency.

***Physical protection***

measures for the protection of nuclear material or authorized facilities, designed to prevent unauthorized access or removal of fissile material or sabotage with regard to safeguards, as, for example, in the Convention on the Physical Protection of Nuclear Material.

***Planned exposure situations***

a situation of exposure that arises from the planned operation of a source or from a planned activity that results in an exposure from a source.

***Planning target volume***

a geometrical concept used in radiation oncology for planning treatment with consideration of the net effect of movements of the patient and of the tissues to be irradiated, variations in size and shape of the tissue, and variations in beam geometry such as beam size and beam direction.

***Positron***

a positively charged particle (+1) having the same mass (511 keV) and magnitude of charge as the electron and constituting the antiparticle of the electron — called also *antielectron*.

***Potential exposure***

exposure that is not expected to be delivered with certainty but that may result from an accident at a source or owing to an event or sequence of events of a probabilistic nature, including equipment failures and operating errors. Potential exposure includes prospectively considered exposures from a source due to an event or sequence of events of a probabilistic nature, including those resulting from an accident, equipment failures, operating errors, natural phenomena (such as hurricanes, earthquakes and floods) and inadvertent human intrusion (such as the intrusion into a near-surface waste disposal facility after institutional control ceases).

***Prodromal period***

during the first 30–120 minutes after total irradiation there are serious implications in the form of anorexia, nausea, vomiting and sometimes water stool with abdominal muscles cramps which progress over 4–8 hours. The injured experiences weakness, drowsiness and fatigue. There are other prodromal symptoms such as pain in parotid glands, metallic taste in the mouth, mild hypotension and mild tachycardia. Prodromal manifestations gradually weaken during 48 hours after exposure.

***Protection***

(against radiation): radiation protection (also *radiological protection*). The protection of people from the effects of exposure to ionizing radiation, and the means for achieving this.

***Protection and safety***

the protection of people against exposure to ionizing radiation or radioactive material and the safety of sources, including the means for achieving this, and the means for preventing accidents and for mitigating the consequences of accidents should they occur.

***Proton***

a charged (+1) elementary nuclear particle (nucleon) with 938 MeV of the repose mass.

***Public exposure***

exposure incurred by members of the public from sources in planned exposure situations, emergency exposure situations and existing exposure situations, excluding any occupational or medical exposure. For planned exposure situations this includes exposure from authorized sources and practices, but excludes the normal local natural background radiation.

***Quality assurance (QA)***

the function of a management system that provides confidence that specified requirements will be fulfilled. The IAEA is revising the requirements and guidance in the subject area of quality assurance for new safety standards on management systems for the safety of nuclear facilities and activities involving the use of ionizing radiation. The term *management system* has been adopted in the revised standards instead of the terms *quality assurance* and *quality assurance program*.

***Quality control (QC)***

part of quality assurance intended to verify that structures, systems and components correspond to predetermined requirements.

***Quality factor (QF)***

determined from the linear energy transfer (LET) value of each type of radiation and used to convert absorbed dose into dose equivalent.

***rad***

stands for “radiation absorbed dose” which is a non-SI unit of absorbed dose (1 rad = 100 erg/g).

***Radiation (ionizing radiation)***

for the purposes of radiation protection, radiation capable of producing ion pairs in biological material(s).

***Radiation blocking of mitoses***

a universal transient cellular response to exposure, resulting in the near future in a delay of cell division.

***Radiation generator***

a device capable of generating ionizing radiation, such as x-rays, neutrons, electrons or other charged particles, that may be used for scientific, industrial or medical purposes.

***Radiation-induced cancer***

malignization of the radiation damaged skin. Time from an acute exposure to beginning of cancer can be from 5 to 60 years. In chronic irradiation which led eventually to chronic dermatitis or ulcer malignant tumor appears against the background of characteristic hyperkeratosis changes of skin. Among radiation-induced skin tumors there dominate squamous cell carcinoma (90 % including 40 % — coarsen) and 10 % basal cell, with occasionally a sarcoma of the subcutaneous tissues.

***Radiation-induced malignancy***

a tumor whose etiologic factor is ionizing radiation.

***Radiation-induced skin fibrosis***

occurs in 4–6 months after acute irradiation. The skin is gradually thickening and together with the subcutaneous cellular tissue becomes woody and painful. There are typical indentation, hyperpigmentation and teleangiectasia.

***Radiation pneumonitis***

acute radiation lung injury. An acute injury may become chronic with advancing growth fibrosis of lung tissues.

***Radiological protection (also radiation protection)***

protection of people from the effects of exposure to ionizing radiation, and the means for achieving this.

***Radiation protection officer***

a person technically competent in radiation protection matters relevant for a given type of practice who is designated by the registrant or licensee to oversee the application of relevant requirements established in international safety standards. Competence of persons is normally assessed by the state by having a formal mechanism for registration, accreditation or certification of radiation protection officers for various types of facilities and activities. States that have yet to develop such a mechanism need to assess the education, training and competence of any individual proposed by the licensee to act as a radiation protection officer and decide, based either on international standards or standards of a state where such a system exists, whether such an individual could undertake the functions of a radiation protection officer, for the required facility or activity.

***Radiation response***

pathophysiological tissue response to action of IR which ends at random and therefore does not require significant therapeutic measures for its elimination. It is observed at moderate level of exposure and usually has the nature of abortive inflammatory reactions (e.g. erythema of the skin, transient dermatitis, cystitis, rectitis, soft tissue swelling, etc.).

***Radiation risks***

- detrimental health effects of exposure to radiation (including the likelihood of such effects occurring),
- any other safety related risks (including those to ecosystems in the environment)

that might arise as a direct consequence of:

- exposure to radiation,
- the presence of radioactive material (including radioactive waste) or its release to the environment,
- loss of control over a nuclear reactor core, nuclear chain reaction, radioactive source or any other source of radiation.

***Radiation source***

a radiation generator, or a radioactive source or other radioactive material outside the nuclear fuel cycles of research and power reactors.

***Radioactive***

exhibiting radioactivity; emitting or relating to the emission of ionizing radiation or particles.

***Radioactive decay***

disintegration of a nucleus that occurs spontaneously or as a result of electron capture. One or more different nuclei are formed and usually particles and gamma rays are emitted.

***Radioactive material***

material designated in national law or by a regulatory body as being subject to regulatory control because of its radioactivity.

***Radioactive source***

a source containing radioactive material for the purposes of utilizing its radioactivity.

***Radioactive waste***

for legal and regulatory purposes, material for which no further use is foreseen that contains, or is contaminated with, radionuclides at concentrations or activities greater than clearance levels as established by the regulatory body.

***Radioactive waste management***

all administrative and operational activities involved in handling, pretreatment, treatment, conditioning, transport, storage and disposal of radioactive waste.

***Radioactivity***

the phenomenon whereby atoms undergo spontaneous random disintegration, usually accompanied by the emission of radiation.

***Radioisotope***

the atom with an unstable nucleus.

***Radiological audit***

a systematic examination or review of radiological procedures that seeks to improve protection of patients, with modification of procedures where indicated and application of new standards if necessary.

***Radiological medical practitioner***

a health professional, with education and specialist training in the medical uses of radiation, who is competent to independently perform or oversee procedures involving medical exposure in a given specialty. Competence of persons is normally assessed by the state by having a formal mechanism for registration, accreditation or certification of such a health professional in the given specialty (e.g. radiology, radiation therapy, nuclear medicine, dentistry, cardiology, etc.). States that have yet to develop such a mechanism need to assess the education, training and competence of any individual proposed by the licensee to act as a radiological medical practitioner and decide, based either on international standards or standards of a state where such a system exists, whether such an individual can undertake the functions of a radiological medical practitioner, within the required specialty.

***Radiological procedure***

a medical imaging procedure or a therapeutic procedure involving ionizing radiation, such as a procedure in diagnostic radiology, nuclear medicine, or radiation oncology, or any interventional, planning or image-guided procedure involving radiation, delivered by a radiation generator, by a device containing a sealed source, by an unsealed source or by a radiopharmaceutical administered to a patient.

***Radiometer***

a device for measuring radionuclide activity.

***Radiometry***

measuring the amount of radionuclide.

***Radionuclide***

a single isotope of a chemical element with the unstable core.

***Radiopharmacist***

a health professional, with education and specialist training in radiopharmacy, who is competent to prepare and dispense radiopharmaceuticals used for the purposes of medical diagnosis and therapy. Competence of persons is normally assessed by the state

by having a formal mechanism for registration, accreditation or certification of radiopharmacists. States that have yet to develop such a mechanism need to assess the education, training and competence of any individual proposed by the licensee to act as a radiopharmacist and decide, based either on international standards or standards of a state where such a system exists, whether such an individual can undertake the functions of a radiopharmacist.

***Radioprotector***

a chemical compound whose preliminary administration weakens effects of radiation.

***Radiosensibilizer***

a chemical compound that can enhance the sensitivity of the biological object to ionizing radiation.

***Radiosensitivity***

the relative susceptibility of a biological object to the harmful effects of the ionizing radiation.

***Radiosensitization***

strengthening sensitivity to ionizing radiation.

***Radiotoxicity***

toxicity of radionuclides, which is caused primarily not by their chemical and physical properties, but by the ability to irradiate cells with radioactive decay.

***Radiotoxins***

products of oxidation of unsaturated fatty acids and phenols (quinones and lipid radiotoxins) formed by radiolysis of water and hydrogen peroxide  $H_2O_2$  radical  $HO^*$ . The radiotoxins inhibit the synthesis of nucleic acids, act on DNA as chemical mutagens, alter the activity of enzymes and react with the lipid-protein intracellular membranes.

***Radon***

radon-222, radioactive gas produced when naturally occurring radium ( $^{226}Ra$ ) decays; found at high levels in some home basements.

***Radon progeny***

the short lived radioactive decay products of radon-222. This includes the decay chain up to but not including lead-210, namely polonium-218 (sometimes called radium A), lead-214 (radium B), bismuth-214 (radium C) and polonium-214 (radium C'), plus traces of astatine-218, thallium-210 (radium C'') and lead-209. Lead-210 (radium D), which has a half-life of 22.3 years, and its radioactive progeny — bismuth-210

(radium E) and polonium-210 (radium F), plus traces of mercury-206 and thallium-206 — are, strictly, progeny of radon-222, but they are not normally included in the meaning of the term *radon progeny*, because they will not normally be present in significant amounts in airborne form. The stable decay product lead-206 is sometimes known as radium G.

***Referring medical practitioner***

a health professional who, in accordance with national requirements, may refer individuals to a radiological medical practitioner for medical exposure.

***rem***

the unit of dose equivalent and dose equivalent, equal to 0.01 Sv. Superseded by sievert (Sv). Abbreviation of *rontgen equivalent man*.

***Reproductive cell death***

the most common form of radiation inactivation of cells in the form of loss of ability to proliferate, i.e. to forming of clones.

***Risk***

a multiattribute quantity expressing hazard, danger or chance of harmful or injurious consequences associated with exposures or potential exposures. It relates to quantities such as the probability that specific deleterious consequences may arise and the magnitude and character of such consequences. The probability of a specified health effect occurring in a person or group as a result of exposure to radiation.

***Risk assessment***

assessment of the radiological risks associated with normal operation and possible accidents involving a source or practice. This will normally include consequence assessment, together with some assessment of the probability of those consequences arising.

***roentgen (R)***

the unit of an exposure dose that measures charge liberated in the air.

***Safety***

see *protection and safety*.

***Safety assessment***

assessment of all aspects of a practice that are relevant to protection and safety; for an authorized facility, this includes siting, design and operation of the facility. This will normally include risk assessment.

***Safety culture***

the assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority, protection and safety issues receive the attention warranted by their significance.

***Safety issues***

deviations from current safety standards or practices, or weaknesses in facility design or practices identified by plant events, with a potential impact on safety because of their impact on defence in depth, safety margins or safety culture.

***Safety of radioactive sources***

measures intended to minimize the likelihood of accidents involving radioactive sources and, should such an accident occur, to mitigate its consequences.

***Safety system***

a system important to safety, provided to ensure the safe shutdown of the reactor or the residual heat removal from the core, or to limit the consequences of anticipated operational occurrences and design basis accidents.

***Safety standards***

standards of safety issued pursuant to Article III(A)(6)50 of the Statute of the IAEA.

***Sealed source***

a radioactive source in which the radioactive material is (a) permanently sealed in a capsule or (b) closely bonded in a solid form.

***Security***

see *nuclear security*.

***Security culture***

characteristics and attitudes in organizations and of individuals which establish that security issues receive the attention warranted by their significance.

***Severe deterministic effect (of radiation)***

a deterministic effect that is fatal or life-threatening or results in a permanent injury that reduces quality of life. See *health effects (of radiation): deterministic effect*.

***sievert (Sv)***

the SI unit of equivalent dose and effective dose, equal to 1 J/kg.

***Somatic effect (of radiation)***

a radiation-induced health effect that occurs in the exposed person. This includes effects occurring after birth that are attributable to exposure in utero. Deterministic effects are normally also somatic effects; stochastic effects may be somatic effects or hereditary effects. Contrasting term: *hereditary effect*. See also *Health effects (of radiation)*.

***Source***

anything that may cause radiation exposure — such as by emitting ionizing radiation or by releasing radioactive material — and can be treated as a single entity for protection and safety purposes. See also *Dangerous sources, Natural sources, Orphan source, Radiation generator, Radiation source, Radioactive source, Sealed source, Unsealed source, Vulnerable source*.

***Special population groups***

members of the public for whom special arrangements are necessary in order for effective protective actions to be taken in the event of a nuclear or radiological emergency. Examples include disabled persons, hospital patients and prisoners.

***Specific activity***

of a material, for the purposes of the Transport Regulations, the activity per unit mass of the material in which the radionuclides are essentially uniformly distributed. Of a radionuclide, the activity per unit mass of that nuclide. Of a material, the activity per unit mass or volume of the material in which the radionuclides are essentially uniformly distributed.

***Standards dosimetry laboratory***

a laboratory, designated by the relevant national authority, that possesses certification or accreditation necessary for the purpose of developing, maintaining or improving primary or secondary standards for radiation dosimetry.

***Stochastic effect (of radiation)***

a radiation-induced health effect, the probability of occurrence of which is greater for a higher radiation dose and the severity of which (if it occurs) is independent of dose. Stochastic effects may be somatic effects or hereditary effects, and generally occur without a threshold level of dose. Examples include solid cancers and leukemia. Contrasting term: *deterministic effect*

***System of Radiological Protection***

the system of protection for practices and for intervention recommended by the

International Commission on Radiological Protection.

***Thermoluminescent dosimetry (TLD)***

dosimetry by means of small tablets or columns (diameter 3–10 mm) with LiF or other special material (eg,  $\text{AlO}_2$ ,  $\text{CaF}_2$ ), whose atoms are able to collect absorbed energy in the electronic shells for a long-time and then give it as a flash light when heated. These dosimeters measure dose in a large range of values equal to 8 of the order.

***Thoron***

radon-220

***Thoron progeny***

the (short-lived) radioactive decay products of thoron. Namely, polonium-216 (sometimes called thorium A), lead-212 (thorium B), bismuth-212 (thorium C), polonium-212 (thorium C', 64 %) and thallium-208 (thorium C'', 36 %). The stable decay product lead-208 is sometimes known as thorium D.

***Threat assessment*** see *assessment*.

***Threshold dose of deterministic effects***

the mean dose which induces any radiation effects in at least 1–5 % of exposed individuals; threshold dose for different radiation deterministic effects is different. If a dose is below threshold dose, deterministic effects do not occur.

***Thresholdless hypothesis***

on humanitarian grounds it is accepted that stochastic effects of low doses have no threshold, this provision is definitely not proven.

***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.

***Tolerance of a tissue***

the ability of a tissue to tolerate exposure without development of a clinically significant effect.

***Tolerant dose***

the maximum dose of exposure which the tissue can endure without clinically significant adverse effect.

### ***Transient population groups***

those members of the public who are residing for a short period of time (days to weeks) in a location (such as a camping ground) that can be identified in advance. This does not include members of the public who may be travelling through an area.

### ***Unsealed source***

a radioactive source in which the radioactive material is neither (a) permanently sealed in a capsule nor (b) closely bonded in a solid form.

### ***Uranium***

1. *Depleted uranium*: uranium containing a lesser mass percentage of uranium-235 than in natural uranium.
2. *Enriched uranium*: uranium containing a greater mass percentage of uranium-235 than 0.72 %.
3. *High enriched uranium* (HEU): uranium containing 20 % or more of the isotope  $^{235}\text{U}$ . HEU is considered a special fissionable material and a direct use material.
4. *Low enriched uranium* (LEU): enriched uranium containing less than 20 % of the isotope  $^{235}\text{U}$ . LEU is considered a special fissionable material and an indirect use material.
5. *Natural uranium*: uranium (which may be chemically separated) containing the naturally occurring distribution of uranium isotopes (approxim. 99.3 % uranium-238 and 0.72 % uranium-235 by mass).

### ***Uranium series***

the decay chain of uranium-238. Namely, uranium-238, thorium-234, protactinium-234, uranium-234, thorium-230, radium-226, radon-222, polonium-218, lead-214, bismuth-214 and polonium-214, lead-210, bismuth-210, polonium-210 and (stable) lead-206, plus traces of astatine-218, thallium-210, lead-209, mercury-206 and thallium-206.

### ***Vulnerable source***

a radioactive source for which the control is inadequate to provide assurance of long-term safety and security, such that it could relatively easily be acquired by unauthorized persons.

### ***Waste***

material for which no further use is foreseen. See also *Radioactive waste*, *Radioactive waste management*

### ***Worker***

Any person who works, whether full time, part time or temporarily, for an employer

and who has recognized rights and duties in relation to occupational radiation protection. See *Emergency worker*.

***workers' health surveillance***

Medical supervision intended to ensure the initial and continuing fitness of workers for their intended tasks.

***Workplace monitoring***

1. Monitoring using measurements made in the working environment.
2. Continuous or periodic measurement of radiological or other parameters or determination of the status of a structure, system or component. Sampling may be involved as a preliminary step to measurement.

***X-rays***

high-energy electromagnetic radiation produced using electrons.

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