

**NCRP**  
**Composite**  
**Glossary**

[updated July 2011]

**absolute risk:** Expression of excess risk due to exposure as the arithmetic difference between the risk among those exposed and that obtained in the absence of exposure. The resultant risk coefficient is normalized to a population base of 10,000 people and is expressed as the number of excess cases per 10,000 persons per gray per year at risk [i.e.,  $(10^4 \text{ PY Gy})^{-1}$ ]. Absolute risk coefficients project can be modeled as a function of time since exposure (or attained age). [159]

**absorbed dose ( $\underline{D}$ ):** The energy imparted to matter by ionizing radiation per unit mass of irradiated material at the point of interest. The SI unit is  $\text{J kg}^{-1}$  with the special name gray (Gy). The special unit previously used was rad.  $1 \text{ Gy} = 100 \text{ rad}$  (see mean absorbed dose). [163]

**absorbed dose ( $\underline{D}$ ):** The energy imparted to matter by ionizing radiation per unit of irradiated material at the point of interest. Absorbed dose is the quotient of  $\overline{d\epsilon}$  by  $\underline{dm}$ , where  $\overline{d\epsilon}$  is the mean energy imparted by ionizing radiation to matter in a volume element and  $\underline{dm}$  is the mass of matter in that volume element:  $\underline{D} = \overline{d\epsilon} / \underline{dm}$ . The SI unit of absorbed dose is joule per kilogram ( $\text{J kg}^{-1}$ ), and its special name is gray (Gy). The special unit previously used was rad.  $1 \text{ Gy} = 100 \text{ rad}$  (see mean absorbed dose). [158]

**absorbed dose ( $\underline{D}$ ):** Quotient of  $\overline{d\epsilon}$  by  $\underline{dm}$ , where  $\overline{d\epsilon}$  is the mean energy imparted by ionizing radiation to matter in a volume element and  $\underline{dm}$  is the mass of matter in that volume element:  $\underline{D} = \overline{d\epsilon} / \underline{dm}$ . For purposes of radiation protection and assessing dose or risk to humans in general terms, the quantity normally calculated is the mean absorbed dose in an organ or tissue (T):  $\underline{D}_T = \overline{\epsilon}_T / \underline{m}_T$ , where  $\overline{\epsilon}_T$  is the total energy imparted in an organ or tissue of mass  $\underline{m}_T$ . The SI unit of absorbed dose is the joule per kilogram ( $\text{J kg}^{-1}$ ), and its special name is the gray (Gy). In previous units often used by federal and state agencies, absorbed dose is given in rad;  $1 \text{ rad} = 0.01 \text{ Gy}$ . [155]

**absorbed-dose coefficient ( $\underline{d}$ ):** In nuclear medicine, the absorbed dose per unit administered activity. [164]

**absorbed fraction (AF):** In the MIRD schema, the fraction of radiation energy emitted within a source tissue that is absorbed in a target tissue. [164]

**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. [163]

**absorbed fraction:** The fraction of energy emitted as a specified radiation in a specified source tissue which is absorbed in a specified target tissue. [161]

**absorbed fraction:** The fraction of ingested or inhaled material that is absorbed by an animal and transferred to the blood, body fluid, or a specific organ or tissue. [154]

**absorption:** The fractional passage of material through a membrane, such as the fraction of intake that passes through the gut wall into the blood. [164]

**absorption:** Movement of material to blood regardless of mechanism. Generally applies to the uptake into blood of soluble substances and material disassociated from particles. [161]

**absorption:** To take in and make part of an existent whole; normally refers to the fractional passage of material through a membrane, such as the fraction of intake that passes through the gut wall into the blood. [154]

**absorption functions:** Mathematical equations describing the rate of transfer of radionuclides into blood after deposition on skin, in wounds, in the gastrointestinal tract and in the respiratory tract (equations can be exponential, polynomial or constant relationships). [161]

**absorption functions  $\underline{A}(t)$ :** Dissolution and absorption functions of radionuclides found in the lung after deposition (functions can be exponential, polynomial or constant relationships). [125]

**accelerator:** A device that accelerates charged particles (e.g., protons, electrons) to high speed in order to produce ionization or nuclear reactions in a target; often used for the production of certain radionuclides or directly for radiation therapy. The cyclotron and the linear accelerator are types of accelerators. [160]

**accelerator head:** The part of the accelerator enclosing the x-ray target or source from which the useful beam emanates. The accelerator head contains shielding and may rotate about an axis. [151]

**accelerator-produced radioactive material (ARM):** Any radioactive material that is produced by a particle accelerator. [141]

**accessible emission limit (AEL):** The maximum accessible emission level permitted within a particular class of lasers. [148]

**accessible environment:** The atmosphere, land surfaces, surface waters, oceans, and all of the lithosphere that is beyond a controlled area and is generally accessible to the public. [152]

**accident:** An unintentional or unexpected happening that is undesirable or unfortunate, especially one resulting in injury, damage, harm or loss. [166]

**accuracy:** A measure of the extent of agreement between the measured value and the true value. [164]

**accuracy:** The extent of agreement between a measurement or prediction of a quantity and its true value. An accurate measurement or prediction should be precise and unbiased (see bias and precision). [163]

**acetabulum:** The socket of the hip's ball-and-socket joint, part of the pelvic bone. [164]

**acinus:** Minute sac-like beginnings of the alveolar gland, an air cell of the lung. [125]

**acoustic cavitation:** The mechanical response of one or more cavities to a sound field; it may be inertial or noninertial. [140]

**acoustic pressure:** The excess of the instantaneous pressure at a point in a sound field over the pressure in the absence of sound. [140]

**acoustic pressure amplitude:** For a sound field where the acoustic pressure varies sinusoidally with the time, the maximal value of the acoustic pressure. For a pulsed field of ultrasound, or for nonlinearly distorted waves. [140]

**acoustic radiation force:** Time-averaged force on an object produced by a sound field. [140]

**acoustic radiation torque:** Time-averaged torque on an object produced by a sound field. [140]

**acoustic streaming:** Time-averaged flow of a liquid or gas produced by a sound field. [140]

**actinide:** Element with atomic number from 90 through 103; a member of the actinide series of rare earths. [161]

**action levels:** The inner-most level around the operating level on a control chart. When measured data reaches or exceeds the action level, the equipment operator must take corrective action (e.g., request service support from the contractor). Note that the equipment can continue to be used unless the measured values exceed the control limits. The corrective action is intended to bring the measured values back toward the operating level and within the action levels. [Comm20]

**activation:** Production of radionuclides by absorption of radiations (e.g., photons, neutrons or alpha particles) by atomic nuclei. [164]

**activation:** The process where an incident particle or x ray interacts with the nucleus of an atom changing its structural and energy stability such that it emits radiation in the form of waves or particles. [Comm20]

**active detector:** A radiation detector which processes the signal at the time of detection (e.g., ionization chambers) and displays the measured value instantaneously. [Comm20]

**activity (A):** Rate of transformation (or disintegration or decay) of radioactive material. The SI unit of activity is the reciprocal second ( $s^{-1}$ ) (meaning one transformation per second), and its special name is the becquerel (Bq). In previous units often used by state and federal agencies, activity is given in curies (Ci);  $1 \text{ Ci} = 3.7 \times 10^{10} \text{ Bq}$ . [166]

**activity:** The average number of spontaneous nuclear transformations occurring in a radioactive material per unit time. The unit for activity in the SI system is reciprocal second ( $s^{-1}$ ) (i.e., one nuclear transformation per second), with the special name becquerel (Bq). The special unit previously used was curie (Ci);  $1 \text{ Ci} = 3.7 \times 10^{10} \text{ Bq}$ . Activity is also expressed as disintegrations per minute per unit area ( $\text{dpm cm}^{-2}$ ) with regard to surface contamination. [165]

**activity, cumulated ( $\tilde{A}$ ):** The time integral of the activity,  $[\int A(t)dt]$ , which is proportional to the sum of all the nuclear transitions during a given time interval. [128]

**activity density:** The density of contamination, express on a mass, volume, or area basis. [154]

**activity median aerodynamic diameter (AMAD):** The diameter of a unit density sphere with the same settling velocity in air as that of an aerosol particle whose activity is the median for the entire aerosol. Fifty percent of the activity

(aerodynamically classified) in the aerosol is associated with particles greater than the AMAD. A lognormal distribution of particle sizes is usually assumed. Used when deposition depends principally on impaction and sedimentation. [166]

**activity median aerodynamic diameter (AMAD):** The diameter in an aerodynamic particle size distribution for which the total activity above and below this size are equal. A lognormal distribution of particle sizes is usually assumed. [164]

**activity median aerodynamic diameter (AMAD):** Median diameter of airborne radioactive particles having the same aerodynamic properties as unit density spheres. Fifty percent of the of the activity (aerodynamically classified) in the aerosol is associated with particles greater than the AMAD. A lognormal distribution of particle sizes is assumed. The default values for environmental (public) and occupational exposures are 1 and 5  $\mu\text{m}$ , respectively. [161]

**acute radiation exposure:** Radiation exposure received during a short-time period (e.g., hours). [167]

**acute radiation syndrome (ARS):** A broad term used to describe a range of signs and symptoms that reflect severe damage to specific organ systems that can lead to death within hours or several weeks. [166]

**additive (absolute risk) model:** A model in which excess risk is expressed as a term to be added to the underlying natural or baseline risk (compare with the multiplicative model). [167]

**adenocarcinoma:** A malignant neoplasm of epithelial cells in glandular or gland-like pattern. [156]

**adenoma:** An ordinary benign neoplasm of epithelial tissue in which the tumor cells form glands or gland-like structures in the stroma, usually well circumscribed, tending to compress rather than infiltrate or invade adjacent tissue. [159]

**adenoma:** A benign epithelial tumor in which the cells form recognizable glandular structures or in which the cells are derived from glandular epithelium. [156]

**adenomatous:** Pertaining to adenoma or to nodular hyperplasia of a gland. [156]

**adenomatous polyposis coli:** Adenomas with colon polyps. [150]

**adiabatic shear:** An instability in metal deformation where the rate of thermal softening exceeds the rate of work hardening associated with the deformation. [156]

**adipose:** Fatty. [156]

**administered activity:** The amount, in terms of activity, of radioactive source material given to a patient during a diagnostic or therapeutic procedure. (Although the term “dose” is often used in practice referring to the administered activity, the latter quantity is not the same as absorbed dose). [167]

**administration (of radioactive material):** Introduction of radioactive material directly into the body by injection, oral administration or by some other route. [167]

**administrative control:** A self-imposed, recommended control below the dose limit. If the administrative control is reached or exceeded, corrective action is initiated. [Comm20]

**administrative dose guidelines:** The predetermined value of radiation dose to workers, below the dose limit, which triggers a specific course of action when the value is exceeded, or is expected to be exceeded. [127]

**administrative level:** A predetermined reference value of a quantity, below a dose limit, that triggers a specified course of action when the value is exceeded or is expected to be exceeded. In the case of space activities, NASA sets administrative levels for a given mission. [142]

**adnexal:** Pertaining to accessory organs, as of the eye. [156]

**advection:** Movement of material due to bulk flow of a medium (e.g., air or water) in which material is dissolved or suspended. [154]

**advisory data set (ADS):** The full data set for a measured dose-related radiation field quantity (i.e.,  $K_{a,r}$  or  $P_{KA}$ ) that is used to evaluate the local dose distribution [i.e., the facility data set (FDS)] for a group of patients for a particular type of FGI procedure, in order to better manage patient doses at the local facility. An ADS for an FGI procedure is obtained by collecting data for a large number of procedures from each of many facilities. The entire data set (typically a lognormal distribution) is used and includes sufficient data to characterize the entire distribution, rather than just the 10th and 75th percentile values typically used for DRLs. The percentages of cases in the ADS and FDS that exceed the substantial radiation dose level (SRDL) selected for the FDS, and the values of  $K_{a,r}$  or  $P_{KA}$  that define the potentially-high radiation dose procedure category are also used in the evaluation (see facility data set, potentially-high radiation dose procedure, and substantial radiation dose level). [168]

**aerodynamic (equivalent) diameter (AD):** The diameter of a unit density sphere having the same settling velocity as the particle of interest. [125]

**aerosol:** Any system of liquid droplets or solid particles dispersed in air, of fine enough particle size, and consequent low settling velocity, to possess considerable stability as an aerial suspension. [166]

**aerosol:** A suspension of solid or liquid particles in a gas. [164]

**aggregated transfer coefficient:** The mass activity density in a specified object per unit areal activity density in the soil. This term is often used to express the transfer of radionuclides from soil to various plants and animals without the necessity of treating the various intermediate functional processes involved in the transfer. [154]

**Agreement State:** Any state with which the U.S. Nuclear Regulatory Commission (NRC) has entered into an effective licensing agreement under Section 274(b) of the Atomic Energy Act of 1954, as amended, to enable the state to regulate source, special nuclear, and byproduct materials. [160]

**air kerma (kerma) (kinetic energy released per unit of mass) ( $\underline{K}$ ):** The quotient of the sum of the initial kinetic energies of all the charged particles liberated by uncharged particles in matter divided by the mass of the matter into which the particles are released and is given the special name gray (Gy).  $1 \text{ Gy} = 1 \text{ J kg}^{-1}$ . In the event that the matter is air, kerma is often referred to as air kerma. [166]

**air kerma (kerma in air):** Kerma (kinetic energy released per unit mass) is the sum of the initial kinetic energies of all the charged particles liberated by uncharged particles per unit mass of a specified material. The SI unit of kerma is joule per kilogram ( $\text{J kg}^{-1}$ ), with the special name gray (Gy). Kerma can be quoted for any specified material at a point in free space or in an absorbing medium (in this case air). [165]

**air kerma-area product ( $\underline{P}_{KA}$ ):** The integral of the air-kerma free-in-air (i.e., in the absence of backscatter) over the area of the x-ray beam in a plane perpendicular to the beam axis. [168]

**air kerma at the reference point ( $\underline{K}_{a,r}$ ):** The air kerma at a point in space located at a fixed distance from the focal spot expressed in gray. For isocentric fluoroscopes (C-arms), the reference point lies on the central axis of the x-ray beam, 15 cm on the x-ray tube side of isocenter (IEC, 2000; 2010). The location of the reference point relative to the x-ray gantry does not change when the source-to-image-receptor distance is changed. Referred to as reference air kerma by IEC (2000; 2004; 2010). [168]

**air-kerma strength ( $\underline{S}_K$ ):** Product of the air-kerma rate and the square of the distance. The units of air-kerma strength are  $\mu\text{Gy m}^2 \text{ h}^{-1}$  or  $\text{cGy cm}^2 \text{ h}^{-1}$ . [155]

**albedo neutrons:** Secondary neutrons produced by interactions of galactic cosmic radiation and the atmosphere, and reflected back into space. [153]

**aleatory:** Uncertainty in estimates of a quantity that involves true variability in measurements. Aleatory uncertainty (i.e., natural variability) can be better characterized through additional research but cannot be reduced except through a change in the technology of measurement. [158]

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**aleatory uncertainty:** Uncertainty in estimates of a quantity that involves true stochastic (unexplained) variability in measurements. Aleatory uncertainty (i.e., natural variability) can be better characterized through additional research but cannot be reduced except through a change in the technology of measurement. It is related to Type-A uncertainty. [163]

**algorithm:** A formula used to compute numerical values from an equation, based on step-by-step numerical computations, as opposed to an algebraic computation. Numerical algorithms implemented with computer software are particularly useful for solving complex differential equations or sets of equations that may lack algebraic solutions. [166]

**aliasing:** The false frequency information (or alias) detected when the signal being detected is greater than the Nyquist frequency. [149]

**alkali metals:** Group I of the periodic table consists of the alkali metals. They are the most electropositive elements known, are monovalent, have low melting points, and react violently with water. [154]

**allantois:** A sac-like diverticulum from the hindgut of amniote embryos. [128]

**allele:** Any alternative form of a gene that can occupy a particular chromosomal locus. In humans and other diploid organisms, there are two alleles, one on each chromosome of a homologous pair. [167]

**alluvial deposit:** Material deposited by flowing water. [154]

**alpha particles:** Nuclei of helium atoms consisting of two protons and two neutrons in close association. They have a net charge of +2 and can therefore be accelerated in large electrical devices similar to those used for protons, and they are also emitted during the decay of some radioactive isotopes. [164]

**alpha particle:** A positively-charged particle ejected spontaneously from the nuclei of some radionuclides. It is identical to a helium nucleus (two protons and two neutrons) with a mass number of four and an electric charge of +2. It has low penetrating power and a short range (a few centimeters in air). [163]

**alpha particles:** Energetic nuclei of helium atoms, consisting of two protons and two neutrons emitted spontaneously from nuclei in the decay of some radionuclides (e.g., <sup>226</sup>Ra). Alpha particles have very low penetrating power (e.g., typically stopped by a few centimeters of air or the outer dead layer of skin and underlying basal layer). Alpha particles are generally not a health problem unless the source is taken into the body via inhalation, ingestion or absorption, or through wounds. [159]

**alpha particle:** A positively charged particle ejected spontaneously from the nuclei of some radioactive elements. It is identical to a helium nucleus with a mass number of four and an electric charge of +2. It has low penetrating power and a short range (a few centimeters in air). The most energetic alpha particle from nuclear transformation will generally fail to penetrate the dead layer of skin cells. Alpha particles may represent a hazard when radionuclides are deposited inside the body (e.g., via inhalation or ingestion). [157]

**alpha radiation:** Energetic nuclei of helium atoms, consisting of two protons and two neutrons, emitted spontaneously from nuclei in the decay of some radionuclides. Alpha radiation is weakly penetrating, and can be stopped by a sheet of paper or the outer dead layer of the skin. Also called alpha particle and sometimes shortened to alpha (e.g., alpha-emitting radionuclide). Energetic helium nuclei constitute a small portion of cosmic radiation and solar particle events. [167]

**alpha radiation:** Energetic nuclei of helium atoms, consisting of two protons and two neutrons, emitted spontaneously from nuclei in the decay of some radionuclides. Alpha radiation is weakly penetrating, and can be stopped by a sheet of paper or the outer dead layer of skin. Also called alpha particle and sometimes shortened to alpha (e.g., alpha-emitting radionuclide). Alpha particles may represent a hazard when radionuclides are deposited inside the body (e.g., via inhalation, ingestion or wounds). [166]



**alpha radiation:** Energetic nuclei of helium atoms, consisting of two protons and two neutrons, emitted spontaneously from nuclei in the decay of some radionuclides. Alpha radiation is weakly penetrating, and can be stopped by a sheet of paper or the outer dead layer of skin. Also called alpha particle and sometimes shortened to alpha (e.g., alpha-emitting radionuclide). Alpha-particle deposition of energy in tissue is characterized by a high linear energy transfer (LET), making such particles more biologically effective than low-LET radiations such as photons or electrons in targeted radiation therapy. [164]

**alpha radiation:** Energetic nuclei of helium atoms, consisting of two protons and two neutrons, emitted spontaneously from nuclei in the decay of some radionuclides. Alpha radiation is weakly penetrating, and can be stopped by a sheet of paper or the outer dead layer of skin. Also called alpha particle and sometimes shortened to alpha (e.g., alpha-emitting radionuclide). [156]

**alveolar dead space:** Portion of the tidal volume that enters the alveoli but does not take part in gas exchange. [125]

**alveoli:** Terminal air sacs of the lung that provide for oxygen-carbon dioxide gas exchange and consist of Type I cells, Type II cells, and macrophages. [125]

**ambient dose equivalent [ $H^*(10)$ ]:** The dose equivalent that would be produced by the corresponding expanded and aligned field in the ICRU sphere at a depth of 10 mm on the radius opposing the direction of the aligned field. The SI unit of ambient dose equivalent is joule per kilogram ( $J\ kg^{-1}$ ) and its special name is sievert (Sv). [163]

**ambient dose equivalent [ $H^*(d)$ ]:** The dose equivalent that would be produced by the corresponding expanded and aligned field in the ICRU sphere at a depth ( $d$ ) on the radius opposing the direction of the aligned field. The SI unit of ambient dose equivalent is joule per kilogram ( $J\ kg^{-1}$ ) and its special name is the sievert (Sv). [158]

**amnion:** The avascular membranous sac that immediately surrounds the amniotic fluid and embryo/fetus. [128]

**amniotic fluid:** The fluid that is contained within the amnion. [128]

**amorphous:** Lacking a definite crystalline form; not crystalline. [152]

**ampere (A):** Unit of electric current. One ampere (1 A) is produced by 1 V acting through a resistance of 1 ohm. [163]

**anaerobic:** Living, acting or occurring in the absence of free oxygen. [152]

**analysis of variance (AOV):** A test of the statistical significance of the differences among the mean scores of two or more groups on one or more variables. [158]

**anaplastic:** Growing without form or structure, and refers to aggressive malignant cancers. [159]

**anatomical dead space:** Volume of the airways of the lung in which no gas exchange occurs. [125]

**angiogenesis:** Development of blood vessels in the embryo or into a solid tumor from surrounding tissue. [156]

**angiography:** The radiographic visualization of blood vessels following introduction of contrast material. [168]

**angiography:** X-ray imaging of the blood or lymph vessels. [156]

**angioma:** A swelling or tumor due to proliferation, with or without dilation, of the blood vessels (hemangioma) or lymphatics (lymphangioma). [159]

**angiosarcoma:** Malignant tumor of vascular tissue; also known as hemangiosarcoma. [156]

**angular distribution:** The distribution with angle of incidence of particles impinging on a detector or a point on the surface of the body. [163]

**angular response:** The response of the instrument detector to particles or photons which impinge on the detector at angles deviant from a normal to the facial plane of usual incidence. [163]

**animal patient (or research animal):** In veterinary medicine, the patient (or research animal) is an animal under the care of the veterinarian. [148]

**anion:** Negatively charged ion. [156]

**anisotropic:** Not isotropic; having different angular incidence in different directions (see isotropic). [158]

**anisotropic:** Not isotropic; having different properties in different directions (see isotropic). [144]

**annihilation radiation:** The electromagnetic radiation emitted as a result of the combination and disappearance of an electron and a positron. Two gamma rays of 0.511 MeV energy each are emitted in most cases. [164]

**annihilation radiation:** The electromagnetic radiation emitted as a result of the combination and disappearance of an electron and a positron. Two photons of 0.511 MeV energy each are emitted at a 180 degree relative orientation in most cases. [161]

**annual dose equivalent:** Sum of the dose equivalent received in a year from external radiation and the committed dose equivalent due to intakes of radionuclides in a year. A similar definition applies to annual effective dose, annual equivalent dose, and annual effective dose equivalent. [152]

**anode:** A positively charged electrode by which electrons leave an electrical device. An electrode is a collector or emitter of electric charge or of electric-charge carriers, as in a semi-conducting device. [158]

**anode:** The positive terminal of an x-ray tube. Typically, a tungsten block embedded in a copper stem and set at an angle to the cathode (the negative terminal of an x-ray tube, from which electrons are emitted). The anode emits x rays from the point of impact of the electron stream from the cathode. [145]

**anomalous cosmic ray:** Component perhaps of a different origin than that of the high-energy cosmic rays. The peak in the energy spectrum at solar maximum is  $\sim 10 \text{ MeV m}^{-1}$ . [153]

**anoxia:** The condition of a lack of oxygen, which is common in sediments of lakes, and which causes alterations in chemical conditions. [154]

**ansatz:** An assumed form for a mathematical statement that is not based on any underlying theory or principle. [153]

**antenna:** A structure that is designed to radiate or receive EM fields efficiently. Individual antennas, or antenna elements, are often used in combinations that are called antenna arrays. [119]

**antibody:** An immunoglobulin molecule with a specific amino acid sequence evoked in humans or other animals by an antigen, and characterized by reacting specifically with the antigen in some demonstrable way, antibody and antigen each being defined in terms of the other. [159]

**apoptosis:** Deletion of cells by fragmentation into membrane-bound particles that are phagocytosed by other cells; often referred to as “programmed cell death.” [167]

**apoptosis:** Genetically-programmed or externally-induced self-destruction of a cell. [156]

**a posteriori:** Probability associated with cases where a set of possible outcomes can be conceived but their probabilities cannot be deduced, such as the survival of a male to age 70. [158]

**apotransferrin:** Transferrin not bound to iron (see transferrin). [156]

**a priori:** Probability defined using deductive reasoning applied to the possible outcomes of a system. [164]

**aqueous:** Watery; prepared with water. [156]

**aquifer:** Saturated geologic unit that is sufficiently permeable to transmit usable quantities of water under ordinary hydraulic gradients. In an unconfined aquifer, there is no restricting, less permeable material at the top of groundwater (*i.e.*, the water table), and groundwater levels are free to rise or fall. In a confined aquifer, a water-bearing unit is confined between two aquitards (also see groundwater). [154]

**aquitard:** Saturated geologic unit that is sufficiently impermeable that it does not transmit usable quantities of water under ordinary hydraulic gradients. [154]

**arachidonic acid:** A polyunsaturated omega-6 fatty acid that is present in the phospholipids of membranes of the body’s cells. [156]

**Archimedean spiral:** A mathematical curve resulting from a linear angular rotation with increasing distance. [153]

**area monitor:** A radiation detector designed to measure the radiation levels in a specified location. [163]

**area occupancy factor (T):** Used for shielding calculations. A factor (usually  $\leq 1$ ) by which the dose-equivalent rate or neutron fluence rate should be multiplied to correct for the degree of occupancy, relative to a work week (nominally of 40 h), of the area in question while the radiation source is “on” and the barrier protecting the point of interest is being irradiated. [144]

**areola:** The pigmented ring of tissue that surrounds the nipple. [149]

**arthrography:** Radiographic evaluation of a joint after injection of radiopaque contrast material into the joint space(s). [145]

**artifact:** Any structure visible in an image that is not part of the object being imaged. [149]

**as low as reasonably achievable (ALARA):** A principle of radiation protection philosophy that requires that exposures to ionizing radiation be kept as low as reasonably achievable, economic and societal factors being taken into account. The ALARA principle is satisfied when the expenditure of further resources would be unwarranted by the reduction in exposure that would be achieved. [168]

**as low as reasonably achievable (ALARA):** A principle of radiation protection philosophy that requires that exposures to ionizing radiation be kept as low as reasonably achievable, economic and social factors being taken into account. The protection from radiation exposure is ALARA when the expenditure of further resources would be unwarranted by the reduction in exposure that would be achieved. [157]

**as low as reasonably achievable (ALARA):** Principle of radiation protection that calls for every reasonable effort to maintain radiation exposures as far below specified limits as is practical, taking into account cost-benefit and any other societal concerns. [Comm20]

**assessment:** A review, evaluation, inspection, test, check, surveillance or audit to determine and document whether items, processes, systems or services meet specific requirements and are performing effectively. [162]

**astronomical unit (AU):** The average distance from the sun to Earth,  $150 \times 10^6$  km. [153]

**ataxia telangiectasia (A-T):** A slowly progressive multisystem disorder appearing at the onset of walking, including but not limited to dilation of small or terminal vessels of a body part, and recurrent infections. [167]

**ataxia-telangiectasia mutation (ATM):** Patients with a mutation in the ATM gene have trouble walking as children (ataxia) and have small red spider-like veins (telangiectasias). They have an increased risk for cancer and are hypersensitive to the effects of ionizing radiation because of defective DNA repair mechanisms. [159]

**atelectasis:** Collapse of the alveoli of the lung or portion of the lung due to pressure of a pleural effusion or blockage of the small bronchial tubes. [125]

**Atomic Energy Act (AEA):** Law passed originally in 1946 and extensively revised in 1954 that governs production and use of radioactive materials (i.e., byproduct material, source material, and special nuclear material) for defense and peaceful purposes and regulation of such radioactive materials to protect public health and safety. The Act provides authority for licensing of nuclear activities by the U.S. Nuclear Regulatory Commission or Agreement States and regulation by the U.S. Department of Energy of its atomic energy defense, research and development activities. [167]

**atomic number ( $Z$ ):** The atomic number of a nucleus is the number of protons contained in the nucleus. [167]

**atomic number ( $Z$ ):** The atomic number of a nucleus is the number of protons contained in the nucleus. Low- $Z$  describes nuclei with  $Z \leq 26$ . High- $Z$  describes nuclei with  $Z > 26$ . [164]

**atomic number ( $Z$ ):** The atomic number is the number of protons contained in the nucleus of an atom. Low- $Z$  refers to atomic nuclei with  $Z \leq 26$ . High- $Z$  refers to atomic nuclei with  $Z > 26$ . [158]

**atomic number:** The number of positively charged protons in the nucleus of an atom. [157]

**attained age:** The period of time that has lapsed since birth. [159]

**attenuation:** The reduction of radiation intensity upon passage of radiation through matter. [168]

**attenuation:** In nuclear-medicine imaging, the absorption of photons in tissue. The attenuation correction is one of several corrections necessary to convert image intensity to disintegration rate in a particular imaged region. [164]

**attenuation:** The extent to which the intensity of a beam of radiation is reduced as it passes through a specific amount of material. [161]

**attenuation length (L):** The penetration distance in which the intensity of a radiation beam is attenuated by a factor of  $e$  (see tenth-value layer). [144]

**attributable risk:** The probability that an individual will die from (or develop) cancer due to exposure to a causative agent such as radiation. [159]

**Auger electron:** The Auger effect is a phenomenon in physics in which the emission of an electron from an atom causes the emission of a second electron. When an electron is removed from a core level of an atom, leaving a vacancy, an electron from a higher energy level may fall into the vacancy, resulting in a release of energy. Although sometimes this energy is released in the form of an emitted photon, the energy can also be transferred to another electron, which is ejected from the atom. This second ejected electron is called an "Auger electron." [159]

**authorized users:** Individuals who by virtue of required training, experience and qualifications are approved to perform specific tasks or operations. [162]

**autocatalysis:** Speeding up (or sometimes slowing down) of the rate of a chemical reaction by the presence of a substance that itself undergoes no permanent chemical change as a result of the reaction. [152]

**autocrine:** Indicating self-stimulation through production of a factor and a specific receptor for it. [150]

**automatic brightness control (ABC):** Maintains a constant level of viewing brightness by adjusting the amount of radiation delivered to the patient to maintain a constant level of radiation at the image intensifier face. [133]

**automatic exposure control (AEC) systems:** Automatic exposure control systems, often referred to as phototimers, are designed to automatically determine and provide the exposure needed to produce an adequate optical density image by sampling the x-ray intensity after passage through the patient and image receptor. [149]

**autoradiograph:** Image of the distribution of activity in a tissue created by the emitted radiations. [156]

**axilla:** The underarm area containing lymph nodes and channels, blood vessels, nerves, muscle, and fat; anterior border is the pectoralis major muscle and posterior border is the latissimus dorsi muscle. [156]

**axillary tail:** Anatomical projection of breast tissue that extends into axilla (axillary tail of Spence). [149]

**azoospermia:** Lack of sperm. [132]

**background:** In nuclear-medicine imaging, background refers to counts in an image that are found outside the region of interest but that likely reflect counts within the region of interest that are not associated with the anatomical structure of interest and that need to be subtracted from the counts in the region of interest. [164]

**background levels:** Levels (e.g., concentrations) of agents, especially hazardous agents in the environment, whose occurrence is not related to human activities at a site. Background sources may be naturally occurring or anthropogenic (man-made). [146]

**background radiation:** Ionizing radiation that occurs naturally in the environment, including cosmic radiation; radiation emitted by naturally-occurring radionuclides in air, water, soil, and rock; radiation emitted by naturally-occurring radionuclides in tissues of organisms (e.g., due to ingestion or inhalation); radiation emitted by man-made materials containing incidental amounts of naturally-occurring radionuclides (e.g., building materials); and radiation emitted by widespread fallout from atmospheric testing of nuclear weapons. In the United States, the average annual effective dose due to natural background radiation is ~1 mSv, excluding the dose rate due to indoor radon, and the average annual effective dose due to indoor radon is ~2 mSv. [167]

**background radiation:** Radiation from cosmic sources, naturally-occurring radioactive material in the earth and in the body (including exposure from radon), and global fallout as it exists in the environment from past testing of nuclear explosive devices. The typically quoted annual average effective dose to an individual from all sources of background radiation is ~3 mSv (~300 mrem). This value includes a major contribution from radon, which is ~2 mSv (~200 mrem). [166]

**background radiation:** The radiation to which a member of the population is exposed from natural sources, such as terrestrial radiation due to naturally-occurring radionuclides in the soil, cosmic radiation originating in outer space, radon, and naturally-occurring radionuclides in the human body. [159]

**back (scattering) reflection:** The reflection of radiation in a direction generally greater than 90 degrees to that of the incident radiation. [144]

**backscattered radiation:** The reflection of radiation in a direction generally greater than 90 degrees to that of the incident radiation. [158]

**baghouse:** A pollution control device that collects the metal oxide fume in the exhaust air of an industrial process. A baghouse usually consists of a plenum into which the dust is collected, fabric bags that allow the air to pass through and the dust to be collected on the outside, bins into which the filtered dust is collected, and conveyors that move the dust from the bins to a chute used to load transport vehicles. [141]

**baghouse dust:** Metal oxide fume, produced during metal-making processes, that is collected in a baghouse. [141]

**barn:** Special unit for the cross section. 1 barn =  $10^{-28}$  m<sup>2</sup> ( $10^{-24}$  cm<sup>2</sup>) (see **cross section**). [151]

**barrier:** Radiation attenuation material used to reduce the dose equivalent on the side beyond the radiation source. [161]

**barrier:** Any natural or man-made part of a disposal system that is intended to inhibit access to disposed waste by humans, plants, animals, air or water, or to inhibit migration of radionuclides from locations of disposed waste to the accessible environment. [152]

**barrier (or protective barrier):** A protective wall of radiation attenuation material(s) used to reduce the dose equivalent on the side beyond the radiation source (see primary and secondary barriers). [151]

**baryon:** Any of the heavier elementary particles such as protons, neutrons [132]

**basal cell:** Cells that form a single row along a basement membrane and are responsible for the pseudostratified appearance of the epithelium. [164]

**basal cell:** Cells that occupy the deepest layer of the epidermis of the skin, and form a continuous layer of cells usually one cell thick. Basal cells can be considered the “stem cells” of the epidermis. [161]

**basal cell nevus syndrome:** Pertaining to basal cell nevi with development of basal cells carcinomas in adult life (see nevi). [150]

**base density:** The optical density due to the supporting base of the film alone. The base density of a film is the optical density that would result if an unexposed film were processed through the fixer, wash and dryer, without first passing through the developer. [149]

**baseline rate:** The cancer experience observed in a population in the absence of the specific agent being studied; the baseline rate might, however, include cancers from a number of other causes, such as smoking, background radiation, etc. [167]

**baseline rate of cancer:** The annual cancer incidence observed in a population in the absence of the specific agent being studied; the baseline rate includes cancers of all other causes not under study, such as smoking and occupational exposures. [159]

**basement membrane:** A very thin membrane beneath the epithelium. [164]

**base pairs (of DNA):** Normally, a base pair involves a pyrimidine (cytosine, thymine) hydrogen bonded to a purine (adenine, guanine), with each component (the purine, the pyrimidine) part of two antiparallel strands winding “right handed” in a double-stranded helix of DNA. [167]

**base-plus-fog density:** The optical density of a film due to its base density plus any action of the developer on the unexposed silver halide crystals. The base-plus-fog density can be measured by processing an unexposed film through the entire processing cycle and measuring the resultant optical density. A low base-plus-fog density is desirable. Factors such as exposure of the film to heat or high humidity can cause an undesirable increase in the base-plus-fog density. [149]



**basic oxygen furnace (BOF):** A high-capacity steelmaking furnace that uses molten iron, scrap and flux to produce steel. The energy to refine the iron and scrap is produced by the exothermic reactions between pure oxygen, blown into the charge at supersonic speed, and elemental iron, and to a lesser extent, the oxygen and the carbon in the iron. [141]

**Bayesian:** A concept named after an 18th century Nonconformist minister (Thomas Bayes); the concept allows one to start with what one already knows or believes and then to determine how new information changes one's confidence in that belief. [164]

**Bayesian:** A method of estimating uncertainty on the basis of probabilities that represent subjective degrees of belief or inferences, rather than purely objective facts (direct observations) (named after an 18th century Presbyterian minister, Thomas Bayes). [163]

**Bayesian probability theory:** Method of estimating uncertainty on the basis of probabilities that represent subjective degrees of belief or inferences, rather than purely objective facts (direct observations). [164]

**beam:** A flow of electromagnetic or particulate radiation that is either (1) collimated and generally unidirectional or (2) divergent from a small source but restricted to a small solid angle (charged-particle beam, radiation beam). [163]

**beam limiting device:** A device that provides a means to restrict the dimensions of the useful beam. Regions outside the beam limiting device, if such device is an integral part of the radiation producing equipment, shall be shielded adequately to meet the leakage requirements of the source assembly to which it is attached. [133]

**beam-on time:** The time that the radiation source is actually producing radiation. [151]

**becquerel (Bq):** The SI special name for the unit of radioactivity. 1 Bq equals one disintegration per second. 37 MBq (megabecquerels) = 1 mCi (millicurie) (see curie and activity). [167]

**becquerel (Bq):** The special name for the unit of activity in the SI system [i.e., one nuclear transformation per second ( $s^{-1}$ )]. The special unit previously used was curie (Ci);  $3.7 \times 10^{10}$  Bq = 1 Ci; 37 MBq (megabecquerels) = 1 mCi (millicurie) [160]

**becquerel (Bq):** The SI special name for the unit [disintegration per second ( $s^{-1}$ )] of radioactivity. 1 Bq = 1 disintegration per second; 1 Bq =  $0.027 \times 10^{-9}$  Ci (see radioactivity and curie).

activity: conversion from conventional to SI units

- 1 nCi =  $3.7 \times 10^1$  disintegrations/s = 37 Bq
- 1  $\mu$ Ci =  $3.7 \times 10^4$  disintegrations/s =  $3.7 \times 10^4$  Bq = 37 kBq
- 1 mCi =  $3.7 \times 10^7$  disintegrations/s =  $3.7 \times 10^7$  Bq = 37 MBq
- 1 Ci =  $3.7 \times 10^{10}$  transitions/s =  $3.7 \times 10^{10}$  Bq = 37 GBq
- 1 kCi =  $3.7 \times 10^{13}$  transitions/s =  $3.7 \times 10^{13}$  Bq = 37 TBq
- 1 MCi =  $3.7 \times 10^{16}$  transitions/s =  $3.7 \times 10^{16}$  Bq = 37 PBq
- 1 GCi =  $3.7 \times 10^{19}$  transitions/s =  $3.7 \times 10^{19}$  Bq = 37 EBq [159]

**below regulatory concern (BRC):** Definable amounts of hazardous substances in a material such that the material can be exempted from regulations governing particular practices or sources (e.g., management and disposal of hazardous wastes) on the basis of considerations that the costs of regulating the materials generally are disproportionate to the low health risks posed to the public by the materials (application of ALARA principle). Amounts of hazardous substances that are BRC can depend on the particular practice or source, and they can be substantially above levels generally considered de minimis. [141]

**benchmarking:** Intercomparison of outputs of different models or codes that purport to solve the same problem. [152]

**beneficiation:** Preliminary conditioning of an ore for refinement. [118]

**benefit-cost analysis:** A systematic quantitative method of assessing the desirability of government projects or policies when it is important to take a long view of future effects and a broad view of possible side effects. [167]

**benefit-cost analysis:** A systematic quantitative method of assessing the desirability of government projects or policies when it is important to take a long view of future effects and a broad view of possible side effects. "Benefit-cost analysis is recommended as the technique to use in a formal economic analysis of government programs or projects. Cost-effectiveness analysis is a less comprehensive technique, but it can be appropriate when the benefits from competing alternatives are the same or where a policy decision has been made that the benefits must be provided." [146]

**benign:** Denoting the mild character of an illness or the nonmalignant character of a neoplasm. [159]

**benign:** A noncancerous condition that does not spread to other parts of the body. [156]

**benthic:** Refers to the sediment surface (or near-surface) habitat in aquatic ecosystems (e.g., benthic organisms). [154]

**benthivorous:** The habit of eating benthos. [154]

**benthos:** Refers to benthic organisms. [154]

**Berkson error:** In the context of this Report, the Berkson error model applied to measurement errors assumes that the true dose equals observed dose plus individual peculiarity, where individual peculiarity is a random variable that has a mean of zero and is independent of observed dose (see measurement error and classical error). [163]

**Berkson error model:** In the context of this Report, the Berkson error model assumes that true dose is equal to the observed dose plus an error introduced by individual peculiarity, which is defined as a random variable that has a mean of zero and is independent of observed dose (see Classical measurement error model). [164]

**beta distribution:** A probability density function often used in Bayesian analyses to estimate the unknown probability of an event. The beta distribution is defined by use of two shape-determining parameters. [164]

**beta particle:** An energetic electron emitted spontaneously from nuclei in the decay of many radionuclides. [160]

**beta particles:** Energetic electrons or positrons (i.e., positively charged electrons) emitted spontaneously from nuclei in the decay of some radionuclides (e.g.,  $^{90}\text{Sr}$ ). Beta particles are not highly penetrating (e.g., the lower-energy beta particles are typically stopped by a few millimeters of tissue; the higher-energy beta particles can be stopped by a few centimeters of tissue. [159]

**beta particle:** A charged particle emitted from a nucleus during nuclear transformation. A negatively charged beta particle is identical to an electron. A positively charged beta particle is called a positron. [157]

**beta radiation:** Energetic electrons or positrons (positively charged electrons) emitted spontaneously from nuclei in decay of some radionuclides. Also called beta particle and sometimes shortened to beta (e.g., beta-emitting radionuclide). [166]

**bias:** The systematic tendency of a measurement or prediction of a quantity to over- or underestimate the true value, on average (see accuracy and precision). [163]

**bias:** Tendency for an estimate to under- or overpredict an actual event or value. [164]

**billet:** A semifinished bar of metal having a square face of less than eight inches on a side and a length of several feet. [141]

**binomial distribution:** A type of discrete probability distribution. When events can be classified in either of two categories, such as true or false, then the binomial distribution represents the expected number of one of the events (true) given the number of trials ( $n$ ) and the probability of the selected event ( $p$ ). [164]

**bioaccumulation:** The process by which nutrients, contaminants or other material accumulate in organisms through one or more mechanisms. [164]

**bioaccumulation factor:** Ratio of the concentration of a radionuclide in a biological organism or tissue to the concentration in water or soil. [152]

**bioassay:** Any procedure used to determine the nature, location or retention of radionuclides in the body by direct (in vivo) measurement or by indirect (in vitro) analysis of material excreted or otherwise removed from the body. Generally used for the purpose of estimating intake and committed dose. [166]

**bioassay:** A technique used to identify, quantify and/or specify the location of radionuclides in the body by direct (in vivo) or indirect (in vitro) analysis of tissues or excretions from the body. [165]

**bioassay:** The determination of kinds, quantities or concentrations, and in some cases the locations of radioactive material in the human body. [157]

**bioavailability:** The degree and rate at which a substance is absorbed into a living system or is made available at the site of physiological activity. [154]

**biodosimetry:** Measurement of biological response as a surrogate for radiation dose. [167]

**biodosimetry:** Use of clinical and laboratory observations to estimate radiation dose received after radiation exposure. [166]

**biodosimetry:** A technique used to determine radiation dose to people using the assessment of individual biological data such as assessment of individuals' signs and symptoms, particularly the time from exposure to onset of vomiting, serial blood counts for lymphocyte depletion, and assays of lymphocyte cytogenetics. [165]

**biodosimetry:** Use of a biological response as an indicator of a dose of an effective agent (e.g., the extent of decline in peripheral blood lymphocytes of humans exposed to ionizing radiation can be used as an indicator of the absorbed dose to the whole body from that exposure). [159]

**biogeochemical:** Of or relating to the partitioning and cycling of chemical elements and compounds between the living and nonliving parts of an ecosystem. [154]

**biohazards:** Micro-organisms or viruses which cause disease, or substances such as toxins or venoms produced by living organisms. [111]

**biokinetic model:** Model describing the time course of absorption, distribution, metabolism and excretion of a substance introduced into the body of an organism. For the purposes of estimating internal dose, what such a model produces (i.e., its output) is an estimate of the number of decays of a radionuclide in each source organ (site of deposition or transit in the body) over a specified period per unit activity absorbed into body fluids. [164]

**biokinetic model:** Model describing the time course of absorption, distribution, metabolism and excretion of a substance introduced into the body of an organism. [161]

**biokinetics:** The time course of absorption, distribution, metabolism and excretion of a substance introduced into the body of an organism. [166]

**bioligand:** A biologic material that acts as a ligand (see ligand). [156]

**biological half-life:** Time required for the body to eliminate half of an administered dose of any substance by metabolic processes of elimination. [159]

**biomagnification factor:** Often used to denote the ratio of mass activity density of a radionuclide in an organism to that in its food (see concentration ratio for general usage). [154]

**biomass:** The amount of specified living matter in a unit area or volume of habitat. [154]

**biopsy:** Removal of an entire abnormality (excisional biopsy) or a sampling or portion of an abnormality (core biopsy and incisional biopsy) for microscopic examination in order to diagnose a problem. [164]

**biosphere:** Zone of the Earth, including the lower part of the atmosphere, the hydrosphere, soil, and the lithosphere to a depth of ~2 km, that contains living organisms. [152]

**biota:** Plants and animals. [164]

**biota:** Plants and nonhuman animals. [154]

**bioturbation:** The mixing of near-surface soils and sediments through the activity of soil and benthic invertebrates, larger vertebrates, and plant roots. [154]

**bisecting angle technique (bisect angle geometry):** A technique for the radiographic exposure of intraoral image receptors whereby the central axis of the x-ray beam is directed at right angles to a plane determined by bisecting the angle formed by (1) the long axis of the tooth or teeth being imaged, and (2) the plane in which the image receptor is positioned behind the teeth. [145]

**bitewing radiograph:** An intraoral radiograph that demonstrates the crowns, necks and coronal thirds of the roots of both upper and lower teeth. So named because the patient bites upon a tab or “wing” projecting from the center of the image-receptor packet. [145]

**bivariate:** The bivariate probability density function is a multivariate distribution of two variables (see multivariate distribution). [158]

**blast furnace:** A closed iron-making furnace in which iron ore, coke and flux are added at the top and hot air is blown in near the bottom. Energy to melt and refine the ore is produced by the reaction of the hot air and the carbon in the coke. Blast furnaces are used to supply the molten iron to basic oxygen furnaces. [141]

**blastocyst:** Developmental stage of most mammalian embryos that follows the morula; typically consists of a hollow sphere of trophoblast cells with an "inner cell mass" of formative cells. [128]

**blastomere:** A cell of a cleavage stage or morula; excludes persisting cells of the polar body. [128]

**blocking agent:** A medication that blocks or reduces the uptake of a radionuclide in a tissue or organ (e.g., potassium iodide). [161]

**blooms:** Semifinished bars of metal having a square face of more than eight to ten inches on a side and a length of several feet. [141]

**body burden:** The total activity of a radionuclide or total amount of a chemical in a living organism. [164]

**body-mass index (BMI):** Ratio of an individual's mass to height-squared [i.e.,  $BMI = \text{mass}/\text{height}^2$  ( $\text{kg m}^{-2}$ )]. [164]

**bog:** A wet quagmire or spongy ground covered with grass or other plants. [154]

**bomb cart:** A trailer chassis designed to hold containerized cargo. [Comm20]

**bone-marrow cellularity:** The fraction of total bone marrow that is made up of proliferative hematopoietic cells as opposed to adipose cells. [164]

**bone-marrow volume fraction:** The fraction of spongiosa volume occupied by bone marrow. [164]

**boundary condition:** Assumed value of a dependent variable or one of its spatial derivatives at boundaries defining the domain over which a differential equation is solved. [164]

**brachytherapy:** A method of radiation therapy in which an encapsulated source is utilized to deliver gamma or beta radiation at a distance up to a few millimeters either by surface, intracavitary or interstitial application. [164]

**brachytherapy:** Radiotherapy in which the source of irradiation is placed close to the surface of the body, within a body cavity (e.g., application of radium to the cervix), or directly in tissue (i.e., interstitially). [159]

**branching angle:** Angle of change in direction of the bulk air-flow moving from the parent airway segment into the daughter segment. [125]

**break-bulk cargo:** Loose cargo, such as cartons, stowed directly in a vessel's hold as opposed to containerized or bulk cargo. [Comm20]

**breast carcinoma in situ:** Breast change in which malignant cells are localized and confined to breast ducts or lobules and may press against adjoining breast tissue but have not penetrated or spread beyond the breast (also called noninvasive breast cancer or noninfiltrating breast cancer). [149]

**breast conservation:** A surgical procedure for removing a cancerous tumor, lesion, or lump along with a rim of normal tissue around it (also called a lumpectomy). [149]

**breast self-examination:** Inspection and palpation of her breasts by the woman herself. [149]

**breathing frequency:** Number of breaths per unit time. [164]

**breathing mode:** Fraction of inhalation and exhalation of air through the nose and mouth (air passing each way, such as 50/50 %, etc). [161]

**breeder:** Nuclear reactor with a chain reaction maintained by fast neutrons and generating more fissile material than it consumes. [154]

**bremstrahlung:** Electromagnetic radiation produced by the acceleration or deceleration of charged particles, particularly in the vicinity of the Coulomb fields of nuclei. [163]

**bremstrahlung:** Secondary photon radiation produced by deceleration of charged particles passing through matter. [166]

**bremstrahlung:** The electromagnetic radiation associated with the acceleration or deceleration of energetic electrons. [161]

**bremstrahlung:** The spectrum of photons produced by the acceleration or deceleration of high-energy electrons, particularly near the coulomb fields of nuclei. [159]

**bremstrahlung:** The electromagnetic radiation associated with the acceleration or deceleration of charged particles, particularly in the vicinity of the Coulomb fields of nuclei (see x ray). [144]

**broad beam:** Conditions of a radiation-shielding situation in which the beam impinging on a barrier surface is laterally extensive. [163]

**broad beam:** Conditions of a radiation-shielding situation in which the beam impinging on a barrier surface includes scattered radiation and is laterally extensive. [151]

**bronchial asthma:** Allergic reaction characterized by a narrowing of the lumen of the bronchial tubes from spasms of the muscles in the walls or a congestive swelling of the bronchial mucous membrane. [125]

**bronchial epithelium:** The surface layer of cells lining the conducting airways of the lung. The thickness decreases with bronchial generation from 80  $\mu\text{m}$  in the trachea to 15  $\mu\text{m}$  in the finest airways. [160]

**bronchioloalveolar adenoma:** Benign lung neoplasm arising from the epithelium lining bronchioles or alveoli. [125]

**bronchioloalveolar carcinoma:** Malignant lung neoplasm arising from the epithelium lining the bronchioles or alveoli. [125]

**bronchus:** One of the two main branches arising from the trachea at its bifurcation, one going to each lung. [164]

**brush cell:** Tall cells that rest on the basement membrane and have a prominent tuft on the luminal surface scattered among the epithelium of the trachea, bronchi and bronchioles. [125]

**bubble:** A cavity that is nearly, or completely, surrounded by liquid. [158]

**bucky:** A component of the mammography x-ray unit that contains a moving grid, holds the x-ray film cassette, and supports the breast during imaging. [149]

**bucky factor:** The factor by which the output of the x-ray tube must be increased in order to compensate for the removal of incident radiation by a grid. [133]

**buffer area or zone:** Refers to adequate areas of land established to effectively separate areas that could release hazardous materials from public or private lands, thus reducing risks to people in the event of contaminant releases. [154]

**buildup (of radiation in material):** That part of the total value of a specified radiation quantity at any point due to radiation that has undergone interactions in the material or that results from such interactions (see scattered radiation). [163]

**buildup cap:** A device placed over an ionization chamber or other type of radiation detector to ensure secondary electron equilibrium at the highest photon energy being measured. [Comm20]

**buildup factor:** Ratio of the total (secondary and scattered plus unscattered) radiation at any point to the radiation that has not undergone interactions (unscattered) from the source to the point. [158]

**bullae:** A blister, usually >5 mm in diameter. [156]

**bundles:** Metal compressed into rectangular shapes for adding to metal-making furnaces; may also be called bales. The machines doing the compressing are typically called balers. [141]

**bunker gear:** A firefighter's protective clothing. Bunker gear usually consists of boots, pants, coat, gloves, hood, helmet, and self-contained breathing apparatus (also called personal protection equipment). [165]

**burial:** With reference to an aquatic ecosystem, the accumulation of sediment over time that can result in burial of material that was deposited earlier. [154]

**bypass migration:** In the context of this Report, bypass migration refers to the movement down through the soil profile of small particles containing  $^{137}\text{Cs}$  or another contaminant. Such movement occurs in cracks from soil drying, tunnels created by soil invertebrates, etc. [154]

**byproduct:** When used in the iron and steel industries, refers to slag or the metal oxide fume (dust) produced during the metal-making process. [141]

**byproduct material:** Any radioactive material (except special nuclear material) produced in a nuclear reactor; tailings or wastes produced by the extraction or concentration of uranium or thorium from ore processed primarily for its source material content; any discrete source of  $^{226}\text{Ra}$  (e.g., sealed or plated source, self-luminous time piece or instrument dial); or any radioactive material produced in a particle accelerator operated to produce radioactive material (see source material and special nuclear material). [157]

**byproduct material:** (1) Any radioactive material (except special nuclear material) yielded in, or made radioactive by, exposure to radiation incident to the process of producing or utilizing special nuclear material, and (2) tailings or waste produced by extraction or concentration of uranium or thorium from any ore processed primarily for its source material content. Byproduct material does not include ore bodies depleted by uranium solution extraction operations and which remain underground. The Energy Policy Act of 2005 amended the definition of byproduct material to include (1) any radioactive material produced in an accelerator, (2) discrete sources of  $^{226}\text{Ra}$ , and (3) any discrete source of naturally occurring radioactive material, other than source material, that NRC determines would pose a threat similar to that posed by a discrete source of  $^{226}\text{Ra}$ . NRC has not yet developed regulations to address control of these materials. [152]

**bystander effects:** A term related to the fact that gene products of transfected DNA can pass from transfected cells to neighboring cells through cell-gap junctions. In radiobiology, the term is used to describe the effects on cells in which



the energy had not been directly deposited. In most instances, the cells so affected were neighbors of the cells directly impacted by the radiation. [167]

**$\chi^2$ -distribution:** The probability distribution of the sum of the squares of a number ( $\nu$ ) of independent standard normal variables. The mathematical formula of the distribution is:

$$p(x) = \frac{1}{2^{\frac{\nu}{2}} \Gamma\left(\frac{\nu}{2}\right)} x^{\frac{\nu-2}{2}} e^{-\frac{x}{2}}, \quad x > 0$$

(i.e., where  $\Gamma(\nu/2)$  denotes the gamma distribution. The parameter  $\nu$  is usually known as the degrees of freedom of the distribution. [164]

**$\chi$ -squared distribution:** A special case of the gamma distribution in which  $\underline{\nu} = \nu/2$  and  $\underline{\lambda} = 1/2$  is an integer and is associated with the degrees of freedom of the  $\chi$ -square. The sum of squares of independent standard normal random variables is  $\chi$ -square (hence gamma) distributed with  $\underline{\nu} = 1/2$  and  $\underline{\lambda} = 1/2$ . [158]

**calcitonin:** A peptide hormone, of which eight forms in five species are known; composed of 32 amino acids and produced by the parathyroid, thyroid and thymus glands; its action is opposite to that of parathyroid hormone in that calcitonin increases deposition of calcium and phosphate in bone and lowers the level of calcium in the blood. [159]

**calibration:** For an instrument intended to measure dose or dose-rate-related quantities, calibration is the determination of the instrument response in a specified radiation field delivering a known dose (rate) at the instrument location; calibration normally involves the adjustment of instrument controls to read the desired dose (rate) and typically requires response determination on all instrument ranges. [166]

**calibration:** The act of standardizing an instrument to a known source, or a laboratory procedure to a known result. [165]

**calibration:** The determination of the instrument response in a specified radiation field delivering a known dose (rate) at the instrument location. Calibration normally involves the adjustment of instrument controls to read the desired dose (rate) and typically requires response determination on all instrument ranges. [163]

**calibration:** For an instrument intended to measure dose or dose rate related quantities calibration is the determination of the instrument response in a specified radiation field delivering a known dose (rate) at the instrument location; calibration normally involves the adjustment of instrument controls to read the desired dose (rate) and typically requires response determination on all instrument ranges. For instruments designed to measure radioactive surface contamination, calibration may be the determination of the detector reading per unit surface activity or the reading per unit radiation emission rate per unit surface area, or the reading per unit activity. [156]

**calibration factor:** A number that converts counts to disintegrations. [164]

**cancer:** A general term for more than 100 diseases characterized by abnormal cells and altered control of proliferation of malignant cells. [168]

**cancer:** A general term for more than 100 diseases characterized by abnormal and uncontrolled growth of cells. [167]

**cancer:** A malignant tumor of potentially unlimited growth, capable of invading surrounding tissue or spreading to other parts of the body by metastasis. [159]

**cancer detection rate:** The overall number of cancers detected per 1,000 patients examined. [149]

**capillary fringe:** Zone immediately above the water table in which water is held by surface tension and is under a pressure less than atmospheric. In the capillary fringe of a porous medium, the volumetric water content is constant. [152]

**capture gamma ray:** A photon emitted as an immediate result of the neutron-capture process. [144]

**carcinogen:** An agent that is associated with an increase risk of cancer. Ionizing radiation is a physical carcinogen; there are also chemical and biological carcinogens; biological carcinogens may be extrinsic (e.g., viruses) or intrinsic (genetic defects). [159]

**carcinogenesis:** Induction of cancer by radiation or any other agent (a somatic effect). [167]

**carcinoid tumor:** A usually small, slow-growing neoplasm composed of islands of cells, usually occurring in the gastrointestinal tract. [150]

**carcinoma:** A malignant tumor (cancer) of epithelial origin. [159]

**carcinoma:** Malignant tumor made up of epithelial cells, tending to infiltrate surrounding tissues and give rise to metastases. [156]

**cardiac catheterization:** Passage of a small catheter through a vessel in an arm, leg or neck and into the heart, permitting the securing of blood samples, determination of intracardiac pressure, detection of cardiac anomalies, and injection of contrast media for imaging of vessels. [168]

**cargo conveyance:** A vehicle or other means of transportation for cargo. [Comm20]

**carina:** Ridge-like structure formed by the bifurcation of the trachea, at the distal end where it branches into the main bronchi. [125]

**C-arm:** A fluoroscopic system where the image receptor and x-ray tube are mounted at the opposite ends of a C-shaped arm. This design allows the x-ray tube and image receptor to be rotated about the patient through at least 90 degrees relative to the patient with no motion of the x-ray tube relative to the image receptor. [168]

**carnivore:** A meat-eating animal (or plant). [154]

**carrier:** A substance to which a radionuclide is attached. The amount of activity per unit mass of the carrier is the specific activity of the -substance. [164]

**case-control study:** An epidemiologic study in which people with disease and a similarly composed control group are compared in terms of exposures to a putative causative agent. [159]

**cassette:** A light-tight case, usually made of thin, low x-ray absorption plastic, for holding x-ray film. Intensifying screens for the conversion of x rays to visible light photons are mounted inside the cassette so that they are in close contact with the film. Almost all mammography cassettes today are equipped with single screens. [149]

**catastrophic incident:** “Any natural or man-made incident, including terrorism, that results in extraordinary levels of mass casualties, damage, or disruption severely affecting the population, infrastructure, environment, economy, national morale, and/or government functions” (FEMA, 2009). [166]

**cathode:** A negatively charged electrode, as of an electrolytic cell, a storage battery, or an electron tube. An electrode is a collector or emitter of electric charge or of electric-charge carriers, as in a semi-conducting device. [158]

**cation:** Positively charged ion. [156]

**cation exchange capacity (CEC):** A measure of the ability of soil particles to adsorb cations. [154]

**cavitation nucleus:** A small body, usually a cavity, which can serve as a site for acoustic cavitation. [140]

**cavity:** A volume filled with gas or vapor, or both. [158]

**cellularity factor:** The fraction of bone-marrow volume in trabecular bone that is made up of active hematopoietic cells. [164]

**cement:** Substance capable of making objects adhere to each other. In construction, cement is a burned and finely pulverized substance containing alumina, silica, lime, iron oxide, and magnesia that is used to form **concrete** when mixed with water, sand and aggregate. [152]

**central radiopharmacy:** A facility that dispenses radiopharmaceuticals to a number of users or institutions. [124]

**central tendency:** A measure of the middle of the data set. There are many different descriptive statistics that can be chosen as a measurement of the central tendency. The most commonly used are the average or arithmetic mean, or the median or geometric mean. [164]

**cephalometer:** A device used in obtaining cephalometric images. It consists of a source assembly, a connector arm, a head holder, and an image-receptor holder. [145]

**cephalometric:** Referring to images of the head, primarily the dentofacial structures, usually obtained in lateral and posteroanterior orientation. The images are used to measure and study maxillofacial growth and maxilla-mandible relationships. [160]

**cephalometric radiography:** Images of the head, primarily the dentofacial structures, usually obtained in lateral and posteroanterior orientation. Reproducible geometry is maintained by use of a cephalometer. The images are used to measure and study maxillofacial growth and maxilla-mandible relationships. [145]

**cervical adenitis:** Inflammation of a lymph node or of a gland in the neck. [159]

**cgs system:** The system of units using centimeters, grams and seconds. [144]

**characteristic curve:** In an unsaturated porous medium, relationship between moisture content and suction pressure, hydraulic conductivity and suction pressure, or hydraulic conductivity and moisture content; also referred to as a moisture characteristic curve. [152]

**characteristic waste:** A solid waste that is not listed by the U.S. Environmental Protection Agency (EPA) as a hazardous waste but exhibits a hazardous waste characteristic. EPA has identified four characteristics of a hazardous waste: ignitability, corrosivity, reactivity and toxicity (40 CFR 261.20 – 262.24). Any unlisted solid waste that exhibits one or more of these characteristics is classified as a hazardous waste under the Resource Conservation and Recovery Act (RCRA). [141]

**characteristic x ray:** Secondary photon radiation produced when a vacancy in the inner electron shell of an atom is filled by an outer-shell electron of the atom. [157]

**charge bucket (box):** A container used to load or charge scrap into a furnace. Charge buckets are usually cylindrical and are used to charge scrap to electric arc furnaces and cupolas; charge boxes are rectangular and are used to charge scrap to basic oxygen furnaces. [141]

**charged particle:** An atomic or subatomic quantity of matter (e.g., electron, proton, alpha particle, ionized atom) having a net positive or negative electrical charge of one or more elementary units of charge. [167]

**charged-particle equilibrium:** When the energy lost from the active detection volume by charged particles escaping the volume is balanced by the energy gained in the volume by charged particles produced in the walls of the detection system. [158]

**charged particle equilibrium:** An equilibrium condition under which the energies, number, and directions of charged particles leaving a mass element of material are equal to the energies, number, and directions of charged particles entering the mass element. [112]

**chart:** A patient's medical record or treatment folder in written or electronic (computerized) format that is the permanent institutional document in a medical facility and that fully describes the medical history and care of the patient. [155]

**chelate:** Chemical compound in which the central atom (usually a metal ion) is attached to neighboring atoms by at least two bonds in such a way as to form a ring structure. [166]

**chelation:** Formation of a chelate; therapeutic administration of a chelating agent. [166]

**chelation:** In chemistry, this describes the combination of a metallic ion with heterocyclic ring structures in such a way that the ion is held by bonds from each of the rings. [154]

**chemisorption:** Adsorption in which forces involved are valence forces of the same kind as those operating in the formation of chemical compounds; also referred to as chemical adsorption. [152]

**chemotactic:** Pertaining to movement of a motile organism in response to chemical stimulation. [156]

**cholangiocarcinoma:** Adenocarcinoma of the bile ducts. [156]

**cholangiography:** Radiographic examination of the bile ducts employing a contrast medium. [156]

**chondroitin:** A mucopolysaccharide widespread in connective tissue, particularly cartilage, and in the cornea. [156]

**chorion:** The outer fetal membrane that adheres to the uterine lining and surrounds the amnion. [128]

**chromatid:** Either of two parallel filaments joined at the centromere that comprise a chromosome. [156]

**chromosphere:** The portion of the solar atmosphere between the photosphere and the corona. The portion of the solar atmosphere in which color can be distinguished. [153]

**ciliated cell:** Roughly columnar cell type having "hairlike structures" or cilia on its upper surface; a major cell type in all airway epithelium. [125]

**cinfluorography:** The production of motion picture photographic records of the image formed on the output phosphor of an image intensifier by the action of x rays transmitted through the patient. [168]

**cinfluorography:** The production of motion picture photographic records of the image formed on the output phosphor of an image intensifier by the action of x rays transmitted through the patient (often called cineradiography or cine). [133]

**Clara cell:** A rounded, club-shaped, nonciliated cell protruding between ciliated cells in the bronchiolar epithelium. Named after Max Clara, an Austrian anatomist, 1899. [150]

**classical error (measurement):** The classical measurement error model assumes that observed dose equals true dose plus measurement error, where measurement error is a random variable that is independent of the true dose and has a mean of zero (see measurement error and Berkson error). [163]

**classical measurement error:** The classical measurement error model assumes that observed dose equals true dose plus measurement error, where measurement error is a random variable that is independent of the true dose and has a mean of zero (see measurement error and Berkson error). [158]

**Classical measurement error model:** The Classical measurement error model assumes that observed dose equals true dose plus measurement error, where measurement error is a random variable that is independent of the true dose and has a mean of zero (see Berkson error model). [164]

**clay:** An earthy material and component of soil that is composed mainly of fine particles of hydrous aluminum silicates and other minerals. [154]

**cleanup:** Decontamination and removal of radioactive or other hazardous materials from a contaminated site. Sometimes used to refer to the more general concept of remediation. [163]

**clearance:** The action that results in the movement of radioactive material from the site of deposition in tissues and organs. This action can be natural, induced or enhanced by therapeutic means. [161]

**clearance:** A regulatory process to certify the removal of solid materials from an existing regulated radiation environment for the purpose of unrestricted release.

**clearance pathway:** Routes by which material deposited in the lungs can move into the blood, lymph nodes or bronchi. [125]

**clearance rate:** Refers to the rate of loss of substances from a compartment. [164]

**cleavage:** First few cell divisions of an ovum. [128]

**clinical breast examination (CBE):** A complete examination of the breasts and axilla with palpation by a health care professional, including examination of the breasts with the woman upright and supine. [149]

**Clinical Decision Guide (CDG):** A new operational quantity introduced to guide physicians in considering the need for medical treatment. The numerical values of dose used as a basis for computing the CDG intake values for different radionuclides, excluding isotopes of iodine, in adults are 0.25 Sv (25 rem) (50 y effective dose) for consideration of stochastic effects; a 30 d RBE-weighted absorbed-dose value of 0.25 Gy-Eq (25 rad-Eq) for consideration of

deterministic effects to bone marrow; and a 30 d RBE-weighted absorbed-dose value of 1 Gy-Eq (100 rad-Eq) for consideration of deterministic effects to the lungs. For radionuclides other than isotopes of iodine, CDGs for children (0 to 18 y of age) and pregnant women are defined as one-fifth the adult value. CDG values for  $^{131}\text{I}$  are based on FDA recommendations that KI be administered to adults >40 y of age if the projected dose to thyroid is  $\geq 5$  Gy (500 rad), to adults 18 to 40 y of age if the projected dose is  $\geq 0.1$  Gy (10 rad), and to pregnant or lactating women or persons <18 y of age if the projected dose is  $\geq 0.05$  Gy (5 rad). [166]

**clinical privileges:** The authorities granted to a physician by a hospital governing board to provide patient care in the hospital. Clinical privileges are limited to the individual's license, experience and competence. [168]

**coefficient of variation (COV):** The ratio of the standard deviation to the mean. [164]

**coefficient of variation (CV):** Ratio of the standard deviation to the mean. [158]

**cohort film badge:** A film badge worn not by the individual of interest but rather by a member of the unit with similar duties and activities whose radiation exposure would presumably be similar to that of the individual. [163]

**cohort study:** An epidemiologic study in which groups of people (the cohort) are identified with respect to the presence or absence of exposure to a disease-causing agent, and in which the outcomes of disease rates are compared; also called a follow-up study. [159]

**collagen:** A fibrous structural protein that constitutes the protein of the white fibers (collagenous fibers) of skin, tendon, bone cartilage, and all other connective tissues. [156]

**collagenase:** An enzyme that catalyzes the degradation of collagen. [156]

**collapse:** Rapid decrease in volume of a cavity which, in an aqueous medium, leads to production of shock waves, free radicals and/or sonoluminescence. [140]

**collective effective dose ( $\underline{S}$ ) (person-Sv):** Most frequently the product of the mean effective dose for a population and the number of persons in the population, but, more precisely, and preferably, the sum of all individual effective doses in the population of concern. [167]

**collimate:** To reduce the cross-sectional area of a beam of photons or particles. [144]

**collimator:** A device used to reduce the cross-sectional area of the useful beam of photons or electrons with an absorbing material. In diagnostic nuclear-medicine imaging, it is a device, usually lead, placed in front of a detector that increases the probability that incident photons will originate from a chosen direction. For example, parallel hole collimators are intended to allow only photons that are orthogonal to the body portion being imaged to interact with the imaging detector. [164]



**collimator:** A device used to reduce the cross-sectional area of the useful beam of photons or electrons with an absorbing material. [151]

**colloid:** Very fine solid particles that can remain suspended for long periods in water without settling, but which are incapable of passing through a semipermeable membrane. [164]

**colloid:** Small, insoluble and nondiffusible particle (as a single large molecule or mass of smaller molecules) in solid, liquid or gaseous form that remains in suspension in a surrounding solid, liquid or gaseous medium of different matter. [160]

**colloid transport:** The movement of particle-reactive contaminants such as  $^{137}\text{Cs}$  attached to colloid-sized particles that occurs as a result of movement of the colloidal particles. [154]

**column:** The solid matrix within a generator upon which the parent radionuclide is chemically or physically bound. [124]

**combined injury:** Radiation injury exacerbated by other types of bodily injury (e.g., skin burns, open wounds). [165]

**comedo:** A dilated hair follicle infundibulum filled with keratin, squamae, bacteria and sebum. [150]

**commercial waste (radioactive):** Radioactive waste generated in any activity by a nongovernmental entity. Often refers to waste containing source, special nuclear, or byproduct material regulated by the U.S. Nuclear Regulatory Commission or an Agreement State, but also may refer to waste containing naturally-occurring and accelerator-produced radioactive material that is currently regulated only by the states. [160]

**committed (dose):** Integral of an internal dose rate parameter over a specified period of time following an acute intake of a radionuclide by ingestion, inhalation or dermal absorption. Time period over which committed doses are calculated normally is 50 y for intakes by adults or from age at intake to age 70 for intakes by other age groups. [156]

**committed dose:** Integral of an internal dose rate over a specified period of time following an intake of a radionuclide by ingestion, inhalation, or dermal absorption. The commitment period of time (time of integration) is 50 y of age for workers and adults and to 70 y of age for children and pregnant women. [166]

**committed dose:** Dose (absorbed dose, dose equivalent, equivalent dose, effective dose, or effective dose equivalent) delivered to specified organs or tissues over a specified period of time following an acute intake of a radionuclide by ingestion, inhalation, or dermal absorption. Time period over which committed doses are calculated normally is 50 y for intakes by adults or from age at intake to 70 y of age for intakes by other age groups. [164]

**committed dose:** Dose delivered to specified organs or tissues over a specified period of time following an acute intake of a radionuclide by ingestion, inhalation or dermal absorption. Time period over which committed doses are calculated normally is 50 y for intakes by adults or from age at intake to age 70 for intakes by other age groups. [152]

**committed effective dose (person-Sv):** Most frequently the product of the mean effective dose for a population and the number of persons in the population, but, more precisely, and preferably, the sum of all individual effective doses in the population of concern. [166]

**committed effective dose  $[E(\tau)]$ :** The sum of the products of the committed organ or tissue equivalent doses and the appropriate weighting factors ( $w_T$ ), where  $\tau$  is the integration time in years following the intake. The commitment period is taken to be 50 y for adults, and to age 70 y for children. [161]

**committed effective dose:** Effective dose due to absorbed doses in the specified organs or tissues over a specified period of time following an intake of a radionuclide by ingestion, inhalation, or dermal absorption. The time period over which the committed effective dose is calculated normally is 50 y for intakes by adults or from age-at-intake to age 70 y for intakes by other age groups. [160]

**committed equivalent dose:** Integral of an equivalent dose rate to an organ or tissue over a specified period of time following an intake of a radionuclide by ingestion, inhalation, or dermal absorption. For workers and adults, the commitment period of time (time of integration) is 50 y and to age 70 for children and pregnant women. [166]

**community (plant or animal):** The assemblage of different plant and/or animal species that occupy a given area, and that provides crucial structure and functional processes to the ecosystem. [154]

**compartment:** In the context of modeling radionuclide transport in the environment or in the body, a compartment is conceptually and mathematically treated as a physically-, functionally- or physiologically-defined space in which a radionuclide can enter and mix throughout at a rate considerably faster than the rate it is lost from the space. [164]

**competing risks:** Other causes of death which affect the value of the risk being studied. Persons dying from other causes are not at risk of dying from the factor in question. [161]

**competitive inhibition:** The competitive exclusion or preferential selection of one ion over another ion of similar charge and chemistry from binding sites on surfaces or sites of membrane penetration. This process occurs, for example, with competition among  $Cs^+$ ,  $K^+$ ,  $NH_4^+$ ,  $Na^+$ , etc. [154]

**complex:** A chemical association of two or more species (as ions or molecules) joined usually by weak electrostatic bonds rather than covalent bonds. [154]

**complex plane:** A representation of complex numbers of the form  $\underline{x} + i\underline{y}$ , where  $\underline{x}$  and  $\underline{y}$  are real numbers.  $\underline{x}$  is called the real part of the complex number, and  $\underline{y}$  is called the imaginary part. One can visualize complex numbers by associating them with points ( $\underline{x}$ ,  $\underline{y}$ ) in a plane. [158]

**Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or “Superfund”):** Law passed in 1980, and amended by Superfund Amendments and Reauthorization Act (SARA) of 1986 and later amendments, that governs federal response and compensation for unpermitted and uncontrolled releases, including threats of release, of hazardous substances, including radionuclides, to the environment. An “unpermitted” release is any release that is not properly regulated under other laws. An important focus of CERCLA/ SARA is remediation of old, unpermitted waste disposal sites that are closed or inactive. Objectives of the Superfund program are to protect human health and the

environment in a cost-effective manner, maintain this protection over time, and minimize amounts of untreated waste in the environment. [152]

**compression:** Involves pressing the breast between the compression device and the platform holding the film during mammography. [149]

**compression device:** A plastic paddle used to reduce blurring due to motion by holding the breast stationary, to help separate structures within the breast, and to decrease the thickness of breast tissue, minimizing the amount of radiation used and the amount of scattered radiation reaching the film. Ideally, the compression device is made of rigid, thin plastic and has a flat bottom surface that is parallel to the plane of the image receptor and with edges perpendicular to the plane of the image receptor to assist in moving breast tissue away from the chest wall and into the field of view. [149]

**compressive strength:** Compressive force per unit area that a material can withstand without significant change in properties. [152]

**Compton scattering:** Inelastic scattering of a photon by an essentially unbound electron. [164]

**computed radiography:** An imaging technique in which photo-stimulable phosphor plates are used as the image receptor for an x-ray image. The plate is then placed in a separate device and interrogated with a laser focused to a small area. The resultant stimulated light emission, proportional to the x-ray dose at that point, is detected and the signal digitized to form an array of pixels representing the x-ray image. [160]

**computed tomography (CT):** An imaging procedure that uses multiple x-ray transmission measurements and a computer program to generate tomographic images of the patient. [168]

**computed tomography dose index (CTDI):** A dose index quantity obtained by integrating over the dose profile resulting from a single computed tomography axial rotation. When obtained using a 10 cm (100 mm) long ionization chamber, it is designated  $\text{CTDI}_{100}$ . When normalized per milliampere-second (mAs), it is designated  $n\text{CTDI}_{100}$ . [160]

**computed-tomography-guided interventional (CTGI) procedure:** An interventional diagnostic or therapeutic procedure which uses external ionizing radiation in the form of computed tomography. [168]

**computed tomography scan:** Contiguous CT image covering the chest, abdomen and pelvis of a given patient. [164]

**concentration ratio ( $C_r$ ):** The ratio of measured activity density ( $\text{Bq kg}^{-1}$ ) in a receptor compartment to that in the relevant donor compartment. Common examples are fish/water, plant/soil, animal/food, milk/food, etc. [164]

**conceptual model:** Set of assumptions and qualitative descriptions about the behavior of a system that provides the basis for subsequent quantitative descriptions of the system and interpretations of results of mathematical, chemical or physical modeling. [152]

**conceptus:** General term referring to the product of conception, from the time the ovum is fertilized through the time of birth or parturition. [161]

**concerned citizens:** The term that has been used extensively in the past for these individuals is “worried well”; the Centers for Disease Control and Prevention and other federal agencies prefer to use the term “concerned citizens.” Concerned citizens may well overwhelm the capabilities of hospital emergency rooms when they do not have traumatic injuries, but are concerned because they may have been exposed to radiation or contaminated with radioactive material. [165]

**concrete:** Material formed by coalescence of particles into one solid mass. In construction, concrete is a material made by mixing cement with water, sand and aggregate. [152]

**concrete (ordinary):** Concrete whose constituents are those usually utilized in construction. Thus, ordinary concrete excludes those mixtures where special materials (iron, etc.) have been added to enhance the radiation-shielding properties. For example, the term excludes “heavy concrete.” [144]

**concrete equivalence:** The thickness of standard-weight concrete [ $2.4 \text{ g cm}^{-3}$  ( $147 \text{ lb foot}^{-3}$ )] affording the same attenuation, under specified conditions, as the material in question. [147]

**confidence interval (CI):** A measure of the extent to which an estimate of risk, dose or other parameter is expected to lie within a specified interval (e.g., a 90 % confidence interval of a risk estimate means that, based on available information, the probability is 0.9 that the true but unknown risk lies within the specified interval). [167]

**confidence interval (CI):** An interval estimate of an unknown parameter, such as a risk. A 95 % confidence interval, as an example, is constructed from a procedure that is theoretically successful in capturing the parameters of interest in 95 % of its applications. Confidence limits are the endpoints of a confidence interval. [159]

**confidence interval:** A statistical interval about the parameters of a distribution (see statistical interval and tolerance interval). [158]

**congenic:** Pertaining to two inbred strains of animals that are genetically identical except at a single locus or a few specified loci so that their known genetic differences are expressed in the same “genetic background.” [167]

**conservative bias:** Tendency of a model to overestimate, rather than underestimate, actual events. [152]

**constant potential:** The potential formed by a constant-voltage generator. [145]

**contact mammography:** Usual mammography, with the breast in direct contact with the Bucky (unlike magnification technique). [149]

**contained activity:** The activity of a radionuclide in a compartment (see inventory). [154]

**containment:** Confinement of material within a designated boundary. [152]

**contaminating radiation:** Radiation different from that expected/desired from the source. [112]

**contamination (radioactive):** Radioactive material that is present in any substance or area or on any surface where its presence is unwanted or unexpected. [166]

**contamination (radionuclide):** Radioactive material that is present in undesired locations such as on the surface of or inside structures, areas, objects or individuals. [165]

**contamination (radioactive):** A radioactive substance dispersed in materials or places where it is undesirable. [164]

**contamination:** Radioactive material suspended in air or deposited in any area or on any surface where its presence is unwanted or unexpected. [158]

**continuous casting:** The process in which molten metal is poured into a machine that produces a continuous ribbon of slabs, blooms or billets. At the output end of the machine, the product is cut into the desired lengths with automated torches. This method has essentially replaced ingot casting in the ferrous steel industry. [141]

**continuous improvement:** The process of continually evaluating programs, processes and tasks with the objective of making them more effective and efficient. The process is a continuous loop of identifying and implementing possible improvements, providing feedback on the changes, and assessing the overall results of the program. [162]

**contralateral:** Originating in or affecting the opposite side of the body. [164]

**contrast:**

- **subject contrast:** the difference between two anatomic structures in attenuation of an x-ray beam or:

$$\underline{C} = \frac{\underline{I}_A - \underline{I}_B}{\underline{I}_B},$$

where  $\underline{C}$  is subject contrast, and  $\underline{I}_A$  and  $\underline{I}_B$  are beam intensities after traversing structures A and B.

- **film contrast:** the ability of a film (or other image receptor) to translate subject contrast to differences in the resulting image. Film contrast depends on both film characteristics and processing. [145]

**control chart:** A graph showing a measured value from a system as a function of time (e.g., dose-rate output from a system as a function of time). [Comm20]

**controlled area:** A limited-access area in which the occupational exposure of personnel to radiation or to radioactive material is under the supervision of an individual in charge of radiation protection. This implies that access, occupancy and working conditions are controlled for radiation-protection purposes. [168]

**controlled area:** Limited-access area in which the exposure of all persons to radiation is under the supervision of an individual in charge of radiation protection. This definition implies that access, occupancy and working conditions are controlled for purposes of radiation protection. [161]

**controlled area:** Surface location, including the location of a waste disposal facility, identified by active or passive institutional control that is intended to be used for monitoring and surveillance of a disposal facility and to restrict or discourage public access, and the subsurface underlying such a surface location. [152]

**control limits:** The upper and lower limits around the operating level on a control chart. If the measured data reaches or exceeds the control limits the operator must cease using the equipment immediately until corrective action can be taken to bring the measured values back toward the operating level and within both the control limits and action levels. [Comm20]

**convection:** Movement of material within a fluid at a nonuniform temperature due to the variation in its density and the action of gravity. [152]

**conventional fluoroscopy:** An imaging technique using x rays to visualize the dynamics of bodily functioning. For example, a material with high x-ray absorption is injected or ingested and fluoroscopy is used to monitor the progress of the material through the blood vessels or gastrointestinal tract. The image receptor can be either an image intensifier and video-camera tube, or a large-area solid-state detector. [168]

**conventional radiography:** An imaging technique where the image receptor consists of a combination of (usually two) intensifying(s) screens in intimate contact with a photographic film (usually a dual-emulsion film). After exposure to the x-ray image, the photographic film is then processed in chemical solutions. Photographic film is relatively insensitive to x rays; the light from the intensifying screens produces most of the film optical density. Also referred to as screen-film radiography. [168]

**conventional risk cross section ( $r_{\sigma_C}$ ):** The probability per unit fluence (mean for the organ or tissue of interest) of producing an endpoint of interest (e.g., cancer mortality or incidence). The conventional risk cross section is a single-valued function of LET and is proportional to  $Q(L) L$ , where  $Q(L)$  is the radiation quality factor as a function of LET. [137]

**conventional true value:** An approximation of the true value of a quantity. Errors must be approximated because the true value cannot be known. [158]

**conversion coefficient:** The quotient of the equivalent dose under specified conditions and the associated field quantity (air kerma or fluence). Conversion coefficients, when given for a range of beam energies (and possibly beam directions), define a conversion function. [164]

**conversion coefficient (organ doses):** The quotient of the organ dose or dose equivalent from external sources under specified conditions by the associated field quantity (e.g., air kerma or fluence). [163]

**conversion coefficient:** The quotient of a dose quantity under specified conditions and an associated field quantity (e.g., air kerma or fluence). [160]

**conversion coefficient:** A parameter that relates one quantity to a second quantity (e.g., luminescence to exposure) (see dose conversion coefficient). [158]

**converter:** The material in an accelerator upon which the electrons impinge and produce bremsstrahlung (see **electron target**). [Comm20]

**conveyance:** A vehicle or other means of transportation. [Comm20]

**coordination complex:** Compound in which an atom or group of atoms is bound to the central atom by a shared pair of electrons supplied by the coordinated group and not by the central atom. [152]

**core:** In the context of nuclear reactors, the core is the fuel assembly where nuclear fission occurs. Damage to the core can result in the release of radioactive fission and activation products. [154]

**cornea:** The transparent epithelial structure forming the anterior part of the external covering of the eye. [156]

**corona:** The portion of the solar atmosphere above the chromosphere. [153]

**coronal mass ejection (CME):** A transient outflow of plasma from or through the solar corona which may be associated with the generation of solar-particle events. [153]

**coronary angiography:** Radiographic visualization of the coronary arteries after the introduction of contrast material. [133]

**corrective action:** An action determined by an assessment team to be the most appropriate to fix the finding or problem or prevent recurrence of the problem. [162]

**correlation:** A measure of the interdependence of two random variables. Positive correlation is the simultaneous increase or decrease in value of two numerically-valued random variables while negative correlation is the simultaneous increase in one and decrease in the second. [164]

**correlative physical examination:** Directed palpation of the breast performed by either the radiologic technologist or the interpreting physician to improve interpretation and ensure that a palpable abnormality is included on the film. [149]

**corrosion:** Wearing away of a material or degradation of material properties by the action of chemicals. [152]

**cortical bone:** The dense outer layer of bone found, particularly, on the outer surface of mammalian long bones [164]

**corticogenesis:** Histogenic process by which the cerebral cortex of the brain is formed. [128]

**cosmic radiation:** Ionizing radiation, including electromagnetic radiation and energetic particles, originating in space or produced by interactions of such radiation with constituents of Earth's atmosphere. [167]

**cosmic radiation:** Penetrating ionizing radiation, both particulate and electromagnetic, that originates in outer space. [161]

**cosmic-ray modulation:** The variation of the observed cosmic-ray intensity as a function of the solar cycle. The cosmic-ray intensity is observed to vary approximately inversely with the solar activity cycle. [153]

**cost-effectiveness:** A systematic quantitative method for comparing the costs of alternative means of achieving the same stream of benefits or a given objective. [146]

**countermeasure:** An action designed to reduce radiation doses in persons contaminated with radioactive materials. [161]

**countermeasure:** As used in this Report, an action designed to reduce human exposure to environmental radioactive contamination. [154]

**count median diameter (CMD):** Particle size for which there are equal numbers of particles above and below this value. [125]

**counts:** Individual radiation events detected using a radiation measurement device. The number of counts collected over a given time interval are related to the disintegration rate of the radionuclide in the sample. [164]

**covariance:** A measure of the strength of the linear relationship between two variables (see correlation). [163]

**cover:** Layer of soil or other earthen or man-made materials installed above waste upon closure of a disposal facility. [152]

**craniocaudal (CC) view:** One of two routine views for mammography. The image receptor is placed caudad to (below) the breast and the vertical x-ray beam is directed from cranial to caudad (downward) through the breast. [149]

**creatinine:** Nitrogenous compound formed as the end product of creatine metabolism. [156]

**credibility interval:** For example, a 90 % credibility interval is a range within which it is believed that there is a 90 % probability that the true but unknown value of a quantity lies. The term “credibility” is used to indicate that probability distributions of parameters or model outputs often are based to a significant extent on subjective and sometimes untestable scientific judgment. [163]

**creep:** Change in shape as a result of constant stress, temperature, or other external influences. [152]

**cribriform:** Sieve-like, with many perforations. [150]

**cricoid cartilage:** Lower-most cartilage of the larynx which is shaped like a signet ring. [125]

**critical group:** Subgroup of an exposed or potentially-exposed population that receives or is expected to receive the highest dose due to exposure. [163]

**critical group:** Subgroup of an exposed or potentially-exposed population that receives or is expected to receive the highest dose or experience the highest risk due to exposure. [152]



**criticality:** A term used in weapon and reactor physics to describe the state of a given fission system when the specified conditions are such that the mass of active material present is precisely a critical mass. Thus, the fission neutron production rate is a constant and is exactly balanced by the combined rate of neutron loss and utilization so that the neutron population remains a constant. Supercriticality occurs when a greater than critical mass of active material is present and the neutron population increases rapidly. [161]

**criticality:** The point at which a nuclear fission reaction becomes capable of sustaining a chain reaction.

**critical organ:** Organ receiving the highest dose or experiencing the highest risk from exposure to radiation or radionuclides. [167]

**critical population:** Subgroup of an exposed or potentially-exposed population that receives or is expected to receive the highest dose or experience the highest risk due to exposure. [161]

**cross section:** The quotient of the probability of an interaction event between a single target entity and incident particles or radiations by the particle or radiation fluence (see fluence). The special unit for the cross section is barn ( $1 \text{ barn} = 10^{-28} \text{ m}^2$ ). [163]

**cross section:** The quotient of probability by particle fluence, referring to the probability of an interaction for a single target entity when subjected to a given particle fluence (see fluence). The interaction is produced by incident charged or uncharged particles. Cross sections are expressed in units of area. [Comm20]

**cumulated activity ( $\tilde{A}$ ):** The time integral of the activity ( $\int \underline{A}(t)dt$ ) which is proportional to the sum of all the nuclear transitions during a given time interval. [164]

**cumulative absorbed dose:** A real-time integration of absorbed dose to the whole body from photons. [165]

**cupola:** An open metal-making furnace in which scrap, coke and flux are added at the top and hot air is blown in near the bottom. Energy to melt the metal is produced by the reaction of the hot air and the carbon in the coke. Cupolas are typically used to produce small batches of iron. [141]

**curie (Ci):** The previous special name for the unit of radioactivity equal to  $3.70 \times 10^{10}$  becquerels (or disintegrations per second) (see becquerel). [164]

**curie (Ci):** The special unit previously used for activity (see activity and becquerel). [157]

**cuticle:** The waxy coating of the epidermis on all aboveground parts of a plant. [154]

**cyclotron:** An accelerator that produces high-speed ions (e.g., protons and deuterons) under the influence of an alternating magnetic field for bombardment and disruption of atomic nuclei. [159]

**cyst:** A fluid-filled sac that may be felt on physical examination or depicted by mammography or ultrasonography. [149]

**cytokines:** Hormone-like low molecular weight proteins that regulate the intensity and duration of immune responses, and play a role in cell-to-cell communication. [156]

**cytotoxicity:** Ability of a substance to induce degenerative changes in cells that may lead to cell death. [156]

**Darcy velocity:** Product of the hydraulic conductivity of a porous medium and the gradient in pressure head. [152]

**dark current:** A type of noise that occurs in light-sensitive detectors, most typically in photomultipliers. Photomultipliers emit a small signal even in the absence of light, mostly due to thermal activity in the photocathode and the dynodes; hence operation at low temperature can alleviate the effect. Leakage currents are sometimes also named “dark” currents (e.g., in semiconductor detectors). [158]

**darkroom fog:** Added optical density on a film due to light leaks or safe lights in a darkroom. It degrades image contrast and must be tested and eliminated to ensure image quality. [149]

**dead-man switch:** A switch constructed so that a circuit-closing contact can be maintained only by continuous pressure on the switch. [148]

**deadtime:** The interval of time between the initial pulse and the time at which a second Geiger discharge (of any size) can be developed (e.g., a Geiger-Muller tube). [161]

**dead-time:** The interval of time during the development of the pulse initiated by the interaction of a radiation-induced event in a detector when additional events are unable to be counted. [158]

**debride:** Remove foreign objects and contaminated and devitalized tissue from or adjacent to a wound or lesion until surrounding healthy tissue is exposed. [156]

**debridement:** The process of removing foreign objects and contaminated and devitalized tissue from or adjacent to a wound or lesion until surrounding healthy tissue is exposed. [166]

**decay (radioactive):** The spontaneous nuclear transformation of one nuclide into a different nuclide or into a different energy state of the same nuclide. [163]

**decay constant ( $\lambda$ ):** The quotient of  $dP$  by  $dt$ , where  $dP$  is the probability that a given nucleus undergoes a spontaneous nuclear transformation in the time interval and has units of  $dt$  ( $s^{-1}$ ) [164]

**decay rate:** The probability that a given nucleus undergoes a spontaneous nuclear transformation in the time interval  $dt$ . The unit for decay rate is the reciprocal second ( $s^{-1}$ ). [161]

**decidua:** Specialized endometrial connective tissue that is differentiated during pregnancy in most mammals that have placentas; it represents maternal tissues that are expelled at parturition. [128]

**decidual basalis:** Decidua at the base of the placenta, to which the placenta is attached. [128]

**deciduous:** Refers to types of shrubs, trees or forests dominated by woody species that drop their leaves seasonally. [154]

**decision dose:** A cumulative absorbed dose to the whole body (from photons) of 50 rad (0.5 Gy) to a specific emergency responder. At that whole-body absorbed dose, the decision at the command level is whether the emergency responder should be withdrawn from the radiation control zones. [165]

**decommission:** The process of closing down a facility followed by reducing the residual quantities of radioactive material to a level that permits the release of the property for either limited (restricted) or unrestricted use. [157]

**decommissioning:** The process of closing down a facility followed by reducing the residual quantities of radioactive material to a level that permits the release of the property for either limited (restricted) or unrestricted use. [160]

**decommissioning:** Removal of a facility or site safely from service and reduction of residual activity and other hazardous substances to levels that permit (1) release of the property for unrestricted use and termination of the license or operating permit or (2) release of the property under restricted conditions and termination of the license or operating permit (see cleanup and remediation). [146]

**decomposition:** The process of the reduction of dead organic matter to its basic chemical components by the action of microorganisms such as fungi and bacteria. [154]

**decontamination:** Action taken to remove radionuclides from clothing and the external surfaces of the body, from rooms, building surfaces, equipment, and other items. [166]

**decontamination:** The removal of radionuclide contaminants from surfaces (e.g., skin) by cleaning and washing. [165]

**decontamination:** Treatment process that reduces or eliminates the presence of a harmful substance, such as a radioactive material. [163]

**decontamination:** The reduction or removal of contaminating radioactive material from a structure, area, object or person. [157]

**decontamination:** Treatment process that reduces or eliminates the presence of a harmful substance, such as a radioactive material, toxic chemical, or infectious agent. [156]

**decorporation:** The therapeutic processes by which radioactive materials are mobilized from tissues and organs and removed from the body by enhanced material excretion. [166]

**dedicated mammography equipment:** X-ray systems designed specifically for breast imaging. Such a unit provides a specialized imaging geometry and a device for breast compression and can consistently produce mammographic images of high quality. [149]

**deep-dose equivalent:** The dose equivalent at a tissue depth of 1 cm. The SI unit of deep dose equivalent is  $\text{J kg}^{-1}$ , and its special name is sievert (Sv) (see personal dose equivalent). [163]

**deep-dose equivalent:** Dose equivalent at a tissue depth of 1 cm. Also called personal dose equivalent at a depth of 1 cm.

The unit for deep dose equivalent in the SI system is  $\text{J kg}^{-1}$ , with the special name sievert (Sv). [160]

**deep-dose equivalent:** The dose equivalent at a tissue depth of 1 cm. Also called personal dose equivalent at a depth of 1 cm.

The SI unit of personal dose equivalent is the joule per kilogram ( $\text{J kg}^{-1}$ ), and its special name is the sievert (Sv) (see personal dose equivalent). [158]

**default value:** Prescribed for a model parameter in the absence of data directly relevant to the assessment situation. [164]

**defense waste:** Radioactive waste from any activity performed in whole or in part in support of U.S. Department of Energy (DOE) atomic energy defense activities. Not all DOE waste is defense waste (e.g., waste from research and development activities not related to atomic energy defense). [152]

**deletions:** Type of mutation in which sections of DNA or chromosomes are removed; term can refer to the removal of a single base or many bases. [159]

**delta function:** A probability density function (distribution) that is zero everywhere except at a specific point and whose integral or area under the curve is the total probability. [164]

**delta ray:** Highly energetic electrons produced during inelastic collisions between ionizing radiation and atomic electrons. In a small proportion of collisions, the ejected electron receives a considerable amount of energy (i.e.,  $>1,000$  eV), allowing it to travel a long distance and leave a trail of secondary ionizations. These secondary ionization events are easily observable in a cloud chamber. [159]

**delta ray:** An electron, stripped from an atom as a charged particle passes through matter, that has enough kinetic energy to cause subsequent ionization at a distant site. [137]

**de minimis:** As applied to hazardous substances, a dose or risk that would generally be considered negligible for any exposure situation, without regard for whether such a dose or risk is reasonably achievable for a particular source or practice. If doses or risks are below de minimis levels, efforts to control exposures generally would be unwarranted (see below regulatory concern). [141]

**densitometer:** An instrument that measures the optical density or degree of blackening of film. [158]

**dental assistant:** A member of the dental office staff whose principal duty is chair side assistance of the dentist in delivery of care. The assistant, properly trained, may be credentialed for exposure of dental radiographs. [145]

**dental bitewing:** An intraoral radiograph that demonstrates the crowns, necks and coronal thirds of the roots of both upper and lower teeth, so named because the patient bites upon a tab or “wing” projecting from the center of the image-receptor packet. [160]

**dental hygienist:** A member of the dental office staff whose principal duty is performing oral prophylaxis and related procedures; in the United States, a graduate of an accredited educational program in dental hygiene and registered in the state or political jurisdiction in which the practice is located. The dental hygiene curriculum includes training in radiography and the hygienist is credentialed to expose dental radiographs. [145]

**dental radiographic technologist:** An individual who is trained and skilled in, and credentialed for, performing routine and specialized radiographic examinations of the dentofacial region. [145]

**dentist:** A graduate of an accredited dental institution with a degree of DDS, DMD, or equivalent. [145]

**deoxyribonucleic acid (DNA):** Genetic material of cells; a complex molecule of high molecular weight consisting of deoxyribose, phosphoric acid, and four bases which are arranged as two long chains that twist around each other to form a double helix joined by hydrogen bonds between the complementary components. [167]

**depassivation:** Removal of protective coating on the surface of a material, resulting in an increase in chemical activity with surrounding materials. [152]

**depleted uranium (DU):** Uranium with an isotopic content of  $<0.7\%$   $^{235}\text{U}$ ; typically DU contains  $\sim 0.2\%$   $^{235}\text{U}$ . [166]

**deposition:** The process of airborne contaminants being deposited onto surfaces such as plant leaves or soil. Several processes can operate to cause deposition, including gravity, atmospheric turbulence, electrostatic attraction, rainfall, etc. [164]

**deposition:** Any action resulting in the occurrence of radioactive material on or in external surfaces of the body or on or in internal tissues and organs. [161]

**deposition density:** The activity of a radionuclide or other contaminant deposited per unit area of ground surface. [164]

**deposition velocity:** Ratio of the deposition rate (flux density) of a contaminant from the atmosphere ( $\text{Bq m}^{-2} \text{s}^{-1}$ ) on the ground surface to the concentration immediately above the ground ( $\text{Bq m}^{-3}$ ). [164]

**deposition velocity:** Ratio of flux density of a contaminant from the atmosphere to the ground surface to the concentration in air above ground. [152]

**depth distribution coefficient:** The coefficient describing the rate of exponential decline in the  $^{137}\text{Cs}$  (or other contaminant) mass activity density with soil depth, expressed in  $\text{cm}^{-1}$ . [154]

**derivative:** As used in the mathematical sense, the derivative represents the instantaneous rate of change of activity in a compartment resulting from the difference between input and loss rates. The dimensional units of the derivative are typically  $\text{Bq t}^{-1}$ . [164]

**dermis:** Layer of the skin between the epidermis and the subcutis, composed of the papillary and reticular layers. [161]

**design basis:** the coherent and complete set of requirements and specifications for a system. [Comm20]

**desorb:** The release of material adsorbed on solid particles back to the aqueous phase. [154]

**desorption:** Any mechanism that removes ions from the solid phase of a medium into the fluid phase (see sorption). [152]

**desquamation:** Loss of the epithelial elements of the skin. [161]

**detector:** A device or component designed to produce a quantifiable response to ionizing radiation, normally measured electronically. [165]

**detents:** Mechanical settings that limit or prevent the motion or rotation of an x-ray tube, cassette assembly, or image-receptor system or that allow exposures with specified tube orientations. [149]

**deterministic:** A description of effects whose severity is a function of dose, for which a threshold may occur. Some examples of somatic effects believed to be deterministic are cataract induction, nonmalignant damage to the skin, hematological deficiencies, and impairment of fertility. [159]

**deterministic calculation:** Methods of exercising mathematical models in which a single set of assumptions (i.e., scenario, model, and model input parameters) is used to calculate a single value of model output. [163]

**deterministic effects:** Effects that occur in all individuals who receive greater than a threshold dose; the severity of the effect varies with the dose above the threshold. Examples are radiation-induced cataracts (lens of the eye) and radiation-induced erythema (skin). [168]

**deterministic effects:** Detrimental health effects for which the severity varies with the dose of radiation (or other toxic substance), and for which a threshold usually exists (i.e., causally determined by preceding events). [167]

**deterministic effects:** Harmful tissue reactions that occur in all individuals who receive greater than a threshold dose of radiation; the severity of the effect varies with the dose. Examples are radiation-induced -cataracts (lens of the eye), radiation-induced erythema (skin), radiation-induced pneumonitis (lungs), hematopoietic failure (bone marrow), hypothyroidism (thyroid), and gastrointestinal failure (gastrointestinal tract). [166]

**deterministic effects:** Effects that typically occur soon after exposure, and that increase in magnitude with increasing dose above a threshold dose level. Examples of such effects include tumor regression, bone-marrow suppression, and nephrotoxicity. [164]

**deterministic effects:** Effects in organisms for which the severity varies with the dose of radiation (or other toxic substance), and for which a threshold usually exists. [156]

**deterministic effects:** Effects for which the severity varies with dose and for which a threshold usually exists (e.g., cataracts and skin burns). [153]

**deterministic methods:** Methods of exercising mathematical models in which a single set of assumptions (i.e., scenario, model, and model input parameters) is used to calculate a single value of model output. [164]

**deterministic model:** A model that uses single-value inputs and parameters to compute single-value outputs. [158]

**deterministic model:** A model whose output is predetermined by the mathematical form of its equations and the selection of a single value for each input parameter. [123]

**detriment:** Measure of stochastic effects from exposure to ionizing radiation that takes into account the probability of fatal cancers, probability of severe heritable effects in future generations, probability of nonfatal cancers weighted by the lethality fraction, and relative years of life lost per fatal health effect. [167]

**detriment:** Health detriment is the sum of the probabilities of all the components of health effects. These include in addition to fatal cancer the probability of heritable effects and the probability of morbidity from nonfatal cancer. [153]

**detritus:** Dead organic matter in various stages of decay or decomposition. Some food chains start with organisms that feed on detritus. [154]

**deuteron:** The nucleus of hydrogen composed of two neutrons and one proton; it thus has the one positive charge characteristic of a hydrogen nucleus. [159]

**developer:** A chemical solution that changes the film latent image to a visible image composed of black metallic silver. [158]

**developer replenishment:** Process whereby fresh developer is added in small amounts to the solution in the developer tank of the processor. The purpose is to maintain the proper chemical activity and level of solution in the developer tank that would otherwise decrease through use. [158]

**development:** Expression used in embryology in reference to the normal growth and differentiation of a part or the whole of an embryo, fetus or child. [128]

**deviance:** A statistic used for evaluating the degree to which a fitted statistical model approximates the data to which it has been fit. The deviance is calculated as minus two times the probability level or probability density function (for discrete and continuous distributions, respectively) according to the fitted model, evaluated at the observed data values. [126]

**diagnostic mammography:** A radiologic examination used to evaluate a patient with a breast mass or masses, other breast signs or symptoms (spontaneous nipple discharge, skin changes, etc.), an abnormal or questionable screening mammogram, or special cases such as a history of breast cancer with breast conservation or augmented breasts as a result of treatment. [149]

**diagnostic reference level (DRL):** A measured dose-related radiation field quantity (e.g.,  $K_{a,i}$  or  $P_{KA}$ ) used to evaluate whether the patient dose (with regard to stochastic effects) for a standardized noninvasive imaging task performed on a standard-size patient or standard phantom is unusually high or low. The upper DRL is typically selected as the 75th



percentile of the distribution of the dose-related radiation field quantity collected from a large number of facilities performing the noninvasive imaging task. [168]

**diagnostic reference level:** A patient dose-related quantity per x-ray procedure or image that, if consistently exceeded in clinical practice, should elicit investigation and efforts for improved patient dose management. [145]

**diagnostic source assembly:** A diagnostic source housing (x-ray tube housing) assembly with a beam-limiting device attached. [145]

**diagnostic x-ray tube housing:** An enclosure so constructed that the leakage radiation from the housing does not exceed specified limits. [148]

**diaphanography:** A noninvasive breast imaging technique that uses visible or near-visible light in an attempt to visualize breast masses. [149]

**diaphragm:** A device with a central aperture designed to restrict the beam to an appropriate area at the point of interest. [144]

**dielectric constant:** Another name for relative permittivity. [119]

**diethylenetriamine pentaacetic acid (DTPA):** Chelating substance that binds metal ions. DTPA is rapidly excreted from the body by the kidneys. [166]

**diethylene triamine pentaacetic acid (DTPA):** Chelating substance used to remove toxic metals from the body (often labeled with a tracer radionuclide such as  $^{99m}\text{Tc}$  or  $^{111}\text{In}$ ). DTPA is rapidly excreted from the body by the kidneys. [124]

**differential analysis:** Method of parameter sensitivity analysis of a model in which a model solution near a point in the domain of parameter values is approximated using lower-order derivatives of the solution at that point. [164]

**diffusion:** Spreading out of a material in a medium, due to thermal or mechanical agitation, in response to a concentration gradient. [156]

**diffusion:** Brownian or random motion of particles due to collisions with surrounding molecules resulting in movement from a region of higher to one of lower concentration. [154]

**diffusion coefficient:** Measure of rate of diffusion of a material in a medium, given by the ratio of the diffusive flux of material crossing a defined boundary to the (negative) concentration gradient. [152]

**diffusion equivalent diameter:** Diameter of a sphere having the same rate of diffusion (or diffusion coefficient) as the particle in question. [125]

**diffusivity:** Hydraulic conductivity divided by differential water capacity, or flux of water per unit gradient of water content in the absence of other force fields. [152]

**digital mammography:** Mammography performed with an image detector that converts the x-ray signal into electronic form. The acquisition and display operations are separated. [149]

**digital radiography:** A diagnostic procedure using an appropriate radiation source and imaging system that collects, processes, stores, recalls and presents image information in a digital array rather than on film. [164]

**digital radiography:** An imaging technique using an x-ray sensitive plate integrated into the x-ray imaging system. The plate converts the absorbed x-ray image into an electrical charge map which is then digitized to form an array of pixels representing the x-ray image. The image information is presented in a digital array rather than on film. [160]

**digital subtraction angiography (DSA):** Radiographic visualization of blood vessels, with images produced by subtracting background structures and enhancing the contrast of those areas that change in density between a preliminary “mask” image and subsequent images. [133]

**diode:** In electronics, a component that restricts the directional flow of charge carriers. Essentially, a diode allows an electric current to flow in one direction, but blocks it in the opposite direction. For the purposes of this Report, a diode refers to a radiation detector that is based on a semiconductor (usually silicon or germanium) diode. [158]

**direct exposure x-ray (film) images:** A dual-emulsion photographic film is exposed directly to x rays, without the use of intensifying screens. The radiation dose required for direct exposure imaging is 10 to 20 times higher than is required with screen-film imaging since the photographic film is relatively insensitive to x-ray exposure. [160]

**directional dose equivalent  $[H'(d, \Omega)]$ :** Dose equivalent at a point in a radiation field that would be produced by the corresponding expanded field in an ICRU sphere at depth ( $d$ ) on a radius in a specified direction ( $\Omega$ ). The SI unit of directional dose equivalent is joule per kilogram ( $J\ kg^{-1}$ ) and its special name is sievert (Sv). [158]

**directly ionizing radiation:** Charged particles (electrons, protons, alpha particles) having sufficient kinetic energy to produce ionization by collision (see ionizing radiation). [151]

**direct radiation:** Radiation emitted from the target or source that passes through the collimator opening (see useful beam and primary radiation). [151]

**disaster:** An incident that overwhelms normal operations. Critical functions and infrastructure are unable to respond much less return to -normal on their own, thus require regional or federal assistance (Farmer, 2006). [166]

**dispersion:** Spreading of a suspended substance in a medium such as air or water due to random variations in the structure of the medium and turbulence, or random variations in the speed and direction of flow. [154]

**dispersion:** Spreading of a flowing substance in a medium due to random variations in the structure of the medium or random variations in the speed and direction of flow. [152]

**dispersion coefficient:** Measure of rate of dispersion of material in flow in a medium, given by the dispersive flux divided by the negative of the concentration gradient. [152]

**dispersivity:** Measure of dispersion characteristics of a porous medium defined as the ratio of the dispersion coefficient to the fluid velocity in the medium. [152]

**disposal:** Placement of waste in a facility designed to isolate waste from the accessible environment without an intention to retrieve the waste, irrespective of whether such isolation permits recovery of waste. [163]

**disposal facility:** Land, structures and equipment used for disposal of waste. [152]

**disposal, geologic:** Isolation of waste using a system of engineered and natural barriers at a depth of up to several hundred meters below ground in a geologically stable formation (see geologic repository). [152]

**disposal, near-surface:** Disposal of waste, with or without engineered barriers, on or below the ground surface, such that the final protective cover above the waste is on the order of a few meters thick, or in mined openings within a few tens of meters of the Earth's surface (see land disposal facility). [152]

**disposal site:** Natural setting at the location of a disposal facility. [152]

**disposal system:** Disposal facility plus surrounding land in a controlled area. [152]

**disposal unit:** Discrete portion of a disposal facility into which waste is emplaced (e.g., single trench, vault, bunker or tumulus). [152]

**disposition:** Reuse, recycling, sale, transfer, storage, treatment, consumption or disposal. [141]

**dissolution rate:** Rate of change of a solid to a liquid form by immersion in a fluid of suitable character. [125]

**distributed source:** An area or volume source with at least one dimension large compared to the dimensions of the detector and that may produce radiations over a wide range of angles of incidence on the detector. [158]

**distribution coefficient ( $K_d$ ):** The distribution coefficient, with typical units of  $L\ kg^{-1}$ , and the activity per kilogram solid phase material divided by activity per liter water at equilibrium. [154]

**distribution coefficient:** Quantity of a contaminant sorbed by solid material per unit mass of the solid divided by the quantity of the contaminant dissolved in a fluid per unit volume of fluid. [152]

**disused source:** A source of radioactive material that is not in active use or is no longer suitable for its intended use. This may result from decay, from obsolete equipment, alternative technology, changes in priorities, or other removal from service (but not from declaration as waste). [141]

**divalent:** Having a valence of two. [156]

**DNA adduct:** A chemical covalently bound to DNA. [125]

**donor:** An entity that provides or releases a contaminant. [154]

**dosage:** The amount of radiopharmaceutical given to a patient, measured in becquerels (Bq). [167]

**dosage calibrator:** A device (ionization chamber) for measuring the amount of radioactive material within a container. Used to verify dosage prior to administration. It is commercially available as a "dose calibrator."

**dose:** General term denoting the quantity of energy from ionizing radiation absorbed in a tissue or organ from either an external source or from radionuclides in the body. When unspecified, dose refers to quantity of absorbed dose, measured in gray ( $1 \text{ Gy} = 1 \text{ J kg}^{-1}$ ) or rad ( $1 \text{ rad} = 100 \text{ ergs g}^{-1}$ ). Depending upon the context in which it used, the generic term dose may also refer to equivalent dose, effective dose or other dose-related quantities. [166]

**dose (radiation dose):** A general term used when the context is not specific to a particular dose quantity. When the context is specific, the name or symbol for quantity is used [e.g., mean absorbed dose in an organ or tissue ( $\underline{D}_T$ ), dose equivalent ( $\underline{H}$ ), equivalent dose ( $\underline{H}_T$ ), or effective dose ( $\underline{E}$ ). [163]

**dose:** Used as a generic term when not referring to a specific quantity, such as absorbed dose, equivalent dose, effective dose, and effective equivalent dose. [159]

**dose:** General term used to denote mean absorbed dose, equivalent dose, effective dose, or effective equivalent dose, and to denote dose received or committed dose. Particular meaning of the term should be clear from context in which it is used. [156]

**dose and dose rate effectiveness factor (DDREF):** The reduction in risk associated with low doses and dose protraction for low-LET radiation cancer risk is conventionally described by the DDREF. The reduction in risk for low doses and the reduction in risk for dose protraction are assumed to be equal. Therefore, the term DDREF is used for estimating effects for either low doses or low dose rates. [167]

**dose and dose-rate effectiveness factor (DDREF):** A judged factor by which the radiation effect, per unit of dose, caused by a given high or moderate dose of radiation received at high dose rates is reduced when doses are low or are received at low dose rates. [159]

**dose and dose-rate effectiveness factor (DDREF):** Factor by which the slope of a pure linear model fitted to the data should be divided to give a lower initial slope at low doses to account for biological repair of radiation damage. The linear term in a linear-quadratic dose-response model reflects DDREF. [126]

**dose-area product:** The incident absorbed dose or air kerma (i.e., without backscatter) (in gray or milligray) times the cross-sectional area of the x-ray beam (in  $\text{cm}^2$ ). [163]

**dose coefficient:** (1) For ingestion or inhalation of radionuclides, committed equivalent or effective dose per unit activity intake; or (2) for external exposure to radionuclides in the environment, equivalent or effective dose rate per unit concentration in an environmental medium. [166]

**dose coefficient:** Dose per unit intake of air, water, food, or other material by inhalation or ingestion. [164]

**dose coefficient:** (1) For ingestion or inhalation of radionuclides, committed dose per unit activity intake; or (2) for direct exposure to radionuclides in the environment, external dose rate per unit concentration in an environmental medium. [163]

**dose coefficient:** (1) For ingestion or inhalation of radionuclides, committed dose per unit activity intake; or (2) for external exposure to radionuclides in the environment, dose rate per unit concentration in an environmental medium. [156]

**dose coefficient:** Dose per unit intake of air, water, food or other material by inhalation or ingestion; Dose per unit of volumetric activity density in air or water by submersion; Dose per unit of areal activity density in surface soil by external exposure. [154]

**dose conversion coefficient (DCC):** The quotient of the organ absorbed dose or dose equivalent under specified conditions by the associated field quantity (e.g., air kerma or fluence). [158]

**dose-effect (dose-response) model:** A mathematical formulation and description of the way the effect (or biological response) depends on dose. [159]

**dose equivalent (H):** The product of the absorbed dose ( $\underline{D}$ ) at a point and the quality factor ( $\underline{Q}$ ) at that point for the radiation type (i.e.,  $\underline{H} = \underline{DQ}$ ). The unit of  $\underline{H}$  is  $\text{J kg}^{-1}$  with the special name sievert (Sv). [164]

**dose equivalent:** The absorbed dose at a point in tissue, modified by the quality factor at that point. The quality factor takes into account the relative effectiveness of a type of ionizing radiation in inducing stochastic health effects (the quality factor for photons is assigned a value of unity). The SI unit for dose equivalent is the joule per kilogram ( $\text{J kg}^{-1}$ ), with the special name sievert (Sv) (see equivalent dose). [159]

**dose equivalent (H):** Absorbed dose ( $\underline{D}$ ) at a point in tissue weighted by quality factor ( $\underline{Q}$ ) for type and energy of the radiation causing the dose:  $\underline{H} = \underline{D} \times \underline{Q}$ . For purposes of radiation protection and assessing health risks in general terms, and especially prior to introduction of the equivalent dose and as used by federal and state agencies, dose equivalent often refers to mean absorbed dose in an organ or tissue ( $\underline{T}$ ) weighted by mean quality factor ( $\overline{Q}$ ) for the particular type of radiation:  $\underline{H}_T = \underline{D}_T \times \overline{Q}$ . The SI unit of dose equivalent is joule per kilogram ( $\text{J kg}^{-1}$ ), and its special name is sievert (Sv). In conventional units often used by federal and state agencies, dose equivalent is given in rem; 1 rem = 0.01 Sv. [158]

**dose-integration period ( $\underline{T}_D$ ):** The time over which a dose rate is integrated. In nuclear medicine this is taken to be infinity as radionuclides of general use in nuclear medicine have relatively-short physical half-lives. In radiological protection, the dose-integration period is termed the dose commitment period and is standardized to 50 y for adults (who are assumed to be at a reference age of 20 y at time of exposure) or a variable time to 70 y of age for those exposed as infants, children or adolescents. [164]

**dose-length product (DLP):** A dose index quantity obtained using the following formula:

$$DLP = \frac{L}{p} \left( \frac{1}{3} CTDI_{100,c} + \frac{2}{3} CTDI_{100,p} \right)$$

where  $L$  is the length of patient scanned,  $p$  is the pitch, and  $CTDI_{100,c}$  and  $CTDI_{100,p}$  are  $CTDI_{100}$  values determined at the center and periphery of a standardized phantom (see pitch and computed tomography dose index). [160]

**dose limit:** A limit on radiation dose that is applied for exposure to individuals in order to prevent the occurrence of radiation-induced deterministic effects or to limit the probability of radiation-induced stochastic effects to an acceptable level. [167]

**dose limit:** A limit on dose that is applied for exposure to individuals in order to prevent the occurrence of radiation-induced deterministic effects or to limit the probability of radiation-related stochastic effects. [168]

**dose limit ( $E_{limit}$ ):** Limit on effective dose that is applied for exposure to individuals in order to prevent the occurrence of radiation induced deterministic effects and to limit the probability of radiation-related stochastic effects to an acceptable level. [155]

**dose limit:** A limit on radiation dose that is applied for exposure to individuals or groups of individuals in order to prevent the occurrence of radiation-induced deterministic effects or to limit the probability of radiation related stochastic effects to an acceptable level. For astronauts working in low-Earth orbit, unique dose limits for deterministic and stochastic effects have been recommended by NCRP. [153]

**dose-line integral (DLI):** The infinite line integral along a given phantom axis of the accumulated absorbed dose  $D(z)$  for a computed tomography scan series, where  $z$  is the distance along the axis of rotation. [147]

**dose rate (radiation dose rate):** Dose delivered per unit time. Dose rate can refer to any dose quantity (e.g., absorbed dose, dose equivalent). [168]

**dose rate:** Dose per unit time; often expressed as an average over some time period (e.g., a year). Can refer to any dose quantity (e.g., absorbed, equivalent or effective dose). [166]

**dose rate:** Dose delivered per unit time. Can refer to any dose quantity (e.g., absorbed dose, dose equivalent). [153]

**dose reconstruction:** Retrospective assessment of dose to identifiable or representative individuals or populations by any means, especially absorbed dose to specific organs or tissues. [164]

**dose reconstruction:** Retrospective assessment of dose to identifiable or representative populations or individuals by any means, especially absorbed dose to specific organs or tissues. The scope of dose reconstruction includes exposure situations in support of epidemiological studies or compensation programs, to guide interventions in accidental or malevolent exposures, or for individual or public information, but excludes demonstration of compliance with regulatory criteria, and projections of dose from future or prospective exposures. [163]

**dose-response curve:** A graphical characterization of the relationship between a defined biological endpoint and the dose received. [161]

**dose-response model:** A mathematical formulation of the way a defined biological endpoint depends upon the dose received. [161]

**dose-response model:** A mathematical formulation of the way in which the effect, or response, depends on dose. [153]

**dose-volume histogram:** A histogram representing the fraction of tissue volume receiving a particular dose range. Dose-volume histograms are used to represent the spatial distribution of dose. [164]

**dosimeter:** A radiation detection device worn or carried by an individual to monitor the individual's radiation exposure (see personal dosimeter and area monitor). [163]

**dosimeter:** A radiation detection device worn or carried by an individual to monitor the individual's radiation exposure (see personal dosimeter, personal monitor, and area monitor). May also refer to devices or objects that accumulate dose and can be evaluated to estimate the dose delivered to a person or region (e.g., biological dosimeter). [161]

**dosimeter:** A radiation detection device worn or carried by an individual to monitor the individual's radiation exposure. For space activities, a device worn or carried by an astronaut in-flight. [153]

**dosimeter:** Dose measuring device (see personal dosimeter and area dosimeter). [145]

**dosimetric model:** (1) For intakes of radionuclides into the body, model that estimates the dose in various organs and tissues per disintegration of a radionuclide in a specified source organ (site of deposition or transit in the body). (2) For external exposure, model that estimates the dose rate in organs and tissues per unit activity concentration of a radionuclide in an environmental medium. [164]

**dosimetry:** The science or technique of determining radiation dose. [168]

**dosimetry:** The science or technique of determining radiation dose. Strictly speaking, involving measured quantities, but also used informally to mean "dose assessment" (i.e., involving measurements and/or theoretical calculations [161]

**dosimetry records:** The collections of information that document the radiation doses that workers receive (e.g., doses that astronauts receive from space flight, mission-related aviation activities, and mission-related biomedical research). The dosimetry records contain, or are linked to, all the basic information that is necessary to obtain the radiation doses. [142]

**doubling dose (DD):** The dose required to double the effect under consideration assuming a linear dose response. [132]

**driving variable:** Variables that serve as primary, controlling inputs to a model, which in turn is used to estimate an output value, or distribution of output values.

**Drosophila:** Genus name for the common fruit fly. [150]

**dross:** Carbonate and nonmetallic oxide compounds produced by the chemical reaction of flux and impurities in a nonferrous metal-making furnace (see slag for a description of a similar material produced in ferrous metal making). [141]

**dry deposition:** The process by which atmospheric gases and particles are transferred to a surface such as vegetation or soil as a result of gravity, random turbulent air motions, diffusion, etc. (see deposition; compare to wet deposition). [154]

**DS86 (Dosimetry System 1986):** A revision of the previous atomic-bomb dosimetry TD65. [132]

**duct:** A channel for transporting fluid from the lobules (breast glands that produce milk) to the nipple. [149]

**ductal carcinoma in situ (DCIS):** A form of breast carcinoma in situ confined to the breast ducts; often reveals itself with microcalcification on mammography (also called noninvasive breast carcinoma or intraductal breast carcinoma) [149]

**duty cycle:** The fraction of the operation cycle of an accelerator during which radiation is produced; the product of the pulse duration and the pulse-repetition frequency. [144]

**dwell time:** The time during which an ultrasound beam is directed to a specific part of a patient's body. [140]

**dynamic:** (1) Time-dependent or (2) in motion. [152]

**dynamic model:** A model based on rates and rate constants and that do not necessarily assume steady-state or equilibrium conditions and thus can provide time-dependent predictions. [154]



**ecological risk:** The probability of harm to plants, animals or habitat in a natural or managed ecosystem from radiation or other forms of stress. [154]

**ecosystem:** A system consisting of substrate (soil, sediment), nutrients, air, water, plants and animals in a defined geographic area that functions to cycle nutrients and to pass energy captured from the sun by green plants. Ecosystems can be natural and self-sustaining, or managed to various degrees to meet human needs. Ecosystems include those in aquatic environments (freshwater, saltwater) and those in terrestrial environments. Aquatic and terrestrial ecosystems can be broken down into much more specific descriptions based on climate, soil type, vegetation type, water depth, etc. [154]

**ectoderm:** Outer germ layer of the embryo and chorion. It forms the epithelial lining of the amnion and all trophoblast derivatives, including epidermal structures and the nervous system. [128]

**edema:** Abnormal accumulation of fluid in the intercellular spaces of the body. [161]

**effective cavity volume (ECV):**

- $\underline{ECV}_1$ : Estimate of a patient's ventral cavity volume taken to be an ellipsoid with polar radius  $\underline{c}$  equal to one-half of the patient's trunk height and equatorial radii  $\underline{a}$  and  $\underline{b}$  both equal to  $\underline{c}/1.618034$ , where the constant 1.618034 is the golden section (or golden proportion) used frequently to predict the length of body segments, given other known body dimensions (Whalen *et al.*, 2008).
- $\underline{ECV}_2$ : Estimate of a patient's ventral cavity volume taken to be an ellipsoid with polar radius  $\underline{c}$  equal to one-half the trunk height, and parameters  $\underline{a}$  and  $\underline{b}$  equal to the equatorial radii of an ellipse approximating the outer-body contour on the CT slice at the level of the mid-sternum. [164]

**effective dose (E):** The sum over specified organs and tissues of the products of the equivalent dose in an organ or tissue ( $\underline{H}_T$ ) and the tissue weighting factor for that organ or tissue ( $\underline{w}_T$ ):

$$E = \sum_T w_T H_T$$

The tissue weighting factors have been developed from a reference population of equal numbers of both males and females and a wide range of ages (ICRP, 1991a; 2007a). Effective dose ( $\underline{E}$ ) applies only to stochastic effects. The unit is joule per kilogram ( $\text{J kg}^{-1}$ ) with the special name sievert (Sv). [168]

**effective dose:** The sum over specified tissues of the products of the equivalent dose in a tissue or organ and the tissue weighting factor for that tissue or organ. The tissue weighting factor represents the fraction of the total radiation detriment to the whole body attributed to that tissue when the whole body is irradiated uniformly. The SI unit for effective dose is joule per kilogram ( $\text{J kg}^{-1}$ ), with the special name sievert (Sv). [165]

**effective dose (E):** Sum over specified organs and tissues (T) of equivalent dose in each tissue weighted by tissue weighting factor ( $\underline{w}_T$ ):  $\underline{E} = \sum \underline{w}_T \times \underline{H}_T$ , where  $\sum \underline{w}_T = 1$  (ICRP, 1991) (supersedes effective dose equivalent.) [164]

**effective dose ( $\underline{E}$ ):** The sum over specified organs and tissues (T) of equivalent dose in each tissue weighted by the tissue weighting factor ( $\underline{w}_T$ ):  $\underline{E} = \sum \underline{w}_T \times \underline{H}_T$ , where  $\sum \underline{w}_T = 1$ . The SI unit for  $\underline{E}$  and  $\underline{H}_T$  is joule per kilogram ( $\text{J kg}^{-1}$ ) with the special name of sievert (Sv). ( $1 \text{ Sv} = 1 \text{ J kg}^{-1}$ ). Supersedes effective dose equivalent. [158]

**effective dose:** The sum of the weighted equivalent doses for the radiosensitive tissues and organs of the body. Each equivalent dose is modified by a tissue weighting factor that takes into account the relative radiation detriment for the tissue or organ. The tissue weighting factor for a particular tissue or organ represents the fraction of the total radiation detriment to the whole body attributed to that tissue when the whole body is irradiated uniformly. The tissue weighting factors have been developed from a reference population of equal numbers of both sexes and a wide range of ages. A similar quantity is effective dose equivalent (an earlier formulation of effective dose) that is also the sum of weighted doses for the radiosensitive tissues and organs of the body. These weighted doses (called dose equivalents) were also modified by tissue weighting factors (but an earlier set of factors different than used for effective dose). The SI unit of effective dose (and effective dose equivalent) is  $\text{J kg}^{-1}$  with the special name sievert (Sv);  $1 \text{ Sv} = 1 \text{ J kg}^{-1}$  (see equivalent dose and radiation detriment). [157]

**effective dose ( $\underline{E}$ ):** Sum over specified organs and tissues (T) of mean dose equivalent in each tissue weighted by tissue weighting factor ( $\underline{w}_T$ ):. It is given by the expression:

$$\underline{E} = \sum \underline{w}_T \underline{H}_T,$$

where  $\underline{H}_T$  is the equivalent dose in tissue or organ T and  $\underline{w}_T$  is the tissue weighting factor for tissue or organ T. The unit for  $\underline{E}$  and  $\underline{H}_T$  is joule per kilogram ( $\text{J kg}^{-1}$ ) with the special name of sievert (Sv).  $1 \text{ Sv} = 1 \text{ J kg}^{-1}$  (supersedes effective dose equivalent). [155]

**effective dose ( $\underline{E}$ ):** The sum over specified tissues of the products of the equivalent dose in a tissue ( $\underline{H}_T$ ) and the tissue weighting factor for that tissue or organ ( $\underline{w}_T$ ) (i.e.,  $\underline{E} = \sum_T \underline{w}_T \underline{H}_T$ ). Effective dose ( $\underline{E}$ ) applies only to stochastic effects. The unit is the joule per kilogram ( $\text{J kg}^{-1}$ ) with the special name sievert (Sv). [153]

**effective dose equivalent ( $\underline{H}_E$ ):**  $\underline{H}_E = \sum \underline{w}_T \times \underline{H}_T$ , where  $\sum \underline{w}_T = 1$ . ( $\underline{H}_E$  is now superseded by effective dose, but still often used by federal and state agencies). [164]

**effective dose equivalent ( $\underline{H}_E$ ):** The sum over specified organs and tissues of the products of the mean dose equivalent in a tissue ( $\underline{H}_T$ ) and the weighting factor for that tissue or organ ( $\underline{w}_T$ ):

$$H_E = \sum_T w_T H_T$$

The formulation differs from effective dose (ICRP, 1991a) and is defined in ICRP (1977). Now superseded in ICRP and NCRP recommendations by effective dose, but the formulation is still in use by most federal and state agencies. [163]

**effective dose equivalent ( $\underline{H}_E$ ):** Sum over specified organs and tissues (T) of mean dose equivalent in each tissue weighted by tissue weighting factor ( $\underline{w}_T$ ):  $\underline{H}_E = \sum \underline{w}_T \times \underline{H}_T$ ,  $\sum \underline{w}_T = 1$  (now superseded by effective dose, but often used by federal and state agencies). [156]

**effective energy:** In reference to bremsstrahlung radiation from an x-ray machine, the monoenergetic photon energy that exhibits the same first half-value thickness in a given material as the x-ray beam. [158]

**effective energy:** In reference to bremsstrahlung radiation from an x-ray machine, the effective energy is the monoenergetic photon energy which exhibits the same first half-value thickness in a given material as the x-ray beam. [112]

**effective half-time:** The time that represents the decline by half of a contaminant in a compartment that results from all exponential loss mechanisms. In the context of medical use of radionuclides, it represents loss of radioactivity from a body compartment that includes both physical decay and also biological clearance. [164]

**effective half-life:** The time in which the radionuclide within an organ decreases by one-half as a result of radioactive decay and biological elimination. [159]

**effective half-time:** The half-time that represents the exponential decline of a contaminant in a compartment that results from all exponential loss mechanisms. [154]

**effective porosity:** Porosity of that part of a medium through which water flows. [152]

**effective trunk mass:** Mass of the trunk as estimated from a computed tomography image using reference values for tissue densities (Whalen et al., 2008). [164]

**effective trunk volume:** Product of the patient's trunk height and trunk area seen in a computed tomography (CT) image, with the latter taken to be the measured cross-sectional area of the CT slice at the level of the mid-sternum (Whalen et al., 2008). [164]

**efficiency (of x-ray production):** The fraction of electron power incident on a target that is converted to x-ray power. [144]

**effluent:** Releases from a facility to the environment via air or water streams. [164]

**effluent monitoring:** The measurement of activity in air, liquids and solid material leaving a facility. [127]

**effluents:** Waste materials discharged into the environment. [141]

**egestion:** The process of losing material from the body by any one of several processes. [154]

**egg cylinder:** The developing embryo, in the implantation chamber that is formed by swelling and closure of the endometrial crypt in which the fertilized egg lodged; usually pertains to rodents. [128]

**Eh:** Symbol for oxidation/reduction potential of a medium. [152]

**elastic recoil:** The process of returning to the original shape after bouncing off an object. [125]

**elastin:** A yellow protein that is the essential constituent of elastic connective tissue. [156]

**electric arc furnace (EAF):** A metal-making furnace that uses the energy of an electric arc produced between a carbon electrode and the metal in the furnace. The feedstock for EAFs consists almost entirely of solid scrap metal. [141]

**electric dipole:** Two equal charges of opposite sign separated by a small distance. [119]

**electric field:** A term that is often used to mean the same as electric field strength. A vector force field that is used to represent the forces between electric charges. Electric field strength is defined as the force per unit charge on an infinitesimally small charge at any given point in space, and it is usually represented by the symbol  $E$ . The unit of electric field strength is volt per meter ( $V\ m^{-1}$ ). [158]

**electric field:** A term that is often used to mean the same as electric field strength. [119]

**electric field intensity:** Another term for electric field strength. (The term "field strength" is preferred.) [119]

**electric field strength:** A vector force field that is used to represent the forces between electric charges. Electric field strength is a unit defined as the force per unit charge on an infinitesimally small charge at any given point in space, and it is usually represented by the symbol  $E$ . The unit of electric field strength is volt per meter ( $V\ m^{-1}$ ). [119]

**electric flux density (displacement):** Usually designated by  $D$ . The electric flux density is a vector equal to the product of the electric field strength and the permittivity. The total electric flux passing through a closed surface is equal to the total charge enclosed by the surface. The unit for  $D$  is coulomb per square meter ( $C\ m^{-2}$ ). [119]

**electric polarization:** Separation of charges in a material to form electric dipoles, or alignment of existing electric dipoles in a material when an electric field is applied. Usually designated  $P$ , the unit of polarization is dipole moment per cubic meter or coulomb per square meter ( $C\ m^{-2}$ ). [119]

**electrokinetic:** The motion of particles or liquids that results from a difference of electric potential. [154]

**electromagnetic radiation:** A traveling wave motion consisting of changing electric or magnetic fields. Familiar types of electromagnetic radiation are: x and gamma rays of short wavelength and high energy; ultraviolet, visible and infrared; microwave; and radiofrequency radiation of relatively long wavelength and low energy. [157]

**electron:** Subatomic charged particle. Negatively charged particles are parts of stable atoms. Both negatively and positively charged electrons may be expelled from the radioactive atom when it disintegrates. [167]

**electron:** A subatomic charged particle. Negatively charged particles are parts of stable atoms. Both negatively and positively charged electrons (positrons) may be expelled from the radioactive atom when it disintegrates (see beta particle). [163]

**electron:** A subatomic particle with a negative charge and often bound to the nucleus of an atom. Electrons and their positively-charged antiparticles (positrons) may be expelled from a radioactive atom when it disintegrates (see beta radiation). [161]

**electron:** Small negatively charged particles that can be accelerated to high energy and velocity close to the speed of light. [153]

**electron accelerator:** A device designed to add substantial kinetic energy to free electrons. These electrons may then impinge on an electron target and produce bremsstrahlung. [Comm20]

**electronic personal dosimeter (EPD):** Active devices that use Geiger- Mueller, scintillation, or solid-state detectors with an associated power supply (battery) to provide a real-time dose or dose-rate reading. [158]

**electron paramagnetic resonance (EPR):** Electron paramagnetic resonance or electron spin resonance spectroscopy is a technique for studying chemical species that have one or more unpaired electrons, such as organic and inorganic free radicals or inorganic complexes possessing a transition metal ion. The basic physical concepts of EPR are analogous to those of nuclear magnetic resonance, but it is electron spins that are excited instead of spins of atomic nuclei. Radiation damage over long periods of time creates free radicals in tooth enamel, that can then be examined by EPR. [164]

**electron paramagnetic resonance (EPR):** A technique for studying chemical species that have one or more unpaired electrons, such as organic and inorganic free radicals or inorganic complexes possessing a transition metal ion. The basic physical concepts of EPR are analogous to those of nuclear magnetic resonance, but it is electron spins that are excited instead of spins of atomic nuclei. Radiation damage over long periods of time creates free radicals in tooth enamel that can then be examined by EPR. [163]

**electron target:** The material in an accelerator upon which the electrons impinge and produce bremsstrahlung (also known as a converter). [Comm20]

**electron volt (eV):** A unit of energy =  $1.6 \times 10^{-12}$  ergs =  $1.6 \times 10^{-19}$  J; 1 eV is equivalent to the energy gained by an electron in passing through a potential difference of 1 V; 1 keV = 1,000 eV; 1 MeV = 1,000,000 eV. [164]

**electron volt (eV):** A unit of energy equal to the kinetic energy gained in a vacuum by a particle having one electronic charge when it passes through a potential difference of 1 V; 1 eV =  $1.6 \times 10^{-19}$  joule or  $1.6 \times 10^{-12}$  erg. [163]

**electron volt (eV):** A unit of energy equal to the kinetic energy gained in a vacuum by an electron having one electronic charge when it passes through a potential difference of 1 volt; 1 eV =  $1.6 \times 10^{-19}$  joule or  $1.6 \times 10^{-12}$  erg. [161]

**electron volt:** Unit of energy equal to that acquired by an electron falling through a potential difference of 1 V. [157]

**electrostatic attraction (or repulsion):** Affinity for attraction (or repulsion) due to electrostatic charges associated with particles. [125]

**element:** Any substance that cannot be separated into different substances by ordinary chemical methods. Elements are distinguished by the number of protons in the nucleus of atoms. [164]

**eluate:** The solvent carrying the decay product when a generator is eluted. [124]

**elute:** To remove the daughter radionuclide from a generator using a suitable solvent. [124]

**embrittlement:** Increase in hardness or decrease in flexibility of a material, resulting in an increased tendency to break or shatter. [152]

**embryo:** In the human, the developing individual from one week after conception to the end of the second month. [168]

**embryo:** A developing vertebrate at stages from the first cleavage until the fetal period. [163]

**emergency:** A sudden, urgent, usually unforeseen occurrence or occasion requiring immediate action. [166]

**emergency coordinator:** The individual within an institution or facility who is assigned the responsibility for developing an emergency plan, maintaining the plan and its distribution lists. [111]

**emergency director:** The individual designated in the emergency plan to exercise command and control over all emergency response personnel for the duration of the emergency. [111]

**emergency management:** The process to achieve a full state of readiness. There are four phases to every disaster: preparedness, response, mitigation and recovery. Each phase takes planning, time and resources from a wide array of partners to ensure a coordinated response. The primary mission of the emergency management is to ensure the entity, institution and staff are prepared to respond to foreseeable disasters (Farmer, 2006). [166]

**emergency operations center (EOC):** A central command and control facility responsible for strategic overview of emergency response. [166]

**emission:** Fields generated at a given distance from an RF source. Emission should not be confused with exposure (i.e., emission does not depend on the presence of a person). [119]

**emphysema:** Abnormal dilation of the pulmonary air spaces (alveoli) accompanied by destruction of respiratory tissue. [125]

**empirical:** Based on direct observation or measurement, rather than theoretical inference. [164]

**encapsulated bubble:** A cavity in which the gas and liquid phases are separated by a thin shell of insoluble solid or liquid material. [140]

**encapsulation:** Incorporation of a foreign body in a fibrous cyst, resulting in isolation from the rest of the body. [156]

**encapsulation:** Incorporation of waste into a solid waste form (e.g., grout, bitumen or polyethylene). [152]

**endemic:** Present in a community or among a group of people; said of a disease prevailing continually in a region. [159]

**endoderm:** Inner germ layer of the embryo. It forms the lining of the gastrocoel, yolk sac, and their derivatives, including portions of the epithelium of the respiratory and digestive systems. [128]

**endoergic; endothermal:** Characterized by the absorption of energy or heat. Endoergic reactions absorb energy as they progress. Endothermal reactions absorb heat as they progress. [144]

**endometriosis:** The presence of extrauterine endometrial tissue, a nonmalignant condition. [132]

**endonuclease:** An intracellular enzyme that cleaves polynucleotides (nucleic acids) at interior bonds, thus producing poly- or oligonucleotide fragments of varying size. [150]

**endothelial:** Pertaining to the endothelium, the layer of epithelial cells that lines the cavities of the heart, of the blood and lymph vessels, and the serous cavities of the body. [156]

**endothelial blood capillary cells:** Layer of flat cells lining the inside blood vessels and capillaries. [125]

**end-point energy:** Maximum energy (normally applies to beta emitters).

**energy density (surface):** Electromagnetic energy incident on a surface per unit surface area. The unit is joule per square meter ( $\text{J m}^{-2}$ ). [119]

**energy density (volume):** Electromagnetic energy in a given volume of space divided by that volume. The unit is joule per cubic meter ( $\text{J m}^{-3}$ ). [119]

**energy dependent detector:** Detector system which has a different response to radiations of different energies, all other factors being equal. [158]

**energy response:** The response of a device as a function of energy. [163]

**energy response:** (Measured dose – true dose)/true dose, where the measured dose is a function of energy. [158]

**energy spectrum (radiation):** The distribution with energy of the number of particles or particle fluence (or number of photons or photon fluence) at a point of interest. [163]

**energy spectrum:** The distribution with energy of the radiation fluence at a point of interest. [158]

**engineered controls:** A system of design features that are intended to prevent or limit exposures to radiation or releases of radioactive materials. [127]

**enhancement factor:** Ratio of activity of a radionuclide per unit mass of particulate material in air above ground to activity of the radionuclide per unit mass of surface soil that provides the source of suspended or resuspended material. [152]

**enolase:** An enzyme catalyzing the reversible dehydration of 2-phospho-D-glycerate to phosphoenolpyruvate and water: a step in both glycolysis and gluconeogenesis. [150]

**enterocolitis:** Inflammation of the small intestine and colon. [156]

**entrance air kerma (or entrance skin exposure):** Air kerma (or exposure) measured free-in-air at the location of the entry surface of an irradiated person or phantom in the absence of the person or phantom. [160]

**entrance-surface absorbed dose ( $D_{\text{skin,e}}$ ):** Absorbed dose on the central x-ray beam axis at the point where the x-ray beam enters the patient or phantom (includes backscattered radiation). [168]

**entrance-surface air kerma ( $K_{\text{a,e}}$ ):** Air kerma on the central x-ray beam axis at the point where the x-ray beam enters the patient or phantom (includes backscattered radiation). [168]

**environment:** Soil, rock, water, atmosphere and biosphere surrounding a waste disposal facility into which radionuclides may be released or transported. [152]

**environmental assessment:** A type of model specifically designed to address questions formulated in the context of an environmental assessment. Environmental assessment models are often less complex mathematically than are models used as tools in research. [164]

**environmental assessment model:** A type of model specifically designed to address questions formulated in the context of an environmental assessment. Environmental assessment models are often less complex mathematically than are models used as tools in research. [123]

**environmental doses:** Doses to the environment and people from a radiation source, as opposed to doses to people from the environment. [Comm20]

**environmental exposure:** Exposure to radiation through environmental pathways. [164]

**environmental monitoring:** The measurement of external dose or the amount of radioactivity in air, soil, water, plant and animal matter in areas outside the control or boundary of a facility. [164]

**environmental monitoring (radiation):** The determination of the types and concentrations of radionuclides in environmental media (e.g., air, soil, water, vegetation) and the resulting radiation dose or dose rate, particularly outside the boundary of a facility. [163]

**environmental monitoring:** The measurement of external exposure or dose due to radioactivity in air, soil, water or vegetation outside the control or boundary of a facility. [158]

**Environmental Restoration Disposal Facility (ERDF):** A large, lined burial ground adjacent to the 200-West Area on the Hanford Site. [154]

**eosinophil:** A granular leukocyte with a nucleus that usually has two lobes connected by a thread of chromatin, and cytoplasm containing coarse, round granules of uniform size. [156]

**ephemeral:** Occurring periodically or occasionally rather than continuously. [154]



**epidemiology:** The study of the determinants of the frequency of disease in humans. The two main types of epidemiologic studies of disease are cohort (or follow-up) studies and case-control studies. [159]

**epidermis:** Outer layer of the skin, consisting of the stratum corneum, stratum lucidum, stratum granulosum, stratum spinosum, and stratum basale. [161]

**epiglottis:** Saddle-shaped plate of cartilage, covered with mucous membrane at the root of the tongue, that folds back over the aperture of the larynx, closing it during the act of swallowing. [125]

**epilation:** Loss of body hair. [161]

**epilimnion:** The upper zone of a thermally-stratified lake where the water is warmer, more oxygen-rich, and more turbulent due to wind and other factors, and often displaying various physical, chemical and biological characteristics that differ from the deeper zone (the hypolimnion). [154]

**epistemic:** Uncertainty in estimates of quantities that involves distributions of confidence in conversion coefficients used to compute the quantity from the measurements. Epistemic uncertainty represents incomplete knowledge about the exact value of a model parameter assumed to be a constant. [158]

**epistemic (Type B) uncertainty:** Uncertainty representing incomplete knowledge about the exact value of a quantity (e.g., model parameter) assumed to be a constant. [164]

**epistemic uncertainty:** Uncertainty in estimates of quantities that involves distributions of confidence in conversion coefficients used to compute the quantity from the measurements. Epistemic uncertainty represents incomplete knowledge about the exact value of a model parameter assumed to be a constant. Also referred to as Type-B uncertainty (see Type-B uncertainty). [163]

**epithelial:** Pertaining to or composed of epithelium, the cellular covering of internal and external surfaces of the body. [161]

**epithelial serous cell:** Found in the trachea and extrapulmonary bronchi of the rat (the function of this cell is unknown although it might contribute to the periciliary liquid layer found beneath the tracheobronchial mucus). [125]

**epoxy:** Resin, containing groups of oxygen atoms joined to two carbon atoms to form a bridge, that polymerizes spontaneously when mixed with a diphenol, forming a strong, hard and chemically resistant adhesive. [152]

**equilibrium:** The situation where input rates to a compartment are equal to loss rates from the compartment, such that a steady-state exists. [164]

**equilibrium:** Condition of equal rates of processes or equal ratios of values of parameters. [152]

**equilibrium factor:** The ratio of the actual potential alpha-energy concentration to the potential alpha-energy concentration that would prevail if all the decay products in each of the radon progeny decay series were in equilibrium with the parent radon. [160]

**equilibrium tenth-value layer ( $T_{V_{10}}$ ):** The thickness of a specific material that attenuates a specified radiation by a factor of 10, under broad-beam conditions, in that penetration region in which the directional and spectral distributions of the radiation are practically independent of thickness. [151]

**equilibrium thickness:** A thickness of material, impinged upon by primary radiations, sufficient to produce a condition of secondary charged-particle equilibrium in the material. [158]

**equivalent dose ( $H_T$ ):** Mean absorbed dose in a tissue or organ ( $D_{T,R}$ ) weighted by the radiation weighting factor ( $w_R$ ) for the type and energy of radiation incident on the body:

$$H_T = \sum_R w_R D_{T,R}$$

The SI unit of equivalent dose is joule per kilogram ( $J\ kg^{-1}$ ) with the special name sievert (Sv).  $1\ Sv = 1\ J\ kg^{-1}$ . [168]

**equivalent dose:** A quantity used for radiation protection purposes that takes into account the different probabilities of stochastic effects that occur with the same absorbed dose delivered by radiations with different radiation weighting factors (the factor by which the mean absorbed dose in a tissue or organ is modified to account for the type and energy of radiation in determining the probability of stochastic effects). The SI unit of equivalent dose is joule per kilogram ( $J\ kg^{-1}$ ), with the special name sievert (Sv) (also see stochastic effects). [165]

**equivalent dose ( $H_T$ ):** The product of the mean absorbed dose in an organ or tissue and the radiation weighting factor ( $w_R$ ) of the radiation type of interest. [164]

**equivalent dose ( $H_T$ ):** Mean absorbed dose in a tissue or organ ( $D_{T,R}$ ) weighted by the radiation weighting factor ( $w_R$ ) for the type and energy of radiation:

$$H_T = \sum_R w_R D_{T,R}$$

For exposure from external sources,  $w_R$  applies to the radiation type and energy incident on the body. The SI unit of equivalent dose is  $J\ kg^{-1}$  with the special name sievert (Sv).  $1\ Sv = 1\ J\ kg^{-1}$ . [163]

**equivalent dose:** Absorbed dose multiplied by the quality factor which represents, for the purpose of radiation protection and control, the effectiveness of the radiation relative to sparsely ionizing radiation. The SI unit of equivalent dose is the joule per kilogram ( $J\ kg^{-1}$ ), with the special name sievert (Sv) (see radiation weighting factor and stochastic effects).

[159]

**equivalent dose ( $H_T$ ):** Mean absorbed dose in a tissue or organ weighted by the radiation weighting factor ( $w_R$ ). The SI unit of equivalent dose is the joule per kilogram ( $J\ kg^{-1}$ ) and its special name is the sievert (Sv).  $1\ Sv = 1\ J\ kg^{-1}$ . For external exposure  $w_R$  applies to the radiation type and energy incident on the body. [158]

**equivalent dose:** The mean absorbed dose in a tissue or organ times the radiation weighting factor. [Comm20]

**equivalent dose:** The mean absorbed dose (gray) in a tissue or organ modified by the radiation weighting factor for the type and energy of radiation incident on the body. The SI unit of equivalent dose is  $J\ kg^{-1}$  with the special name sievert (Sv);

1 Sv = 1 J kg<sup>-1</sup>. For low linear-energy-transfer radiations (e.g., gamma rays, electrons), the radiation weighting factor is assigned a value of unity and therefore 1 Gy is numerically equivalent to 1 Sv. [157]

**equivalent dose ( $H_T$ ):** Quantity developed for purposes of radiation protection and assessing health risks in general terms, defined as mean absorbed dose in an organ or tissue (T) weighted by radiation weighting factor ( $w_R$ ) for type and energy of the radiation causing the dose:  $H_T = D_T \times w_R$  (ICRP, 1991a). The SI unit of equivalent dose is the joule per kilogram (J kg<sup>-1</sup>), and its special name is the sievert (Sv). In conventional units often used by federal and state agencies, equivalent dose is given in rem; 1 rem = 0.01 Sv (see dose equivalent). [156]

**equivalent dose ( $H_T$ ):** Mean absorbed dose in a tissue or organ weighted by the radiation weighting factor ( $w_R$ ) for the type and energy of radiation incident on the body. The equivalent dose in tissue or organ T is given by the expression:

$$H_T = \sum w_R D_{T,R},$$

where  $D_{T,R}$  is the mean absorbed dose in the tissue or organ T due to radiation type R.

The SI unit of equivalent dose is the joule per kilogram (J kg<sup>-1</sup>) with the special name sievert (Sv). 1 Sv = 1 J kg<sup>-1</sup>. [155]

**equivalent dose ( $H_T$ ):** The product of the mean absorbed dose in an organ or tissue and the radiation weighting factor ( $w_R$ ) of the radiation type of interest. For external exposure  $w_R$  applies to the radiation type incident on the body. [153]

**erosion:** The process of surface or near-surface soil being moved away from a given location by the action of wind or water. [154]

**error:** Difference between a computed or estimated result and the actual value (see random error, systematic error, bias). [164]

**error function:** Integral over normal or Gaussian probability function defined as:

$$\text{erf}(z) = \frac{2}{\sqrt{\pi}} \int_0^z e^{-t^2} dt.$$

which gives the probability that the value of the parameter  $t$  does not exceed  $z$ . [152]

**erythema:** A redness of the skin. [161]

**eschar:** A slough produced by a thermal burn, a radiation burn, a corrosive application, or by gangrene. [161]

**esophagus:** Portion of the digestive canal between the pharynx and the stomach that extends from the lower border of the cricoid vertebra to the cardiac orifice of the stomach. [164]

**ethylenediaminetetraacetic acid (EDTA):** A chelating substance similar to diethylenetriamine pentaacetic acid (DTPA) in that it binds metal ions. EDTA is rapidly excreted from the body by the kidneys. [166]

**etiology:** The science or description of cause(s) of disease. [159]

**euthyroid:** A normally functioning thyroid [159]

**eV (electron volt):** A unit of energy =  $1.6 \times 10^{-12}$  ergs =  $1.6 \times 10^{-19}$  J; 1 eV is equivalent to the energy gained by an electron in passing through a potential difference of 1 V; 1 keV = 1,000 eV; 1 MeV = 1,000,000 eV. [132]

**evaporation:** Removal of water from the Earth's surface into the atmosphere by vaporization. [152]

**evapotranspiration:** A process referring to the loss of water from the soil both by evaporation and by transpiration from the plants growing thereon. [154]

**Ewing's sarcoma:** A malignant neoplasm, occurring usually before age 20, about twice as frequently in males relative to females, and, in ~75 % of the patients, involves bones of extremities. Named after James Ewing, a U.S. pathologist, 1866 to 1943. [150]

**excess absolute risk (EAR):** The absolute difference between the instantaneous incidence or mortality rates between two groups of people (e.g., those exposed to radiation at a given level and those unexposed). [126]

**excess lifetime risk (ELR):** The excess risk from induced cancer due to exposure when the effects over an entire lifetime are accounted for. Individuals who would have died of cancer anyway but die early because of exposure are not included. [126]

**excess relative risk:** An expression of excess risk relative to the underlying (baseline) risk; if the excess equals the baseline the relative risk is two. [167]

**exclusion zone:** Area from which all employees and members of the public are excluded during scanning of conveyances. The exclusion zone is typically surrounded by radiation shielding with interlocked doors (or a fence with interlocked gates), in either case designed to maintain the effective dose rate at 0.05  $\mu$ Sv or less in any one hour (above background radiation dose levels) outside the exclusion zone. [Comm20]

**excreta:** Waste material (perspiration, urine, stools) eliminated by the body. [164]

**exempt:** Excluded from regulation as hazardous or radioactive material. [160]

**exempt material:** Material that is excluded from regulation as hazardous or radioactive material. [141]

**exfiltration:** Process of upward movement of materials buried in the Earth's surface into the atmosphere. Exfiltration normally occurs for gaseous materials but may also occur for liquids in arid environments. [152]

**exon:** A portion of DNA that codes for a section of the mature messenger RNA from that DNA, and is therefore expressed ("translated") into protein at the ribosome. [150]

**expanded and aligned field:** A hypothetical field in which the fluence and its energy distribution are the same as in the expanded field, but the fluence is unidirectional. [158]

**expanded and aligned field:** A uniform, unidirectional radiation field with fluence and its energy distribution equal to that of the actual field at the point of reference. [144]

**expanded field:** A hypothetical radiation field in which the fluence and its angular and energy distributions have the same value throughout the volume of interest as in the actual field at the point of reference. [158]

**expiratory reserve volume:** Largest amount of air that can be forced out of the lungs after a normal breath has been let out; includes the tidal volume expired down to the residual volume. [125]

**exponential distribution:** A probability density distribution that is a special case of the gamma distribution and is associated with the same kind of systems that give rise to Poisson distributions (i.e., events that occur randomly with a constant average rate such as radioactive decay). The lengths of intervals between random events will have an exponential distribution. [164]

**exposure:** A general term used to express the act of being exposed to ionizing radiation (also called irradiation). Exposure is also a defined ionizing radiation quantity. It is a measure of the ionization produced in air by x or gamma rays. The unit of exposure is coulomb per kilogram ( $\text{C kg}^{-1}$ ). The special name for exposure is roentgen (R), where  $1 \text{ R} = 2.58 \times 10^{-4} \text{ C kg}^{-1}$ . [168]

**exposure:** Often used in its general sense, meaning an irradiation. When used as a defined radiation quantity, exposure is a measure of the ionization produced in air by x or gamma radiation. The SI unit of exposure is coulomb per kilogram ( $\text{C kg}^{-1}$ ). The special unit for exposure is roentgen (R), where  $1 \text{ R} = 2.58 \times 10^{-4} \text{ C kg}^{-1}$ . Air kerma is often used in place of exposure. An exposure of 1 R corresponds to an air kerma of 0.87 rad (8.7 mGy) (also see rad, roentgen, gray, air kerma). [165]

**exposure:** Most often used in a general sense meaning to be irradiated. When used as the specifically defined radiation quantity, exposure is a measure of the ionization produced in air by x or gamma radiation. The unit of exposure is coulomb per kilogram ( $\text{C kg}^{-1}$ ). The special unit for exposure is roentgen (R), where  $1 \text{ R} = 2.58 \times 10^{-4} \text{ C kg}^{-1}$ .

- **acute:** Radiation exposure of short duration.
- **chronic:** Radiation exposure of long duration, because of fractionation or protraction. [164]

**exposure:** The act or condition of being subject to irradiation (e.g., when a person is near a radiation source). It does not imply that external or internal radionuclide contamination has occurred, only that the potential for contamination has occurred. In the context of airborne radionuclides, exposure is the product of the air concentration of radionuclides to which a person is exposed and the duration of the exposure. Exposure is often used in a general sense meaning to be irradiated. When used as the specifically defined radiation quantity, exposure is a measure of the ionization produced in air by x or gamma radiation. The unit of exposure is coulomb per kilogram ( $\text{C kg}^{-1}$ ) with the special name roentgen (R), where  $1 \text{ R} = 2.58 \times 10^{-4} \text{ C kg}^{-1}$ . [161]

**exposure:** A general term used to express the act of being exposed to ionizing radiation. Also refers to inhalation intake (e.g., for radon) expressed in working level months (see working level month). Exposure is also a defined ionizing radiation

quantity. It is a measure of the ionization produced in air by x or gamma rays. The unit of exposure is coulomb per kilogram ( $C\text{ kg}^{-1}$ ). The special name for exposure is roentgen (R), where  $1\text{ R} = 2.58 \times 10^{-4}\text{ C kg}^{-1}$ . [160]

**exposure:** The condition of having contact with a physical (e.g., ionizing radiation), chemical (e.g., carcinogen), or biological (e.g., virus) agent. [159]

**exposure:** Most often used in a general sense meaning to be irradiated. When used as the specifically defined radiation quantity, exposure is a measure of the ionization produced in a specified mass of air under standard conditions by x or gamma radiation. The unit of exposure is coulomb per kilogram ( $C\text{ kg}^{-1}$ ). The special SI unit for exposure is roentgen (R), where  $1\text{ R} = 2.58 \times 10^{-4}\text{ C kg}^{-1}$  (exactly). [158]

**exposure:** A general term used to express the act of being exposed to ionizing or nonionizing radiation. Exposure is also a defined ionizing radiation quantity. It is a measure of the ionization produced in air by x or gamma rays. The unit of exposure is coulomb per kilogram ( $C\text{ kg}^{-1}$ ). The special name for exposure is roentgen (R), where  $1\text{ R} = 2.58 \times 10^{-4}\text{ C kg}^{-1}$  (see irradiation). [157]

**exposure:** Often used in a general sense meaning to come into contact with a hazardous substance such as radiation, radioactive material, or a chemical through one or more mechanisms. When used as the specifically defined external radiation quantity, exposure is a measure of the ionization produced in air by x or gamma radiation. The unit of exposure is coulomb per kilogram ( $C\text{ kg}^{-1}$ ). The special unit for exposure is roentgen (R), where  $1\text{ R} = 2.58 \times 10^{-4}\text{ C kg}^{-1}$ . [154]

**exposure:** A measure of the ionization produced in air by x or gamma radiation. Exposure is the sum of electric charges on all ions of one sign produced in air when all electrons liberated by photons in a volume of air are completely stopped, divided by the mass of the air in the volume. The unit of exposure in air is the roentgen (R) or in SI units it is expressed in coulombs (C),  $1\text{ R} = 2.58 \times 10^{-4}\text{ C kg}^{-1}$ .

- **acute exposure:** Radiation exposure of short duration.
- **chronic exposure:** Radiation exposure of long duration, because of fractionation or protraction. [153]

**exposure assessment:** A specification of the population potentially exposed to hazardous agents and the pathways and routes by which exposure can occur, and quantification of the magnitude, duration and timing of the exposures and resulting doses that organisms might receive; also may be referred to as dose assessment. [164]

**exposure pathway:** The physical course a hazardous agent takes from its source to an exposed organism. [164]

**exposure rate:** The exposure per unit time [e.g.,  $1\text{ R h}^{-1}$  ( $8.7\text{ mGy h}^{-1}$ ) ( $\sim 10\text{ mGy h}^{-1}$  air-kerma rate)]. [165]

**exposure route:** The means of intake of a substance by an organism (e.g., ingestion, inhalation or dermal absorption). [164]

**exposure route:** The means of intake of a radionuclide by an individual (e.g., ingestion, inhalation, through a wound or dermal absorption). Also, route of intake. [161]

**exposure scenario:** A credible series of events that could result in exposure of organisms to hazardous agents (e.g., after emplacement of hazardous waste in a disposal facility and closure of the facility). [164]

**exposure scenario:** A credible series of events that could result in exposure of individuals to radiation. A description of the radiation environment at locations and times of exposure and the behavior of individuals in that environment. [163]

**extended source (of radiation):** A source of particles or photons which cannot be considered a point source (e.g., whose linear dimensions are greater than one-tenth the distance between source and observation point). [144]

**external:** Unwanted radioactive material deposited on the outside of the body on the clothing, skin, hair, or body cavities such as the outer ear and eye. [161]

**external dose:** Dose to organs or tissues of an organism due to radiation sources outside the body. [164]

**external dose:** Dose to organs or tissues of an organism due to radiation sources located on or outside the body. [163]

**external source (radiation):** A source located on or outside the body that emits radiation that penetrates the epidermis and irradiates organs and tissues. [163]

**extrapolation:** Use of a data set or model under conditions different from those for which it was established. [164]

**extravasation:** Discharge or escape, as of blood, from a vessel into the tissues. [156]

**extravehicular activity (EVA):** Any activity undertaken by the crew outside a space vehicle. [167]

**extrinsic mortality:** Causes of death that originate from the environment outside the individual (e.g., accidents, homicide, suicide, infectious and parasitic diseases, famine); its counterpart is intrinsic mortality. [150]

**facility data set (FDS):** Consists of all of the data for a measured dose-related radiation field quantity (i.e.,  $K_{a,r}$  or  $P_{KA}$ ) for all cases of the specified procedure performed at an individual facility. A FDS is compared against the advisory data set (ADS) for the FGI procedure in order to better manage patient doses at the local facility. The percentages of cases in the FDS and ADS that exceed the substantial radiation dose level (SRDL) selected for the FDS, and the values of  $K_{a,r}$  or  $P_{KA}$  that define the potentially-high radiation dose procedure category are also used in the evaluation (see advisory data set, potentially-high radiation dose procedure, and substantial radiation dose level). [168]

**fallout:** The radioactive material falling from the atmosphere to Earth's surface after a radiological or nuclear incident, such as a weapons test or accident. [166]

**fallout:** Radioactive material falling from the atmosphere to the Earth's surface after a nuclear incident, such as a weapons test, accident, or detonation of an improvised nuclear device. [165]

**family member:** Any person who provides support and comfort to a patient on a regular basis and is considered by the patient as a member of their "family" whether by birth or marriage or by virtue of a close, loving relationship. [166]

**far field:** The electromagnetic field at a point far enough away from a radiofrequency source such that the fields are approximately plane-wave in nature. [119]

**fascia:** A sheet or band of fibrous tissue that lies deep to the skin or invests muscles and various body organs. [156]

**fast neutrons:** Neutrons of energies above a few hundred kiloelectron volts (keV). [167]

**fast neutrons:** Neutrons of energies above a few hundred thousand electron volts (see neutron). [163]

**fault tree analysis:** Systematic approach used in analyzing the reliability of complex systems in which probabilities of failure of individual components of a system and resulting chains of cause-effect consequences within the system are estimated. [152]

**fauna:** The assemblage of animal species in a given area. [154]

**favorable propagation path:** A concept suggesting that the Archimedean spiral path from the earth to the sun would connect to a specific solar longitude. It is based on the concept that charged particles travel along the interplanetary magnetic field which is transported out from the sun. For an idealized constant speed solar wind flow, if the interplanetary magnetic field is frozen in the plasma, then the result would form an Archimedean spiral. [153]

**FDA compliance air-kerma rate:** An FDA compliance measurement for air-kerma rate. For C-arm systems the measurement is made 30 cm in front of the image receptor at any source-to-image-receptor distance. Therefore, the



location of the reference point for this measurement will change relative to the x-ray gantry when the source-to-image-receptor distance is changed. [168]

**feed transfer coefficient:** Fraction of the amount of an element or radionuclide ingested daily by an animal that is deposited in 1 kg of meat, milk, eggs or other product. This term has the units of  $d\text{ kg}^{-1}$ . [154]

**femoral:** Pertaining to the femur. [164]

**femur:** The bone in the leg that extends from the hip to the knee. [164]

**ferrous:** Pertaining to iron and steel. [141]

**fertile:** Nonfissionable material from which fissionable material is generated by neutron absorption and subsequent nuclei conversions. Fertile materials are  $^{232}\text{Th}$  which can be converted into fissionable  $^{233}\text{U}$ , and  $^{238}\text{U}$  which can be converted into fissionable  $^{239}\text{Pu}$ . [154]

**fetus:** In the human, the developing young in the uterus after the second month. [168]

**fetus:** The developing conceptus, from the time that its external resemblance to the adult is sufficient to make it grossly recognizable as a member of the major taxonomic group to which it belongs until its time of hatching or birth (from the eight week of gestation until birth in humans). [163]

**fiberoptic bronchoscopy:** Use of a flexible material (glass or plastic) that transmits light to obtain visual images of the lung airways. [125]

**fibrin:** An insoluble protein essential to the clotting of blood, formed from fibrinogen by action of thrombin. [156]

**fibroadenoma:** A benign breast condition common in young adult women in which the breast develops a solid lump, usually firm but movable in the breast. [149]

**fibroblast:** An immature fiber-producing cell of connective tissue capable of differentiating into a cell specialized for producing various connective tissues such as cartilage or bone. [156]

**fibroma:** Tumor composed mainly of fibrous or fully developed connective tissue. [156]

**fibronectin:** An adhesive glycoprotein; one form circulates in plasma, another is a cell-surface protein that mediates cellular adhesive interactions. [156]

**fibroplasia:** The formation of fibrous tissue, as in wound healing. [156]

**fibrosarcoma:** A malignant neoplasm derived from deep fibrous tissue characterized by bundles of immature proliferating fibroblasts that invade locally and metastasize via the blood stream. [156]

**Fick's law of diffusion:** The flux of a gas is equal to the gas diffusion coefficient multiplied by the gas concentration spatial gradient along the axis of transport. [125]

**field point:** A point at which the electric or magnetic field is being evaluated. [119]

**field size:** The geometrical projection of the x-ray beam on a plane perpendicular to the central ray of the distal end of the limiting diaphragm, as seen from the center of the front surface of the source. [163]

**film:** A thin, transparent sheet of polyester or similar material coated on one or both sides with an emulsion sensitive to radiation and light. [168]

**film:** A thin, transparent sheet of polyester or similar material coated on one or both sides with an emulsion sensitive to radiation and light. [158]

- **direct exposure film:** Film that is highly sensitive to the direct action of x rays rather than in combination with an intensifying screen.
- **screen film:** Film whose light absorption characteristics are matched to the light emission characteristics of intensifying screens; screen film is not designed for use as direct exposure film. [145]

**film badge:** An assembly containing a packet of unexposed photographic film and a variety of filters (absorbers); when the film is developed, the dose and type of radiation to which the wearer was exposed can be estimated. [163]

**film badge:** An assembly containing a packet of unexposed photographic film and a variety of filters (absorbers); when the film is developed, the dose and type of radiation to which the wearer was exposed can be estimated. Although current radiation badges typically use thermoluminescent dosimeters, they are often referred to as film badges. [161]

**film speed:** For intraoral films, film speed is expressed as the reciprocal of the exposure (i.e.,  $R^{-1}$ ) necessary to produce a density of one above base plus fog.

- **D-speed film:** Direct exposure film with a speed range of 12 to 24  $R^{-1}$ .
- **E-speed film:** Direct exposure film with a speed range of 24 to 48  $R^{-1}$ .
- **F-speed film:** Direct exposure film with a speed range of 48 to 96  $R^{-1}$ .

Faster films need less exposure (i.e., a larger value of  $R^{-1}$ ) to produce the same film density (e.g., F-speed film is faster than E-speed film). For screen films, film speed is usually expressed in combination with an intensifying screen. [145]

**filter; filtration:** Material in the useful beam that usually preferentially absorbs the less penetrating radiation. The total filtration consists of inherent and added filters. [158]

- **inherent filtration:** The filter permanently in the useful beam; it includes the window of the x-ray tube and any permanent enclosure for the tube or source.

- **added filtration:** Filter in addition to the inherent filtration. [145]

**filtration:** Material in the useful beam that usually preferentially absorbs the less penetrating radiation. The total filtration consists of inherent and added filters. [163]

**finding:** Any condition or action that deviates from an applicable regulation, standard or procedure or adversely impacts the quality or reliability of any aspect of the radiation-safety program. [162]

**fine-needle aspiration biopsy:** A diagnostic technique used to sample cells from breast lumps. Cells from lumps are aspirated with a thin needle, smeared on a glass slide, stained, and evaluated by a pathologist. [149]

**finite-difference method:** Method of solving systems of partial differential equations in which differentials are approximated by finite differences, resulting in a series of algebraic equations. [152]

**finite-element method:** Method of solving systems of partial differential equations in which independent variables are discretized, which creates an integral form of the differential equations and provides a system of linear algebraic equations. [152]

**first-degree relative:** Mother, daughter or sister. [149]

**first ionization potential:** The energy required to remove the first electron from an electrically neutral atom. (The ionization potential is usually given in electron volts.) [153]

**first-order kinetic relationship:** Solution of an equation with independent and dependent variables that are related to functions of the first order of time. [125]

**first-order kinetics:** First-order processes occur in a system in which the loss rate from any compartment is proportional to the inventory of material in the compartment. The use of rate constants and half-times implies the operation of first-order kinetics. [164]

**fissile:** The property of radionuclides such as  $^{235}\text{U}$  and  $^{239}\text{Pu}$  of being able to fission when a neutron enters the nucleus, releasing more neutrons and large amounts of energy. [164]

**fissile:** A descriptor of a nuclide that is capable of undergoing nuclear fission, usually following the absorption of a slow neutron. [127]

**fission:** The splitting of fissile atoms to form energy and associated byproducts. [164]

**fission (nuclear):** The splitting apart of an atomic nucleus, either spontaneously or when induced by absorption of a neutron, to form energy and associated byproducts. [163]

**fission (nuclear):** A nuclear transformation characterized by the splitting of a nucleus into at least two other nuclei and the release of a relatively large amount of energy. [160]

**fission product:** An atom, either stable or radioactive, produced by fission (common examples are  $^{131}\text{I}$ ,  $^{90}\text{Sr}$ , and  $^{137}\text{Cs}$ ). [163]

**fission product:** Atom, either stable or radioactive, produced by splitting apart of an atomic nucleus, either spontaneously or when induced by absorption of a neutron. [156]

**fission products:** A large group of atoms, stable or unstable, produced directly or indirectly from fragments of atoms split by fission. Common examples are  $^{131}\text{I}$ ,  $^{90}\text{Sr}$ ,  $^{137}\text{Cs}$ , and many others [161]

**fission yield:** The fraction of nuclear fissions that yield a specific fission product. Fission products with mass numbers around 90 and 140 have particularly high fission yields. [154]

**fixation:** The act, process or result of becoming attached to or taken in, as in the metabolic assimilation of atmospheric nitrogen into ammonia by soil microorganisms or the incorporation of atmospheric carbon into green plants by photosynthesis. [154]

**fixer:** A chemical solution that removes the undeveloped silver halide crystals from film. Fixer also helps to harden the gelatin containing the black metallic silver so the film may be dried more readily. [149]

**fixer retention:** The inadequate removal of fixer from the film by the water in the wash tank of the processor. Retained fixer causes brown discoloration of the radiograph (often within a year or less). [149]

**floodplain:** The area of land covered by a stream during extreme flooding events. [154]

**flora:** The assemblage of plant species in a given area. [154]

**fluence:** The number of particles or photons per unit of cross-sectional area perpendicular to the direction of the particle (units of  $\text{m}^{-2}$  or  $\text{cm}^{-2}$ ) (i.e., particles per  $\text{m}^2$  or per  $\text{cm}^2$ ). [163]

**fluence:** The number of particles or photons per unit of a cross-sectional area (units of  $\text{m}^{-2}$ ). [160]

**fluence ( $\Phi$ ):** The quotient of  $dN$  by  $da$ , where  $dN$  is the number of particles or photons that enter a sphere of cross-sectional area  $da$ . The unit for particle fluence is  $\text{m}^{-2}$ , but it is also commonly expressed in  $\text{cm}^{-2}$  (i.e., particles per  $\text{m}^2$ , or per  $\text{cm}^2$ ). [158]

**fluence:** The number of photons per unit area (units of  $\text{m}^{-2}$ ). [Comm20]

**fluence ( $\Phi$ ):** The quotient of  $dN$  by  $da$ , where  $dN$  is the number of particles incident on a sphere of cross-sectional area  $da$  (i.e.,  $\Phi = dN/da$ ). The unit for fluence is  $\text{m}^{-2}$ , commonly given in  $\text{cm}^{-2}$ . In this Report, distributions of fluence are also noted variously as a function of one or more other variables [e.g.,  $\Phi(L,t)$ , the distribution of fluence as a function of linear energy transfer ( $L$ ) and time ( $t$ )]. [153]

**fluence rate:** Fluence per unit time. The unit for fluence rate is  $\text{m}^{-2} \text{s}^{-1}$ . [163]

**fluence rate:** The quotient of  $d\Phi$  by  $dt$ , where  $d\Phi$  is the increment of the fluence in the time interval  $dt$ . The unit for fluence rate is  $m^{-2} s^{-1}$ . [158]

**fluence rates:** The number of photons per unit area per unit time (units of  $m^{-2} s^{-1}$ ). [Comm20]

**fluorography:** Another mode of operation of a fluoroscope. Fluorography is intended to record images of moving objects for a few seconds at a time (e.g., cinefluorography of the heart). [168]

**fluoroscope (medical):** An instrument used in medical procedures for observing the internal structure of the body by means of the image of the anatomy examined formed on an image receptor when the patient is placed between the image receptor and an x-ray beam. [168]

**fluoroscopically-guided interventional (FGI) procedure:** An interventional diagnostic or therapeutic procedure performed via percutaneous or other access routes, usually with local anesthesia or intravenous sedation, which uses external ionizing radiation in the form of fluoroscopy to: localize or characterize a lesion, diagnostic site, or treatment site; monitor the procedure; and control and document therapy. [168]

**fluoroscopy:** A medical x-ray procedure used for observation of the internal features of the body by means of the fluorescence produced on a screen by a continuous field of x rays transmitted through the body. Fluoroscopy is intended to observe moving objects for relatively long periods of time (seconds to minutes) without the intent of preserving the images. [168]

**fluoroscopy:** A medical x-ray procedure used for real-time observation of the internal features of the body by means of the fluorescence produced on a screen by a continuous field of x rays transmitted through the body. [163]

**fluoroscopy:** The process of producing a real-time image using x rays. The machine used for visualization, in which the dynamic image appears in real time on a display screen (usually video) is a fluoroscope. The fluoroscope can also produce a static record of an image formed on the output phosphor of an image intensifier. The image intensifier is an x-ray image receptor that increases the brightness of a fluoroscopic image by electronic amplification and image minification. [147]

**flux:** The quotient of  $dN$  by  $dt$ , where  $dN$  is the increment of the particle number in the time interval  $dt$ . The unit for flux is reciprocal second ( $s^{-1}$ ). [163]

**flux ( $\dot{N}$ ):** The quotient of  $dN$  by  $dt$ , where  $dN$  is the increment of the particle number in the time interval  $dt$  (i.e.,  $\dot{N} = dN/dt$ ). The unit for flux is the reciprocal second ( $s^{-1}$ ). [158]

**focal spot:** The point on an x-ray tube anode at which electrons are directed in order to maximize the amount of photons in the useful x-ray beam. [133]. The smaller the focal spot, the better the limiting spatial resolution of the x-ray system, especially in magnification mammography. [149]

**focal spot, effective:** The apparent size of the radiation source region in a source assembly when viewed from the central axis of the useful radiation beam. [145]

**fog:** A darkening of the whole or part of a radiograph by sources other than the radiation of the primary beam to which the film was exposed. This can be due to chemicals in the processing solutions, light, or nonprimary beam radiation. [145]

**fogging:** A darkening of the whole or part of a photographic emulsion by sources other than the radiation to which the film was exposed. This can be due to chemicals in the processing solutions or to light. [158]

**foliar interception constant:** A parameter that describes the efficiency with which vegetation intercepts depositing aerosol particles. [154]

**follicular:** A spherical mass of cells usually containing a cavity. [159]

**food chain:** The hierarchical order of groups of organisms based on what each group eats (e.g., mountain lions feed on mule deer which feed on certain plants; large trout feed on minnows which feed on aquatic insects which feed on detritus). [164]

**food web:** A series of alternate, interconnected food chains, reflecting the idea that many organisms have diets that are very broad and that can change from time to time depending on food quality or availability. [154]

**footprint:** Refers to the area contaminated with radioactive material from the radiological or nuclear terrorism incident. [165]

**fractionation:** The delivery of a given total dose of radiation as several smaller doses, separated by intervals of time. [167]

**frag:** Shredded scrap, typically in the ferrous industries (see shredder). [141]

**frayed edge site:** The edge of a mineral particle of illite where weathering of the crystalline layers of mica have caused “fraying,” exposing additional surface area onto which cations of cesium and other elements can sorb. [154]

**free air exposure:** Exposure to an unconfined, uncollimated source in air under conditions in which scattered radiation makes up an insignificant proportion of the total intensity. [112]

**free-in-air exposure/dose:** Exposure or dose in air as opposed to a dose to an individual or a phantom measured at that point at that location. [158]

**free radicals:** Highly reactive molecules containing an odd number of electrons. [167]

**frequency:** (1) The time rate at which a quantity, such as an electric field, oscillates. The frequency is equal to the number of cycles through which the quantity changes per second. Frequency is expressed in hertz (Hz). The unit for hertz is the reciprocal second ( $s^{-1}$ ). (2) The number of occurrences of an event in some defined interval. [158]

**frequentist approach:** A statistical approach for uncertainty for which the probability of an event occurring in a particular trial is defined as the long-term relative frequency that the event would occur in a sequence of similar trials. [164]

**frisker:** Generic name for hand-held instrument generally used for surveying external surfaces of people and objects. [161]

**frost heaving:** Refers to the formation of ice crystals in the near surface soil that can push small soil particles toward the surface. [154]

**fuel element:** A nuclear fuel component for a nuclear reactor that contains the fissile fuel matrix encapsulated in a cladding material. [154]

**fuel matrix:** Fuel in a reactor consists of fuel assemblies that come in many configurations, but generally consist of the fuel matrix, which contains the fissionable material (typically uranium oxide or uranium metal) usually in the form of plates or cylindrical pellets. The cladding (typically zirconium, aluminum or stainless steel) surrounds the fuel, confining and protecting it. [154]

**fuel reprocessing:** A process whereby irradiated nuclear fuel is chemically dissolved and fissile materials such as uranium and plutonium are separated from the other components and radioactive contaminants for reuse. [154]

**fuel reprocessing:** Separation and extraction of various chemical elements in spent nuclear fuel. [152]

**functional area manager:** The manager of any of the functional groups responding to the emergency director during a radiation emergency. [111]

**functional residual capacity (FRC):** Air in the lung which remains after the tidal air is exhaled. [125]

**fundamental frequency:** For a periodic function in general, the repetition frequency. For a function formed by low-frequency periodic modulation of a high-frequency periodic function, the fundamental frequency of the latter; in this case, the (low) frequency of the modulation is the repetition frequency. [140]

**fused aluminosilicate particles (FAP):** Particles composed of heat-treated montmorillonite clay. [161]

**G<sub>1</sub>:** In the cycle of cell division, the G<sub>1</sub> phase is a period of apparent inactivity between M phase (see G<sub>2</sub>) and S phase. [167]

**G<sub>2</sub>:** In the cycle of cell division, the G<sub>2</sub> phase is a period of apparent inactivity between the S phase (DNA synthetic phase) and the M phase (mitosis when cell division takes place). [167]

**galactic cosmic radiation (GCR):** The charged-particle radiation outside the magnetosphere of Earth. The GCR consists of 2 % electrons and positrons and 98 % nuclei, the latter consisting (by fluence) of 87 % protons, 12 % helium ions, and 1 % high atomic number, high-energy (HZE) particles. [167]

**gamma camera:** An imaging device that displays the distribution of activity within a source such as the body. It records the quantity and distribution of photons emitted by the radioactive material in the area of interest. The gamma camera is the principal imaging device used in nuclear medicine. [166]

**gamma distribution:** A probability density function that can take on a variety of shapes from exponential (a special case of the gamma) to positively skewed monomodal distributions. The gamma distribution is also linked to the kinds of processes that give rise to Poisson and exponential distributions (e.g., the sum of independently and identically distributed exponential random variables is gamma distributed). [164]

**gamma radiation:** Electromagnetic radiation emitted in de-excitation of atomic nuclei, and frequently occurring in decay of radionuclides. Also called gamma ray and sometimes shortened to gamma (e.g., gamma-emitting radionuclides) (see photon and x ray). [167]

**gamma radiation:** Electromagnetic radiation (photons) emitted in de-excitation of atomic nuclei, and frequently occurring in decay of radionuclides. Also called gamma ray and sometimes shortened to gamma (e.g., gamma-emitting radionuclide) (see photon and x ray). [166]

**gamma ray:** A single photon of electromagnetic radiation emitted in the process of nuclear transition or radioactive decay. [164]

**gamma ray:** Electromagnetic radiation emitted by the atomic nucleus in the process of nuclear transition or radioactive decay. Gamma rays have high penetrating ability compared with alpha and beta particles. [163]

**gamma rays:** Electromagnetic radiation (photons) emitted in nuclear transitions (e.g., radioactive decay of <sup>137</sup>Cs) with energies particular to the transition. High-energy gamma rays have moderate-to-high penetrating power, are often able to penetrate deep into the body, and require thick shielding, such as up to a meter of concrete. [159]

**gamma rays:** Electromagnetic radiation emitted by the atomic nucleus. Gamma rays have high penetrating ability compared to alpha and beta particles. [157]

**gamma rays:** Short-wavelength electromagnetic radiation of nuclear origin (approximate range of energy: 10 keV to 9 MeV). [153]



**gamma-ray spectroscopy:** The measurement of the energy and intensity of gamma or x rays using detectors such as sodium iodide or germanium to quantify the activity of specific radionuclides that emit photons from the nucleus. [158]

**gamma spectrometry:** The measurement of the energy and intensity of gamma or x rays using detectors such as sodium iodide or germanium to quantify the activity of specific radionuclides that emit photons from the nucleus. [161]

**gantry:** The rotating arm on which the accelerator head (or  $^{60}\text{Co}$  source) is mounted. The gantry, and therefore the useful beam of radiation, typically can rotate 360 degrees about its axis. [151]

**gas-body activation (GBA):** A sub-category of noninertial cavitation involving the mechanical response of stabilized gas bodies to a sound field. [140]

**gas exchange (respiratory):** Process by which inhaled air supplies molecules of oxygen to the body and exhaled air removes molecules of carbon dioxide to the outside air. [125]

**gas-phase boundary zone:** Distance above a reactive or absorbing surface within which transfer of gas or vapor from an air stream to the surface is occurring. (Distance depends on the diffusion coefficient of the gas or vapor, temperature difference between the stream and surface and turbulent mixing in the gas stream.)

**Gaussian plume model:** Pollutant diffusion model distribution of material in a plume that is assumed to be Gaussian in shape. [164]

**Geiger-Muller counter:** A gas-filled radiation detector most often used to detect the presence of low dose rate beta particles, x rays, or gamma rays. The detector is not appropriate for use with pulsed radiation sources or when the type or energy of the radiation is to be determined. [156]

**Geiger-Muller detector:** A gas-filled radiation detector most often used to detect the presence of low dose-rate beta particles, x rays, or gamma rays. The detector is not appropriate for use with pulsed radiation sources or when the type or energy of the radiation is to be determined. [164]

**gene nomenclature:** Conforms to the international standards. Each of the major organisms (e.g., humans, rats, mice) has its own nomenclature. This nomenclature can be accessed through any of several web search engines. In general, human genes are identified with capitalized, italicized letters (e.g., RET), and its expressed protein is identified with all capital letters (e.g., RET). For rats and mice, the genes are identified with an initial capitalized letter plus others in lower case and all letters italicized (e.g., Ret) and its expressed protein identified with all capitalized letters (e.g., RET). [159]

**gene nomenclature:** Each major organism (e.g., humans, rats, mice, etc.) has an international committee overseeing nomenclatural aspects of gene identification. Thus, each major organism has its own genetic nomenclature. Each of the nomenclatures (e.g., “gene nomenclature humans,” or “gene nomenclature mice”) can be readily accessed through normal web search engines. In general, human genes are all italicized capital letters (e.g., MYC) while rats and mice

genes have only the first letter normally capitalized and all are italicized (e.g., *Myc*). Each gene nomenclature roster contains the earlier-used gene symbols(s) in addition to its present nomenclatural designation, and in some instances, there can only be referral to an earlier (synonym) symbol. [150]

**general license:** Permission to possess and use radioactive material without formal review and issuance of documents by the NRC or an Agreement State. [141]

**generator:** A device containing a radionuclide that decays to another radionuclide (decay product) that is to be extracted and used. The original radionuclide is firmly bound in the generator and remains behind (see eluate, elute). [124]

**generic:** Of, applied to, or referring to a whole kind, class or group; not site-specific. Often refers to a collection of data representing measurements made under a variety of conditions, or general assumptions intended to be broadly applicable to any site. [164]

**generic:** A term often applied to, or referring to, a whole kind of class or group. Often refers to a collection of data representing measurements made under a variety of conditions, or general assumptions intended to be broadly applicable. [163]

**generic parameter:** A parameter value that is applied broadly to different sites and for different conditions, as opposed to a site-specific parameter. [154]

**generic parameter value:** A parameter value that is applied broadly to different sites and for different conditions, as opposed to a site-specific parameter. [164]

**genetic effects:** Changes in reproductive cells that may result in detriment to offspring. [168]

**geologic repository:** System intended for disposal of radioactive waste in excavated geologic media; includes a subterranean mined facility for disposal of waste and portion of the geologic setting that provides a barrier to movement of radionuclides in waste. [152]

**geomagnetosphere:** The region around Earth occupied by Earth's magnetic field. [137]

**geometric distortion:** Distortion of the recorded image due to the combined optical effect of finite size of the focal spot and geometric separation of the anatomic area of interest from the image receptor and the focal spot. [145]

**geometric mean (GM):** The geometric mean of a set of  $n$  values is the  $n$ th root of the product of the  $n$  values. To take a simple case, the GM of ( $a, b$ ) is the square root (second root) of  $a$  times  $b$ , which is written  $(a \times b)^{1/2}$  or  $\sqrt{(a \times b)}$ . In nuclear-medicine imaging applications, the GM of the anterior and posterior views, modified by attenuation correction factors, is used to estimate the activity concentration in a tissue. [164]

**geometric mean (GM):** The geometric mean of a set of  $n$  values is the  $n$ th root of the product of the  $n$  values [e.g., the geometric mean of  $(a, b)$  is the square root (second root) of  $a$  times  $b$ , which is written  $(a \times b)^{1/2}$ ]. [163]

**geometric mean:** The geometric mean of a set of positive numbers is the exponential of the arithmetic mean of their logarithms. The geometric mean of a lognormal distribution is the exponential of the mean of the associated normal distribution. [159]

**geometric mean (GM):** The  $n$ th root of the product of  $n$  values in a set. To take a simple case, the GM of  $a, b$  is the square root (second root) of  $a$  times  $b$ , which is written  $(a \times b)^{1/2}$  or  $\sqrt{(a \times b)}$ . [158]

**geometric mean diameter:** Median diameter of a lognormal distribution of particle diameters. [156]

**geometric standard deviation (GSD):** For a lognormal distribution it is the exponential of the standard deviation of the associated normal distribution (always  $\geq 1$ ). [164]

**Geostationary Operational Environmental Satellite (GOES):** A satellite in geosynchronous orbit used for monitoring protons. The satellite travel at the same angular speed above the equator as Earth's rotation and therefore appears stationary when observed from Earth's surface. [153]

**geotropism:** The degree of instrument reading change as a function of the physical orientation of the meter. [112]

**gestation:** Maintenance of the conceptus within the body of the parent, in a uterus, ovary or oviduct. [161]

**glaciofluvial:** Produced by the action of glaciers and streams, for example moraines and gravel deposits. [154]

**glomerular:** Pertaining to a small tuft or cluster, or to a small convoluted mass of capillaries, especially in the kidney. [156]

**glycoprotein:** Any of a class of conjugated proteins consisting of a compound of protein with a carbohydrate group. [156]

**goblet cells:** Epithelial cells that are distended with mucin so as to have a goblet shape (mucin is capable of being discharged upon the epithelial surface). [125]

**goiter:** Enlargement of part or all of the thyroid gland. [159]

**Gompertz function/distribution:** A statistical distribution developed in 1825 by the British actuary Benjamin Gompertz to describe age-specific mortality risks. Gompertzian mortality is characterized by a linear increase in age-specific death rates on a plot where the horizontal axis (age) is arithmetic and the vertical axis (death rate) is semilogarithmic. [150]

**gonad:** An ovary or testis. [161]

**Gorlin's syndrome:** Synonymous with "basal cell nevus syndrome." [150]

**grab sample:** A sample of limited volume taken at random or at preselected frequencies. [164]

**granulation:** Process of forming granulation tissue or cytoplasmic granules. [156]

**granulomatous:** Composed of granulomas (*i.e.*, small nodular delimited aggregation of mononuclear inflammatory cells). [156]

**Graves' disease:** A thyroid disorder characterized by an enlarged thyroid, exophthalmos, "orange-peel" skin, and hyperthyroidism. [164]

**Graves' disease:** A disease state in which the thyroid gland enlarges and may produce excessive amounts of thyroid hormone. Currently considered to represent an autoimmune disease that is caused by the formation of abnormal immunoglobulin stimulators of the thyroid gland. [159]

**gray (Gy):** The special name for the SI unit  $\text{J kg}^{-1}$  (*i.e.*, energy imparted per unit mass of a material).  $1 \text{ Gy} = 1 \text{ J kg}^{-1}$ . [168]

**gray (Gy):** The SI special name for the unit of the quantities absorbed dose and air kerma.  $1 \text{ Gy} = 1 \text{ J kg}^{-1}$ . [167]

**gray (Gy):** The SI unit of absorbed dose of radiation,  $1 \text{ Gy} = 1 \text{ J kg}^{-1}$ . [164]

**gray (Gy):** The SI special name for the unit ( $\text{J kg}^{-1}$ ) of absorbed dose.  $1 \text{ Gy} = 1 \text{ J kg}^{-1}$  (see absorbed dose and rad). [159]

**gray (Gy):** The SI special name for the unit of the quantities absorbed dose and air kerma.  $1 \text{ Gy} = 1 \text{ J kg}^{-1}$ . [158]

**gray (Gy):** The special name for the SI unit of absorbed dose expressed in terms of energy imparted per unit mass of a material.  $1 \text{ Gy} = 1 \text{ J kg}^{-1}$  (see rad). [157]

**gray equivalent (Gy-Eq):** The special name for the unit of the quantity gray equivalent ( $\underline{G}_T$ ). Also given as the product of  $\underline{D}_T$  and  $\underline{R}_i$ , where  $\underline{D}_T$  is the mean absorbed dose in an organ or tissue and  $\underline{R}_i$  is a recommended value for RBE for deterministic effects for a given particle type  $i$  (*i.e.*,  $\underline{G}_T = \underline{R}_i \times \underline{D}_T$ ). An  $\underline{R}_i$  value applies to the particle type incident on, or emitted from radioactivity within, the body. The dose limits for deterministic effects from space radiation are given in terms of the quantity gray equivalent. [167]

**gray equivalent (Gy-Eq):** The name for the unit of the quantity gray equivalent ( $G_T$ ) (NCRP, 2000),  $1 \text{ Gy-Eq} = 1 \text{ J kg}^{-1}$ . [153]

**gray equivalent (Gy-Eq):** The special name for the unit of the quantity gray equivalent ( $\underline{G}_T$ )  $1 \text{ Gy-Eq} = 1 \text{ J kg}^{-1}$  [see gray equivalent ( $\underline{G}_T$ )]. [142]

**gray equivalent ( $\underline{G}_T$ ):** The product of  $\underline{D}_T$  and  $\underline{R}_i$ , where  $\underline{D}_T$  is the mean absorbed dose in an organ or tissue and  $\underline{R}_i$  is a recommended value for relative biological effectiveness for deterministic effects for a given particle type  $i$  (*i.e.*,  $\underline{G}_T = \underline{R}_i \underline{D}_T$ ). An  $\underline{R}_i$  value applies to the particle type incident on the body. The dose limits for deterministic effects from space radiation are given in the quantity gray equivalent [see gray equivalent (Gy-Eq)]. [142]

**grid:** A device used to reduce scattered radiation reaching an image receptor during the making of a radiograph. It consists of a series of narrow (usually lead) strips closely spaced on their edges, separated by spacers of low density material. [145]

**groundshine:** The scattering of photons or neutrons from a source by the surface or volume of the ground. [Comm20]

**groundwater:** Water below the land surface in a zone of saturation that is under a pressure equal to or greater than atmospheric pressure. [163]

**Group IA:** Alkali metals are the elements located in Group IA of the periodic table. The alkali metals exhibit many of the physical properties common to metals, although their densities are lower than those of other metals. Alkali metals have one electron in their outer shell, which is loosely bound. This gives them the largest atomic radii of the elements in their respective periods. Their low ionization energies result in their metallic properties and high reactivities. An alkali metal can easily lose its valence electron to form the univalent cation. Alkali metals have low electronegativities. They react readily with nonmetals, particularly halogens. [154]

**grout:** Thin mortar used for filling spaces; any of various other materials (as a mixture of cement and water or chemicals that solidify) used for a similar purpose and to reduce the mobility of contaminants. [154]

**grout:** Any concrete-like material used to encapsulate waste or provide fill in waste disposal units. [152]

**G-value (or G-factor):** A measure of the number of a particular chemical species produced in a medium by deposition of ionizing radiation. [Comm20]

**half-life (radioactive):** The time in which one-half of the atoms (on average) of a particular radioactive substance disintegrate into another nuclear form (also called physical or radiological half-life). [166]

**half-life ( $T_{1/2}$ ):** Time over which half the atoms of a particular radionuclide decay to another nuclear form. [164]

**half-life:**

- **biological:** The time required for the body to eliminate one-half of an administered quantity of any substance by regular processes of biological elimination.
- **radioactive:** The time in which one-half of the atoms (on average) of a particular radioactive substance disintegrate into another nuclear form. The usual meaning when the term half-life is not further specified. [163]

**half-life ( $T_{1/2}$ ):** Time over which half the atoms of a particular radionuclide decay to another nuclear form. [156]

**half-life ( $T_{1/2}$ ):** Time required to reduce spontaneously the activity of a radionuclide to one-half of the activity originally present. Physical or radioactive half-life refers to reduction of activity by radioactive decay; biological half-life refers to elimination of the activity by biological processes and effective half-life refers to the combined action of radioactive decay and biological elimination. [155]

**half-time:** The time required for half of the quantity of a substance in a physical or biological compartment (see compartment) to be lost from the compartment by one or more mechanisms other than radioactive decay. [164]

**half-time:** The time required for half of the quantity of a radionuclide in a biological compartment to be cleared by biological processes in the absence of further input into the compartment. [161]

**half-value layer:** The thickness of a specified substance that, when introduced into the path of a given beam of ionizing radiation, reduces the air-kerma rate (or exposure rate) by one-half. [163]

**half-value layer (HVL):** The thickness of a given material required to reduce the radiation absorbed dose rate by a factor of two (also known as the half-value thickness). HVL is used as a descriptor of beam quality or hardness. [Comm20]

**half-value layer (HVL):** The thickness of a specified substance which, when introduced into the path of a given beam of radiation, reduces the radiation field quantity to one-half its original value. [151]

**half-value thickness:** The thickness of a given material required to reduce the radiation intensity by a factor of two. [112]

**Hanford:** Refers to the Hanford Site or Hanford Reservation, a large U.S. Department of Energy facility located in the state of Washington. [154]

**Hanford Reach:** The 82 km (51 miles) of the Columbia River that flows through or beside the Hanford Site. It is the last stretch of the Columbia River in the United States above Bonneville Dam that remains unimpounded. [154]

**hard top:** A cargo containment that has a solid metal top, as opposed to a open or soft top. [Comm20]

**harmonic:** A spectral component whose frequency is n times that of the fundamental where n is a positive non-zero integer. [140]

**Haversian canal:** Any of the many tiny canals that contain blood vessels and connective tissue and that form a network in the long or cortical bones of the body. [164]

**hazard:** Act or phenomenon that has the potential to produce harm or other undesirable consequences to humans (e.g., ionizing radiation). [152]

**hazard function, and hazard rate:** The derived age-specific probability of death or occurrence of an adverse event; also known as the instantaneous failure rate or force of mortality. [150]

**Hazardous and Solid Waste Amendments:** Amendments to the Resource Conservation and Recovery Act (RCRA) passed in 1984, which added the land disposal restrictions, minimum technology requirements, and expanded corrective action authorities to the law. [146]

**hazardous chemical:** Any chemical that is a physical hazard or a health hazard as defined by the Occupational Safety and Health Administration (OSHA, 1994a). [145]

**hazardous waste:** Waste as defined under the RCRA of 1976 (42 U.S.C. 6901 et seq.). Under RCRA regulations, a hazardous waste is a solid waste or combination of solid waste that, because of its quantity, concentration, or physical, chemical or infectious characteristics may (1) cause or significantly contribute to an increase in mortality or an increase in serious irreversible or incapacitating reversible illness; or (2) poses a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported or disposed of or otherwise managed. A solid waste is hazardous if it meets one of three conditions: (1) exhibits a characteristic of a hazardous waste (40 CFR 261.20 – 262.24), (2) has been listed as hazardous (40 CFR 261.31 – 261.33), (3) is a mixture containing a listed hazardous waste and a nonhazardous solid waste (unless the mixture is specifically excluded or no longer has any of the characteristics of hazardous waste). [141]

**health detriment:** Measure of stochastic effects from exposure to ionizing radiation that takes into account the probability of fatal cancers, probability of severe hereditary effects in future generations, probability of nonfatal cancers weighted by the lethality fraction, and relative years of life lost per fatal health effect. [161]

**health detriment:** Term describing the total health impact on a population of an exposure to radiation. [126]

**health physicist:** An individual qualified by training and experience to be professionally engaged in the practice of health physics. [166]

**health physics:** The profession devoted to the protection of humans and their environment from potential radiation hazards, to the identification of potential beneficial effects of radiation, and to the assistance in the development of beneficial effects of ionizing and nonionizing radiation. [166]

**health physics:** The science concerned with the recognition, evaluation and control of health hazards to permit the safe use and application of ionizing radiation. [163]

**heap-leach extraction:** The application of chemical agents to ore stockpiles or mine walls for the extraction of the mineral content. [118]

**heat:** In metal-making, a term used for a single batch of metal being produced in a metal-making furnace. [141]

**heavy-charged particles:** Atomic and subatomic charged particles with masses substantially heavier than that of an electron. [161]

**heavy ions:** Synonymous with heavy charged particles, heavy nuclei, high- $Z$  particles, or HZE particles. [167]

**heavy ions:** Nuclei of elements heavier than helium such as nitrogen, carbon, boron, neon, argon or iron which are positively charged due to some or all of the planetary electrons having been stripped from them. [163]

**heavy melt:** A blend of miscellaneous ferrous scrap containing individual pieces at least 0.32 mm (1/8 inch) thick and having an average density of about 0.88 grams per cubic centimeter (65 pounds per cubic foot). Heavy melt typically contains cut pieces of plate, structural sections, truck parts, and machinery parts. [141]

**hectare (ha):** A unit of area equal to  $10^4$  m<sup>2</sup> (2.47 acres). [154]

**heliocentric:** A measurement system with its origin at the center of the sun. [153]

**heliolongitude:** Imaginary lines of longitude on the sun measured east (left) or west (right) of the central meridian (imaginary north-south line through the middle of the visible solar disk) as viewed from Earth. The left edge of the solar disk is 90°E and the right edge is 90°W. [153]

**heliosphere:** The immense negative bubble containing the solar system, solar wind, and entire solar magnetic field. It extends beyond the orbit of Pluto. [153]

**heliosphere:** A region of the atmosphere from 600 to 1,500 miles above Earth's surface. [132]

**hemangioma:** A congenital anomaly in which proliferation of blood vessels leads to a mass that resembles a neoplasm; it can occur anywhere in the body but is most frequently noticed in the skin and subcutaneous tissues. [159]

**hemangiosarcoma:** Malignant neoplasm originating from blood vessels and involving endothelial and fibroblastic tissue. [156]

**hematoma:** Localized collection of extravasated blood, usually clotted, in an organ, space or tissue. [156]

**hematopoietic stem cells:** Self-renewing blood and bone-marrow forming cells. [164]



**hemosiderin:** Insoluble form of storage iron, visible microscopically both with and without the use of special stains. [156]

**hemostasis:** Arrest of the escape of blood by either natural (clot formation or vessel spasm) or artificial (compression or ligation) means. [156]

**Henry's law:** The solubility of a gas in a liquid is proportional to the partial pressure of the gas (i.e., by doubling the pressure, twice as much gas passes into solution). [125]

**hepatobiliary:** Pertaining to the liver-bile-gall bladder system. [156]

**hepatoma:** Any tumor of the liver. [156]

**herbaceous:** Refers to non-woody vegetation such as grasses and other plant species composed mainly of soft, green tissue. [154]

**herbivore:** An animal that eats plants. [154]

**hereditary effects:** Effects expressed in offspring due to alteration of reproductive cells in the parent(s). [157]

**heritable (effects):** Effects expressed in offspring due to alteration of reproductive cells in the parent(s). [168]

**heritable effects:** Changes in reproductive cells that may be passed on to offspring of persons or animals. Often called genetic effects (see genetic effects). [167]

**heritage:** A term collectively referring to the influence of species, genetic background, ethnic group, and environment on susceptibility to thyroid carcinoma. [159]

**hermaphrodite phantom:** A nongender-specific mathematical phantom having both male and female organs. [158]

**heterozygous:** Pertaining to an individual's possessing different alleles at a given locus. [167]

**heuristic:** Proceeding along empirical lines, using rules of thumb, to find solutions or answers; not rigorous. [152]

**hexavalent:** Having a valence of six. [156]

**high atomic number, high-energy (HZE) particles:** Heavy ions having an atomic number greater than that of helium (such as argon, boron, carbon, iron ions, neon, or nitrogen that are positively charged) and having high kinetic energy. [167]

**high dose rate (HDR):** As used in brachytherapy, HDR refers to a type of remote afterloader housed in a treatment room that contains a high activity source of radiation used to deliver a therapeutic treatment to a patient in a relatively short treatment time. [155]

**higher-risk source:** A radioactive-material source in Security Groups A, B or C (Table 7.1). [157]

**high-fired oxide:** A highly insoluble metal oxide, usually of uranium or plutonium, commonly produced by combustion in air. [156]

**high-LET radiation:** Neutrons or charged particles, such as protons or alpha particles that produce ionizing events densely spaced on a molecular scale (e.g.,  $>10 \text{ keV } \mu\text{m}^{-1}$ ). [159]

**high-level radioactive waste:** (A) Highly radioactive material resulting from reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such waste that contains fission products in sufficient concentrations, and (B) other highly radioactive material that the U.S. Nuclear Regulatory Commission, consistent with existing law, determines by rule requires permanent isolation. In most countries other than the United States, high-level waste also includes waste from any source that contains high concentrations of shorter-lived radionuclides and high concentrations of long-lived, alpha-emitting radionuclides. At the present time, however, high-level waste in the United States includes only waste produced directly in chemical reprocessing of spent nuclear fuel. [152]

**hilar area or nodes:** depression or recess at entrance or exit of vessels to an organ; the root of the lung and its lymph nodes. [125]

**histiocytoma:** Tumor containing histiocytes (i.e., macrophages). [156]

**histogenesis:** The formation or development of tissues from the undifferentiated cells of the germ layers of the embryo. [128]

**histopathology:** Pathologic histology (i.e., that dealing with the minute structure, composition and function of diseased tissues). [156]

**hit-size effectiveness function (HSEF):** At a given absorbed dose, the “weighting” function of the specific energy ( $z$ ) which yields the biological endpoint in question (e.g., risk of cancer) when multiplied by the distribution in  $z$  and integrated over  $z$ . [137]

**Hodgkin’s disease:** A type of malignancy of lymphoid cells, named after a British physician, Thomas Hodgkin (1798 to 1869). [167]

**homeostasis:** The tendency of biological systems to maintain relatively constant conditions in the internal environment while continuously interacting with and responding to changes originating within or outside the system. [156]

**home range:** The geographic extent of land-use by animals for feeding, finding shelter and mates, and other needs. [154]

**homogeneity:** The properties, or conditions of isotropy or anisotropy are constant from point to point in the groundwater medium. [129]

**homolog:** Chemical element belonging to same group of the periodic table as another element (e.g., halogens, actinides). [152]

**homozygous:** Pertaining to an individual's possessing a pair of identical alleles at a given locus. [167]

**hot cell:** A heavily shielded enclosure for handling, processing or storing highly radioactive sources. [127]

**hot metal:** Molten iron from a blast furnace used in basic oxygen furnaces and sometimes in electric arc furnaces. [141]

**humerus:** The upper arm bone between the shoulder and elbow. [164]

**humic:** Of or derived from organic materials (partially decayed plant or animal matter) in soil. [152]

**humic matter:** A brown or black organic material resulting from partial decomposition of plant or animal matter and forming the organic portion of soil. [154]

**hustlers:** Small trucks for moving cargo containers around within a seaport. [Comm20]

**hyaluronic acid:** A mucopolysaccharide found in lubricating proteoglycans of synovial fluid, vitreous humor, cartilage, blood vessels, and skin. [156]

**hydraulic conductivity:** Volume of water that will move per unit time under a unit hydraulic gradient through a unit cross-sectional area perpendicular to direction of flow. [152]

**hydrolysis:** Cleavage of a compound by the addition of water, the hydroxyl group being incorporated into one fragment and the hydrogen atom in the other. [156]

**hydrophilic:** Having a strong affinity for water; absorbing water. [156]

**hydrophilic molecule:** Molecule that readily absorbs moisture; bibulous. [125]

**hygroscopicity:** Degree of absorption and retention of moisture, for example, by an airborne particle. [161]

**hyperemia:** An excess of blood in a part of the body. [156]

**hypergeometric distribution:** A discrete probability distribution that describes the number of successes expected when sampling a finite population without replacement. [158]

**hyperkeratosis:** Hypertrophy of the horny layer of the skin, or any disease characterized by it. [156]

**hyperparathyroidism:** A condition due to an increase in the secretion of the parathyroids, causing elevated serum calcium, decreased serum phosphorus, and increased excretion of both calcium and phosphorus, calcium stones, and sometimes generalized osteitis fibrosa cystica. [159]

**hyperplasia:** Abnormal increase in volume of a tissue or organ caused by the formation and growth of new normal cells. [156]

**hyperthyroidism (thyrotoxicosis):** Functional, metabolic state caused by excessive thyroid hormone. [159]

**hyperthyroidism:** A condition in which an overactive thyroid gland produces excessive thyroid hormone, leading to a characteristic clinical picture. Since the thyroid uses iodine to make its hormone (thyroxine or T-4), radioactive iodine in small dosages can be used to image the thyroid and in large dosages to treat it (reduce its function). [124]

**hypocellular:** Having an abnormal decrease in the number of cells present. [156]

**hypolimnetic:** Refers to the hypolimnion zone in lakes. [154]

**hypolimnion:** The deeper water zone in a thermally stratified lake, characterized by colder, oxygen-depleted, less turbulent water, and often displaying various physical, chemical and biological characteristics that differ from the near-surface zone (the epilimnion). [154]

**hypopharynx:** Lowermost portion of the pharynx that leads to the larynx and esophagus. [125]

**hypothalamus:** The ventral and medial region of the diencephalons forming the walls of the ventral half of the third ventricle in the brain; it is delineated from the thalamus by the hypothalamic sulcus, lying medial to the internal capsule and subthalamus. [159]

**hypothyroidism:** Functional, metabolic state caused by inadequate amounts of thyroid hormone. [159]

**hysteresis:** Dependence of the state of a system on its previous history, generally a retardation or lagging of an effect behind the cause of the effect. [152]

**HZE:** A heavy ion having an atomic number greater than that of helium and having high kinetic energy. [167]

**ICRU sphere:** A tissue-equivalent sphere prescribed in ICRU Report 33 as having a diameter of 30 cm, a composition by mass of 76.2 % oxygen, 10.1 % hydrogen, 11.1 % carbon, and 2.6 % nitrogen, and density of  $1 \text{ g cm}^{-3}$ . [158]

**illite:** A weathered form of the mineral mica and a 2:1 clay mineral that is extremely effective for the irreversible fixation of cesium atoms. [154]

**image contrast:** The optical density difference between adjacent areas in a radiographic image resulting from attenuation differences in the imaged object. Film contrast depends on both film characteristics and processing. [158]

**image intensifier:** An x-ray image receptor which increases the brightness of a fluoroscopic image by electronic amplification and image minification. [168]

**image quality:** The overall clarity of a radiographic image. Image sharpness, contrast and noise are three common measures of image quality. [168]

**image receptor:** A system for deriving a diagnostically-usable image from the x rays transmitted through the patient. Examples: screen-film system, photostimulable storage phosphor, solid-state detector. [168]

**image sharpness:** How well the margins of linear structures, masses and calcifications are depicted in the radiograph. [149]

**immediate dose management:** Actions taken to address the potential for high doses from transient events in the space radiation environment that could impact the conduct or completion of the mission or mission tasks. Immediate dose management actions may be taken to avoid exceeding administrative levels or dose limits. [142]

**impedance, wave:** The ratio of the electric field strength to the magnetic field strength of a wave. For a plane wave in free space, the wave impedance is equal to the square root of the ratio of the permeability to the permittivity of free space and is equal to 377 ohms. For a plane wave in a material, the wave impedance is equal to 377 times the square root of the ratio of the relative permeability to the relative permittivity of the material. [119]

**implant:** A completed assembly of radioactive sealed sources with or without applicators that is placed in a patient with therapeutic intent. [155]

**implantation:** Term most commonly referring to blastocyst adhesion and attachment to or embedment in the endometrium. [128]

**importance analysis:** Analysis of performance assessment models for the purpose of identifying assumptions and parameter values which, when changed within credible bounds, can affect a decision about compliance of a waste disposal facility with applicable regulatory performance objectives. [152]

**improvised nuclear device (IND):** A device designed by terrorists to produce a nuclear detonation. This includes stolen and subsequently modified nuclear weapons but does not include stockpiled weapons in the custody of the military. [166]

**inadvertent intruder:** Hypothetical individual who might occupy a waste disposal site after facility closure and engage in normal activities, such as agriculture, dwelling construction, permanent residence, or other pursuits, that might result in the individual being unknowingly exposed to waste materials. [152]

**inadvertently-exposed individual:** Any individual within the exclusion zone who is unintentionally exposed to radiation during a conveyance scan with the Cargo Advanced Automated Radiography System. [Comm20]

**incidence:** The rate of occurrence of a disease, usually expressed in number of cases per million. [161]

**incidence:** The rate at which new cases of a disease develop during some specific time period. The number of new cases of disease found in a population measured over a period of time. [159]

**incident:** Refers to a situation, accidental or deliberate, in which radionuclides are dispersed resulting in possible exposure of persons that could result in external or internal radionuclide contamination. [161]

**incident:** An occurrence or situation. [111]

**incident air kerma ( $K_{a,i}$ ):** Air kerma from the incident beam on the central x-ray beam axis at the focal-spot-to-surface distance (does not include backscattered radiation). [168]

**incident air kerma (or dose):** Air kerma (or dose) measured free-in-air (i.e., without backscatter) at the location of the entry surface of an irradiated person or phantom in the absence of the person or phantom. [163]

**inclination:** This is the acute angle that the trajectory of an orbit makes with the earth's equator. [132]

**indirect bioassay:** The assessment of radioactive material deposited in the body by detection of radioactivity in material excreted or removed from the body. [164]

**indirect (in vitro) bioassay:** The assessment of radioactive material deposited in the body by detection of activity in material excreted or removed from the body (in vitro measurement). [161]

**indirectly ionizing radiation:** Uncharged particles (e.g., neutrons, photons, gamma rays) that are capable of releasing charged particles when interacting with matter (see ionizing radiation). [158]

**individual monitoring:** The performance and interpretation of measurements of activities in the body, or in products eliminated from the body by devices, where such measurements are intended to provide an estimate of the dose to tissues

of the body. The results of individual monitoring are mainly used to confirm the safety of working conditions, to identify unexpected exposures, and to keep records. [164]

**individual (personal) monitoring:** The performance and interpretation of measurements by devices worn by individuals, where such measurements are generally intended to provide an estimate of the dose equivalent. The results of individual monitoring are mainly used to confirm the safety of working conditions, to identify unexpected exposures, and to maintain records of exposure. [163]

**individual (personal) monitor or dosimeter:** A small radiation detector that is worn by an individual. Common individual dosimeters contain film, thermoluminescent or optically-stimulated luminescent materials as the radiation detector. [148]

**induction:** The specific morphogenetic effect that is brought about by a (chemical) stimulus that is transmitted from one embryonic part to another. [128]

**induction furnace:** Furnace that uses electrically induced heating to melt the metal. Induction furnaces are either operated in vacuum or in air. The feedstock to an induction furnace consists of solid metal, including scrap metal. [141]

**inertial cavitation:** A class of acoustic cavitation involving growth and collapse of one or more cavities (previously called “transient cavitation”). [140]

**inertial impaction of particles:** Fraction of particles that may contact airway walls because of their inertia (particles do not follow the curvature of the airstream exactly).

**inferior:** Situated below or directed downward; opposite of superior. [159]

**infiltrate:** To flow into. [154]

**infiltration:** Process of downward movement of water from the ground surface into underlying materials. [152]

**influence quantity:** A quantity that is not the quantity measured but that affects the result of the measurement. An example of an environmental influence quantity would be temperature. [158]

**ingestion:** The process in which radioactive material is taken into the digestive system. The amount ingested is equivalent to an intake, although only a fraction may be absorbed into the blood system and deposited in tissues and organs and eventually excreted, mostly in urine. The ingested activity that is not absorbed to blood is excreted in feces. [161]

**ingot:** The first rough shape produced by pouring molten metal into a mold (ingot mold). [141]

**inhalability (inspirable particulate mass):** Fraction of the suspended material in ambient air that enters the nose or mouth with the volume of air inhaled. [161]

**inhalation:** The process in which air and substances, such as radioactive materials, entrained in the air are taken into the respiratory tract through the nose or mouth. The activity inhaled may differ from the activity deposited in the respiratory tract since some fraction, depending upon its physical and chemical properties and the physiological state of the individual, may be promptly exhaled. [161]

**initial condition:** Assumed value of a dependent variable or one of its time derivatives at the time the solution of a differential equation or set of equations is begun. [164]

**in situ:** Refers to being in the natural or original position or place. [163]

**in situ:** Confined to site of origin, not having invaded adjoining tissues or metastasized to other parts of the body (e.g., intraductal). [156]

**inspection:** Physical examination of equipment or a process to confirm that it meets the expectations of performance. [162]

**inspiratory capacity:** Index of the maximum volume of air breathed in during inhalation; includes the tidal volume and inspiratory reserve volume. [125]

**installation:** Radiation sources with associated equipment, and the space in which they are located. [148]

**instantaneous dose-equivalent rate (IDR):** The dose-equivalent rate in Sv h<sup>-1</sup> as measured with the accelerator operating at the absorbed-dose output rate  $\dot{D}_0$ . IDR is specified at 30 cm beyond the penetrated barrier. [151]

**institution:** The management structure and its associated activities carried out at one or more sites; examples would include private industries, government research laboratories, hospitals, nuclear power plants, and universities. [162]

**institutional control:** Control of a waste disposal site by an authority or institution designated under laws of a country, state or local authority. Institutional control may be active (e.g., monitoring of effluents, surveillance, remedial activities, fences, or guards) or passive (e.g., records or warning signs). [152]

**instrument:** A complete system consisting of one or more assemblies to quantify one or more characteristics of radiation or radioactive material. [165]

**intake:** The amount of radioactive material taken into the body by inhalation, absorption through the skin, ingestion, or through wounds. It is distinguished from “uptake,” which is the amount of material that eventually enters the systemic circulation, or “deposition,” which is the amount of the substance that is deposited in organs and tissues. [166]

**intake:** The amount or quantity of activity taken into the body by inhalation, absorption through the skin, ingestion, or through wounds; also the process or an event of radioactive material entering the body by any pathway. [164]

**intake (radionuclides):** (1) The process of radionuclides entering the body; or (2) the amount of radionuclides taken into the body by inhalation, absorption through the skin, ingestion, or through wounds. [163]



**intake retention fraction:** Ratio of the activity measured in the body, or in excreta, to the intake. [156]

**integrated reference air kerma (IRAK):** Special term used in brachytherapy for integrated reference air kerma strength, a product of  $\underline{S}_K$  and treatment time. The unit of IRAK is Gy m<sup>2</sup>. [155]

**integration:** Process of presenting results of a performance assessment and important assumptions that determined the results in a manner that provides the basis for identifying conditions under which a disposal facility is expected to comply with applicable regulatory performance objectives. [152]

**integrin:** Any one of many membrane proteins in the plasma membrane of cells. [156]

**intended use:** Use of a product, process or service in accordance with the specifications, instructions and information provided by the manufacturer. [168]

**intensity (of radiation field):** Radiation fluence rate, radiation energy fluence rate, or quantities derived from these, such as absorbed dose rate and dose equivalent rate. [163]

**intercept:** The process of capturing an aerosol depositing on the landscape by vegetation. [154]

**interception:** The process of capturing an aerosol depositing on the landscape by vegetation. [164]

**interception:** Process by which the physical size of an inhaled particle (equal to the particle radius) brings it into direct contact with the airway wall. [125]

**interception fraction:** Fraction of material deposited from the atmosphere onto the land surface that is intercepted and immediately retained on surfaces of vegetation. [154]

**interference (in shielding barrier):** Discontinuity or void in a shielding barrier (e.g., aperture, piping, ductwork, maze), which tends to reduce the effective thickness of the barrier. [144]

**interlock:** Device that automatically shuts off or reduces the radiation emission rate from an accelerator to acceptable levels. In certain applications, an interlock can be used to prevent entry into a treatment room. [151]

**interlock detectors:** Detectors that produce a logic signal which changes depending upon the conditions. Such a system may trip the interlock and de-energize an accelerator if a certain dose rate is exceeded at a specific location. [Comm20]

**interlock enforced search:** A system of interlock switches which must each be actuated before the scan can be initiated and sensors positioned to provide an unobstructed view of the entire exclusion zone (this might be accomplished by video surveillance or with other sensors). [Comm20]

**intermediate-level radioactive waste:** Class of radioactive waste defined and used in many countries other than the United States that contains concentrations of shorter-lived and long-lived radionuclides intermediate between those in low-level and high-level wastes. [152]

**internal:** Unwanted radioactive material deposited within the body following an intake of the material by absorption through the skin, ingestion, inhalation, or through wounds. [161]

**internal contamination:** Radioactive contamination of organs or tissues of an organism due to intakes of radionuclides (e.g., by ingestion, inhalation, through wounds, or dermal absorption). [166]

**internal dose:** Dose to organs or tissues of an organism due to intakes of radionuclides (e.g., by ingestion, inhalation, through wounds, or dermal absorption). [161]

**internal emitter:** In the context of nuclear medicine, a radionuclide that is administered as part of a radiopharmaceutical for diagnosis or -therapy. [164]

**internal exposure:** Exposure to radiation originating from a source within the body (e.g., as a result of intakes of radionuclides into the body by inhalation or ingestion). [161]

**internal radiation:** Ionizing radiation originating from a source within the body of an organism. [164]

**internal source (radiation):** A source located inside the body that irradiates organs and tissues. All radiations emitted by radionuclides incorporated in the body are potentially-important sources of radiation exposure. [163]

**International System of Quantities and Units [Système Internationale (SI)]:** The International System of Quantities and Units as defined by the General Conference of Weights and Measures in 1960 and periodically revised since. These units are generally based on the meter/kilogram/second units, with special quantities for radiation including the becquerel, gray and sievert. [160]

**interplanetary magnetic field:** The magnetic field in interplanetary space. The interplanetary magnetic field is transported out from the sun via the solar wind. [153]

**interplanetary shocks:** An abrupt change in velocity or density that is moving faster than the wave propagation speed in interplanetary space. [153]

**interspecies:** Between or among different species (e.g., dogs, cats, humans). [164]

**interventionalist:** An individual who has been granted clinical privileges to perform or supervise FGI procedures in a facility, and who is personally responsible for the use of radiation during a specific FGI procedure in that facility (see clinical privileges). [168]

**intra**dermal: Within the dermis. [161]

**intramuscular** (i.m.): Within muscle tissue. [161]

**intraoral radiography**: Radiography with an image receptor placed intraorally and lingually or palatally to the teeth. [160]

**intraoral radiograph**: Radiograph produced on an image receptor placed intraorally and lingually or palatally to the teeth. [145]

**intraperitoneal**: Within the peritoneal cavity. [161]

**intraspecies**: Within the same species (e.g., different strains of rats). [150]

**intravenous** (i.v.): Within a vein. [166]

**intrinsic background**: The contribution to an instrument reading from the instrument itself, independent of any external radiation. [158]

**intrinsic mortality**: A collection of causes of death thought to arise from processes within the body (e.g., genetic diseases, both germ line and somatic; spontaneous and heart diseases, as well as the degenerative diseases of aging). Its counterpart is extrinsic mortality. [150]

**intrinsic permeability**: Property of a porous medium defined as the ratio of the product of the hydraulic conductivity and the absolute viscosity of the fluid to the product of the density of the fluid and the acceleration due to gravity. [152]

**in utero**: In the uterus; refers to a fetus or embryo. [164]

**invasive breast cancer**: Disease in which breast cancer cells have penetrated surrounding breast tissue and can spread into distant organs. [149]

**inventory**: In the context of this Report, inventory refers to the total content of  $^{137}\text{Cs}$  in specific compartments, such as the sediments in a lake, a given area of soil, etc. (see contained activity). [154]

**inventory**: Quantity of a radionuclide placed in a waste package, disposal unit, or facility, usually expressed in terms of activity. [152]

**inverse square law**: The rule that states that the intensity of radiation from a point source decreases as  $1 / \underline{d}^2$  from the source in a nonabsorbing medium, where  $\underline{d}$  is the distance from the source. [163]

**inverse-square law**: The dose from a point source decreases as  $\underline{d}^{-2}$  from the source in a nonabsorbing medium, where  $\underline{d}$  is the distance from the source. [Comm20]

**invertebrates:** Generally, small animals without an internal skeletal structure. [154]

**in vitro:** From Latin “in glass,” refers to a procedure done outside the body (e.g., in a test tube), as opposed to in vivo. [164]

**in vitro:** Cell culture conditions in glass, plastic or other material-type containers. [159]

**in vivo:** From Latin “in life,” refers to a procedure performed in the living body, as opposed to in vitro. [164]

**in vivo:** From Latin “in life”; refers to a procedure done in the living body, as opposed to a procedure done outside the body (in vitro) (e.g., in a test tube). [163]

**in vivo:** In the living organism. [159]

**iodide:** The anionic form of iodine such as in potassium iodide. [159]

**ion channel:** A structure and/or mechanism that allows ions of a specific size and charge to pass through an otherwise impermeable membrane. [154]

**ionic strength:** A measure of the strength of a chemical bond formed between oppositely charged species because of their mutual electrostatic attraction. [154]

**ionization:** The process by which a neutral atom or molecule acquires a positive or negative charge through the loss or gain of an orbital electron. [164]

**ionization chamber:** A device for measurement of exposure, air kerma, absorbed dose, or their rates by measuring the ionization produced in the gas in a chamber (an enclosure between two conducting electrodes) by ionizing radiation. [163]

**ionization chamber:** A device for detection of ionizing radiation or for measurement of exposure, air kerma, or absorbed dose (or their corresponding rates). [160]

**ionization chamber:** A device for detection of ionizing radiation or for measurement of exposure, air kerma, or absorbed dose, and exposure, air-kerma, or absorbed-dose rate. [147]

**ionizing radiation:** Any radiation capable of displacing electrons from atoms or molecules, thereby producing ions. Examples include alpha radiation, beta radiation, gamma or x rays, and cosmic rays. Minimum energy of ionizing radiation is a few electron volts (eV);  $1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$ . [167]

**ionizing radiation:** Particulate or electromagnetic radiation that is capable of removing electrons from a neutral atom or molecule either directly or indirectly, resulting in an excess charge. Examples include alpha and beta particles, gamma and x rays, and cosmic rays. The minimum energy of ionizing radiation is a few electron volts (eV);  $1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$ . [163]

**ionizing radiation:** Electromagnetic radiation (x or gamma rays) or particulate radiation (alpha particles, beta particles, electrons, positrons, protons, neutrons, and heavy charged particles) capable of producing ions by direct or secondary processes in passage through matter. [161]

**ionizing radiation:** Radiation sufficiently energetic to dislodge electrons from an atom, thereby producing an ion pair.

Ionizing radiation includes x and gamma radiation, electrons (beta radiation), alpha particles (helium nuclei), and heavier charged atomic nuclei. [159]

**ionizing radiation:** The production of ions by any radiation capable of displacing electrons from atoms or molecules.

Examples include alpha radiation, beta radiation, gamma radiation, x rays, and cosmic rays. Minimum energy of ionizing radiation is a few electron volts (eV);  $1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$ . [158]

**ionosphere:** Region from 50 miles above Earth stretching into outer space. An arbitrary upper limit of 600 miles is sometimes applied. [132]

**ipsilateral:** Originating in or affecting the same side of the body. [149]

**iris:** The circular pigmented membrane behind the cornea perforated by the pupil. Its circular muscle fibers allow the size of the pupil to be varied. [132]

**iron:** When used in the iron and steel industries, refers to a high carbon content elemental iron-based metal in which the carbon exceeds 3 % and is found in the interstitial matrix of the metal. [141]

**irradiation:** The process of being exposed to ionizing radiation. [168]

**irradiation:** Exposure to ionizing or nonionizing radiation (see exposure). [167]

**irradiation:** The action of incurring radiation by a body, tissue or organ from either external or internal radiation sources. [161]

**irradiation by incorporated radionuclides:** Exposure to radiation originating from a source within the body (e.g., as a result of intakes of radionuclides into the body by inhalation or ingestion). [164]

**irradiation time:** The time that a single point on a conveyance is exposed to radiation as the conveyance is imaged by CAARS, typically on the order of milliseconds. [Comm20]

**isocenter:** The point defined by intersection of the gantry axis of rotation and the beam centerline of a medical accelerator or cobalt unit. Typically, the isocenter is located 1 m from the radiation source. [151]

**isokinetic sampling:** Sampling an effluent without perturbing the dynamic flow of either the effluent or particulates within the effluent. [127]

**isolation:** Disposal of waste in a manner that is expected to provide adequate protection of human health and the environment. [152]

**isomer:** Compound capable of existing in two or more geometrical configurations. [156]

**isomorphic:** Having identical or similar structure or form. [152]

**isotope:** Form of a particular chemical element determined by the number of neutrons in the atomic nucleus. An element may have numerous stable or unstable (radioactive) isotopes. [164]

**isotope:** One of several nuclides of a chemical element having the same number of protons in their nuclei, but different nuclear mass numbers due to different numbers of neutrons in the nucleus. An element may have numerous stable or unstable (radioactive) isotopes. [163]

**isotope:** One of several nuclides having the same number of protons in their nuclei, but different nuclear mass numbers due to different numbers of neutrons in the nucleus. [160]

**isotropic:** Denoting that the angular distribution of incident fluence is the same from all directions. [163]

**isotropic:** Characteristic of a medium denoting that properties at any point within the medium are the same in all directions. [152]

**justification (in radiation protection):** The principle of radiation protection that any decision that alters the existing radiation exposure situation should do more good than harm. [168]

**justification:** The part of the decision making process in which the options that are expected to do more good than harm are identified. [167]

**K061:** Baghouse dust from a steelmaking electric arc furnace. K061 is listed as a regulated hazardous waste by the EPA because of its heavy metal content. [141]

**kaolinite:** A highly-weathered 1:1 type of clay mineral in some soils that does not strongly bind cesium. [154]

**K cell:** A granule-containing cell type residing in the tracheobronchial epithelium that could be involved in pulmonary circulation that closely resembles the gastrointestinal Kultschitzky cell.

**keratin:** Scleroprotein that is the primary component of epidermis, hair, nails, horny tissues, and the organic matrix of tooth enamel. [156]

**kerma (kinetic energy released per unit mass) ( $\underline{K}$ ):** The sum of the initial kinetic energies of all the charged particles liberated by uncharged particles in a mass of material. The unit for kerma is  $\text{J kg}^{-1}$ , with the special name gray (Gy). Kerma can be quoted for any specified material at a point in free space or in an absorbing medium (e.g., air kerma). [168]

**kerma ( $\underline{K}$ ):** The sum of the initial kinetic energies of all the charged particles liberated by uncharged particles per unit mass of specified material. The SI unit for kerma is  $\text{J kg}^{-1}$ . The special name for kerma is the gray (Gy). Kerma can be quoted for any specified material at a point in free space or in an absorbing medium. [158]

**kerma-area product ( $\underline{KAP}$ ):** The incident air kerma (in gray or milligray) times the cross-sectional area of the x-ray beam (in  $\text{cm}^2$ ). [160]

**kilodalton (kD):** 1 kD is equal to approximately the weight of 1,000 hydrogen atoms, and is equivalent to  $1.66 \times 10^{-21}$  g. This unit used to express the size of proteins. [159]

**kiloton energy (kt):** Defined strictly as  $10^{12}$  calories (or  $4.2 \times 10^{19}$  ergs). This is approximately the amount of energy that would be released by the explosion of 1 kt (1,000 tons) of TNT (see TNT equivalent). [159]

**kilovolt (kV):** A unit of electrical potential difference equal to 1,000 volts. [149]

**kilovolt peak (kVp):** (also see operating potential): The crest value in kilovolts of the potential difference of a pulsating potential generator. When only one-half of the voltage wave cycle is used, the value refers to the useful half of the cycle. [149]

**kinetic energy released per unit mass (kerma):** The sum of the initial kinetic energies of all the charged particles liberated by uncharged particles per unit mass of specified material. The unit for kerma is  $\text{J kg}^{-1}$ , with the special name gray (Gy).



Kerma can be quoted for any specified material at a point in free space or in an absorbing medium (e.g., air kerma).

[151]

**kinetics:** The study or modeling of rates and rate processes. [164]

**kriging:** A group of geostatistical techniques to interpolate the value of a random field (e.g., the elevation of the landscape as a function of the geographic location) at an unobserved location from observations of its value at nearby locations. [163]

**kriging:** Geostatistical interpolation method for predicting, without bias and with minimum variance, spatial distributions of properties of geologic systems on the basis of observations at discrete locations. [152]

**kurtosis:** Degree of peakedness or flatness of a probability density function. [163]



**lag period:** Because of latency, the period of expression of the risk after exposure is sometimes assumed to start after an initial lag period. [126]

**lamina propria:** Connective tissue layer of the mucous membrane in humans. [125]

**land disposal facility:** Land, buildings and equipment intended to be used for disposal of wastes in a subsurface facility located within a few tens of meters of the Earth's surface or in an above-grade facility. A geologic repository is not considered a land disposal facility. [152]

**landfill:** A disposal facility or part of a facility where waste is placed in or on land and which is not a pile, a land treatment facility, a surface impoundment, an underground injection well, a salt dome formation, a salt bed formation, an underground mine, a cave, or a corrective action management unit. [160]

**Langerhans' cells:** Dendritic, clear cells in the epidermis, containing distinctive granules that appear rod-like or racket-shaped but lack tonofilaments, melanosomes and desmosomes. Named after a German anatomist, Paul Langerhans, 1847 to 1888. A tonofilament is a structural cytoplasmic protein that is particularly well-developed in the epidermis. A melanosome is a generally oval pigmented granule produced by melanocytes. A desmosome is a site of adhesion between two epithelial cells. [150]

**lanthanide:** Element with atomic number from 58 through 71; a member of the lanthanide series of rare earths. [161]

**larynx:** Organ structure of the muscle and cartilage at the upper end of the human trachea containing the vocal cords. [164]

**laser:** A device that utilizes the natural oscillations of atoms or molecules between energy levels for generating coherent electromagnetic radiation in ultraviolet, visible or infrared regions of the spectrum. Laser is an acronym for light amplification by stimulated emission of radiation. [157]

**latent image:** The invisible change produced in an x ray or photographic film emulsion by the action of ionizing radiation or light, from which the visible image is subsequently developed and fixed chemically; or the change produced in a photo-stimulatable storage phosphor and recovered by scanning with a laser. [158]

**latent period:** The period of time between exposure to ionizing radiation and the appearance of the radiation effect. Also referred to as the lag period. [161]

**latent period:** The time period between exposure and expression of the disease. For example, after exposure to a dose of radiation, there typically is a delay of several years (the latent period) before any cancer is observed. [159]

**latent period:** Period or state of seeming inactivity between time of exposure of tissue to an injurious agent and an observed response (also time to response or induction period). [153]

**lateral view:** A 90 degree view performed medial to lateral or lateral to medial; used for triangulation with the craniocaudal and to demonstrate gravity-dependent calcifications. [149]

**lateromedial:** A 90 degree view performed with the x-ray beam directed from the outer aspect of the breast to the inner aspect of the breast. [149]

**lateromedial oblique:** Performed with the x-ray beam directed from the lower-outer to the upper-inner aspect of the breast; the exact reverse of the mediolateral-oblique view; improves visualization of medial breast tissue (also called true reverse oblique). [149]

**late somatic effects:** Radiation effects occurring a considerable time after exposure to radiation; these effects include mutagenesis, teratogenesis and carcinogenesis.

**Latin Hypercube Sampling (LHS) method:** Technique of stratified random sampling from specified probability distributions of variables in which probability distributions are divided into intervals of equal probability and one sample is taken at random from each interval (see Monte-Carlo analysis). [164]

**latitude:** The range between the minimum and maximum radiation exposures to an image receptor that yield diagnostic images of structures. [145]

**lavage:** Washing out of an organ (i.e., stomach, intestinal tract, sinuses, or lung). [161]

**lay-down yard:** The area of a seaport where cargo containers are stacked while awaiting transport to their destination. [Comm20]

**LD<sub>50/30</sub>:** Lethal dose causing death in 50 % of the subjects within 30 d. Also, the lethal /dose can be specified for other percentages of the population under study, such as 5 %, 10 %, etc. and for different time periods such as 60 d (e.g., LD<sub>10/60</sub>). [161]

**leach:** Dissolve soluble material by the action of percolating liquid. [118]

**leachate:** The water that has been in contact with sediment or soil and whose chemical characteristics have been affected by properties of the sediment or soil, as well as the duration of contact. [160]

**leachate:** The solution or product obtained by leaching. [118]

**leaching:** The process of dissolving and moving out of a contaminant or element from a solid material such as soil by the action of a percolating liquid such as water (see solution phase transport). [154]

**leaching:** Extraction or removal of a soluble substance from a solid material by contact with water. [152]

**leaded apron:** An apron made with lead, a radiation absorbing material used to reduce radiation exposure. [145]

**leaded glove:** A glove made with lead, a radiation absorbing material used to reduce radiation exposure. [145]

**lead equivalence:** The thickness of lead affording the same attenuation, under specified conditions, as the material in question. [151]

**leakage radiation:** All radiation, except the useful beam, coming from within the accelerator head and other beam-line components. It is attenuated by shielding in the protective source housing as specified by the IEC. [151]

**leakage radiation technique factors:** Technique factors specified for x-ray source assemblies at which leakage radiation is measured. [147]

**lean body mass:** The total body weight minus the fat mass. Lean body mass consists of water, bones, collagen and muscle. [164]

**legacy source:** In this Report, a radiation source from the past, often referring to radiation-producing machines, radioactive waste, or materials from prior operations at an educational institution. [157]

**leukocyte:** A colorless blood corpuscle (white-blood cell) capable of ameboid movement. Granular leukocytes include neutrophils, eosinophils and basophils; nongranular leukocytes include lymphocytes and -monocytes. [161]

**license:** Permission issued by the U.S. Nuclear Regulatory Commission (NRC) or an Agreement State in accordance with applicable laws or regulations. [160]

**licensed material:** Any source material, special nuclear material, or byproduct material received, processed, used or transferred under a general license or specific license issued by the NRC or an Agreement State pursuant to the regulations in 10 CFR Part 20 – reference or state-equivalent regulations. [141]

**Lieberkuhn, crypts of:** Intestinal glands, named after a German anatomist Johann N. Lieberkuhn (1711–1756). [150]

**Life Span Study:** Study of the Japanese atomic-bomb survivors; the sample consists of 93,741 persons (in city) of whom 86,572 survivors have a defined dose assigned to them. [161]

**lifetime risk:** The lifetime probability of expressing a particular detrimental effect (e.g., dying of a specific disease). [161]

**lifetime risk:** The lifetime probability of dying of a specific disease. [153]

**lifetime risk:** The excess absolute risk (of cancer) due to an agent like radiation expressed throughout the lifetime of the exposed individuals. [126]

**Li-Fraumeni syndrome:** Familial breast cancer in young women, with soft-tissue sarcomas in children and other cancers in close relatives. [167]

**ligand:** Atom, group of atoms with similar chemical properties, ion, radical, or molecule that forms a coordination complex with a central atom or ion. [156]

**ligands:** In chemistry, an atom, ion or functional group that is bonded to one or more central atoms or ions, usually metals, generally through coordinate covalent bonding. An array of such ligands around a center is termed a complex. [161]

**ligation:** Binding. [150]

**light ions:** Nuclei of hydrogen and helium which are positively charged due to some or all of the planetary electrons having been stripped from them. [153]

**likelihood function:** Functions constructed from a statistical model and a set of observed data that give the probability of those data for various values of model parameters, such as regression coefficients in a dose-response curve. Parameter values that maximize the probability are maximum-likelihood estimates of the parameters. [164]

**limit:** In radiation protection, the dose in a given time interval established by authoritative or consensus bodies above which the health consequences to an individual would be regarded as unacceptable. [161]

**limit:** In radiation protection, the level of dose established by authoritative or consensus bodies above which the consequences to an individual would be regarded as unacceptable. [127]

**lineal energy ( $\bar{y}$ ):** The quotient of  $\bar{\epsilon}$  by  $\bar{l}$ , where  $\bar{\epsilon}$  is the energy imparted to the matter in a given volume by an energy deposition event and  $\bar{l}$  is the mean chord length in that volume (i.e.,  $\bar{y} = \bar{\epsilon} \bar{l}^{-1}$ ). The unit for lineal energy is  $\text{J m}^{-1}$ , commonly given in  $\text{keV } \mu\text{m}^{-1}$ . [158]

**linear accelerator:** A device that accelerates electrons along a linear path into an electron target or converter where the energy is converted into bremsstrahlung or x rays. [163]

**linear-energy transfer (LET):** The average amount of energy lost per unit of particle track length and expressed in  $\text{keV } \mu\text{m}^{-1}$ .

- **low-LET:** Radiation having a low linear-energy transfer (e.g., electrons, x rays, and gamma rays).
- **high-LET:** Radiation having a high linear-energy transfer (e.g., protons, alpha particles, heavy ions, and the interaction products of fast neutrons). [167]

**linear energy transfer (LET):** Average amount of energy lost by charged particles per unit of particle track length, expressed in  $\text{keV } \mu\text{m}^{-1}$ .

- **low-LET:**  $<10 \text{ keV } \mu\text{m}^{-1}$  such as for electrons.
- **high-LET:**  $>10$  to  $100 \text{ keV } \mu\text{m}^{-1}$  such as for neutrons and alpha particles. [163]

**linear energy transfer (LET):** Mean energy lost by charged particles in electronic collisions per unit track length. Unit: keV  $\mu\text{m}^{-1}$ . [159]

**linear energy transfer [LET ( $\underline{L}$ ):** Quotient of  $d\bar{E}$  by  $dl$ , where  $d\bar{E}$  is the energy lost by a charged particle in traversing a distance  $dl$  in a material:  $\underline{L} = d\bar{E}/dl$ . The SI unit of LET is the joule per meter ( $\text{J m}^{-1}$ ). For purposes of radiation protection, LET normally is specified in water and given in units of keV  $\mu\text{m}^{-1}$ .

- **low-LET:** Particulate or electromagnetic radiation resulting in LET below  $\sim 10$  keV  $\mu\text{m}^{-1}$ ; electrons and x or gamma rays are common examples.
- **high-LET:** Particulate radiation resulting in LET greater than about 10 to 100 keV  $\mu\text{m}^{-1}$ ; neutrons and alpha particles are common examples. [152]

**linearity:** The extent to which an instrument reading is proportional to the true quantity being measured as the intensity of the quantity changes. [158]

**linear-quadratic model (also linear-quadratic dose-response relationship):** expresses the incidence of (e.g., mutation or cancer) as partly directly proportional to the dose (linear term) and partly proportional to the square of the dose (quadratic term). The linear term will predominate at lower doses, the quadratic term at higher doses. [153]

**lipophilic:** Having an affinity for fat. [156]

**lipophilicity:** Affinity for fat. [125]

**litter:** Largely undecomposed organic matter lying on the soil surface. [154]

**lobe:** A portion of the breast that contains a complete unit for producing, transporting and delivering milk. [149]

**lobular carcinoma in situ (LCIS):** A high-risk condition in which multiple atypical cells fill and distend the lobules.

Because it is a risk factor and not a direct precursor of invasive cancer, LCIS is considered a marker for increased risk of development of breast cancer in any location in either breast (also called lobular neoplasia). [149]

**localization:** Prebiopsy localization provides a method for biopsy of nonpalpable mammographic abnormalities; can be performed by needle placement alone, spot dye injection, or needle-hookwire methods. [149]

**locus:** The position of a gene on a chromosome, different forms of genes (alleles) being found at the same position on homologous chromosomes. [167]

**logistic distribution:** A symmetric and bell-shaped probability density function (Appendix B.8) similar to a normal distribution but narrower with more mass in the tails. Logistic regression is used when the dependent variable is dichotomous as is the case in some dose-response data sets where the response is classified as either true or false. [158]

**lognormal:** If the logarithms of a set of values are distributed according to a normal distribution the values are said to have a lognormal distribution, or be distributed log normally. [154]

**lognormal distribution:** A probability density function in which the logarithms of a set of values are normally distributed. [168]

**lognormal distribution:** A probability density function in which the logarithms of the values have a normal distribution. It is characterized by two parameters: geometric mean and geometric standard deviation, mean and standard deviation, or mean and standard deviation of the logarithms. The lognormal distribution is asymmetric and bounded at the lower end by zero because the logarithm is defined only for positive numbers. [164]

**lognormal distribution:** A set of values whose logarithms are normally distributed. The lognormal distribution is asymmetric. It is bounded at the lower end by zero because the logarithm is defined only for positive numbers. [163]

**lognormal distribution:** A set of values whose logarithms are normally distributed is said to be lognormally distributed. The lognormal distribution is asymmetric. It is bounded at the lower end by zero because the logarithm is defined only for positive values. [161]

**lognormal distribution:** A probability density function in which the logarithms of a set of values are normally distributed. [158]

**log-triangular (distribution):** A probability density function in which the logarithms of the values have a triangular distribution. [163]

**log-triangular distribution:** A probability density function in which the logarithms of the values have a triangular distribution. It is usually characterized by three parameters: minimum value, mode (or apex), and maximum value. [164]

**log-uniform distribution:** A probability density function in which the logarithms of the values have a uniform distribution. It is usually characterized by two parameters: the minimum and maximum values. [164]

**lossy:** The causing of attenuation or dissipation of electrical energy. [119]

**low dose rate (LDR):** As used in brachytherapy, LDR refers to the use of sealed sources placed in a patient on a permanent or temporary basis to deliver a therapeutic dose of radiation. [155]

**low-LET radiation:** X and gamma rays or light, charged particles such as electrons that produce sparse ionizing events far apart on a molecular scale (e.g.,  $<10 \text{ keV } \mu\text{m}^{-1}$ ). [159]

**low-level mixed waste (LLMW):** Low-level radioactive waste (LLRW) determined to contain both source, special nuclear, or byproduct material subject to the AEA of 1954, as amended, and a hazardous component subject to the RCRA, as amended. [141]

**low-level radioactive waste:** A general term for a wide range of radioactive waste that contain low concentrations of radionuclides, where the low concentrations are defined by U.S. regulations. [163]

**low-level radioactive waste:** Radioactive waste that (A) is not high-level radioactive waste, spent nuclear fuel, transuranic waste, or byproduct material as defined in Section 11(e)(2) of the Atomic Energy Act, and (B) the U.S. Nuclear Regulatory Commission, consistent with existing law, classifies as low-level radioactive waste. Byproduct material referred to in Clause (A) essentially is uranium or thorium mill tailings. Low-level radioactive waste does not include waste containing naturally occurring and accelerator-produced radioactive material (NARM), although such waste may be managed as low-level waste. In most countries other than the United States, low-level waste includes only radioactive waste that contains the lowest concentrations of radionuclides, but low-level waste in the United States can contain high concentrations of shorter-lived radionuclides and high concentrations of long-lived radionuclides other than long-lived, alpha-emitting transuranium radionuclides. [152]

**Low-Level Radioactive Waste Policy Act (LLRWPA):** Law passed in 1980 and amended in 1985 that governs disposal of low-level radioactive waste by states or State Compacts. The Act does not govern disposal of low-level waste generated at U.S. Department of Energy sites unless such waste is sent to a disposal facility established under the Act. All waste disposals under the Act will be licensed by the U.S. Nuclear Regulatory Commission or an Agreement State. [152]

**lux:** A unit of illumination equal to the direct illumination on a surface that is everywhere 1 m from a uniform point source of one candle intensity or equal to one lumen per square meter. [149]

**lymph:** A transparent, usually slightly yellow, often opalescent liquid found within the lymphatic vessels, and collected from tissues in all parts of the body and returned to the blood via the lymphatic system. It is ~95 % water, with the remainder consisting of plasma proteins. Its cellular component consists chiefly of lymphocytes. [161]

**lymphatic system:** Complex network of capillaries, vessels, valves, ducts and organs involved in producing, filtering and conveying lymph and various blood cells. [164]

**lymph nodes:** Kidney-bean-shaped structures scattered along vessels of the lymphatic system seen in the axilla or sometimes in the breast itself; act as filters, collecting bacteria or cancer cells that may travel through the lymph system (also called lymph glands). [164]

**lymph nodes:** Kidney bean-shaped structures scattered along vessels of the lymphatic system seen in the trachealbronchial and other regions of the respiratory tract, axilla, and throughout the body; act as filters, collecting. Insoluble matter such as radioactive particles, bacteria or cancer cells that may travel through the lymph system (also called lymph glands). [161]

**lymphocyte:** Any of the mononuclear, nonphagocytic leukocytes found in blood, lymph, and lymphoid tissues which comprise the body's immunocompetent cells and their precursors. [161]

**lysimeter:** Tank containing soil or other earthen materials, which is placed into the ground so that its surface is on the same level as that of the surrounding land, that may be used to measure infiltration of precipitation or leaching and transport of contaminants contained in a waste form placed inside the device. [152]



**lysis:** Destruction or decomposition, especially by enzymatic digestion. [156]

**lysosome:** One of the minute bodies occurring in many types of cells, containing various types of hydrolytic enzymes and normally involved in the process of localized intracellular digestion. [156]

**macrophage:** Any of the large, mononuclear, highly phagocytic cells derived from monocytes that occur in the walls of blood vessels and in loose connective tissue. [161]

**macrophyte:** Higher plants (multicellular, vascular angiosperms) that grow in aquatic environments. Macrophytes may be free-floating or rooted in the sediment and may be submerged, have floating leaves or be emergent (projecting above the water surface). [154]

**magnetic field:** A term that is often used to mean magnetic flux density. However, in common usage, magnetic field is also used to mean magnetic field strength. To avoid confusion specific terminology should be used (i.e., magnetic flux density and magnetic field strength). [119]

**magnetic field strength:** A vector field, usually designated  $\mathbf{H}$ , that is equal to the magnetic flux density  $\mathbf{B}$  divided by the magnetic permeability of the medium ( $\mu$ ). Magnetic field strength is the component of the magnetic field that is measured. Its unit is ampere per meter ( $\text{A m}^{-1}$ ).  $\mathbf{H}$  is a useful quantity because it is independent of the magnetization current in materials. [119]

**magnetic flux density:** A vector force field that is used to describe the force perpendicular to the velocity of a moving charged particle. Magnetic flux density is defined as the force per unit charge on an infinitesimal moving charge at a given point in space according to the equation  $\mathbf{F}/q = \mathbf{v} \times \mathbf{B}$  where  $\mathbf{v}$  is the velocity of the particle,  $q$  is its charge,  $\mathbf{F}$  is the vector force acting on the particle,  $\mathbf{B}$  is the magnetic flux density and  $\times$  denotes the vector product. The magnetic flux density is the product of the magnetic field strength and permeability. The unit is tesla (T). [119]

**magnetic resonance imaging (MRI):** An imaging modality using a strong magnetic field and radiofrequency signals to produce multiplanar images of the body. A superimposed magnetic field gradient enables spatial localization of the image plane. Image contrast is based on the hydrogen concentration, molecular response to radiofrequency signals, and flow of structures within the part of the body being imaged. [164]

**magnification (in medical x-ray imaging):** (1) geometric magnification is an imaging procedure carried out with magnification usually produced by purposeful introduction of distance between the subject and the image receptor; and (2) electronic magnification is selection of an imaging field-of-view with a smaller size using an image intensifier or flat-panel detector image receptor. [168]

**magnification (in medical x-ray imaging):** An imaging procedure carried out with magnification usually produced by purposeful introduction of distance between the subject and the image receptor. [160]

**magnification view:** A technique for producing an enlarged image with greater detail of a small area of abnormal breast tissue. [149]

**malignant:** Cancerous; a growth of cancer cells. [161]

**malignant:** In reference to a neoplasm, having the properties of locally invasive and destructive growth and metastasis. [159]

**mammogram:** An x-ray image of the breast recorded on film, paper or digital receptor. [149]

**mammography:** An x-ray examination of the breast. [160]

**Mammography Quality Standards Act (MQSA):** MQSA went into effect in 1994 and required all mammography facilities in the United States to be accredited by an approved body and undergo annual inspections by state or federal inspectors. The Food and Drug Administration is responsible for implementing MQSA and developing national mammography regulations. [149]

**marine:** Refers to saltwater habitat such as oceans, seas and estuaries. [154]

**mass activity density ( $\underline{A}_m$ ):** The activity of a specified radionuclide per unit mass of a specified substance. Typical units are  $\text{Bq g}^{-1}$ . [154]

**mass balance models:** Relatively-mechanistic models of considerable complexity that maintain a full accounting of the inventories of the contaminant of interest in each compartment, but which require extensive input data. [164]

**mass energy-absorption coefficient:** The probability that energy will be transferred from indirectly ionizing radiation and deposited in the vicinity of the interaction point. [Comm20]

**mass energy-transfer coefficient:** The mass-energy transfer coefficient of a material, for uncharged particles, is the fraction of incident radiant energy that is transferred to kinetic energy of charged particles by interactions in traversing a distance  $d_l$  in material of density  $\rho$ . [158]

**mass loading:** Refers to mass of material suspended in air or water (see soil loading, sediment loading). [154]

**mass loading:** Concentration of particulate material in air resulting from suspension or resuspension of surface soil. [152]

**mass median aerodynamic diameter (MMAD):** The aerodynamic diameter of a particle having median mass (i.e., the masses of particles above and below this value are equal). [164]

**mass median diameter (MMD):** The particle diameter for which there is an equal mass of particles above and below this size. [125]

**mass stopping power:** Ratio of the average energy lost by a charged particle in traversing a distance in a material to the density of the material. [125]

**mass transfer coefficient:** Proportionality factor for mass transfer due to mass concentration gradient of the gas. [125]

**mast cell:** A connective tissue cell that elaborates granules containing histamine or heparin. [156]

**mast cell:** Cells of the subepithelial source of the globule leukocytes that contain substances (e.g., histamine) which mediate allergic reactions. [125]

**material safety data sheet:** Written or printed material concerning a hazardous chemical that is prepared in accordance with an Occupational Safety and Health Administration regulation. [145]

**maximally-exposed individual:** Individual assumed to receive the highest dose or to be at greatest risk from exposure to radiation. [161]

**maximum permissible concentration (MPC):** The concentration of a radionuclide in air or water that would lead to an amount of the radionuclide in the critical organ that would just deliver the maximum permissible dose rate to that organ. A phrase used when the conventional system of units is employed. It corresponds to the Derived Reference Air Concentration (DRAC). [118]

**may:** The term *may* (or *may not*) (in italics) indicates a reasonable practice that is permissible. When the term “may” appears in the context of its general usage, it is not italicized. [168]

**mean:** Sum of the measured values divided by the number of measurements. The mean value is also often called the (arithmetic) average value. The mean of a distribution is the weighted average of the possible values of the random variable. [168]

**mean absorbed dose ( $\bar{D}_T$ ):** The mean absorbed dose in an organ or tissue (organ dose), obtained by integrating or averaging absorbed doses at points in the organ or tissue. [168]

**mean absorbed dose ( $\bar{D}_T$ ):** The mean absorbed dose in an organ or tissue, obtained by averaging absorbed doses at points in the organ or tissue. [166]

**mean absorbed dose:** The total energy imparted to an organ or tissue divided by the mass of the organ or tissue. The SI unit of mean absorbed dose is joule per kilogram ( $\text{J kg}^{-1}$ ), with the special name gray (Gy). [165]

**mean absorbed-dose rate [ $\dot{D}(r_T, t)$ ]:** The time-dependent rate at which the absorbed dose is delivered to target tissue  $r_T$  within a patient from radioactive material distributed within a source tissue at time  $t$  post-administration. [164]

**mean absorbed dose ( $\bar{D}_T$ ):** The mean absorbed dose in an organ or tissue, obtained by integrating or averaging absorbed dose over the entire volume of the organ or tissue (i.e., the total energy deposited in the organ or tissue divided by the total mass of the organ or tissue). Also referred to as organ dose. [163]

**mean absorbed dose ( $\bar{D}_T$ ):** The mean absorbed dose ( $\bar{D}$ ) in a specified tissue or organ (T) of the human body given by:

$$D_T = \frac{1}{m_T} \int_{m_T} D dm$$

where  $\underline{m}_T$  is the mass of the tissue or organ, and  $\underline{D}$  is the absorbed dose in the mass element  $\underline{dm}$ . Sometimes called organ dose or organ absorbed dose. [158]

**mean diameter:** Average diameter of the particles (sum of all diameters divided by the number of particles). [156]

**mean free path:** The average distance between scattering events in interplanetary particle propagation. Also, the average distance between particle collisions with nuclei, atoms or molecules in a material. [164]

**mean free path** [for a given type of interaction (e.g., scattering or absorption)]: The average distance that particles of a specified type travel before a specified type of interaction takes place in a given medium. If the term mean free path is used without specifying the interaction, the term means the average distance a particle will travel before having an interaction of any sort. [144]

**mean glandular dose:** The energy deposited per unit mass of glandular tissue (the radiosensitive tissue in the breast) averaged over all the glandular tissue in the breast (i.e., the mean absorbed dose to glandular tissue). [160]

**mean glandular dose:** Calculated from values of entrance exposure (free-in-air), the x-ray beam quality (half-value layer), and compressed breast thickness, mean glandular dose is the energy deposited per unit mass of glandular tissue (by far the most radiosensitive tissue in the breast) averaged over all the glandular tissue in the breast (i.e., the mean absorbed dose to glandular tissue). The mean glandular dose should be <3 mGy for a single screen-film craniocaudal view of a standard (4.2 cm thick, 50 % glandular, 50 % adipose) breast. The mean glandular dose is the value used to estimate the radiation risk of the exposure. [149]

**measurand:** The particular quantity subject to measurement. [164]

**measurement error:** In the context of this Report, a random variable that is independent of the true dose and has a mean of zero (see Berkson and classical error). [163]

**meat transfer coefficient ( $\underline{E}_f$ ):** Fraction of the amount of an element ingested daily by an herbivore that is deposited in 1 kg of meat. [152]

**mechanical clearance function [M(t)]:** Rate of movement of particles, either phagocytized or unphagocytized, from the lung or tracheobronchial airways up the tracheobronchial tree. [125]

**mechanical clearance rate:** Rate of movement of particles, either phagocytized or unphagocytized, from the lung or tracheobronchial airways up the tracheobronchial tree. [164]

**median:** Of a set of  $\underline{n}$  values, the median is the value that is as frequently exceeded (by other values in the set) as not. The median value of a distribution is the 50th percentile. [168]

**median:** Of a set of  $\underline{n}$  values, the median is the value that is as frequently exceeded (by other values in the set) as not. To determine the median value, arrange the set of values in order to generate the sequence:  $\underline{x}_1 \leq \underline{x}_2 \leq \underline{x}_3 \leq \dots \leq \underline{x}_n$ . When  $\underline{n}$  is

odd, the median is the value in the center of the sequence; there will be  $(n - 1)/2$  values that are smaller and  $(n - 1)/2$  values larger than the median. The median value of a distribution is the 50th percentile. [164]

**medical audit:** Systematic collection and analysis of mammography results, comparing those results with outcomes data. [149]

**medical facility:** A hospital, clinic or other facility that provides medical services. [163]

**medical facility:** A hospital, clinic or other facility that may practice radiation therapy with sealed sources or radiopharmaceuticals and that provides in-patient care. This definition specifically excludes the patient's own home. [155]

**Medical Internal Radiation Dose (MIRD) Committee:** A committee of the Society of Nuclear Medicine responsible for the internal dosimetry of radiopharmaceuticals used diagnostically and therapeutically. [164]

**mediolateral-oblique (MLO) view:** Now one of the standard two views of the breast. The image receptor is angled 30 to 60 degrees from horizontal so that the cassette assembly is parallel to the pectoral muscle and the corner of the cassette holder fits comfortably into the axilla. The x-ray beam is directed from the superomedial to the inferolateral aspect of the breast. [149]

**mediolateral view:** Previously, one of the more common routine views for mammography in addition to the craniocaudal view. The image receptor is placed lateral to the breast, and the horizontal x-ray beam is directed from medial to lateral aspect through the breast. [149]

**medulla:** The central or inner portion of an organ. [156]

**medullary:** Relating to the medulla or marrow. [159]

**megaton energy (Mt):** Defined strictly as  $10^{15}$  calories (or  $4.2 \times 10^{22}$  ergs). This is approximately the amount of energy that would be released by the explosion of 1,000 kt ( $10^6$  tons) of TNT (see TNT equivalent). [159]

**melanoma:** A malignancy derived from cells capable of forming melanin, most commonly in the skin. [161]

**member of the public:** In the context of possible radiation exposure from a radioactive patient, this term refers to any individual, not a member of the patient's family and not an individual exposed to radiation in the course of their employment. [155]

**members of the public:** All persons who are not already considered occupationally exposed by a source or practice under consideration. When being irradiated as a result of medical care, patients are in a separate category. [164]

**menarche:** The onset of menstrual function (menses). [150]

**menopause:** The cessation of menstrual function (menses). [150]

**mental retardation:** Congenital, but nonspecific reduction in cognitive capacities. Severe mental retardation is often used to signify an individual who is unable to perform simple calculations, to make simple conversation, to care for himself or herself, or was or is institutionalized. Such individuals are generally found to have an intelligence test score which is <70 on conventional tests. [161]

**mesenchymal:** Pertaining to the meshwork of embryonic connective tissue in the mesoderm from which are formed the connective tissues of the body and also the blood vessels and lymph vessels. [156]

**mesenchyme:** Embryonic connective tissue derived from mesoderm. [128]

**mesenchymoma:** A mixed mesenchymal tumor composed of two or more cellular elements that are not commonly associated, exclusive of fibrous tissue. [156]

**mesoderm:** Middle germ layer of the embryo. It forms muscles, the circulatory and excretory systems, and the dermal, skeleton and connective tissue. [128]

**meta-analysis:** An analysis of epidemiologic data from several studies based on data included in publications. [159]

**meta-analysis:** The process of using statistical methods to combine the results of different studies; “meta” is a prefix denoting “after.” [150]

**metacarpal:** Any of the bones extended from the carpals in the wrist to the phalanges of the fingers in humans, or corresponding structures in animals. [156]

**metal oxide fume:** Airborne oxides of the metal and other elements being melted or refined in a metal-making furnace. [141]

**metastasis:** The shifting of a disease or its local manifestations, from one part of the body to another, as in the appearance of neoplasms in parts of the body remote from the site of the primary tumor. [159]

**metastasis:** The shifting of a disease or its local manifestations from one part of the body to another. In cancer, the spread of the disease from a primary site results from dissemination of tumor cells. [150]

**mica:** A group of various colored or transparent complex mineral silicates crystallizing in forms that readily separate into very thin layers. Examples include muscovite and biotite. [154]

**micaceous:** The property of being generated from or containing mica (see mica). [154]

**microcalcifications:** Tiny white specks of calcium salts that can sometimes be seen on a mammogram. In clusters, they can be the only sign of ductal carcinoma in situ or early invasive cancer, or they can be associated with benign breast changes (also called calcifications). [149]

**microcephaly:** Condition of abnormal smallness of the head, sometimes associated with mental defects. [128]

**microdosimetric event:** Energy transfer within a designated site, regardless of the source of the energy (i.e., must include not only the primary particle traversal, but energy depositions from secondary radiations). The events are statistically independent from each other. [137]

**microlesion:** Term introduced by National Academies, National Research Council in 1973 to describe the localized damage along a heavy-charged particle track that is distinct from the damage caused by low-LET radiation. [132]

**microorganism:** Organisms of microscopic size, such as bacteria, protozoa, etc. [154]

**migration:** In the context of this Report, movement of substances in the environment (e.g., by means of air, surface water, groundwater, biological movements, gravity, etc.). Migration may be controlled by numerous phenomena including, for example, advection, diffusion and sorption. [164]

**milk transfer coefficient:** Fraction of the amount of an element ingested daily by a cow or goat that is secreted in 1 L of milk. [164]

**mill:** Can refer either to the metal-making facility (e.g., steel mill) or the machinery used to roll the metal shapes (e.g., rolling mill, plate mill, finishing mill). [141]

**milliamper (mA):**  $10^{-3}$  ampere. In radiography, the current flow from the cathode to the anode that, in turn, regulates the intensity of radiation emitted by the x-ray tube. [147]

**milliamper-minute (mA min):** The product of the x-ray tube operating current and exposure time in minutes. [147]

**milliamper seconds (mAs):** The product of electron current (milliamper) and the exposure time (in seconds). For a fixed operating potential, total x-ray output is linearly proportional to milliamper seconds. [149]

**milligrams radium equivalent (mgRaEq):** Strength of a given source in milligrams radium equivalent is the mass in milligram of  $^{226}\text{Ra}$ , encapsulated in a cylinder with wall thickness of 0.5 mm platinum-iridium, that gives the same transverse-axis radiation output, or air-kerma strength, as the source itself. [155]

**mill tailings:** Residues from chemical processing of uranium or thorium ores for their source material content. Mill tailings are a form of byproduct material, as defined in the Atomic Energy Act. [160]



**minimum detectable (amount of a quantity):** The smallest amount of the measurand of a quantity that can be distinguished from a zero value of that measurand within a stated confidence limit. A measurand is the true value of a quantity (such as mass, activity or dose) that is being measured. [163]

**minimum-detectable activity (MDA):** Level of activity detectable with a method or device that reduces the chance for mistaking true activity for background or vice versa, to a selected probability (e.g., 5 %). [161]

**minimum detectable level:** A general term for the lowest value of a quantity that a measurement device is capable of detecting. [168]

**minimum detectable level:** The threshold of detection for the device in question. [164]

**minimum induction period:** The period of time between the exposure to a causative agent and the initial detection of an increased rate of disease. [159]

**minor hazard:** A hazard that has limited adverse impact on the radiation-safety program. [162]

**Mir:** The Russian (previously Soviet) orbital space station. [167]

**MIRD schema:** The system of equations and procedures described by the Medical Internal Radiation Dose (MIRD) Committee for use in medical radionuclide dose calculations. [164]

**missed dose:** The dose that could have been received by a worker that was not registered by the worker's dosimeter. [163]

**mitigation:** Elimination of the threat or vulnerability or at least lessening the consequences or severity of the disaster (Farmer, 2006). [166]

**mixed bed:** Mixtures of materials in ion-exchange media that sorb anions and cations. [152]

**mixed field:** Radiation field composed of more than one type of radiation. [163]

**mixed oxide (MOX):** Combined uranium and plutonium oxides used as nuclear fuels. [156]

**mixed waste:** Waste containing radionuclides (i.e., source, special nuclear, or byproduct materials), as defined in the Atomic Energy Act, and hazardous chemical waste regulated under the Resource Conservation and Recovery Act (RCRA). Mixed waste also may include (1) waste containing radionuclides as defined in the Atomic Energy Act and hazardous chemical waste regulated under the Toxic Substances Control Act (TSCA) and (2) waste containing naturally occurring and accelerator-produced radioactive material and hazardous chemical waste regulated under RCRA or TSCA. [152]

**mobility:** The capability of moving or being moved. [154]

**mode:** The value that is measured (or estimated) most frequently (i.e., the mode is the most probable value). [164]

**model:** Mathematical or conceptual representation of an environmental or biological system, sometimes including specific numerical values for parameters of the system. Models are used to estimate quantities or concentrations of contaminants in certain compartments (see compartment) or organisms based on other information. [164]

**model:** A mathematical or physical representation of an environmental or biological system, sometimes including specific numerical values for parameters of the system. [163]

**model:** A schematic description of a system, theory or phenomenon that accounts for its known or inferred properties and may be useful for further study of its characteristics. [159]

**model calibration:** Process of fitting a model to represent site-specific conditions using data for that site. [152]

**model prediction:** The result or dependent variable produced by model calculation. [164]

**model prediction/result/output:** The result or dependent variable produced by model calculation. [163]

**model structure:** With respect to mathematical models, the conceptual design, mathematical equations, and set of algorithms that determine results or predictions produced from a given set of input data or assumptions. [164]

**model uncertainty:** Uncertainty about model equations and model accuracy. [164]

**model uncertainty:** The extent to which imperfect knowledge about the exact model equations affects imprecision and inaccuracy in model results (see model validation). [163]

**model validation:** Investigation of the extent of agreement or discrepancy between model predictions and measured datasets that were not used in developing the model or its parameters and that were obtained over a range of conditions that represent the extent of intended application of the model. [163]

**moderate hazard:** A hazard that has the potential to cause a radiation exposure in excess of regulatory dose limits, property damage, regulatory fines or penalties, or adverse public response. [162]

**modulus of elasticity:** Ratio of stress placed on a material to resulting strain [also called Young's modulus after Thomas Young (1777–1829)]. [152]

**moisture content:** Volumetric fraction of a porous medium, including solid medium and pore spaces, that is occupied by liquid water. [152]

**molecular diffusion:** The spreading out of molecules or ions in a fluid, in a direction tending to result in uniform concentrations in all portions of the system. [125]

**mollusca:** A large phylum of animals that are often called shellfish and that includes slugs, snails, mussels, clams and oysters. Mollusks have soft bodies protected by a hard, calcareous shell. [154]

**moment (of a distribution); (central moment):** The  $n$ th moment of a real-valued function  $f(x)$  of a real variable is  $\mu_n = \int_{-\infty}^{+\infty} x^n f(x) dx$ . The  $n$ th moment of a probability density function  $f(x)$  is the expected value of  $x^n$ . The moments about its mean are called central moments and describe the shape of the function. [158]

**monitor:** To determine the level of ionizing radiation or radioactive contamination in a given region. Also, a device used for this purpose. [163]

**monitored natural attenuation:** The concept of leaving contamination in place, but conducting monitoring over a period of time sufficient to prove (or disprove) that risks to human health and environmental quality remain within acceptable limits for a given type of land-use. [154]

**monitoring:** Means provided to indicate continuously or intermittently the level of activity or radiation exposure. [165]

**monitoring:** Measurement of radiation levels or quantities of radionuclides in environmental media. [164]

**monitoring:** Periodic or continuous determination of exposure rate or dose rate in an area (area monitoring), or of the exposure received by a person (personal monitoring), or the measurement of contamination levels. [163]

**monitoring:**

- Periodic or continuous estimation of the exposure rate in an area (area monitoring) or the exposure received by a person (individual or personal monitoring).
- The use of portable survey meters to determine the presence or quantity of radioactive contamination on an individual, or the use of a dosimeter (*i.e.*, a small portable measurement and recording device) to determine an individual's radiation dose or intake of activity. [161]

**monitoring (dose):** The actions taken to monitor radiation dose to patients and staff during FGI procedures. [168]

**monitoring:** The routine and normally repeated measurement of radiation levels or quantities of radionuclides in environmental media such as air, water, soil, vegetation, fish, milk, etc. [154]

**monitor unit (MU):** The unit of measure of the quantity of ionizing radiation passing through a monitor chamber assembly located in the path of the useful beam from an accelerator. The value of the monitor unit is determined by calibrating the resulting absorbed dose in water usually at the isocenter under specified conditions. [151]

**monocyte:** A mononuclear, phagocytotic leukocyte, 13 to 25  $\mu\text{m}$  in diameter. [156]

**monodisperse:** Pertaining to particles with a very narrow range of sizes, so that all have the same deposition characteristics when inhaled. [161]

**monodisperse aerosol:** Aerosol composed of particles having a single size or a very small range of sizes. [125]

**monoenergetic:** Possessing a single energy, or being within a narrowly limited band of energies. [163]

**monomer:** A simple molecule of low molecular weight, capable of combining via covalent bonds to form a polymer. [156]

**monotocous:** Giving birth to one offspring at a time. [128]

**monovalent:** Having a valence of one. [156]

**Monte Carlo (analysis, simulation):** Computation of a probability distribution of an output of a model on the basis of repeated calculations using random sampling of input variables from specified probability distributions. [163]

**Monte-Carlo analysis:** Computation of a probability distribution of an output of a model on the basis of repeated calculations using random sampling of input variables from specified probability distributions. [164]

**Monte-Carlo simulation:** Computation of a probability distribution of an output of a model on the basis of repeated calculations using random sampling of input variables from specified probability distributions. [166]

**morbidity:** Illness of any type or the risk of such illness (e.g., number of illnesses per 1,000 appendectomies). [161]

**morbidity:** A diseased state. The ratio of sick to well in a community, or the frequency of the appearance of complications following a medical procedure or other treatment. [159]

**mortality:** Death or the risk of death (e.g., number of deaths per 1,000 appendectomies). [161]

**mortality (rate):** The frequency at which people die from a disease (e.g., a specific cancer), often expressed as the number of such deaths per 100,000 population per year. [159]

**morula:** Globular solid mass of blastomeres formed by the initial cleavages of the zygote; period of embryonic development that precedes the blastula. [128]

**mucociliary clearance rate:** Time rate of movement for particles up the mucus escalator of the tracheobronchial airways. [164]

**mucociliary clearance velocity (mucous flow rates):** Time rate of movement for particles up the mucus escalator of the tracheobronchial airways. [125]

**mucociliary escalator:** Mucus flow moving up the tracheobronchial airways due to ciliary action. [161]

**mucoepidermoid:** Composed of mucus-producing epithelial cells. [156]

**mucopolysaccharide:** A group of polysaccharides containing hexosamine that form many of the mucins when dispersed in water. [156]

**mucous escalator:** Mucus flow moving up the tracheobronchial airways due to ciliary action. [125]

**mucus cells or mucus glands:** Cells or glands secreting a viscid fluid consisting of mucin, inorganic salts, and water that are present in the bronchi.

**multicompartment model:** A conceptual or mathematical model that contains two or more compartments that are connected by functional processes which transfer material between the compartments. [164]

**multidose:** Refers to a vial, etc., that contains enough of a radiopharmaceutical that doses for more than one patient can be taken from it. [124]

**multiple tube installation:** An installation consisting of more than one x-ray source in the same room or of sources located in adjacent rooms that are close enough to require consideration of their combined workloads in radiation protection design. [145]

**multiplicative-chain model:** Model in which the dependent variable is expressed as simple products (or quotients) of independent variables. [164]

**multiplicative model:** A model based on the assumption that the relative risk resulting from the exposure to two risk factors is the product of the relative risks from the two factors taken separately. [126]

**multiplicative transfer:** A transfer between populations in which the excess relative risk (ERR) is assumed to be transferable. The ERR from the exposed population is applied to the baseline rate for that cancer in the new population. [126]

**multivariate distribution:** Multidimensional analogs of a univariate probability density function such as the normal, lognormal or triangular. In dose assessment, the multivariate distributions of interest are those that represent two or more interdependent variables where interdependence means that the probability associated with a value of any one of the variables is conditional on the values of the other variables. [164]

**municipal/industrial landfill:** A facility for disposal of solid waste that meets the regulatory criteria established under Subtitle D of the RCRA or is otherwise acceptable for disposal of nonhazardous waste. [141]

**mutagenesis:** Induction of a change in genetic material by radiation or any other agent; this could be either a somatic or a genetic effect, depending on whether body cells or germ cells are affected. [161]

**mycorrhizae:** Underground structures that form a symbiotic (mutually beneficial) relationship between fungal mycelia and host plants. [154]

**myelodysplasia process:** An abnormality in the development of the spinal cord, especially the lower part. [150]

**myxedema:** Advanced deficiency of thyroid hormone characterized by a relatively hard edema of the subcutaneous tissue, dryness and loss of hair, subnormal temperature, hoarseness, muscle weakness, and depressed or delayed tendon reflexes; may be associated with drowsiness and slow thought processes. [159]

**N95:** By NIOSH classification, an N95 filter or mask traps 95 % of particles with a diameter of 0.3  $\mu$ m or larger [161]

**nanoparticles:** Particles having mean diameters in the nanometer range. [156]

**narrow beam:** Conditions in which the measurement of ionizing radiation passing through a barrier does not include a contribution from scattered radiation within the barrier. These conditions can be met with a parallel beam of radiation having a small cross-sectional area impinging on a thin barrier and using a small detector located far from the barrier. [151]

**nasal septum:** Wall or septum between the two nasal cavities. [125]

**nasal turbinates:** Three scroll-like bones coming from the outer walls of the superior, middle, and inferior passages in the main nasal cavity that provide filtration, temperature control and aeration in the nose. [125]

**nasal valve:** Smallest part of the nasal airway forming the anterior-posterior portion of the nose that filters the incoming air.

**natural background radiation:** Radiation originating from natural sources such as cosmic radiation, naturally-radioactive minerals and gases in earth, and naturally-radioactive elements in the body ( $^{14}\text{C}$ ,  $^{40}\text{K}$ , and others), typically contributes an annual effective dose of 1 to 3 mSv (100 to 300 mrem) in the United States. [161]

**naturally-occurring and accelerator-produced radioactive material (NARM):** Any naturally occurring radioactive material other than source, special nuclear, or byproduct material, or any radioactive material produced in an accelerator. [152]

**naturally-occurring radioactive material (NORM):** Materials found in the natural environment containing inherent concentrations of radionuclides. Examples include materials containing long-lived radioactive isotopes of the elements uranium, thorium and potassium, and of their decay products (e.g., the elements radium and radon) that have always been present in Earth's crust. [160]

**naturally-occurring radioactive material (NORM):** Any radioactive material that is naturally occurring and that is not source, special nuclear, or byproduct material. [141]

**near-field:** The electromagnetic field close enough to the radiofrequency source such that the field is not plane-wave in nature. The spatial variation of the strength of the electromagnetic wave is usually more rapid in the near field than in the far field. [119]

**near-surface disposal:** Disposal of waste, with or without engineered barriers, on or below the ground surface, such that the final protective covering is on the order of a few meters thick, or in mined openings within a few tens of meters of the Earth's surface. [152]

**necrosis:** The morphological changes indicative of cell death caused by enzymatic degradation. [161]

**negligible individual dose:** A level of effective dose to an individual per source or practice that may be ignored. This term was defined in NCRP Report No. 116 and its recommended value is 0.01 mSv. [160]

**neoplasm:** In a more literal sense, any new growth of cells or tissues. The term is customarily used with rather specific reference to a focus of intermittently or constantly progressive comparatively unlimited or uncontrolled new growth that manifests varying degrees of autonomy, and may be benign or malignant. [159]

**neovascularization:** New blood vessel formation. [156]

**neurofibrosarcoma:** A malignant peripheral nerve sheath tumor. [156]

**neuron:** The nerve cell with its processes, collaterals and terminations: it is regarded as the structural unit of the nervous system. [128]

**neutron:** An elementary particle that is electrically neutral. The nuclei of all atoms except hydrogen contain neutrons. [167]

**neutron:** Particles with a mass similar to that of a proton, but with no electrical charge. Because they are electrically neutral, they cannot be accelerated in an electrical field. [164]

**neutron:** An uncharged elementary particle having a mass slightly greater than a proton that is usually stable when within the nucleus but is unstable otherwise. [163]

**neutron:** An elementary particle with a mass close to that of a proton that is electrically neutral. The nuclei of all atoms except  $^1\text{H}$  contain -neutrons. Also called neutron particle and sometimes shortened to -neutron (e.g., neutron-emitting radionuclide). Neutron particles may represent a hazard when radionuclides are deposited inside the body (e.g., via inhalation, ingestion or wounds). [161]

**neutron:** Uncharged particle found in the nucleus of every atom except  $^1\text{H}$ . Energetic neutrons are produced in spontaneous fission of nuclei (e.g.,  $^{252}\text{Cf}$ ), fission induced by absorption of neutrons by nuclei (e.g.,  $^{239}\text{Pu}$ ), and by absorption of other particles by nuclei (e.g., absorption of alpha particles by  $^9\text{Be}$ ). [159]

**neutron:** The neutral particle which comprises approximately half of the mass of the nuclei for all elements except hydrogen. [Comm20]

**neutron:** An elementary particle that is electrically neutral. The nuclei of all atoms except hydrogen contain neutrons. Neutrons are emitted during the fission process and cause the chain reaction to occur. [126]

**neutron activation:** The formation of a new or different isotope through the absorption of neutrons by the nucleus of a given nuclide. Often, a process causing the formation of certain radionuclides in the vicinity of a nuclear fission reaction. [164]



**neutron activation:** The formation of a radionuclide through the absorption of neutrons by the nucleus of a given nuclide.

An example is the formation of  $^{32}\text{P}$  through absorption of a neutron by  $^{32}\text{S}$ . [163]

**neutron capture:** A process in which a neutron becomes part of the nucleus with which it interacts without release of another heavy particle. [164]

**neutron capture gamma ray:** A photon emitted as an immediate result of the neutron-capture process. [151]

**neutron generator:** A type of accelerator in which the ion beam or the x-ray beam is used mainly for the production of neutrons (e.g., low-voltage deuteron accelerators). [144]

**neutron source strength:** The number of neutrons emitted from a source per unit time. [158]

**neutron source strength ( $Q_n$ ):** The number of neutrons emitted from the head of the linear accelerator per gray of x-ray absorbed dose at the isocenter. [151]

**neutrophil:** A granular leukocyte having a nucleus with three to five lobes. [161]

**nevi (nevus):** A circumscribed malformation of the skin. [150]

**NIH transfer (model):** A model in which the excess absolute risk (EAR) is assumed to apply both in the exposed population and the proposed transfer population and the result is projected to lifetime multiplicatively. (It is called NIH because the National Institutes of Health used it in preparing radioepidemiological tables). [126]

**nipple discharge:** Secretion of fluid from the nipple, either spontaneously or elicited from the nipple area. Nipple discharge (other than milk in a lactating woman) often results from benign breast changes or minor hormonal irregularities but, if spontaneous, needs to be checked by a health professional. [149]

**nodularity:** General lumpiness of normal textured tissue consistency, often bilateral. [149]

**nodule:** A discrete small lump as opposed to normal nodularity. [149]

**noise:** The presence of random fluctuations in image intensity that do not relate to the subject being imaged. Noise is related to both imaging speed and resolution. Generally, faster systems have greater noise. [145]

**noncancer:** Health effects other than cancer (e.g., cataracts, cardiovascular disease) that occur in the exposed individual. [153]

**nonferrous metals:** Metals other than iron and steel, including stainless steel. [141]

**nonhydrogenous material:** Any material that does not contain hydrogen atoms. [Comm20]

**noninertial cavitation:** A class of acoustic cavitation in which collapse does not occur. It includes acoustically induced translational motion of bubbles, bubble growth by rectified diffusion or coalescence, continuous heat production, radiation forces on neighboring particles and microstreaming [140]

**nonintrusive inspection:** This technology refers to a variety of advanced systems that permit U.S. Customs and Border Protection to inspect cargo and conveyances for the presence of contraband without physically opening or entering the shipment. [Comm20]

**nonionizing radiation:** Electromagnetic radiation that includes the ultraviolet, visible, infrared, microwave, radiofrequency, and extremely-low-frequency portions of the electromagnetic spectrum. Unlike ionizing radiation, nonionizing radiation is unable to ionize atoms in its interactions with matter. [161]

**normal distribution:** The normal distribution is an unbounded symmetric distribution, characterized by its mean and standard deviation. In a normal distribution, the median is equal to the mean. [168]

**normal distribution:** An unbounded symmetric distribution, characterized by its mean and standard deviation. In this distribution, the median and the mode are both equal to the mean. [164]

**normal distribution:** An unbounded symmetric probability density function. In this distribution, the median and the mode are both equal to the mean. [159]

**noteworthy practice:** A practice that leads to the improvement in the effectiveness or efficiency of the radiation-safety program. Typically noteworthy practices exceed the requirements of the existing radiation-safety program. [162]

**notional dose:** A substitute dose value in the record of a person for a period when no dose assessment was available. [163]

**NTA<sup>®</sup> film:** Nuclear Track Emulsion<sup>®</sup> film developed by Kodak (Rochester, New York) and used to detect neutrons. [163]

**nuclear fuel cycle:** Activities associated with production, utilization and disposition of fuel for nuclear reactors, including power reactors, research reactors, and defense and radionuclide production reactors, and byproducts related to such activities. [163]

**nuclear incident:** Pertains to an improvised nuclear device (IND) or other type of nuclear detonation. [161]

**nuclear-medicine physician:** Physician licensed to practice medicine who is qualified by training and experience to be authorized under the facility's license to prescribe the administration of therapeutic amounts of radiopharmaceuticals. [161]

**nuclear-medicine physician:** Physician licensed to practice medicine who is qualified by training and experience to be authorized under the facility's license to prescribe the administration of therapeutic amounts of radiopharmaceuticals.

Use of the term “nuclear-medicine physician” does not require that the physician be part of a facility’s nuclear-medicine group. [155]

**nuclear reaction:** An interaction between a photon, particle or nucleus and a target nucleus, leading to the emission of one or more particles and/or photons. [163]

**Nuclear Waste Policy Act (NWPA):** Law passed in 1982 and amended in 1987 that governs U.S. Department of Energy (DOE) program for disposal of commercial spent nuclear fuel and high-level radioactive waste in a geologic repository. The Act also governs disposal of DOE’s spent nuclear fuel and high-level waste when such waste is co-disposed in the same facility as commercial waste. All waste disposals under the Act will be licensed by the U.S. Nuclear Regulatory Commission. [152]

**nuclear yield:** The amount of energy that is released when a nuclear weapon is detonated, expressed usually as the equivalent mass of trinitrotoluene (TNT) [e.g., in kilotons (thousands of tons of TNT)]. [165]

**nuclide:** A species of atom having specified numbers of neutrons and protons in its nucleus (see radionuclide). [163]

**nuclide:** Species of atoms having a specified number of protons and neutrons in its nucleus. Unstable nuclides, that transform to stable or unstable progeny and release radiations, are called radionuclides. [161]

**nulliparous:** Never having borne children. [150]

**numerical solution:** Solution of a differential or integral equation that is not expressed in algebraic form but is expressed in terms of numerical values of dependent variables corresponding to specified values of independent variables. [164]

**n-unit:** An historical measure of neutron radiation, widely used for a certain time. An “n” unit was defined as the quantity of neutron radiation registering 1 R in a certain standard detector. [158]

**Nyquist frequency:** A sampling rate of noise that is at least twice the signal bandwidth in order to reconstruct the original waveform (Nyquist theorem). [149]



**objective health detriment:** All stochastic health effects for which quantitative estimates of the probability of occurrence as a function of radiation dose have been derived from actual exposed populations. [127]

**occlusal radiograph:** An intraoral radiograph made with the image receptor placed between the occlusal surfaces of the teeth, parallel to the occlusal plane, with the x-ray beam directed caudad or cephalad. [145]

**occupancy factor (I):** The factor ( $\leq 1$ ) by which the workload should be multiplied to correct for the degree of occupancy (by any one person) of the area in question while the radiation source is in the “on” position and emitting radiation. [151]

**occupational dose:** The dose received by an individual in a restricted area, or in the course of employment in which the individual’s duties necessarily involve exposure to radiation (medical doses involving diagnosis or treatment of the exposed individual that are not required as a condition of employment are excluded). [167]

**occupational dose:** The dose received by an individual in a restricted area, or in the course of employment in which the individual’s duties necessarily involve exposure to radiation (medical doses involving diagnosis or treatment of the exposed individual are excluded). [124]

**occupational dose/exposure:** The dose/exposure received by an individual in a restricted area, or in the course of employment in which the individual’s duties necessarily involve exposure to radiation (medical doses involving diagnosis or treatment of the exposed individual are excluded). [158]

**occupational exposure:** Radiation exposures to individuals that are incurred in the workplace as a result of situations that can reasonably be regarded as being the responsibility of management (radiation exposures associated with medical diagnosis of or treatment for the individual are excluded). [168]

**occupational exposure:** Exposures to individuals that are incurred in the workplace as the result of situations that can reasonably be regarded as being the responsibility of management (exposures associated with medical diagnosis or treatment are excluded). [164]

**occupational exposure (or dose):** Radiation exposures (or doses) to individuals that are incurred in the workplace as a result of situations that can reasonably be regarded as being the responsibility of management (radiation exposure or doses associated with medical diagnosis of or treatment for the individual are excluded). [163]

**occupational exposure:** Exposures to individuals that are incurred in the workplace as a result of situations that can reasonably be regarded as being the responsibility of management (radiation exposures received by patients associated with their medical diagnosis or treatment are excluded). [157]

**occupied area:** Any room or other space, indoors or outdoors, that is likely to be occupied by any person, either regularly or periodically during the course of the person’s work, habitation or recreation, and in which an ionizing radiation field exists because of radiation sources in the vicinity. [151]

**odds ratio (OR):** The ratio of the number of people incurring an event to the number of people having non-events. [159]

**offload:** The process of removing cargo containers from a cargo container ship. [Comm20]

**olfactory region:** Membranes in the upper part of the nasal cavities that contain the olfactory receptors for the sense of smell. [125]

**omnivore:** An animal that eats both meat and vegetable matter. [154]

**oncogenes:** Genes that encode the potential for cancer induction. [159]

**oncogene:** Genes that under normal circumstances code for proteins associated with normal cell growth, but may foster malignant processes if mutated or activated. [150]

**operable unit:** A discreet portion of a site that is investigated and considered for cleanup or remediation separately from other portions of the site; dividing a site into two or more operable units allows separate investigations and cleanups to proceed at their own pace. [154]

**operating level:** The average performance value expected from a device operated under specified input conditions. On a control chart the operating level is bounded by an upper and lower action level, and upper and lower control limits. [Comm20]

**operating level:** The central value about which we expect day-to-day measurements to fluctuate: for example, the empirically determined mid-density on a sensitometric film. [149]

**operating potential:** (see kilovolt peak). The potential difference between the anode and cathode of an x-ray tube.

**operational quantities:** Quantities used in practical applications for monitoring and investigating situations involving internal or external radiation doses. They are defined for measurements and assessments of doses in the body. [161]

**operational quantity:** A quantity with which, by means of its measurement, compliance with dose limits may be demonstrated. Examples of operational quantities are ambient dose equivalent, directional dose equivalent, and personal dose equivalent at various depths. [163]

**operator:** Any individual who personally utilizes or manipulates a source of radiation. [145]

**opportunistic dosimetry:** Use of commonly-occurring natural or man-made materials that respond to ionizing radiation in ways that provide a record of past exposure and that can be used to reconstruct doses to nearby individuals. [163]

**optically stimulated luminescence (OSL):** Light from a laser or light-emitting diodes is used to stimulate a crystal so that light is emitted, the amount of which is proportional to the dose received. Aluminum oxide is a common OSL material. [Comm20]

**optically-stimulated luminescent (OSL) dosimeter:** A dosimeter containing a crystalline solid for measuring radiation dose, plus filters (absorbers) to help characterize the types of radiation encountered. When irradiated with intense light, OSL crystals that have been exposed to ionizing radiation give off light proportional to the energy they received from the radiation. The intense illuminating light needs to be of a different wavelength than the emitted light. [163]

**optically-stimulated luminescent dosimeter (OSLD):** Light emitted from a crystal stimulated by the light of a laser or light-emitting diodes. The intensity of the emitted light is proportional to the dose received. Aluminum oxide is a common OSLD material. [161]

**optically-stimulated luminescent dosimeter:** A dosimeter containing a crystalline solid for measuring radiation dose. When used for personal dosimetry, filters (absorbers) are included to help characterize the types of radiation encountered. When irradiated with intense light, optically-stimulated luminescent crystals that have been exposed to ionizing radiation give off light proportional to the energy they received from the radiation. [160]

**oral and maxillofacial radiology:** The dental specialty that deals with the production and interpretation of images of dentomaxillofacial structures, practiced by a dental specialist who has undergone additional training in the use of imaging procedures for diagnosis and treatment of diseases, injuries, and abnormalities of the orofacial structures. In general, the individual should be credentialed by either the American Board of Oral and Maxillofacial Radiology or a comparable specialty board, or be eligible to sit for credentialing by such a board. [145]

**ordinary concrete:** A Portland-cement concrete whose constituents are those usually utilized in construction. Thus, ordinary concrete excludes those mixtures called heavy concrete, in which a special material (e.g., iron) has been added to enhance the radiation-shielding properties. Cured ordinary concrete is specified with a density of  $2.35 \text{ g cm}^{-3}$ . Other terms found in the literature that are synonymous with ordinary concrete are standard-weight and normal-weight concrete. Often the density is rounded off to  $2.4 \text{ g cm}^{-3}$ . [151]

**organ dose:** The mean absorbed dose ( $\underline{D}_T$ ) in a specified tissue or organ (T) of the human body given by:

$$D_T = \frac{1}{M_T} \int_0^M D \, dm$$

where  $\underline{M}_T$  is the mass of the tissue or organ, and  $\underline{D}$  is the absorbed dose in the mass element  $\underline{dm}$ . [164]

**organ dose equivalent ( $\overline{H}_T$ ):** The mean dose equivalent for an organ or tissue, obtained by integrating or averaging dose equivalents at points in the organ or tissue. It is the practice in the space radiation protection community to obtain point values of absorbed dose ( $\underline{D}$ ) and dose equivalent ( $\underline{H}$ ) using the accepted quality factor-LET relationship [ $\underline{Q}(\underline{L})$ ], and then to average the point quantities over the organ or tissue of interest by means of computational models to obtain the organ dose equivalent ( $\overline{H}_T$ ). For space radiations, NCRP adopted the organ dose equivalent as an acceptable approximation for equivalent dose ( $\underline{H}_T$ ) for stochastic effects. [156]

**organ or tissue weighting factor ( $w_T$ ):** A factor that indicates the ratio of the risk of stochastic effects attributable to irradiation of a given organ or tissue (T) to the total risk when the whole body is uniformly irradiated. [116]

**oronasal breathing:** Respiratory intake of air either by nose and/or mouth. [164]

**oropharynx:** Central portion of the pharynx lying between the soft palate and upper portion of the epiglottis. [164]

**orphan (unaccounted-for) source:** A source of radioactive material that is subject to regulatory control, but has been abandoned, lost, misplaced, stolen or removed without authorization. [161]

**osmosis:** Passage of a solvent through a semipermeable membrane or porous partition in response to a concentration gradient. [152]

**osteoporosis:** A disorder in which bones become increasingly porous, brittle, and subject to fracture due to loss of calcium and other mineral components, sometimes resulting in pain, decreased height, and skeletal deformities. [159]

**osteoprogenitor cells:** The bone-forming cells of the body that reside in the skeletal endosteum. [164]

**osteosarcoma:** Malignant tumor of the connective tissue of the bone. [161]

**oxidation:** Any reaction in which one or more electrons are removed from a chemical species. [156]

**oxidation state:** Net positive charge on an atom due to loss of electrons to other atoms in a compound. [156]

**paired-image radiation transport (PIRT):** A Monte-Carlo-based radiation transport technique that enables particle tracking beyond the confines of the trabecular bone volume. This approach is in contrast to calculations that assume an infinite spongiosa volume. [164]

**pair production:** The simultaneous production of an electron and a positron by an interaction of a photon or a fast charged particle with the electronic field of a nucleus or other particle. [144]

**pair recombination:** When an electron and positron combine they produce electromagnetic radiation known as annihilation radiation. Two gamma rays of 0.511 MeV energy each are emitted in most cases. [Comm20]

**palpable:** Perceptible to touch. [159]

**palpation:** Generally, examination by touch; the part of breast examination during which the breast tissue and structures are felt with the finger pads. [149]

**pancytopenia:** A pronounced reduction in circulating erythrocytes, white-blood cells, and platelets. [161]

**panoramic examination:** A method of radiography by which continuous curved tomograms of the maxillary and mandibular dental arches and their associated structures may be obtained. [160]

**panoramic radiography (pantomography):** A method of radiography by which continuous tomograms of the maxillary and mandibular dental arches and their associated structures may be obtained. [145]

**papillary:** Relating to, resembling, or provided with papillae (nipple-like processes). [159]

**parafollicular:** Associated spatially with a follicle. [159]

**paralleling technique (parallel geometry):** Intraoral radiography in which the plane of the image receptor is parallel to the long axes of the teeth being radiographed. The central beam of the x-ray field is directed at right angles to both. [145]

**parameter:** Any of a set of independent variables in a model whose value affects the quantitative prediction, characteristics or behavior of the model. [164]

**parameter:** Any of a set of independent variables in a model whose values determine the characteristics or behavior of the model. [152]



**parathyroid gland:** Any of usually four small kidney-shaped glands that lie in pairs near or within the posterior surface of the thyroid gland and secrete parathyroid hormone, a hormone necessary for the metabolism of calcium and phosphorus. [159]

**parenchyma:** The essential or functional elements of an organ, as distinguished from its stroma or framework. [156]

**parenteral:** Not through the alimentary canal (e.g., by subcutaneous, intramuscular, intrasternal or intravenous injection). [161]

**particle:** A small volume of solid material, such as dust. [166]

**particle:** A small volume of solid material, such as a spect of dust of certain nuclei. [164]

**particle accelerator:** A device for imparting energy of motion to charged particles. [157]

**particle clearance:** Clearance of particles deposited in the respiratory tract by mucous clearance, phagocytosis or dissolution and absorption. [161]

**particle clearance velocity:** Speed of clearance of particles deposited in the respiratory tract by mucous clearance, phagocytosis, or dissolution and absorption. [164]

**particle dissolution rate:** Rate at which the change from a solid to a liquid form takes place. [164]

**particulate:** Material in the form of small particles. [164]

**particulate:** An adjective pertaining to particles of solid material. [161]

**partition coefficient:** The fraction of a substance retained with a particular rate constant in a multi-component retention

equation (i.e., if 
$$R(t) = \sum_i A_i e^{-\lambda_i t}$$
 the  $A_i$  are the partition coefficients). [156]

**partition coefficient:** Ratio of mass of a contaminant in solution per unit volume of water to the mass of the contaminant in a waste form per unit mass of the waste form at equilibrium. [152]

**partitioning:** Term used to describe the relative percentage of elements concentrating in the various byproducts of the metal-making process (e.g., in the metal, slag or dross, or oxide fume). [141]

**parturition:** The process of giving birth. [128]

**passive detector:** A radiation detector which integrates the amount of radiation to which it is exposed (e.g., thermoluminescent dosimeters). Passive detectors are later interrogated to determine the dose. [Comm20]

**path length:** Total length of the path of a particle moving through a medium, measured along the actual path, whether or not rectilinear. [164]

**pathobiology:** The structural and functional manifestations of a disease or injury. [156]

**pathway:** Route or mechanism of transport of contaminants in the environment, the means of release of contaminants from a facility, or the means of exposure of humans or other organisms. [164]

**pathway:** Route of entry of radionuclides into the body. [161]

**pathway:** Routes by which material deposited in organ systems can be transported away from the affected organs. For example, materials deposited in the respiratory tract can move out of the respiratory tract by absorption into blood, to the gastrointestinal tract via the pharynx and to regional lymph nodes via lymphatic channels. [161]

**pathway:** Route or means of release of contaminants from a disposal facility, transport of contaminants in the environment, or exposure of humans. [152]

**peak skin dose ( $D_{\text{skin,max}}$ ):** The maximum absorbed dose to the most heavily irradiated localized region of skin (i.e., the localized region of skin that lies within the primary x-ray beam for the longest period of time during an FGI procedure). [168]

**peat:** Semi-carbonized plant tissue in a state of partial decay that accumulates in wet habitats. [154]

**Peclet number:** Average groundwater flow velocity multiplied by a characteristic length (e.g., average particle diameter) divided by the diffusion coefficient. Used to identify whether mechanical dispersion or diffusion is the controlling transport mechanism in a flow system. For example, when the Peclet number is  $>10$ , mechanical dispersion is dominant, and when the Peclet number is less than one, diffusion is dominant. [152]

**pentavalent:** Having a valence of five. [156]

**penumbra:** The region of partial illumination or radiation caused by light or x rays not originating from a point source. [159]

**percentile (of a distribution):** The value of the random variable below which the proportion of the distribution equals the value of the percentile. For example, the probability of an event associated with a random variable smaller than the fifth percentile is  $\leq 0.05$ . [164]

**percutaneous:** Performed through the skin. [161]

**performance assessment:** Iterative process involving site-specific, prospective modeling evaluations of the postclosure time phase of a waste disposal system for the purpose of (1) determining whether reasonable assurance of compliance with regulatory performance objectives can be demonstrated, and (2) identifying critical data, facility design, and model development needs for defensible and cost-effective licensing decisions and developing and maintaining operating limits (waste acceptance criteria) for specific disposal facilities. [152]

**performance check:** Following calibration, a source check carried out to ensure that the instrument response to radiation from a known source has not changed beyond acceptable bounds. [112]

**performance measure:** The ongoing monitoring and reporting of program accomplishments, particularly progress towards preestablished goals. It is typically conducted by institutional or program management. A “program” may be any activity, project, function or policy that has an identifiable purpose or set of objectives. [162]

**performance objective:** Customer or management expectations for the effectiveness and performance of the task, process or program being evaluated. [162]

**performance objective:** Standard that defines acceptable projected exposures of individuals or populations or concentrations of radionuclides in the accessible environment following closure of a waste disposal facility. [152]

**periapical radiograph:** An intraoral radiograph that demonstrates the crowns and roots of teeth and the surrounding alveolar bone structures. [145]

**permeability, hydraulic:** Same as hydraulic conductivity, except definition applies to any fluid. [152]

**permeability, magnetic:** The degree of magnetization of a material that responds linearly to an applied magnetic field. The unit of permeability is henry per meter ( $\text{H m}^{-1}$ ) or newton per square ampere ( $\text{N A}^{-2}$ ). The value of the magnetic permeability ( $\mu$ ) in a vacuum ( $\mu_0$ ) is  $4\pi \times 10^{-7} \text{ H m}^{-1}$ .

**permittivity:** A property of material that indicates how much polarization occurs when an electric field is applied to it. [119]

**persistence of vision:** A visual phenomenon that is responsible for the apparent continuity of rapidly presented discrete images (as in motion pictures or television) consisting essentially of a brief retinal persistence of one image so that it is overlapped by the next and the whole is centrally interpreted as continuous. [133]

**personal dose equivalent (at 10 mm):** An operational quantity used in personal monitoring. In this case, measured at a depth of 10 mm. [165]

**personal dose equivalent [ $H_p(d)$ ]:** The dose equivalent in soft tissue, at an appropriate depth ( $d$ ) below a specified point on the body. The SI unit of personal dose equivalent is joule per kilogram ( $\text{J kg}^{-1}$ ) and its special name is the sievert (Sv). [158]

**personal dose equivalent:** The personal dose equivalent [ $H_p(d)$ ] is the dose equivalent in soft tissue, at an appropriate depth ( $d$ ) below a specified point on the body. The unit of personal dose equivalent in the SI system of units is joule per kilogram ( $\text{J kg}^{-1}$ ) and its special name is the sievert (Sv). [144]

**personal dose equivalent at 10 mm [ $H_p(10)$ ]:** The dose equivalent in soft tissue at a depth of 10 mm below a specified point on the body. The SI unit of  $H_p(10)$  is  $\text{J kg}^{-1}$  and its special name is sievert (Sv). There are also personal dose equivalent quantities measured at other depths [e.g.,  $H_p(0.07)$  at a depth 0.07 mm;  $H_p(3)$  at a depth 3 mm] [168]

**personal dosimeter:** A small radiation detector that is worn by an individual. Common personal dosimeters contain film, thermoluminescent, or optically-stimulated luminescent materials as the radiation detection device. [163]

**personal monitoring:** The use of a small radiation detector (dosimeter) that is worn by an individual. Common personal dosimeters contain film, thermoluminescent, or optically-stimulated luminescent materials as the radiation-detection device. [168]

**personal monitoring:** The use of portable survey meters to determine the presence or quantity of radioactive contamination on an individual, or the use of a dosimeter (i.e., a small portable measurement and recording device) to determine an individual's radiation dose. [157]

**personal (individual) monitor or dosimeter:** A small radiation detector that is worn by an individual. Common individual dosimeters contain film, thermoluminescent materials, or optically-stimulated luminescent materials as the radiation detector device. [158]

**personal protective equipment (PPE):** Specialized clothing or equipment worn to protect against contamination with radionuclides. [161]

**personal protective equipment:** Specialized clothing or equipment worn by an employee to protect against a hazard. [157]

**personal radiation detector:** A device worn by an individual to monitor the radiation dose received by the individual. [165]

**person-gray:** A unit of population exposure (collective dose) obtained by summing individual absorbed dose values for all people in the exposed population. Thus, the collective dose contributed by one person exposed to 1 Gy is equal to that contributed by 100,000 people each exposed to 10  $\mu$ Gy. [126]

**personnel monitoring:** Periodic or continuous determination of the exposure received by a person, or the measurement of personal contamination levels. [164]

**personnel monitoring:** The performance and interpretation of measurements by devices worn by individuals, where such measurements are generally intended to provide an estimate of the dose equivalent. The results of individual monitoring are mainly used to confirm the safety of working conditions, to identify unexpected exposures, and to maintain records of exposure. [161]

**person-sievert (person-Sv):** The unit of collective effective dose. [160]

**person-year (PY):** The number of persons exposed times the average number of years of follow-up after exposure. [126]

**pertechnetate:** Anionic form of technetium used widely in nuclear scanning ( $^{99m}\text{TcO}_4$ ). [159]

**perturbation analysis:** Method of investigating effects of parameter uncertainty on output of a model in which probability distribution functions of parameters are incorporated explicitly in model equations. [152]

**pH:** Symbol for degree of acidity or alkalinity of a solution. [156]

**pH:** A measure of acidity and alkalinity of a solution that is a number on a scale on which a value of seven represents neutrality, lower numbers indicate increasing acidity and higher numbers increasing alkalinity. [154]

**phagocytic cells:** Cells with the ability to engulf solid material. [156]

**phagocytosis:** The engulfing of microorganisms or other cells and foreign particles by phagocytes. [156]

**phalanx:** Any bone of a finger or toe (plural: phalanges). [156]

**phantom:** A volume of tissue- or water-equivalent material used to simulate the absorption and scattering characteristics of the patient's body or portion thereof. [164]

**pharynx:** Passageway for air from the nasal cavity to the larynx and for food from the mouth to the esophagus which also acts as a resonating cavity for sound. (The upper portion is lined with pseudostratified ciliated columnar epithelium, middle portion with stratified, columnar epithelium, and the lower portion with stratified, squamous epithelium.) [164]

**phase velocity:** The velocity of a point of constant phase on a single frequency wave. [119]

**phosphate rock:** An ore from which phosphorus is extracted and which often contains low concentrations of uranium. [118]

**photodegradation:** Degradation of organic compounds due to the action of light; results in the formation of free radicals and causes oxidation, cleavage, and other reactions that degrade organic compounds. [154]

**photodisintegration:** Any transformation of a nucleus induced by photons. [144]

**photoelectric effect:** The interaction of a photon with a bound electron of an atom, resulting in the absorption of the incident photon and the release of the electron from that atom with energy equal to the photon energy minus the electron binding energy. [161]

**photoelectric effect:** The interaction of a photon with an atom, resulting in the absorption of the incident photon and the release of a bound electron from that atom with energy equal to the photon energy minus the electron binding energy. [Comm20]

**photofission:** Fission of a nucleus induced by a photon. [144]

**photomultiplier tube:** A device that converts incident light to an electrical signal, either as a current or voltage pulse. [161]

**photon:** Quantum of electromagnetic radiation, having no charge or mass, that exhibits both particle and wave behavior, such as a gamma or x ray. [168]

**photoneutron:** A neutron released from a nucleus as the result of the absorption of an energetic photon. [Comm20]

**photon flash:** The high intensity production of photons in a short time period often associated with the pulses of a linear accelerator. [Comm20]

**photonuclear:** Pertaining to the interaction of a photon with a nucleus. [Comm20]

**photosphere:** The portion of the sun visible in white light. Also the limit of seeing down through the solar atmosphere in white light. [153]

**physical-chemical form:** Form of a material related to its physical and chemical properties. [164]

**physical decay constant:** The decay rate of a radionuclide calculated as the natural log of two divided by the half-life of the radionuclide. [164]

**physical half-life:** Time required for a radioactive atom to lose 50 % of its activity due to decay. [159]

**physisorption:** Adsorption in which forces involved are intermolecular forces (i.e., van der Waals forces) of the same kind as those responsible for the imperfection of rare gases and condensation of vapors, and which do not involve a significant change in electronic orbital patterns of the species involved. [152]

**phytoextraction:** The uptake of contaminants by plant tissues which can be harvested and disposed of. [154]

**phytoplankton:** That portion of the plankton that is classified as being in the plant kingdom (see plankton). [154]

**phytoremediation:** The process of using plants for cleanup or stabilization of contaminated soils or water. [154]

**phytostabilization:** The process of stabilizing soil and preventing its erosion by management to ensure the presence of protective vegetation cover. [154]

**pia (pial surface):** The delicate fibrous membrane that closely envelops the brain and spinal cord. [128]

**pica:** A medical disorder characterized by an appetite for substances largely non-nutritive (e.g., clay, coal, soil, chalk, paper, soap) or an abnormal appetite for some things that may be considered foods, such as food ingredients (e.g., flour, raw potato, raw rice, starch, ice cubes, salt, blood). Geophagia is a special case of pica involving ingestion of earth substances and is often associated with specific ages, ethnicities, and even pregnancy. [163]

**piezometric surface:** In a confined groundwater system, surface obtained by connecting equilibrium water levels in tubes penetrating the aquifer and open to the atmosphere. In an unconfined aquifer, the piezometric surface is the same as the water table. Also called the potentiometric surface. [152]

**piscivore:** An animal that eats fish. [154]

**pitch ( $p$ ):** In computed tomography (CT), the ratio of the patient translation per gantry rotation to the nominal beam width for the CT scan. [160]

**pixel:** A two-dimensional picture element in a digital image. [164]

**placenta:** Vascular, membranous structure that forms within the uterus from maternal and embryonic tissues during pregnancy; it provides communication between the woman and her embryo/fetus via the umbilical cord. [128]

**placenta-hemochorial:** Placenta in which the trophoblast of the internal membrane is in direct contact with circulating maternal blood. [128]

**planar imaging:** An imaging procedure in nuclear medicine that yields a two-dimensional representation of the activity distribution in a region of the body or over the whole body. Planar images are typically obtained by detecting photons emitted from within the patient from the anterior and posterior views. [164]

**plane wave:** A wave in which the wave fronts are planar, **E** and **H** have constant values in the planes of the wave fronts, and **E**, **H**, and the direction of propagation are all mutually perpendicular. [119]

**plankton:** The small, passively floating or weakly swimming plant and animal life in a body of water. [154]

**planned special exposure:** A radiation dose that is authorized for a worker that will exceed occupational dose limits. The planned special exposure is considered only in exceptional circumstances when it can be justified and when alternatives that might prevent a worker from exceeding limits are unavailable or impractical. [127]

**plant-to-soil concentration ratio ( $B_v$ ):** Ratio of concentration of a radionuclide in vegetation to concentration in dry soil. [152]

**plasminogen activator:** An enzyme such as urokinase that catalyzes the activation of plasminogen to plasmin. [156]

**platelet:** The smallest formed element of blood; disk-shaped, non-nucleated cells that adhere to uneven or damaged surfaces and participate in clot formation; also called thrombocytes. [161]

**pleura:** Serous membrane enveloping the lungs and lining the walls of the thoracic cavity. [125]

**plot:** A defined land area used for making measurements or taking samples. [154]

**plow layer:** The depth to which soil is generally tilled. [129]

**pluripotent:** Having ability to affect more than one organ at a time.

**pneumoconiosis:** Disease of the lungs, characterized by fibrosis and caused by the chronic inhalation of mineral dusts, especially silica and asbestos. [125]

**point isotropic specific absorbed fraction:** Fraction of the energy emitted by a point isotropic source that is absorbed per gram of tissue at a distance from the source. [125]

**point source (of radiation):** Any radiation source as viewed from a distance that is much greater than the linear size of the source, and for which the inverse square law is applicable. [161]

**Poisson distribution:** A discrete probability distribution that arises from such situations as events that occur randomly through time with a constant average rate ( $\bar{x}$ ). [164]

**polarization of electromagnetic wave:** Orientation of the incident electric and magnetic field vectors with respect to the absorbing object. When associated with an antenna, polarization generally refers to the direction of the electric field vector. [119]

**pollutant:** Includes, but is not limited to, any chemical element, substance, compound or mixture, including disease-causing substances, which after release into the environment and upon external exposure, ingestion, inhalation or assimilation into any organism, either directly from the environment or indirectly by ingestion through food chains, will, or may reasonably be anticipated to, cause death, disease, behavioral abnormalities, cancer, genetic mutation, or physiological malfunctions (including malfunctions in reproduction, or physical deformations in such organisms or their offspring). [141]

**pollution prevention:** Pollution prevention means “source reduction” and other practices that reduce or eliminate the generation of pollutants through (1) increased efficiency in the use of raw materials, energy, water or other resources; or (2) protection of natural resources by conservation. [141]

**polychlorinated biphenyls (PCBs):** Family of chemicals composed of biphenyl molecules that have been chlorinated to varying degrees. [152]

**polydisperse:** Mixture composed of particles with a range of sizes. [156]

**polydisperse aerosols:** Aerosols composed of particles with a range of sizes. [161]



**polymer:** Compound, usually of high molecular weight, formed by the combination of simpler molecules (monomers). [156]

**polymorphism:** In genetics, the occurrence together in the same population of two or more genetically determined phenotypes in such proportions that the rarest of them cannot be maintained merely by recurrent mutation. [167]

**polymorphonuclear:** Having a nucleus so deeply lobed or so divided as to appear to be multiple. [156]

**polytocous:** Giving birth to several offspring at one time. [128]

**polytropic index of a gas:** In a small decrease of volume caused by a small increase of pressure, the ratio of the fractional increase in pressure to the fractional decrease in volume. [140]

**popliteal:** Pertaining to the area behind the knee. [156]

**pore velocity:** Average rate of flow in pores of a groundwater medium, which is approximated as the flux divided by the effective porosity. [152]

**pore water:** Water in the spaces between soil or sediment particles. [154]

**porosity:** Property of voids or openings in a porous medium; total porosity is the ratio of the volume of all openings to the total volume of the material, and effective porosity refers to the porosity of that part of the material through which flow occurs. [152]

**porous flow:** Groundwater flow which is predominantly through pores in the medium, or through the interstitial spaces between small grains of material. [123]

**portal monitor:** A radiation detection system used to monitor trucks and rail cars carrying scrap as they enter a facility. This term also applies to systems used to monitor personnel. [141]

**position-indicating device (PID) (cone, pointer cone, pointer):** An open-ended device on a dental x-ray machine (in the shape of a cylinder or parallelepiped) designed to indicate the direction of the central ray and to serve as a guide in establishing a desired source-to-image receptor distance. Provision for beam collimation and added filtration can be incorporated into the construction of the device.

- **short cone:** An open ended cylinder that establishes a source-to-image receptor distance of approximately 20 cm.
- **long cone:** An open ended cylinder that establishes a source-to-image receptor distance of about 40 cm. [145]

**positioning:** The maneuvers the radiologic technologist uses to place the breast in the desired position on the film for a specific mammographic view. [149]

**positron:** A particle equal in mass to an electron and having an equal but positive charge. Some radionuclides emit positrons.

[163]

**positron:** The antimatter counterpart of the electron equal in mass and charge but of opposite sign to an electron. [161]

**positron:** An antiparticle equal in mass to an electron and having an equal but positive charge. [160]

**positron emission tomography (PET):** An imaging technique using radionuclides that emit positrons (positively charged electrons), whose annihilation photons are imaged in coincidence to form tomographic views of the body. [164]

**possibilistic, possibility theory:** Generalization of probability theory developed to account for limitations of classical probability theory in dealing with imprecision. [152]

**postclosure:** Times subsequent to cessation of waste emplacement activities at a disposal facility and actions to prepare disposal site for long-term waste isolation (e.g., construction of caps and covers, seals, and surface markers). [152]

**potentially exposed:** All monitored and unmonitored personnel who have the potential for being exposed to radiation in the course of their duties. [164]

**potentially exposed:** All monitored and unmonitored persons who have the potential for being exposed to radiation or to have an intake of radionuclides. [161]

**potentially-high radiation dose procedure:** An FGI procedure for which more than 5 % of cases of that procedure result in  $\underline{K}_{a,r}$  exceeding 3 Gy or  $\underline{P}_{KA}$  exceeding 300 Gy cm<sup>2</sup>. [168]

**potentially radioactive scrap metal (PRSM):** Scrap metal that has been used in a regulated radiation environment and has a potential of containing radioactive materials via surface transfer or by nuclear activation. [141]

**power density:** The power incident on a surface per unit surface area. [119]

**Poynting vector:** A vector equal to the vector product of **E** and **H**. It is usually designated as **S** and has the units of watt per square meter (W m<sup>-2</sup>). The integral of **S** represents the instantaneous power transmitted through a closed surface. [119]

**practicable:** Likely to meet a need, but not yet tested in practice or proved in service or use (implies an expectation). [168]

**practical:** Proven effective in use (implies an actual established usefulness). [168]

**precipitation:** Rain, snow, sleet or any other form of water deposited from the atmosphere onto the Earth's surface. [152]

**precipitation scavenging:** The process of removal of aerosol particles or gases from the atmosphere by rain or snowfall (also called wet deposition). [154]

**precision:** Acceptable degree of uncertainty of an estimate with respect to an actual event or outcome (result). [164]

**precision:** The degree of reproducibility of a measurement or prediction of a quantity. A measurement or prediction can be precise without being accurate and unbiased (see accuracy and bias). [163]

**preimplantation period:** Time between egg fertilization and the implantation of the embryo in the wall of the uterus. [128]

**preloaded applications:** “Hot source” brachytherapy technique that consists of placing the radioactive sources manually or placing applicators previously loaded with radioactive sources in the treatment site during an operative procedure. [155]

**preneoplastic:** Preceding the formation of a malignancy. [156]

**preparedness:** The process of anticipating potential vulnerabilities and developing comprehensive plans with all involved agencies, educating personnel on the plans, and practicing the plans. [166]

**pressure head:** Height above a given point in an aquifer to which water will rise when an open, vertical tube is inserted down to that point. [152]

**prevalence:** The number of cases of a disease in existence at a given time per unit of population, usually per 100,000 persons. [161]

**primary barrier:** A wall, ceiling, floor or other structure designed to attenuate the useful beam to the required degree. [151]

**primary producer:** Refers to green plants that convert solar energy into chemical energy through the process of photosynthesis. In aquatic ecosystems, for example, phytoplankton, algae and macrophytes constitute the primary producers. [154]

**primary protective barrier:** A barrier sufficient to attenuate the useful beam to the required degree. [147]

**primary radiation (useful beam):** Radiation emitted directly from the source that is intended to be used for medical purposes. [151]

**probabilistic risk assessment:** Type of risk assessment in which probabilistic methods are used to describe processes and events acting on a natural or engineered system and their consequences and to derive a distribution of risk based on repeated random sampling of distributions of input variables. [152]

**probability density (distribution) function (PDF):** Estimate of the likelihood of occurrence of different possible values of a measured value, a model parameter, or model output. [164]

**probability distribution:** Estimate of the likelihood of occurrence of different possible values of a measured value, a model parameter, or model output. [160]

**process:** A series of actions that achieves an end result and usually includes two or more tasks. [162]

**process history:** The use of historical information regarding past use to determine the potential of materials have been radioactively contaminated or activated. [141]

**processor:** An automated device that transports film at a constant speed by a system of rollers through developing, fixing, washing and drying cycles. [149]

**processor artifact:** Any unwanted or artificial image feature appearing on a radiograph due to malfunction or misuse of the film processor. [149]

**prodromal:** Relating to prodrome (an early or premonitory symptom of a disease). [165]

**program:** The integration of a set of processes and other activities that are planned, initiated and managed in a coordinated way to achieve desired results. Examples of programs are the internal/external dosimetry -program, the self-assessment program, or the entire radiation-safety -program. [162]

**projection:** The direction of the central ray (e.g., mediolateral, craniocaudal) in an x-ray exam. [168]

**projection model:** A mathematical model that describes the excess cancer risk at different levels of dose, time after exposure, or baseline level of risk, in terms of a parametric function of those factors. It becomes a projection model when parameter estimates based on data on a particular range of observations are used to estimate (or project) excess risk for factor values outside the range (e.g., from the observation period to lifetime). [126]

**prolactin:** Hormone secreted by the anterior pituitary that promotes the growth of breast tissue and stimulates and sustains milk production in postpartum mammals. [156]

**promoter:** An agent that is not by itself carcinogenic but can amplify the effect of a true carcinogen by increasing the probability of late-stage cellular changes necessary to complete the carcinogenic process. [159]

**prompt (neutrons or gamma rays):** Neutrons or gamma rays emitted instantaneously from nuclear fission as opposed to those emitted after some delay (e.g., delayed gamma rays from fission product decay). [163]

**prompt photon radiation:** In the context of this Report, photons emitted instantaneously from a nuclear explosion as opposed to photons emitted from fission product decay (delayed photons). [158]

**propagate (uncertainties):** The process of combining estimates of uncertainty in various parameters in a model, each represented by a probability density function, in an appropriate manner in order to estimate the resultant uncertainty in the output of the model. Also the process of combining various approaches to model structure. [163]

**propagation coefficient:** A quantity that describes the propagation of a wave. Usually designated  $k$ , it is equal to the radian frequency divided by the phase velocity, and has the unit of reciprocal meter ( $m^{-1}$ ). [119]

**proportional counter:** A detection device for ionizing radiation in which the magnitude of the output pulse is proportional to the energy of the incident radiation. Thus, the energy of incident radiations can be identified. [161]

**proportional mortality ratio:** The ratio of the percentage of a specific cause of death among all deaths in a population being studied divided by the comparable percentage in a standard population. [159]

**prospective dose assessment:** Dose assessment performed in cases when intakes have not yet taken place. [164]

**prospective dosimetry:** Dosimetry performed to predict the dose before the exposure takes place. For example, in medical exposures, dosimetry to estimate doses to tumors and normal organs prior to the administration of a radiopharmaceutical for therapy. [164]

**prostacyclin:** An intermediate in the metabolic pathway of arachidonic acid; it is a potent vasodilator and inhibitor of platelet aggregation. [156]

**protease:** Any proteolytic enzyme. [156]

**protection quantity:** A radiation protection quantity used to express dose limits. Examples of protection quantities are effective dose and organ equivalent dose. [161]

**protection quantity:** A quantity used to express dose limits. Examples of protection quantities are effective dose and organ equivalent dose. [158]

**protective apron:** An apron made of radiation absorbing materials, used to reduce radiation exposure. [133]

**protective barrier:** A barrier of radiation absorbing material(s) used to reduce radiation exposure. [145]

- **primary protective barrier:** A protective barrier used to attenuate the useful beam for radiation protection purposes.
- **secondary protective barrier:** A barrier sufficient to attenuate scattered and leakage radiation for radiation protection purposes. [145]

**protective clothing:** Gloves, aprons, gowns, etc., made of radiation absorbing materials used to reduce radiation exposure. [161]

**protective devices (medical exposure):** Devices such as gloves, aprons and gowns made of radiation absorbing materials, used to reduce occupational radiation exposure in medical procedures. [168]

**protective glove:** A glove made of radiation absorbing materials used to reduce radiation exposure to the hands. [133]

**protective source housing:** The part of the accelerator or teletherapy unit enclosing the x-ray target and/or source(s) from which the useful beam emanates. This component contains shielding and may rotate about an axis. [151]

**proton:** The nucleus of the hydrogen atom. Protons are positively charged. [167]

**proton:** An elementary nuclear particle with a positive charge equal to the charge of an electron and a mass equal to the nucleus of the hydrogen atom. [163]

**proton:** A positively-charged elementary particle that is the nucleus of the  $^1\text{H}$  atom. [161]

**protooncogenes:** A gene conserved long on the evolutionary scale present in the normal human genome, that appears to have a role in normal cellular physiology and is often involved in regulation of normal cell growth or proliferation, however as a result of somatic mutations these genes may become oncogenic. [150]

**protraction:** The continuous delivery of a radiation dose over a period of time. [161]

**protraction:** Extending the length of exposure, for example, the continuous delivery of a radiation dose over a longer period of time. [153]

**provider:** Referring physician or other health care professional who refers women for mammography (e.g., family practice physician, nurse practitioner, physician's assistant). [149]

**Prussian blue:** A hexacyanoferrate compound that reduces the absorption of cesium from the stomach, and which is often administered to domestic animals to reduce levels of  $^{137}\text{Cs}$  in animal products. [164]

**public:** All persons who are not considered occupationally exposed by a source or practice under consideration. [164]

**pulmonary:** The removal of material from the respiratory tract by particle transport and by absorption into blood. [161]

**pulmonary fibrosis:** Formation of scar tissue within the connective tissue of the lungs following pulmonary disease or inflammation. [164]

**pulmonary lymph nodes:** Lymph nodes found in the pulmonary parenchyma, usually at bifurcations of bronchi and bronchioles. [125]

**pulmonary region:** Gas exchange region of the lungs; consists of alveoli and respiratory bronchioles. [161]

**pulmonary thromboembolism:** Blockage of a blood vessel in the lungs, usually by a clot in the heart that has become detached from its site of formation. [125]

**pulmonary tuberculosis:** Infectious disease of the lung caused by tubercle bacillus and characterized pathologically by inflammatory infiltrations, formation of tubercles, caseation, necrosis, abscesses, fibrosis, and calcification. [125]

**pulse cycle:** The fraction of the operation cycle of an accelerator during which radiation is produced; the product of the pulse duration and the pulse-repetition frequency. [151]

**pump test:** Method of estimating hydraulic properties of aquifers in which a well is pumped at a constant rate and drawdown of the piezometric surface or water table is observed in wells at some distance from the pumped well. In a steady-state pump test, pumping is continued until water levels in observation wells approach equilibrium, which enables a calculation of the transmissivity of the aquifer. In a transient pump test, drops in water levels in observation wells are measured as a function of pumping time, which enables a calculation of specific storage as well as transmissivity. [152]

**p value:** A probability value summarizing the strength of the statistical evidence against a particular null hypothesis in favor of a particular alternative hypothesis. If the null hypothesis is true, observational data corresponding to a  $p$  value of 0.05 or less are likely to occur about one time in 20,  $p = 0.01$  one time in a hundred, etc. Thus, the smaller the  $p$  value, the greater the strength of the evidence is considered to be against the null hypothesis. Conventionally,  $p < 0.05$  is considered “significant,”  $p < 0.01$  “highly significant,”  $p$  close to 0.05 “marginally significant,”  $0.05 < p < 0.10$  “no significant but suggestive,” and  $p > 0.10$  “no significant.” [164]



**qualified expert:**

- **medical:** A person qualified to address the medical needs of a radiation contamination incident will be a board certified physician, nurse, or medical practitioner trained in nuclear medicine, radiology, or other discipline in which knowledge of radiation, radionuclides, radiobiology, and treatments with blocking and decorporation agents.
- **radiation safety:** A person qualified to respond to a radionuclide contamination incident will have the knowledge and training to measure radiation, to evaluate radiation-safety techniques, and to advise regarding radiation protection needs. The qualified expert is likely, but not necessarily, a person who is certified by the American Board of Health Physics, the American Board of Radiology, the American Board of Medical Physics, or the Canadian College of Physicists in Medicine. [161]

**qualified expert:** A medical or health physicist who is certified by the American Board of Radiology, American Board of Medical Physics, American Board of Health Physics, or Canadian College of Physicists in Medicine, and is experienced in dosimetry and radiation shielding of high-energy (5 to 10 MV) ionizing radiation. [Comm20]

**qualified expert:** A person having the knowledge and training to measure radiation, to evaluate radiation safety techniques, and to advise regarding radiation protection needs. For ionizing radiation, the qualified expert is a person who is certified by the American Board of Health Physics, the American Board of Radiology, the American Board of Medical Physics, or the Canadian College of Physicists in Medicine. [157]

**qualified expert:** A medical physicist or medical health physicist, who is competent to design radiation shielding, evaluate the results of radiation dosimetry measurements, and specify radiation precautions to be observed when administering or handling radioactive materials. The qualified expert is a physicist certified by the American Board of Radiology, American Board of Medical Physics, American Board of Health Physics, or the Canadian College of Physicists in Medicine. [155]

**qualified expert:** A medical or health physicist who is competent to design radiation shielding in radiotherapy facilities, and who is certified by the American Board of Radiology, American Board of Medical Physics, American Board of Health Physics, or Canadian College of Physicists in Medicine. [151]

**qualified physicist:** A medical physicist or medical health physicist who is competent to conduct the radiation protection and patient safety functions described for FGI-procedure equipment and facilities. The qualified physicist is a person who is certified by the American Board of Radiology, American Board of Medical Physics, American Board of Health Physics, or Canadian College of Physicists in Medicine. [168]

**quality assurance:** The planned and systematic activities necessary to provide adequate confidence that a product or service will meet the given requirements. [168]

**quality assurance (QA):** Process of ensuring proper documentation of data, of interpretations of data, which are embodied in assumptions, and of computer codes. [163]

**quality control (QC):** The routine performance of tests and tasks and the interpretation of data from the tests of equipment function and the corrective actions taken. [163]



**quality control technologist:** The technologist assigned the task of QC testing and maintaining QC records for radiographic imaging systems. [149]

**quality factor (Q):** The factor by which absorbed dose ( $\underline{D}$ ) at a point is modified to obtain the dose equivalent ( $\underline{H}$ ) at the point (i.e.,  $\underline{H} = \underline{QD}$ ), in order to express the effectiveness of an absorbed dose (in inducing stochastic effects) on a common scale for all types of ionizing radiation. There is a specified dependence [ $\underline{Q}(\underline{L})$ ] of the quality factor ( $\underline{Q}$ ) as a function of the unrestricted linear energy transfer ( $\underline{L}$ ) in water at the point of interest. [164]

**quality factor (Q):** Dimensionless factor developed for purposes of radiation protection and assessing health risks in general terms that accounts for the relative biological effectiveness of different radiations in producing stochastic effects and is used to relate absorbed dose ( $\underline{D}$ ) at a point in tissue to dose equivalent ( $\underline{H}$ ) at a point, where  $\underline{H} = \underline{D} \times \underline{Q}$ . The quality factor is a specified function of unrestricted linear energy transfer in water, and is defined with respect to the particular type and energy of radiation incident on tissue at the point of interest. [163]

**quasithreshold dose:** The dose at which the extrapolated straight portion of the dose-response curve intercepts the dose axis at unity survival fraction. [153]

**rad:** The special name for the previous unit of absorbed dose.  $1 \text{ rad} = 0.01 \text{ J kg}^{-1}$ . In SI units, it is replaced by the special name gray (Gy).  $1 \text{ Gy} = 100 \text{ rad}$ . [164]

**rad:** The special unit previously used for the quantity absorbed dose;  $100 \text{ rad} = 1 \text{ Gy}$  (see gray). [163]

**radial cutoff LET ( $L_r$ ):** The energy lost per unit track-length deposited within a given distance ( $r$ ) from the track trajectory. The radial cutoff LET accounts for spatial differences in energy distribution. [137]

**radian frequency:** The angular rate at which a quantity such as an electromagnetic field is oscillating. The radian frequency is equal to  $2\pi f$ , where  $f$  is the frequency in hertz (Hz). [119]

**radiation (ionizing):** Electromagnetic radiation (x or gamma rays) or particulate radiation (alpha particles, beta particles, electrons, positrons, protons, neutrons, and heavy charged particles) capable of producing ions by direct or secondary processes in passage through matter. [168]

**radiation:** Energy propagated through space in the form of electromagnetic waves or particles (see ionizing radiation and nonionizing radiation). [161]

**radiation:** Energy emitted in the form of waves or particles by radioactive atoms as a result of radioactive decay or produced by artificial means, such as x-ray generators. [159]

**radiation (ionizing):** Electromagnetic radiation (x or gamma rays) or particulate radiation (alpha particles, beta particles, electrons, positrons, protons, neutrons, and heavy charged particles) capable of producing ions by direct or secondary processes in passage through matter. [158]

- **leakage radiation:** All radiation coming from within the source assembly except for the useful beam. It includes the portion of the radiation coming directly from the source and not absorbed by the source assembly, as well as the scattered radiation produced within the source assembly.
- **scattered radiation:** Radiation that, during interaction with matter, is changed in direction. The change is usually accompanied by a decrease in energy. For purposes of radiation protection, scattered radiation is assumed to come primarily from interactions of primary radiation with tissues of the patient.
- **useful beam:** The radiation that passes through the opening in the beam-limiting device that is used for imaging. [145]

**radiation:**

1. The emission and propagation of energy through space or through matter in the form of waves, such as electromagnetic, sound, or elastic waves.
2. The energy propagated through space or through matter as waves; radiation or radiant energy, when unqualified, usually refers to electromagnetic radiation; commonly classified by frequency— Hertzian, infrared, visible, ultraviolet, x and gamma rays.
3. Corpuscular emission, such as alpha and beta particles, or rays of mixed or unknown type, such as cosmic radiation.

- **background radiation:** The amount of radiation to which a member of the population is exposed from natural sources, such as terrestrial radiation from naturally-occurring radionuclides in the soil, cosmic radiation originating in outer space, and naturally-occurring radionuclides in the soil, cosmic radiation originating in outer space, and naturally-occurring radionuclides deposited in the human body. The natural background radiation received by an individual depends on geographic location and living habits. In the United States, the background radiation is on the order of  $1 \text{ mSv y}^{-1}$ , excluding indoor radon which amounts to  $\sim 2 \text{ mSv y}^{-1}$  on average.
- **ionizing radiation:** Any electromagnetic or particulate radiation capable of producing ions, directly or indirectly, in its passage through matter. [153]

**radiation biology (radiobiology):** That branch of science dealing with radiation effects on biological systems. [145]

**radiation control zones:** Categorized by exposure rate. Three zones are defined:

- cold [outdoor exposure rate  $\leq 10 \text{ mR h}^{-1}$  ( $\sim 0.1 \text{ mGy h}^{-1}$  air-kerma rate)];
- hot [ $> 10 \text{ mR h}^{-1}$  ( $\sim 0.1 \text{ mGy h}^{-1}$ )]; or
- or dangerous-radiation zones [ $\geq 10 \text{ R h}^{-1}$  ( $\sim 0.1 \text{ Gy h}^{-1}$ )]. [165]

**radiation detriment:** Measure of stochastic effects from exposure to ionizing radiation that takes into account the probability of fatal cancers, probability of severe heritable effects in future generations, probability of nonfatal cancers weighted by the lethality fraction, and relative years of life lost per fatal health effect. [168]

**radiation detriment:** The risk of radiation-induced health outcomes, including fatal and nonfatal cancer, hereditary effects, and loss of life-span from cancer and hereditary disease, weighted for severity and time of expression of the harmful effect. [161]

**radiation detriment:** Radiation detriment is the risk of radiation-induced health outcomes, including fatal and nonfatal cancer, hereditary effects, and loss of life-span from cancer and hereditary disease, weighted for severity and time of expression of the harmful effect. [157]

**radiation dose (or dose):** A general term used when the context is not specific to a particular radiation dose quantity. When the context is specific, the name for the quantity is used (e.g., absorbed dose, equivalent dose, effective dose). [166]

**radiation dose rate (or dose rate):** The radiation dose delivered per unit time. [166]

**radiation effectiveness factor (REF):** A dimensionless quantity that represents the relative biological effectiveness of a specific type, and sometimes energy, of ionizing radiation for purposes of estimating cancer risks and probability of causation of specific cancers in persons on the basis of estimates of mean absorbed dose from each radiation type in specific organs or tissues in which a cancer has occurred. [163]

**radiation field:** The type of radiation and its energy and angular spectrum at a point in question. [163]

**radiation length:** The mean path length required to reduce the energy of a relativistic charged particle by a factor of  $e$ , usually denoted by the symbol  $X_0$ . [144]

**radiation level:** The exposure rate of the radiation field at the point in question. [158]

**radiation level:** The dose-equivalent rate of the radiation field at the point in question. [144]

**radiation oncologist:** Physician licensed to practice medicine who is qualified by training and experience to prescribe the administration of brachytherapy treatment. Use of the term “radiation oncologist” does not require that this physician be part of a facility’s radiation-oncology department or group. In certain jurisdictions, the qualifications required under the appropriate regulatory authority may also be met by osteopaths. [155]

**radiation protection survey:** An evaluation of the radiation protection in and around an installation that includes radiation measurements, inspections, evaluations and recommendations. [151]

**radiation quality:** A general term referring to the relative biological effectiveness of the radiation of interest. For example, the absorbed dose from an exposure to neutron radiation may be quantitatively the same as that from an exposure to gamma rays in a volume of tissue on the order of  $1 \text{ cm}^3$ . However, at a higher resolution of a few micrometers the ionizing events will be more uniformly dispersed for the gamma-ray radiation than for the neutron radiation, thus producing quantitatively different biological effects (see relative biological effectiveness). [163]

**radiation quality:** A general term referring to the spatial distribution of absorbed dose. For example, an exposure to neutron radiation may be quantitatively the same as an exposure to gamma rays, in the sense that, for large volumes of tissue on the order of  $1 \text{ cm}^3$ , the absorbed energy is the same, yet at resolutions of a few micrometers the ionizing events will be more uniformly dispersed for the gamma-ray radiation than for the neutron radiation, thus producing quantitatively different biological effects (see relative biological effectiveness). [158]

**radiation safety (radiation protection):** Concerned with recognition, evaluation and control of risks due to radiation exposure. [161]

**radiation safety:** Control of the sources of radiation and the exposure to radiation to protect people and the environment from unnecessary exposure and the deleterious effects of exposure to radiation. [127]

**radiation-safety committee (RSC):** The committee established at many academic and other institutions to provide oversight for the radiation-safety program and advice to the radiation-safety officer. Typically the members of the committee have institutional or program responsibilities for the use of radioactive materials or radiation-producing equipment at the institution. [162]

**radiation-safety credentials:** Documentation of successful completion of training in the practical radiation protection aspects of the use of FGI procedures (e.g., knowledge of equipment operation, optimal imaging techniques, patient and staff radiation dose management, benefit-risk tradeoffs, and the potential for early or late detrimental radiation effects). Radiation safety credentials include initial and refresher training. [168]

**radiation-safety officer (RSO):** The person directly responsible for the radiation-safety program. It is the RSO's responsibility to ensure that the radiation-safety program is in compliance with regulations, standards, internal policy documents, implementing procedures, industry best practices, and goals. [162]

**radiation-safety officer:** The person who has administrative responsibility and authority for radiation protection such as in a hospital or university. Other facilities may use titles such as radiation protection supervisor or radiation-safety manager for persons having similar responsibilities and authorities. [161]

**radiation safety officer (RSO):** The person directly responsible for radiation protection. It is the RSO's responsibility to ensure that all procedures are carried out in compliance with pertinent established rules, including recommendations in this Report. [157]

**radiation safety officer (RSO):** An individual who meets the applicable regulatory requirements of training and experience to be named on a facility's license as the RSO. Depending on the license and complexity of the program, the RSO may be a nuclear-medicine physician, a radiologist, a radiation oncologist, a nuclear pharmacist, a medical physicist, or a medical health physicist. Facilities may use alternate titles such as radiation protection supervisor or radiation safety manager. Throughout this Report, any reference to the RSO is intended to include individuals designated by the RSO such as radiation safety staff. [155]

**radiation safety records:** The collections of information that relate to radiation exposure of the astronauts. The radiation safety records consist of multiple sources of information that are linked (*i.e.*, the dosimetry records and their supporting data and files, and other information that bears on the radiation exposure of astronauts). [142]

**radiation safety survey:** An evaluation of the radiation safety in and around an installation. [148]

**radiation survey:** Evaluation of radiation hazards that customarily includes a physical survey of the arrangement and use of equipment and measurements of the exposure rates under expected operating conditions. [161]

**radiation transport code:** Algorithms used to determine the attenuation of ionizing radiation as it passes through various types of matter (*e.g.*, shielding, walls, human tissue) before it interacts with the material of interest. [137]

**radiation-transport model:** A mathematical model that simulates the transport and energy deposition of photons and/or radioactive particles from a source to a measurement point or to a point in the body. [163]

**radiation types (ionizing):**

- **alpha particles:** Energetic nuclei of helium atoms, consisting of two protons and two neutrons emitted spontaneously from nuclei in the decay of some radionuclides (*e.g.*,  $^{226}\text{Ra}$ ). Alpha particles have very low penetrating power (*e.g.*, typically stopped by a few centimeters of air or the outer dead layer of skin). Alpha particles are generally not a health problem unless the source is taken into the body *via* inhalation, ingestion or absorption, or through wounds.
- **beta particles:** Energetic electrons or positrons (*i.e.*, positively charged electrons) emitted spontaneously from nuclei in the decay of some radionuclides (*e.g.*,  $^{90}\text{Sr}$ ). Beta particles are not highly penetrating (*e.g.*, the lower-energy beta particles are typically stopped by a few millimeters of tissue; the higher-energy beta particles can be

stopped by a few centimeters of tissue). However, beta particles on the skin can cause significant injury if not removed by timely decontamination.

- **gamma rays:** High-energy electromagnetic radiation (photons) emitted in nuclear transitions (e.g., radioactive decay of  $^{137}\text{Cs}$ ) with energies particular to the transition. Gamma rays have moderate-to-high penetrating power, are often able to penetrate deep into the body, and require thick shielding, such as up to ~3 feet (1 m) of concrete.
- **neutrons:** Uncharged particles found in the nucleus of every atom except  $^1\text{H}$ . Energetic neutrons are produced in spontaneous fission of nuclei (e.g.,  $^{252}\text{Cf}$ ), fission induced by absorption of neutrons by nuclei (e.g.,  $^{239}\text{Pu}$ ), and by absorption of other particles by nuclei (e.g., absorption of alpha particles by  $^9\text{Be}$ ). Neutrons have no electric charge, are usually highly penetrating, have an enhanced ability to cause biological damage, and require thick shielding.
- **photons:** Quanta of electromagnetic radiation, having no charge or mass, but having momentum (see gamma rays and x rays).
- **x rays:** Electromagnetic radiation (photons) emitted in transitions of atomic orbital electrons after ionization or excitation of atoms (yielding characteristic x rays), or in the deceleration of energetic charged particles (e.g., electrons) in passing through matter (bremsstrahlung). X rays are typically of lower energy than gamma rays, but some orbital electron transitions are of higher energy than some nuclear transitions, so there can be an overlap between the low-energy gamma rays and high-energy x rays. X rays have moderate-to-high penetrating power, are able to penetrate deep into the body, and may require shielding of up to a few tens of centimeters of concrete. [165]

#### radiation units and names:

- **becquerel (Bq):** The SI special name for the unit [disintegration per second ( $\text{s}^{-1}$ )] of activity. 1 Bq = 1 disintegration per second (see activity and curie).
- **curie (Ci):** The previous special unit for activity. 1 curie =  $3.7 \times 10^{10}$  disintegrations per second =  $3.7 \times 10^{10}$  Bq (see activity and becquerel).
- **gray (Gy):** The SI special name for the unit ( $\text{J kg}^{-1}$ ) of absorbed dose. 1 Gy =  $1 \text{ J kg}^{-1}$  (see absorbed dose and rad).
- **rad:** The previous special unit for absorbed dose. 1 rad =  $0.01 \text{ J kg}^{-1}$ ; 100 rad = 1 Gy (see absorbed dose and gray).
- **rem:** The previous special unit for equivalent dose and effective dose. 1 rem =  $0.01 \text{ J kg}^{-1}$ ; 100 rem = 1 Sv (see equivalent dose, effective dose, and sievert).
- **roentgen (R):** The previous special unit for exposure. 1 R =  $2.58 \times 10^{-4}$  coulombs per kilogram ( $\text{C kg}^{-1}$ ) (see exposure).
- **sievert (Sv):** The SI special name for the unit ( $\text{J kg}^{-1}$ ) of equivalent dose and effective dose. 1 Sv =  $1 \text{ J kg}^{-1}$  (see equivalent dose, effective dose, and rem). [165]

**radiation weighting factor ( $w_R$ ):** A factor used to allow for differences in the biological effectiveness between different radiations when calculating equivalent dose ( $H_T$ ) (see equivalent dose). These factors are independent of the tissue or organ irradiated. [168]

**radiation weighting factor ( $w_R$ ):** A factor used in radiation protection to place on a common scale, the biological effectiveness of different radiations when calculating equivalent dose ( $H_T$ ) (see equivalent dose). These factors are independent of the tissue or organ irradiated. [166]

**radiation weighting factor ( $w_R$ ):** Dimensionless weighting factor developed for purposes of radiation protection and assessing health risks in general terms that accounts for relative biological effectiveness of different types (and, in some cases, energies) of radiations in producing stochastic effects and is used to relate mean absorbed dose in an organ or tissue (T) to equivalent dose. The radiation weighting factor is intended to supersede the mean quality factor ( $\bar{Q}$ ) and is defined with respect to the type and energy of the radiation incident on the body or, in the case of sources within the body, emitted by the source. [159]

**radiation weighting factor:** The factor by which the mean absorbed dose in a tissue or organ is modified to account for the relative biological effectiveness for stochastic effects of the type of radiation incident on the body (see **stochastic effects**). [157]

**radiation worker:** An employee who works in a controlled area (see controlled area). A radiation worker has significant potential for exposure to radiation in the course of the employee's assignments or is directly responsible for or involved with the use and control of radiation. A radiation worker generally has training in radiation management and is subject to routine personal monitoring. [168]

**radiation work permit (RWP):** With regard to radiation safety, an authorization to perform a specific procedure that will involve the exposure of persons to radiation or uncontained radioactive material in a specified area of a facility. [127]

**radioactive contamination:** Unintended and undesirable sources of radioactive materials deposited in the environment, research laboratories, hospitals, or other facilities and equipment and radioactive materials deposited on or in persons. [166]

**radioactive contamination:** Unintended and undesirable sources of radiation deposited on the environment, research laboratories, or other facilities. [158]

**radioactive contamination:** Unintended and undesirable sources of radiation deposited in the environment, research laboratories, or other facilities that utilize radionuclides or radiation sources. At particle accelerators, radioactive contamination is substantially different in form than that found in many laboratories that use radioactive materials. At accelerator laboratories, contamination is defined as radioactive substances in the form of acquired (activated) materials, rather than materials produced directly by deliberate irradiation of an article or substance. In the case of solids, it takes the form of a surface layer, which may, or may not, be readily removed in a process of decontamination. [144]

**radioactive decay:** The spontaneous transformation of one nuclide into a different nuclide or into a different energy state of the same nuclide. The process results in a decrease, with time, of the number of the radioactive atoms in a sample. Decay generally involves the emission of alpha or beta particles from the nucleus of the decaying nuclide and possibly gamma rays from the newly formed nucleus. [166]

**radioactive decay:** The spontaneous transformation of one radionuclide into a different nuclide or into a different energy state of the same radionuclide. The process results in a decrease, with time, of the number of the radioactive atoms in a sample. Decay generally involves the emission from the nucleus of alpha particles, beta particles, or gamma rays. [164]

**radioactive decay:** The spontaneous transformation of one nuclide into a different nuclide or into a different energy state of the same nuclide. The process results in an exponential decrease, with time, of the number of the radioactive atoms in a sample at a rate controlled by its half-life. [163]

**radioactive decay:** The spontaneous transformation of one nuclide into a different nuclide or into a different energy state of the same nuclide. The process results in a decrease, with time, of the number of original radioactive atoms in a sample. Decay generally involves the emission from the nucleus of alpha particles, beta particles, or gamma rays. [160]

**radioactive decay:** The spontaneous transformation of one nuclide into a different nuclide or into a different energy state of the same nuclide. The process results in a decrease, with time, of the number of the radioactive atoms in a sample. Decay generally involves the emission from the nucleus of alpha particles, beta particles, or gamma rays. [156]

**radioactive scrap metal (RSM):** Scrap metal that, by being present in a radiation environment, has become radioactive or is contaminated with radioactive materials. [141]

**radioactive series:** A succession of nuclides, each of which transforms by radioactive decay into the next until a stable nuclide results. The first member is called the parent and the subsequent members of the series are called progeny, daughters or decay products. [160]

**radioactive waste:** Solid, liquid or gaseous materials of no value that contain radionuclides, either man-made or naturally occurring, and are regulated as hazardous material due to the presence of radionuclides. [163]

**radioactivity:** Property or characteristic of a unstable atomic nucleus to spontaneously transform with emission of energy in the form of ionizing radiation. [166]

**radioactivity:** The property of some atomic nuclei of spontaneously emitting gamma rays or subatomic particles (e.g., alpha and beta particles). [165]

**radioactivity:** The property of some atomic nuclei of spontaneously-emitting subatomic particles (e.g., alpha and beta particles) and/or gamma rays. [159]

**radioactivity area:** Any area in which radioactive materials are present.

**radioactivity, induced:** Activity in nuclides produced by nuclear reactions.

**radioanalysis:** Measurement of activity content. [161]

**radiobiology:** That branch of science dealing with radiation effects on biological systems. [161]

**radiograph:** A film or other record produced by the action of x rays on a sensitized surface. [168]

**radiographic noise:** Unwanted fluctuations in optical density on the mammographic image. [149]

**radiographic sharpness:** The distinctness or perceptibility of the edge or boundary of the structure in a radiograph. [149]



**radiography:** The production of images on film or other media by the action of x rays transmitted through a patient. [168]

**radiography:** The production of conventional (e.g., film) or digital images by the action of x rays transmitted through an individual or an object. [163]

**radiography:** The production of images on film or other media by the action of x rays transmitted through an individual or an object. [158]

**radioimmunoassay (RIA):** An in vitro test in which very small quantities of certain substances in blood, urine, etc. can be measured by using specific antibodies or other agents which have been labeled with radioactive tracers. Since the patient does not receive the radioactive material, there is no patient radiation exposure involved. [124]

**radioiodine:** A radioisotope of iodine (e.g.,  $^{123}\text{I}$ ). [159]

**radioisotope:** A radioactive atomic species of an element with the same atomic number and usually identical chemical properties. [159]

**radiological:** A general term pertaining to radiation and radioactive material. [165]

**radiological dispersal device (RDD):** A device designed to spread radioactive material through a detonation of conventional explosive or other (non-nuclear) means. [166]

**radiological incident:** Pertains to dispersal of one or more radionuclides. [161]

**radiological triage:** The process of sorting people involved in a radiological incident based on their risk of having significant radionuclide contamination or radiation dose. [166]

**radiological work control:** The process of controlling any work that requires the handling of radioactive material. The process should identify radiological conditions, establish worker protection and monitoring requirements, and contain specific approvals for radiological work activities. The radiation protection program should provide an administrative process for planning and controlling radiological work and informing the worker of the radiological conditions. [Comm20]

**radiology:** That branch of healing arts and sciences that deals with the use of images in the diagnosis and treatment of disease. [168]

**radiology:** That branch of healing arts and sciences that deals with the use of conventional or digital images in the diagnosis and treatment of disease. [163]

**radiolysis:** Chemical decomposition brought about by radiation. [152]

**radionuclide:** An unstable atom that transforms to a stable or unstable atom and in the process releases radiations. [166]

**radionuclide:** A radioactive element, man-made or from natural sources, with a specific atomic weight. [165]

**radionuclide:** Naturally-occurring or artificially-produced radioactive element or isotope. [164]

**radionuclide:** An unstable (radioactive) nuclide. A species of atom characterized by the constitution of its nucleus (i.e., the number of protons and neutrons) and the excess energy available in the unstable nucleus. [163]

**radionuclide:** An unstable (radioactive) nuclide. A nuclide is a species of atom characterized by the constitution of its nucleus (i.e., the number of protons and neutrons, and the energy content). [160]

**radiopaque:** Not penetrable by x rays or other forms of radiant energy; radiopaque areas appear light or white on the exposed film. [149]

**radiopharmaceutical:** A radioactive substance administered to a patient for diagnostic or therapeutic nuclear-medicine procedures. A radiopharmaceutical contains two parts, the radionuclide and the pharmaceutical [e.g.,  $^{99m}\text{Tc}$  DTPA (diethylenetriaminepentaacetate)]. In some cases the two are one (e.g.,  $^{133}\text{Xe}$  gas). [164]

**radiotherapy:** The medical specialty concerned with the use of electromagnetic or particulate radiation in the treatment of disease. [159]

**radon:** Colorless, odorless, naturally-occurring, and radioactive gaseous element formed by radioactive decay of isotopes of radium. [164]

**radon:** The noble gas element with  $Z = 86$  with no known stable nucleus. Commonly it refers to the colorless, odorless, naturally-occurring  $^{220}\text{Rn}$  and  $^{222}\text{Rn}$  formed by radioactive decay of  $^{224}\text{Ra}$  and  $^{226}\text{Ra}$ , respectively. [161]

**radon (and radon progeny):** Radon is a colorless, odorless, naturally-occurring, and gaseous element resulting from radioactive decay of isotopes of radium. Radon is also the common name for the specific radionuclide  $^{222}\text{Rn}$  and is used throughout this Report in that context. Radon progeny are short-lived decay products of  $^{222}\text{Rn}$  (i.e.,  $^{218}\text{Po}$ ,  $^{214}\text{Pb}$ ,  $^{214}\text{Bi}$ , and  $^{214}\text{Po}$ ). [160]

**radon (and radon progeny):** Radon (Rn) is a colorless, odorless, naturally-occurring, and gaseous element resulting from radioactive decay of isotopes of radium. Radon progeny are short-lived decay products of  $^{222}\text{Rn}$  or  $^{220}\text{Rn}$ . [157]

**radon progeny:** Short-lived decay products of  $^{222}\text{Rn}$  (i.e.,  $^{218}\text{Po}$ ,  $^{214}\text{Pb}$ ,  $^{214}\text{Bi}$  and  $^{214}\text{Po}$ ) or  $^{220}\text{Rn}$  (i.e.,  $^{216}\text{Po}$ ,  $^{212}\text{Pb}$ ,  $^{212}\text{Bi}$  and  $^{212}\text{P}$ ). [164]

**radon progeny:** The decay products of  $^{222}\text{Rn}$  (e.g., the short-lived progeny  $^{218}\text{Po}$ ,  $^{214}\text{Pb}$ ,  $^{214}\text{Bi}$ , and  $^{214}\text{Po}$ ) or  $^{220}\text{Rn}$  (e.g., the short-lived progeny  $^{216}\text{Po}$ ,  $^{212}\text{Pb}$ ,  $^{212}\text{Bi}$ , and  $^{212}\text{Po}$ ). [163]

**raffinate:** Fluid from the purification step in a mill, depleted in the mineral of interest relative to the fluid entering the purification process. The raffinate may be reused in the process stream or discarded. [118]

**rainout:** In-cloud scavenging of gases or particles. [154]

**rainsplash:** The process of soil particles being moved vertically and horizontally by the energy of falling raindrops. [154]

**random:** Events detected by a PET scanner that are within the timing window of the scanner and are ascribed as true coincidence events originating from the annihilation of a positive beta particle to two photons but that are actually unrelated photons that happen to be detected within the timing window (i.e., the time-interval used to define coincidence events) of the pet scanner. [164]

**random error:** An error associated with random (statistical) fluctuations inherent to or associated with the determination of a particular quantity. Such errors may be evaluated using standard statistical -techniques. [164]

**rank correlation:** A measure of the interdependence between rankings of random variables, rather than their actual values (see correlation). [164]

**rare earth:** A member of the lanthanide series (atomic number 58 through 71) or, more rarely of the actinide series (atomic number 90 through 103). [156]

**rare earth:** Commonly used to refer to intensifying screens that contain one or more of the rare-earth elements and that make use of the absorption and conversion features of these elements in x-ray imaging. [145]

**rate constant:** The fractional loss of a substance from a compartment per unit time with units of  $t^{-1}$ . [164]

**rate constant:** A constant (units of inverse time) that relates the number of entities (e.g., atoms), that decay or leave a compartment per unit time to the number present in the compartment. [156]

**RBE-weighted absorbed dose:** A product of the absorbed dose in an organ or tissue and the relative biological effectiveness (RBE) of that radiation: [161]

$$AD_T = \sum D_{T,R} \times RBE_{T,R}$$

where  $D_{T,R}$  is the absorbed dose in tissue or organ T due to radiation type R and  $RBE_{T,R}$  is the relative biological effectiveness of radiation R in producing a specific effect in a particular organ or tissue T. The unit of RBE-weighted absorbed dose is  $J\ kg^{-1}$ , termed the gray-equivalent (Gy-Eq). The RBE-weighted absorbed dose is intended to account for differences in biological effectiveness in producing deterministic health effects in organs and tissues of reference man due to the quality of radiation (IAEA, 2005b). [161]

**R<sub>E</sub>:** The mean radius of Earth; 1 R<sub>E</sub> equals 6,371 km. [132]

**reach stacker:** A mobile lifting machine used to stack cargo containers at seaports. [Comm20]

**reactive safety system:** A system feature which is capable of detecting certain abnormal conditions and which shuts down the primary radiation source when such conditions are detected. [Comm20]

**real line:** The x axis of the complex plane. [158]

**reasonable assurance:** Concept that acknowledges that proof of the future performance of waste disposal systems over time periods of many hundreds to thousands of years cannot be achieved in the ordinary sense of the word. In judging the

long-term performance of waste disposal systems on the basis of model predictions or studies of physical systems including natural analogs, what is required is reasonable assurance, making allowance for the time period, hazards, and uncertainties involved, that the outcome of waste disposal will be in compliance with applicable regulatory performance objectives. [152]

**receptor:** In the context of this Report, an entity that receives contamination from or as a result of actions of a donor. [154]

**receptor:** Any device that absorbs a portion of the incident radiation energy and converts this portion into another form of energy that can be more easily used to produce desired results (e.g., production of an image) (also see image **receptor**). [145]

**recharge:** Refers to the addition of water to an aquifer from precipitation, irrigation or seepage from an adjacent area. [154]

**recommendation:** Suggestion that, when implemented, could improve the performance and effectiveness of a task, process or program. [162]

**recovery:** Returning to normal, or redefining normal, which is typically the most difficult and of longest duration (Farmer, 2006). [166]

**recycled material:** A material that is used, reused or reclaimed. A material is “used or reused” if it is employed as an ingredient (including use as an intermediate) in an industrial process to make a product or is employed in a particular function or application as an effective substitute for a commercial product. The complete definitions for materials that are “recycled” are found in 40 CFR § 261.1(c). [141]

**recycling:** The use or reuse of a waste material as an effective substitute for a commercial product, as an ingredient, or as feedstock in an industrial or energy-producing process; the reclamation of useful constituent fractions within a waste material; removal of contaminants from a waste to allow it to be reused. [146]

**redox:** Related to or producing processes of oxidation and reduction. [152]

**reduction:** Chemical change that involves a gain of electrons, either by removal of oxygen or an addition of hydrogen, or simply by addition of electrons. [152]

**redundancy (in interlock systems):** Repetition; a situation in which two or more systems are designed to perform the same or approximately the same function, thus providing a safety factor in the instance of the failure of one of the systems.

**reefer:** A refrigerated cargo container or trailer. [Comm20]

**reentrant electrons:** Decay products of unstable nuclei produced by the nuclear interactions of trapped galactic cosmic radiation (GCR) ions. [142]

**reference individual:** Stylized representation of a human of specified age with defined anatomical and physiological characteristics, which is used for purposes of radiation protection. [152]

**reference level:** The predetermined value of a quantity, below a limit, which triggers a specified course of action when the value, usually a dose level, is exceeded or is expected to be exceeded. [161]

**Reference Man:** A standardized descriptor of an individual with body size, anatomy, physiology, and composition as given in ICRP publications. [163]

**Reference Man/Woman:** Standardized descriptor of a gender-specific individual with body size, anatomy, physiology and composition as given in ICRP publications. [158]

**Reference Man/Woman/Child:** Standardized descriptor of a gender-specific individual with body size, anatomy, physiology and composition as given in ICRP publications. [161]

**reflected (scattered) radiation:** Radiation that, during passage through matter, has been deviated in direction. It may have been modified by a change, usually a decrease, in energy. Scattering in 180 degree direction is backscattering. [158]

**reflection coefficient ( $\alpha$ ):** The fraction of radiation (e.g., fluence, energy, absorbed dose) expressed by the ratio of the amount backscattered to that incident. [151]

**refractory:** Clay-based material that is used to either conduct heat or insulate the shell of a furnace or molten metal ladle from the high thermal content of the molten metal. Many refractory materials contain naturally-occurring radioactive materials. [141]

**regolith:** A layer of loose, heterogeneous material covering solid rock. [153]

**regression (analysis):** Based on empirical data, the relationship between a variable and one or more other variables that takes into account the degree of correlation among the variables. [163]

**regression analysis:** Based on empirical data, of relationship between a variable and one or more other variables that takes into account the degree of correlation among the variables. [158]

**regulated medical waste:** Regulated medical waste consists of: (1) liquid or semi-liquid blood or other potentially infectious materials, (2) contaminated items that would release blood or other potentially infectious materials in a liquid or semi-liquid state when compressed, (3) items caked with dried blood or other potentially infectious materials and capable of releasing these materials when handled, (4) contaminated sharps, and (5) pathological and microbiological wastes containing blood or other potentially infectious materials. [145]

**Reichert's membrane:** Acellular mucoprotein layer between the trophoblast and endoderm of the placental disk; especially prominent in rodents with inverted yolk sacs. [128]

**relative biological effectiveness (RBE):** For a specific radiation (A), the ratio of absorbed dose of a reference radiation required to produce a specific level of response in a biological system to absorbed dose of radiation (A) required to produce an equal response. The reference radiation normally is x or gamma rays with an average linear-energy transfer of  $3.5 \text{ keV } \mu\text{m}^{-1}$  or less. Relative biological effectiveness generally depends on dose, dose per fraction if the dose is fractionated, dose rate, and biological endpoint. [167]

**relative biological effectiveness (RBE):** Factor used to compare the biological effectiveness of absorbed doses from different types of ionizing radiation, determined experimentally. RBE is the ratio of the absorbed dose of a reference radiation to the absorbed dose of the radiation in question required to produce an identical biological effect in a particular experimental organism or tissue. [166]

**relative biological effectiveness (RBE):** A factor used to compare the biological effectiveness of absorbed doses from different types of ionizing radiation, determined experimentally. RBE is the ratio of the absorbed dose of a reference radiation (usually taken as 250 kVp x rays) to the absorbed dose of the radiation in question required to produce an identical biological effect in a particular experimental organism or tissue. [164]

**relative permittivity:** The electrical permittivity of a material divided by the permittivity of free space. [119]

**relative risk:** The ratio of the risk of a given disease in those exposed to the risk of that disease in those not exposed. [167]

**relative risk:** An expression of excess risk relative to the underlying (baseline) risk; if the excess equals the baseline the relative risk is two. [164]

**relative risk (RR):** Expression of risk due to exposure as the ratio of the risk among the exposed to the risk among unexposed. Relative risk coefficients distribute the radiogenic excess in proportion to the natural incidence or mortality over the interval of expression. Relative risk can be modeled as a function of time since exposure (or attained age). [159]

**relaxation length:** The distance by which an exponentially decreasing quantity is reduced to  $1/e$  (i.e.,  $1/2.71828$ ) of its initial value. [158]

**relaxation length:** A measure of the rate of decline of the amount of a substance with depth in the soil with units of centimeters. Technically, it is the inverse of the depth distribution coefficient with units of  $\text{cm}^{-1}$ . [154]

**rem:** The special name for the previous unit numerically equal to the absorbed dose ( $\underline{D}$ ) in rad, modified by a quality factor ( $\underline{Q}$ ) which accounts for the different biological effects of different types of radiation. In SI units, it is replaced by the special name sievert (Sv), which is numerically equal to the absorbed dose ( $\underline{D}$ ) in gray modified by a radiation weighting factor ( $\underline{w}_R$ ).  $1 \text{ Sv} = 100 \text{ rem}$ . [164]

**rem:** The special unit previously used for the quantities equivalent dose and effective dose (or effective dose equivalent);  $100 \text{ rem} = 1 \text{ Sv}$  (see sievert). [163]

**rem:** The special name for the previous unit numerically equal to the absorbed dose ( $\underline{D}$ ) in rad ( $100 \text{ erg g}^{-1}$ ), modified by a radiation weighting factor ( $\underline{w}_R$ ) or quality factor ( $\underline{Q}$ ) which accounts for the different biological effects of different types

of radiation. In the SI system of units, it is replaced by the special name sievert (Sv), which is numerically equal to the absorbed dose ( $\underline{D}$ ) in gray ( $\text{J kg}^{-1}$ ) modified by a radiation weighting factor ( $\underline{w}_R$ ).  $1 \text{ Sv} = 100 \text{ rem}$ . [161]

**rem:** The special name for the conventional unit numerically equal to the absorbed dose ( $\underline{D}$ ) in rad, modified by a quality factor ( $\underline{Q}$ ).  $1 \text{ rem} = 0.01 \text{ J kg}^{-1}$ . In the SI system of units, it is replaced by the special name sievert (Sv), which is numerically equal to the absorbed dose ( $\underline{D}$ ) in gray modified by a radiation weighting factor ( $\underline{w}_R$ ).  $1 \text{ Sv} = 100 \text{ rem}$ . [156]

**rem ball:** A neutron radiation detection and quantification device designed to mimic the human body with regard to absorption and scattering characteristics, and produce a reasonable approximation to the neutron dose equivalent encountered by an exposed individual. [Comm20]

**remediate:** To take action to reduce risks to human health or the environment posed by the presence of radioactive or hazardous chemical contaminants at a site including, but not restricted to, excavation of contaminated soil, removal of contaminants from building surfaces or equipment, stabilization of buried waste, and installation of engineered barriers (e.g., caps on waste trenches) to reduce the potential for migration of contaminants. [163]

**remediation:** Actions taken to reduce risks to human health posed by the presence of radionuclides. [161]

**remobilization:** The condition where material sorbed to sediment or soil particles can be desorbed into water as a result of chemical or other changes. [154]

**rep (roentgen equivalent physical):** An obsolete unit of absorbed dose of any ionizing radiation with a magnitude of  $93 \text{ ergs g}^{-1}$ . It was superseded by the rad. [158]

**repeat analysis:** A systematic approach to determine the number of and causes for radiographs being repeated. Analysis of data on repeats helps identify ways to improve mammography quality. [149]

**replenishment rate:** The amount of chemicals added per sheet of film processed in order to maintain the proper chemical activity of developer and fixer solutions. [149]

**reporting threshold:** The lowest value (not necessarily the minimum detectable value) that was recorded. [163]

**research model:** Any model developed to fulfill research objectives. Usually research models are developed to provide insight into explicit processes and mechanisms and thus are mathematically more complex than assessment models. [123]

**residence time ( $\underline{\tau}$ ):** The average time that an administered radionuclide spends in the source organ. In nuclear-medicine studies, this is calculated as the cumulated activity in an organ divided by the radioactivity (or activity) administered to the patient. [164]

**residual (contamination or dose):** Radioactive material in structures, materials, soils, groundwater, and other media at a site resulting from activities under the site operator's control, especially radioactive material remaining at a site after

decommissioning and remediation. Residual radioactive material does not include naturally-occurring radioactive material in its undisturbed state. [160]

**residual maximum beta range ( $R_{res}$ ):** The residual maximum beta range ( $R_{res}$ ) is the range in an absorbing material of a spectrum of beta particles with residual maximum energy. [112]

**residual radioactive material:** Radioactive material in structures, materials, soils, groundwater, and other media at a site resulting from activities under the site operator's control, especially radioactive materials remaining at a site after decommissioning and remediation. Residual radioactive material does not include naturally occurring radioactive materials in their undisturbed state. [146]

**residual volume:** Air that remains in the lung following maximum exhalation. [125]

**resolution:** In the context of an image system, the output of which is finally viewed by the eye, the smallest size or highest spatial frequency of an object of given contrast that is just perceptible. The intrinsic resolution, or resolving power, of an imaging system is measured in line pairs per millimeter, ordinarily using a resolving power target. The resolution actually achieved when imaging lower contrast objects is normally much less, and depends upon many variables such as subject contrast levels and noise of the overall imaging system. [158]

**Resource Conservation and Recovery Act (RCRA):** Law passed in 1976 as amendment to Solid Waste Disposal Act of 1975, and amended in 1980 and again in 1984 by Hazardous and Solid Waste Amendments, that governs generation, transport, treatment, storage and disposal of solid hazardous waste and disposal of nonhazardous solid waste in municipal/industrial landfills. Solid hazardous wastes regulated under RCRA are defined in 40 CFR Part 261, Subpart A, and specifically exclude source, special nuclear, and byproduct materials as defined in the Atomic Energy Act. Objectives of RCRA include protection of human health and the environment, expeditious reduction or elimination of generation of hazardous waste, and conservation of energy and natural resources (*i.e.*, material recycling and recovery). [152]

**respiratory protection device (respirator):** A device worn on the face or head to prevent the inhalation of toxic or radioactive materials. [161]

**respiratory protection device or respirator:** A device worn on the face or head to prevent the inhalation of toxic or radioactive materials. [127]

**respiratory tract:** Consists of the naso-oro-pharyngo-laryngeal, tracheobronchial, and pulmonary regions common to humans and animals. [161]

**response:** How entities, institutions and people react to the threat (Farmer, 2006). [166]

**response (instruments):** For purposes of calibration, the quotient of the instrument reading by the true value of the quantity being measured. [161]



**response surface:** Parametric approximation of a multiparameter (usually linear) function; coefficients of the function are fit to the parametric approximation using a limited set of responses, and the function is used to approximate other responses in the domain. [152]

**responsible administrator (RA):** An individual at an educational institution who has overall management responsibility for the radiation safety program. Examples of an RA are: the principal of a high school (delegated by the school board); the chancellor, president or other senior manager at a small college, specialty academy, or a larger college or university. In the case of a larger college or university, the RA or a designee will also serve as the executive representative to the radiation safety committee. [157]

**resuspension:** Transfer of material that has been deposited on the ground surface to the atmosphere through some form of disturbance, such as wind; also commonly used to mean suspension for material on the ground surface that was not deposited from the atmosphere. These terms can also apply to suspension or resuspension of sediments into the water column of an aquatic system. [164]

**resuspension:** Transfer of radioactive material that has been deposited on surfaces to the ambient air; also commonly used to mean suspension of radioactive material from surfaces that was not deposited from the air. [161]

**resuspension:** Transfer of material that has been deposited on the ground surface to the atmosphere; also commonly used to mean suspension for material on the ground surface that was not deposited from the atmosphere. [152]

**resuspension:** A general term used to indicate the process whereby material is transferred from the soil surface to the atmosphere. [129]

**resuspension factor (or ratio):** Ratio of the volumetric activity density measured in air or water to the areal activity density measured on the soil or sediment surface; usually given in units of  $m^{-1}$ . [154]

**resuspension factor:** Ratio of concentration of a radionuclide in air, often at height of 1 m above ground, to its areal concentration on the ground surface; usually given in units of  $m^{-1}$ . [152]

**resuspension rate:** Fractional rate of release of radionuclides from ground surface into air; usually given in units of  $s^{-1}$ . [152]

**retardation coefficient, retardation factor:** Measure of capability of a porous medium to impede by sorption the movement of a contaminant being carried by a fluid, given by ratio of the average velocity of the contaminant to the average velocity of the fluid. [152]

**retardation factor:** The ratio of the velocity of water through a porous medium such as soil to the velocity of a specified contaminant that is dissolved or suspended in the water. [154]

**retention:** As used in mathematical models, retention is quantitatively expressed by parameters such as biological or effective half-time, or rate constants pertaining to specific loss processes from an organism or from a specific compartment such as an organ or other component of the ecosystem. High retention implies a low loss rate. [164]

**retention:** Describes the propensity for radioactive materials to remain at the sites of deposition on or within the body. As used in mathematical models, retention is quantitatively expressed by such parameters as biological half-times or rate constants pertaining to specific loss processes from an organism or from a specific compartment such as an organ or other component of the ecosystem. High retention implies a low clearance rate. [161]

**retention fraction:** Ratio of the activity measured in the whole body, some part of the body, or in an excreta sample, to the intake. [161]

**retention times:** Specific times of retention of a substance that has been inhaled or injected in an organ or organs of the body. [164]

**reticuloendothelial:** Pertaining to the reticuloendothelium, a network of cells and tissues with both endothelial and reticular attributes, found throughout the body, but especially in the blood, connective tissue, spleen, liver, lungs, bone marrow, and lymph nodes. [156]

**retrospective dose assessment:** Dose assessment performed after the intake of radionuclides has occurred. [164]

**reverberatory furnace:** A gas-fired furnace used in the aluminum, copper and brass industries in which the heat is reflected off the roof of the furnace onto the metal. [141]

**rhabdomyosarcoma:** A highly malignant tumor arising in striated muscle or in embryonal mesenchymal cells. [156]

**rheology:** Study of the flow of matter embracing elasticity, viscosity, and plasticity. [125]

**rhizosphere:** The soil layer that surrounds and is influenced by plant roots. [154]

**$R_r$  (recommended value for relative biological effectiveness):** A best estimate, for radiation protection purposes, of the relative biological effectiveness (RBE) for deterministic effects of a given particle type, by which the mean absorbed dose in an organ or tissue ( $\underline{D}_T$ ) is modified to obtain gray equivalent (Gy-Eq). [142]

**rigidity:** The momentum of a charged particle per unit charge, which determines the curvature of the particle's trajectory in a magnetic field. Two particles with different charge but the same rigidity will travel along a path having the same curvature in a given magnetic field. [158]

**Ringer's Lactate:** Intravenous solution containing sodium chloride, potassium chloride, calcium chloride, and sodium lactate. [156]

**riparian:** Refers to habitat along floodplains of streams (e.g., riparian vegetation or wildlife). [154]

**risk:** Probability of harm combined with the potential severity of that harm. [167]

**risk:** A chance of injury, loss, or detriment; a measure of the deleterious effects that may be expected as a result of an action or inaction. [159]

**risk:** Probability of harm, sometimes combined with potential severity of that harm. For example, in regard to impacts on human health resulting from disposal of radioactive waste, risk is the probability of a response (e.g., cancer) in an individual or frequency of a response in a population taking into account (1) the probability of occurrence of processes and events that could result in release of radionuclides to the environment and the magnitude of such releases, (2) the probability that individuals or populations would be exposed to radionuclides released to the environment and the magnitude of such exposures, and (3) the probability that a given exposure would produce a harmful response. [154]

**risk:** The probability of a specified effect or response occurring.

- **absolute risk:** Expression of excess risk due to exposure as the arithmetic difference between the risk among those exposed and that obtaining in the absence of exposure.
- **annual risk:** The risk in a given year from an earlier exposure. The annual risk (average) from an exposure is the lifetime risk divided by the number of years of expression.
- **lifetime risk:** The total risk in a lifetime resulting from an exposure(s). It is equal to the average annual risk times the period of expression.
- **relative risk:** An expression of excess risk relative to the underlying (baseline) risk; if the excess equals the baseline risk the relative risk is two. [153]

**risk assessment:** An evaluation that considers both the consequences of a hazardous incident and the probability that the incident could occur. [162]

**risk assessment:** The process by which the risks associated with an action or inaction are identified and quantified. [159]

**risk assessment:** Analysis of potential adverse impacts of an event (e.g., radioactive waste disposal) upon the well-being of an individual or a population (referring to humans or other organisms). Risk assessment is a process by which information or experience concerning causes and effects under a given set of circumstances is integrated with the extent of those circumstances to quantify or otherwise describe risk. Often, risk assessment for radionuclides in the environment involves estimation of concentrations in environmental media, human exposure to that media, radiation dose resulting from the exposure, and the calculation of health risk resulting from the estimated dose. [154]

**risk characterization:** An integration and interpretation of the information developed during hazard identification, dose-response assessment, and exposure assessment to yield an estimate of risk to human health or other organisms, including an identification of limitations and uncertainties in the models and the data. Risk characterization is the final step of a risk assessment. [141]

**risk coefficient:** (1) Probability of a cancer (fatal cancer or cancer incidence) per unit radiation dose; or (2) probability of a cancer per unit activity intake of a radionuclide or per disintegration per unit volume, area or mass of a radionuclide in the environment. [167]

**risk coefficient:** The increase in the annual incidence or mortality rate per unit dose: (1) absolute risk coefficient is the observed minus the expected number of cases per person year at risk for a unit dose, and (2) the relative risk coefficient is the fractional increase in the baseline incidence or mortality rate for a unit dose. [161]

**risk cross section:** The probability of a particular excess cancer mortality per particle fluence (excluding delta rays). [153]

**risk estimate:** The number of cases (or deaths) that are projected to occur in a specified exposed population per unit dose for a defined exposure regime and expression period; number of cases per person-gray or, for radon, the number of cases per person cumulative working level month. [161]

**risk estimate:** The increment of the incidence or mortality rate projected to occur in a specified exposed population per unit dose for a specified exposure regimen and expression period. [159]

**risk management:** The process by which results of risk assessments are integrated with other information (e.g., results of benefit-cost analysis, societal concerns) to make decisions about the need for, method of, and extent of risk reduction or control. [154]

**robust:** Insensitive to changes in assumptions, data, or other information, or resistant to a broad range of external conditions. [152]

**roentgen (R):** The special name for the unit of exposure. Exposure is a specific quantity of ionization (charge) produced by the absorption of x- or gamma-radiation energy in a specified mass of air under standard conditions.  $1 \text{ R} = 2.58 \times 10^{-4}$  coulomb per kilogram ( $\text{C kg}^{-1}$ ). [168]

**root cause:** The reason for the occurrence of a deficiency or the failure of a process that when corrected will prevent recurrence. [162]

**runoff:** The process of water running off the land surface rather than infiltrating the soil. [154]

**sabot:** A collar surrounding a munition to fit it to the bore diameter of the weapon. [156]

**Safe Drinking Water Act (SDWA):** Law passed in 1974 and amended several times since, most recently by the Safe Drinking Water Act Amendments of 1996, that addresses protection of the nation's drinking water supplies and resources. The Act provides authority for National Primary Drinking Water Regulations for hazardous contaminants in drinking water, including radionuclides, and national requirements for State Underground Injection Control programs. [152]

**safelight:** A lighting fixture used to provide a minimal amount of working light in a darkroom. A safelight has appropriate filters and produces light that will not fog exposed radiographic film within a specified period of time. The filter removes most of the light to which the radiographic film is sensitive. Most safelights will fog film if the amount of light (wattage of the bulb) is excessive, if the filter is damaged or of the wrong type, or if the time a film is exposed to the safelight is too long. [149]

**safety culture:** The collective actions and attitudes of an institution and its workers which elevate the priority of safety issues to the proper level and encourage the adoption of the best available safety technology and standards-of-practice. [162]

**saline:**

- **isotonic:** A solution of sodium chloride in purified water of the same osmotic pressure as blood serum.
- **physiological:** A 0.9 % solution of sodium chloride in water that is isotonic. [161]

**sampling:** The process of taking a representative small portion or quantity of some material for testing or analysis. [164]

**sarcoma:** A tumor, often highly malignant, composed of cells derived from connective tissue such as bone, cartilage, muscle, blood vessel, or lymphoid tissue. [161]

**saturated zone:** That portion of the subsurface zone in a geohydrologic system in which essentially all openings (void spaces or pores) are filled with water. [154]

**saturated zone:** Portion of subsurface zone in a geohydrologic system in which all openings (void spaces or pores) are filled with water. [152]

**saturation:** Fraction of openings (void spaces or pores) of subsurface zone that are filled with water. [154]

**scale:** Typically in ferrous metals, a surface iron oxide. A form of surface corrosion. [141]

**scaling factor:** Factor used to infer the value of an unknown quantity from a known or measured quantity; often used to estimate the inventory of a radionuclide that is difficult to measure in low-level waste on the basis of the inventory of an easy-to-measure radionuclide. [164]

**scaling law:** A principle for estimating a secondary measurement based on a primary measurement of size, weight, mass, volume, length, activity, etc. [125]

**scan:** An image of the distribution of radioactivity in the body, strictly speaking made with a rectilinear scanner, but now loosely applied to any such image; also, to make such an image. [164]

**scan time:** The total time required for an imaging scan of a conveyance by CAARS, typically on the order of 25 to 30 s. [Comm20]

**scatter:** In nuclear-medicine imaging, measured events in an acquired image arising from photons that have interacted with body tissue or with the collimator so that the spatial origin of the photon is misplaced in the generated image. The scatter correction is one of several corrections necessary to convert image intensity to disintegration rate in a particular imaged region. [164]

**scatter:** Deflection of radiation interacting with matter, causing change of direction of subatomic particles or photons, attenuation of the radiation beam, and usually some absorption of energy. [158]

**scattered radiation:** Radiation that, during passage through matter, is changed in direction and is usually accompanied by a decrease in energy. [163]

**scatter fraction  $a(\theta)$ :** The ratio of absorbed dose of photons at 1 m from a tissue-equivalent scattering object to the absorbed dose measured at the isocenter of the surface of the scattering object. This quantity is a function of the scatter angle ( $\theta$ ), incident beam quality, and beam area. A scattering phantom is typically a water-equivalent sphere or right circular cylinder of 28 to 30 cm diameter. [151]

**scenario:** Set of assumptions about a future set of conditions and circumstances and of the behavior of individuals within that context. [154]

**scenario:** Set of assumptions about the future behavior of a disposal system, past exposures of individuals, or future exposures of individuals. [152]

**scenario dose conversion factor:** For a specified exposure scenario, dose or dose rate per unit concentration of a radionuclide in a specified source region. [152]

**scintigraphy:** A diagnostic technique based on the detection of radiation emitted by radioactive substances injected into the body; also called radionuclide scanning or external scintigraphy. [164]

**scintillation counter:** A radiation detector composed of a combination of a scintillating medium, photocathode, photomultiplier device, and associated electronic circuits for counting light emissions produced in the phosphor by ionizing radiation. [161]

**scintillation counter:** A radiation detector composed of a combination of phosphor, photomultiplier device, and associated electronic circuits for counting light emissions produced in the phosphor by ionizing radiation. [157]

**scintillation detector:** Detection device for ionizing radiation that registers flashes of light (scintillations) generated by the radiation incident on certain materials. [163]

**scintillator:** A material that emits visible light usually in the visible range upon absorption of radiation. [161]

**sclera:** The tough supporting tunic of the eyeball covering it except for the segment covered by the cornea. [132]

**scrap metal:** Metal that is no longer used in a facility or for a specific purpose; it no longer serves its intended function and is awaiting a disposition decision. [141]

**screen:** Phosphor crystals coated on a plastic support that emit light when exposed to radiation. The light emitted by the screen exposes the film that is in contact with the screen creating a latent image on x-ray film. [149]

**screen-film combination:** A particular intensifying screen used with a particular type of film. Care must be taken to match the number of screens (one or two) to the number of sides of the film on which emulsion is coated and to match the light output spectrum of the screen to the light sensitivity of the film. [149]

**screen-film contact:** The close proximity of the intensifying screen to the emulsion of the film. Good screen-film contact is essential in order to achieve a sharp image on the film. [149]

**screen-film mammography:** Mammography performed with a high- detail intensifying screen(s) that is in close contact with matched film in the cassette, both of which are designed for breast imaging. [149]

**screening:** Process of rapidly identifying potentially-important radionuclides or release, transport or exposure pathways by eliminating those of known lesser significance. Also used to describe, using simplified bounding calculations, the upper limit of exposure, dose or risk. [164]

**screening:** Process of rapidly identifying persons potentially contaminated with radionuclides or exposed to external radiation. [161]

**screening-level models:** Simple models employing conservative assumptions for the expressed purpose of eliminating radionuclides and pathways of negligible importance. [154]

**screening mammography:** X-ray breast examination of asymptomatic women in an attempt to detect breast cancer when it is small, nonpalpable and confined to the breast. [149]

**screening models:** Simple models employing conservative assumptions for the expressed purpose of eliminating radionuclides and pathways of negligible importance. [164]

**scrubber:** An air pollution collection system in which water spray is used to remove dust from the furnace exhaust air. Scrubbers are typically used in basic oxygen furnaces because the dust temperature exiting the furnace is capable of igniting the fabric bags used in baghouses. The wet dust slurry is typically sent to a thickener to dewater the slurry. [141]

**sealed source:** Radioactive material encased in a capsule designed to prevent leakage or escape of the material. [166]

**sealed source:** A radioactive source sealed in a container or having a bonded cover, in which the container or cover has sufficient mechanical strength to prevent contact with a dispersion of the radioactive material under the conditions of use and wear for which it was designed. [148]

**sebaceous:** Oily or oil-containing. [156]

**secondary barrier:** A wall, ceiling, floor or other structure designed to attenuate the leakage and scattered radiations to the required degree. [151]

**secondary calibration laboratory:** A laboratory that maintains and uses standards the calibrations of which are directly relatable to primary standards. The National Institute of Standards and Technology (NIST) is the primary standards and calibration laboratory in the United States. Secondary laboratories participate in a routine cooperative program with NIST to assure the quality of their techniques, procedures and equipment. [158]

**secondary electrons:** Electrons, such as delta rays, ejected along the path of a charged particle or a photon. [161]

**secondary protective barrier:** A barrier sufficient to attenuate scattered and leakage radiations to the required degree. [147]

**secondary radiation:** Radiation resulting from absorption of other radiation in matter; may be either electromagnetic or particulate. [158]

**secondary radiation:** All radiation produced by scattering off of objects or leakage through the protective source housing of the treatment unit. That is, all radiation in the treatment room except for the primary beam. [151]

**secretory cell:** Low ciliated and taller nonciliated cells comprising the main portion of the epithelium of the terminal bronchus. [164]

**sediment:** The solid matter, organic and/or inorganic, that settles to the bottom of a water body; material deposited by water, wind, or glaciers. [154]

**sedimentation:** The process of sediment deposition and accumulation on the bottom of a body of water. [154]

**sedimentation:** Process by which a particle deposits on the wall of a tube in the lung due to gravitational settling. [125]



**sediment loading:** Refers to the suspension of fine sediment particles in the water column caused by inputs from land or resuspension of sediments by water turbulence or other disturbance. [154]

**segmented region:** A region, typically in an imaging modality such as planar, SPECT, PET, CT, or MRI that is distinguished from adjacent regions by drawing a contour around its borders. Segmentation is typically used to identify normal organs or tumors for dose calculations. [164]

**self assessment:** The process that an institution uses to critically review its own activities and performance in relation to regulations, standards, internal policy documents, implementing procedures, industry best practices, and goals. [162]

**self-shielding:** In accelerator practice, characteristic of a radiation-source design in which sufficient shielding material is incorporated adjacent to the source to reduce external dose rates below dose limits. [144]

**semifinished shapes:** Regarding metal making, these are blooms, billets and slabs; also referred to as primary shapes. [141]

**senescence:** Refers to the aging of plant leaves and dropping to the ground after photosynthetic processes essentially terminate. [154]

**sensitivity:** A measure of the ability of a radiation measuring device to detect small doses or low levels of contamination. [165]

**sensitivity:** The probability of detecting a cancer when a cancer exists, otherwise defined as the fraction of all patients found to have breast cancer within 1 y after screening who were correctly diagnosed as being suspicious for breast cancer at the screening session. [149]

**sensitivity analysis:** Analysis of the sensitivity of a model output to the values of input and parameter variables. This analysis can help determine which parameters or processes have the greatest impact on a prediction, or on the uncertainty in a prediction. [164]

**sensitivity analysis:** Analysis of the sensitivity of a model output to the values of input and parameter variables. This analysis can help determine which parameters or processes have the greatest impact on a prediction or on the uncertainty in a prediction. Analyses are typically conducted at two levels, local and global. Local sensitivity measures the impact of a parameter on model output in the region near a specific value whereas global sensitivity measures the impact of a parameter across its possible range of values. [163]

**sensitivity analysis:** Analysis of effects of perturbations in input parameters or other assumptions on output of a model, without regard for their possible variability or uncertainty. [152]

**sensitometer:** A device used to reproducibly expose film to a number of different known levels of light intensity. The film produced by the use of a sensitometer is used to check the consistency of performance of a film processor. [149]

**sensitometric strip:** A sheet of film exposed to a series of different light intensities by a sensitometer. Such strips are used to measure the range of densities, from minimum to maximum, resulting from a reproducible exposure. [149]

**sensitometry:** A quantitative measurement of the response of film to light exposure and photographic processing. [149]

**separations facility:** In the context of this Report, a facility where irradiated nuclear fuel is chemically dissolved and fissile materials such as uranium and plutonium are separated from the other components and radioactive contaminants. [154]

**septa:** In a collimator used for radionuclide imaging in nuclear medicine, the walls that define the holes of the collimator. [164]

**serious hazard:** A hazard that could result in injury or occupational illness, environmental harm, or property damage. [162]

**sestamibi:** Sestamibi [Cardiolite<sup>®</sup> (E.I. du Pont de Nemours and Company, Wilmington, Delaware)] labeled with <sup>99m</sup>Tc. Used to visualize some types of breast cancer utilizing a gamma camera. [160]

**sestamibi scintimammography:** Sestamibi [Cardiolite<sup>®</sup> (E.I. du Pont de Nemours and Company, Wilmington, Delaware)] labeled with <sup>99m</sup>Tc. Scintimammography is used to visualize some types of breast cancer utilizing a gamma camera. [149]

**severe hazard:** A hazard that has the potential to cause death, severe injury, or occupational illness, significant risk to the public, extensive environmental harm, or significant property damage. [162]

**shag trucks:** Also called a “yard jockey,” is used to move trailers around a seaport and is rarely used on the street. The driver can reach directly behind him and step through to hook up air lines and electrical connections. [Comm20]

**shall:** The term *shall* (or *shall not*) (in italics) indicates a recommendation from NCRP that is necessary to meet the currently accepted standards of radiation protection. [168]

**shall:** The term *shall* (in italics) indicates a recommendation from NCRP that is necessary to meet the currently accepted standards of radiation protection. When the term “shall” is used to express requirements from regulatory agencies or other cognizant authorities, it is not in italics. [157]

**shallow dose:** The absorbed dose calculated at a depth of 0.07 mm in a sphere of soft tissue of density 1.0 and diameter of 300 mm. Presumed to be the dose received by the basal layer of the epidermis. [156]

**Shannon’s entropy:** Expected value of the amount of information available to associate with a probability. Using Shannon’s entropy, the least-biased probability density function consistent with a given set of information can be defined. [152]

**shear:** A machine used to cut metal scrap into desired lengths. [141]

**shielding:** Any material or obstruction that attenuates radiation (i.e., reduces the radiation level by absorption and scattering) and thus tends to protect personnel or materials from the effects of ionizing radiation. [161]

**shielding design goal (P):** Practical values, for a single radiotherapy source or set of sources, that are evaluated at a reference point beyond a protective barrier. When used in conjunction with the conservatively safe assumptions recommended in this Report Nos. 147 and 151, the shielding design goals will ensure that the respective annual values for effective dose recommended by NCRP for controlled and uncontrolled areas are not exceeded. For mixtures of low and high linear-energy-transfer radiation, the quantity dose equivalent is used. P can be expressed as a weekly or annual value (e.g., mSv week<sup>-1</sup> or mSv y<sup>-1</sup> dose equivalent), but is most often expressed as weekly values since the workload for a radiotherapy source has traditionally utilized a weekly format. [151]

**shielding factor:** A ratio of the exposure or dose rate indoors to that outdoors due to attenuation of radiation by the structure components. [163]

**shielding, local:** Shielding material installed adjacent to, or close by, a radiation source (e.g., diaphragm and collimator around x-ray producing target). [144]

**should:** The term should (or should not) (in italics) indicates an advisory recommendation from NCRP that is to be applied when practicable or practical (e.g., cost-effective). When the term “should” appears in the context of its general usage, it is not italicized. [168]

**should:** The term should (in italics) indicates an advisory recommendation from NCRP that is to be applied when practicable or practical (e.g., cost effective). When the term “should” is used to express requirements from regulatory agencies or other cognizant authorities, it is not in italics. Also, when the term “should” appears in the context of its general usage, it is not in italics. [157]

**shredder:** A machine that rips large, thin metal objects into irregular pieces on the order of a few inches up to around 8 to 10 inches in length and a few inches in width. The product is called shred or frag. The goal of shredding is to produce appropriate sizing to meet specific disposition requirements. [141]

**side-stream extraction:** The extraction of a mineral that is a by-product of the principal mineral being extracted. [118]

**sievert (Sv):** The special name (in the SI system) for the unit of equivalent dose and effective dose (or effective dose equivalent); 1 Sv = 1 J kg<sup>-1</sup>. [168]

**sievert (Sv):** Special name for the SI unit of dose equivalent, equivalent dose, and effective dose. 1 Sv = 1 J kg<sup>-1</sup>. [167]

**sievert (Sv):** The special name for the SI unit of dose equivalent, equivalent dose, and effective dose. 1 Sv = 1 J kg<sup>-1</sup>. J kg<sup>-1</sup> is also the SI unit for the ICRU operational quantities (see operational quantity). [163]

**sievert (Sv):** The SI special name for the unit (J kg<sup>-1</sup>) of dose equivalent, equivalent dose, and effective dose. 1 Sv = 1 J kg<sup>-1</sup>; the unit for weighted dose is also the sievert. [159]

**sievert (Sv):** The special name for the unit of effective dose ( $\underline{E}$ ), equivalent dose ( $\underline{H}_T$ ), dose equivalent ( $\underline{H}$ ), and organ dose equivalent ( $\overline{H}_T$ ),  $1 \text{ Sv} = 1 \text{ J kg}^{-1}$ . [153]

**signal-to-noise ratio:** The ratio of an instrument's output due to the actual input (signal) to the reading due to background interference. [158]

**signal-to-noise ratio:** The ratio of input signal to background interference. The greater the ratio, the clearer the image. [145]

**significance level:** A preset value (e.g., 0.05) for statistical hypothesis testing such that a  $p$  value obtained below the preset value indicates rejection of the null hypothesis (e.g., rejection at level 0.05). Thus,  $p$  values of 0.05 or less indicate a significant result whereas for  $p$  values of 0.10 or more the result is not significant (see  $p$  values). [164]

**significance level:** A preset value (e.g., 0.05) for statistical hypothesis testing such that a  $p$  value obtained below the preset value indicates rejection of the null hypothesis. [158]

**single photon emission computed tomography (SPECT):** An imaging technique in which one or more (typically two opposed) photon detector heads rotate around a region of the body and acquire images at various angles around the body. The collections of such images is then used to generate tomographic images ("slices") analogous to CT images. The computational methods (i.e., reconstruction techniques) used for generating the tomographic images include filtered back-projection and estimator-based (e.g., maximum-likelihood) iteration. [164]

**single-photon emission computed tomography (SPECT):** An imaging technique in which one or more gamma cameras sample a region of the body from several angles, producing tomographic images ("slices") of the region. [160]

**sink:** A space or location that receives materials such as contaminants, but that does not lose the material once it enters the space. [154]

**sinter:** A solid recycled iron-rich material composed of iron oxides and carbonates and coke dust that is heated to fuse the material into a size that can be added to a blast furnace. Sinter use is exclusive to steelmaking facilities using basic oxygen furnaces. [141]

**site-specific:** Pertaining to a particular location (e.g., of a disposal facility). [152]

**site-specific data:** Data used in radiological assessment models which are directly relevant to the particular location for which the assessment is being performed. When site-specific data are not available, default or generic values are often used. [154]

**SI unit:** 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 system, with special derived quantities the special names for units of radiation quantities including the becquerel, gray and sievert. [161]

**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. [166]

**SI units:** Units of the International System of Units as defined by the General Conference on Weights and Measures in 1960. They are the base units, such as meter (m), kilogram (kg), second (s), and their combinations, which have special names [e.g., the unit of energy ( $1 \text{ J} = 1 \text{ kg m}^2 \text{ s}^{-2}$ ) or absorbed dose ( $1 \text{ Gy} = 1 \text{ J kg}^{-1}$ )]. [159]

**skeletal endosteum:** A thin, 10  $\mu\text{m}$  layer of cells on the surfaces of the bone trabeculae and cortical Haversian canals. These cells make up the transition from marrow to bone and are considered the target in dose-based estimation of radiation-induced leukemia risk. The osteoprogenitor cells reside in this layer. [164]

**skewness:** A representation of the degree of asymmetry in a probability distribution. [163]

**skyshine:** Radiation scattered back to Earth by the atmosphere above a radiation source. [Comm20]

**skyshine:** Radiation scattered back to Earth by the atmosphere above a radiation-producing facility. [151]

**slabs:** Rectangular semifinished bars of metal that are typically several inches thick, three or more feet wide, and several feet long. Thin slabs are typically about an inch thick. [141]

**slag:** Carbonate and nonmetallic oxide compounds produced by the chemical reaction of flux and impurities in a steelmaking furnace. Iron and steelmaking slags tend to be rock-like when they cool and harden (see **dross** for a description of a similar material produced in nonferrous metal making). [141]

**slant thickness ( $t_s$ ):** For radiation that is obliquely incident on a shielding barrier, the slant thickness ( $t_s$ ) equals  $t (\cos \theta)^{-1}$ , where  $\theta$  is the angle of obliquity and  $t$  is the thickness of the barrier. [151]

**slowing down (of neutrons):** Decrease in neutron kinetic energy, usually due to repetitive collisions with the matter through which they traverse. [158]

**slug test:** Method of estimating hydraulic conductivity in aquifers in which a slug of water is removed from a well and the rate at which the piezometric surface or water table returns to its original level is observed. [152]

**slurry:** A mixture of water and solid particles capable of flowing. [154]

**snowpack:** Snow accumulated over a prolonged period of cold. [154]

**soil amendment:** Any substance added to the soil to achieve a goal, such as increased crop production, decreased plant uptake of a contaminant, etc. [154]

**soil horizon:** Refers to a layer of soil, specified by physical depth boundaries or by certain soil characteristics. [154]

**soil loading:** Refers to the accumulation of soil particles on plants or suspended in air. This is caused by resuspension of soil by various physical processes. [154]

**soil-to-plant concentration ratio ( $B_v$ ):** The ratio of the concentration of a radionuclide  $i$  in fresh vegetation to that in dry soil.  $Cr_i$ , the ratio of the concentration of a radionuclide  $i$  in dry vegetation to that in dry soil. [129]

**solar cycle:** The solar-activity cyclic behavior, usually represented by the number of sunspots visible on the solar photosphere. The average length of solar cycles since 1900 is 11.4 y. [160]

**solar flare:** The name given to the sudden release of energy (often  $>10^{32}$  ergs) in a relatively small volume of the solar atmosphere. Historically, an optical brightening in the chromosphere, now expanded to cover almost all impulsive radiation from the sun. [153]

**solar maximum:** The period of the 11 y solar cycle during which the solar wind is at its most intense resulting in lower levels of galactic cosmic radiation about Earth. [153]

**solar maximum:** The portion of the 11 y solar cycle during which the solar wind is at its most intense level, resulting in lower levels of GCR radiation. [137]

**solar minimum:** The portion of the 11 y solar cycle during which the solar wind is at its least intense resulting in higher levels of galactic cosmic radiation about Earth. [153]

**solar minimum:** The portion of the 11 y solar cycle during which the solar wind (ionized gas carrying magnetic fields that can alter the radiation in interplanetary space) is at its weakest, resulting in higher levels of GCR radiation. [137]

**solar particle:** Penetrating particulate ionizing radiation that originates from the sun. [160]

**solar particle event (SPE):** An eruption at the sun that releases a large number of particles (primarily protons) over the course of hours or days. [167]

**solar wind:** The plasma flowing into space from the solar corona. The ionized gas carrying magnetic fields can alter the intensity of the interplanetary radiation. [153]

**solid waste:** Material regulated under the Resource Conservation and Recovery Act (RCRA) and defined in 40 CFR Parts 261.2 and 261.4. Solid waste includes, but is not restricted to, material that has been discarded, abandoned or is inherently waste-like, and such waste can be a solid, liquid or gas. [146]

**solubility limit:** Maximum amount of a substance that can be dissolved in a unit volume of a solvent under specified conditions. [152]

**solution phase transport:** Refers to the transport of dissolved contaminants by the movement of groundwater or surface water. [154]

**somatic cells:** Nonreproductive cells. [159]

**somatic effects:** Effects of radiation limited to the exposed individual, as distinguished from hereditary effects that may be expressed in subsequent unexposed generations. [157]

**somatic effects:** Radiation effects induced in body tissues in the person irradiated (see genetic effects). [124]

**somatopleure:** A basic anatomical element of the vertebrate embryo/fetus and its membranes; composed of ectoderm and adjacent layers of somatic mesoderm. It gives rise to the chorion, amnion and the primitive embryonic body wall. [128]

**somite:** One of the many paired segmental masses of early mesoderm in vertebrate embryos that give rise to dermatomes, myotomes and sclerotomes. [128]

**sonoluminescence:** Production of light by inertial cavitation. [140]

**sorb:** The attachment some material of interest to a solid surface by one of several possible mechanisms. [154]

**sorption:** A general term indicating attachment to something. This may occur by absorption through a membrane to inner spaces of a solid, or adsorption to the surface of a solid. [154]

**sorption:** Any mechanism that removes ions from fluid phase of a medium to solid phase, including adsorption (attraction to a surface), absorption (incorporation into the interior of a solid), and ion exchange (adsorption, with a charge-for-charge replacement of ionic species on a surface by other ionic species in solution). Desorption includes the opposite of each of these reactions. [152]

**sorption isotherm:** Curve of sorption as a function of concentration of a contaminant in a solid/fluid system with all other parameters held constant (e.g., temperature, pressure, ratio of amount of fluid to amount of solid). [152]

**source (or radiation source):** Radiation-producing equipment or an aggregate of radioactive nuclei. [168]

**source material:** Uranium, thorium or any combination thereof in any physical or chemical form, or ores that contain by weight 1/20 of 1 % (0.05 %) or more of uranium, thorium or any combination thereof. Source material does not include special nuclear material (see special nuclear material). [157]

**source organ:** The organ containing the radionuclide that is the source of the energy deposited in a target organ. [128]

**source organ/tissue:** The organ or tissue containing the radionuclide that is the source of the energy deposited in a target organ or region. [161]

**source term:** The rate of release of radionuclides, usually over time. [163]

**source term:** Rate of release of radionuclides from a waste-disposal facility, usually over time. [160]

**source-to-image distance (SID):** The distance between the center of the source's front surface (i.e., the x-ray focal spot or sealed radioactive source) and the surface of the image detector. [133]

**source-to-image receptor distance:** The distance between the center of the source's front surface (i.e., the x-ray focal spot or sealed radioactive source) and the surface of the image receptor. [148]

**source-to-skin distance:** The distance measured along the central ray from the center of the front surface of the source (x-ray focal spot or sealed radioactive source) to the surface of the irradiated object or patient. [148]

**source-to-surface distance (source-to-skin distance):** The distance, measured along the central ray, from the center of the front surface of the source (x-ray focal spot) to the surface of the irradiated object or patient. [145]

**space-charge screening:** A transitory high concentration of ions of either charge existing in a limited volume of space which alters the electric field characteristics within a gas-filled detector. [Comm20]

**space radiation:** Penetrating ionizing radiation, both particulate and electromagnetic, that originates in outer space. [160]

**spall:** Small particles of armor plate dispersed by an armor-piercing munition. [156]

**spallation:** A nuclear reaction in which an incoming particle causes a target to fragment into many pieces. [156]

**spallation:** A nuclear reaction in which light particles are ejected as a result of bombardment, for example, by high-energy protons. [153]

**spallation:** Breaking off of material in layers parallel to a surface. [152]

**spallation neutrons:** Neutrons produced by using an accelerator to bombard target materials containing high- $Z$  nuclei (e.g., mercury or tungsten) with energetic protons or other charged particles.

**spallation products:** Fragments resulting from a spallation reaction. [156]

**spatially isotropic (or isotropic) field:** Uniform directional distribution of the particle fluence (or fluence rate) in space. [144]

**spatial resolution:** The ability to image two separate objects and visually detect one from the other. [149]



**special form:** Radioactive material that is either in a single piece or is contained in a sealed capsule that can be opened only by destroying the capsule, or material that satisfies the test requirements of U.S. Department of Transportation regulation 49 CFR Part 173.469. [141]

**special nuclear material:** Defined by Title I of the Atomic Energy Act of 1954 as plutonium,  $^{233}\text{U}$ , or uranium enriched in the isotopes  $^{233}\text{U}$  or  $^{235}\text{U}$ . The definition includes any other fissile material that the U.S. Nuclear Regulatory Commission (NRC) determines to be special nuclear material, but does not include source material. NRC has not declared any other material as special nuclear material. [Comm20]

**special nuclear material:** Plutonium,  $^{233}\text{U}$ , uranium enriched in the isotope 233 or in the isotope 235 and any other material NRC determines to be special nuclear material, or any material artificially enriched by any of these types of radioactive material. [157]

**special nuclear material:** (1) Plutonium, uranium enriched in the isotope 233 or 235, and any other material that the U.S. Nuclear Regulatory Commission determines to be special nuclear material, or (2) any material artificially enriched in any of the foregoing. Special nuclear material does not include source material. [152]

**speciation:** In the context of this Report, speciation refers to the chemical and physical form of a radionuclide or other contaminant and possible changes due to circumstances or conditions. [154]

**speciation:** Particular chemical compounds or forms and valence states in which a chemical element can exist in a given environment. [152]

**specific absorbed fraction (SAF) ( $\Phi$ ):** The absorbed fraction per unit mass of the target organ,  $\Phi = \phi / m$ . [164]

**specific absorption rate (SAR):** The time rate at which radiofrequency energy is absorbed in an incremental mass divided by that mass. Average SAR in a body is the time rate of the total energy absorbed divided by the total mass of the body. The units are watt per kilogram ( $\text{W kg}^{-1}$ ). [119]

**specific activity:** Activity of a radionuclide per unit mass of the radionuclide; also may refer to activity of a radionuclide per unit mass of material in which the radionuclide is dispersed. [166]

**specific activity:** Activity of a given radioactive nuclide per unit mass of a compound, element, or nuclide. [159]

**specific activity method:** A model which estimates dose from a radionuclide by assuming the specific activity in food or water is equal to or a fraction of the specific activity in air for a given location. This approach bypasses the steps normally used in radionuclide transport models; however, it is primarily applicable to radionuclides that have an abundant stable carrier in nature such as water for tritium and carbon dioxide for  $^{14}\text{C}$ . [123]

**specific activity model:** Model that estimates dose from exposure to a radionuclide by assuming that the specific activity in tissues of an exposed individual is equal to, or a fraction of, the specific activity in air or water at a particular location. [152]

**specific bremsstrahlung constant ( $\Gamma_{br}$ ):** Constant that relates the activity in a point source of beta-emitting radiation to the bremsstrahlung exposure rate from that source. The unit of the specific bremsstrahlung constant is  $R\text{ cm}^2\text{ mCi}^{-1}\text{ h}^{-1}$ . [155]

**specific energy ( $z$ ):** Energy absorbed within a given site divided by the mass of the site. Unlike lineal energy ( $y$ ) specific energy may be related to more than one deposition event. [137]

**specific gamma-ray constant ( $\Gamma_\gamma$ ):** Constant that relates the activity in a point source of penetrating radiation (photons) to the exposure rate from the source. The units of the specific gamma-ray constant is  $R\text{ cm}^2\text{ mCi}^{-1}\text{ h}^{-1}$ , equivalent to the exposure rate in air in  $R\text{ h}^{-1}$  at 1 cm from a 1 mCi source. The specific gamma-ray constant is unique to the radionuclide under consideration. [155]

**specific individual:** A real individual for whom physical and physiological information is available that would allow the analyst to personalize the biokinetic or dosimetric models (e.g., bioassay data are available), or for whom personal information is available that would allow the analyst to personalize the exposure history (e.g., dietary information and work or residence information are available). [164]

**specificity:** The probability of a normal mammogram report when no cancer exists, otherwise defined as the fraction of all patients found not to have breast cancer within 1 y after screening who were correctly identified as normal at the time of screening. [149]

**specific license:** Written permission to possess and use radioactive material issued by the NRC or an Agreement State after the agency reviews and approves an application for the possession and use of the radioactive material. [141]

**specific quality function [ $q(z)$  or  $q(y)$ ]:** The microdosimetric analog of the quality factor as a function of LET [ $Q(L)$ ].  $q(y)$  is the specific quality function based on lineal energy ( $y$ );  $q(z)$  is the equivalent function based on specific energy ( $z$ ). [137]

**specific risk:** A risk model that involves numerous modifications of a risk model to account for factors such as age at exposure, gender, and source of radiation. [159]

**specific storage:** Volume of water released from a unit volume of a saturated medium under a unit decline in hydraulic head. [152]

**specimen radiography:** The technique for examining a biopsy specimen by x-ray imaging. [149]

**speed:** (also see film speed). As applied to an image receptor, an index of the relative exposure required to produce an image of acceptable quality; faster image receptors need less exposure. [145]

**spent nuclear fuel:** Fuel that has been withdrawn from a nuclear reactor following irradiation, the constituent elements of which have not been separated by reprocessing. [163]

**spent source:** A source of radioactive material no longer suitable for its intended purpose as a result of radioactive decay.

[141]

**spherical wave:** A wave in which **E** and **H** are uniform on the surface of a sphere. **E**, **H** and the direction of propagation are all mutually perpendicular. An idealized point source radiates spherical waves. [119]

**splanchnopleure:** A basic anatomical element of the vertebrate embryo/fetus that is composed of endoderm and the adjacent inner layers of lateral plate (splanchnic) mesoderm. It gives rise to the allantois and the vascular areas of the yolk sac, muscles and the connective tissue of the wall of the gut and its derivatives (thyroid, respiratory tract, liver, stomach and intestines). [128]

**splash albedo electrons:** Electrons scattered upward by interactions in the atmosphere. [142]

**spongiosa:** The bone-marrow intermixture characteristic of trabecular bone. [164]

**spot compression:** Allows for greater reduction in thickness of the localized area of interest and improved separation of breast tissues by the use of a small compression device; requires collimation to the area of interest (also called coned compression). [149]

**spot film:** A radiograph taken during a fluoroscopic examination. [133]

**squamous:** Scaly or plate-like; flattened. [156]

**stability constants:** When a complex is formed between a metal ion and an a ligand in solution, the equilibrium may be expressed by the stability constant which is related to the free energy change for the process. [154]

**stabilized gas body:** A gas-filled cavity which is stabilized by structures which partially or completely surround it. [140]

**standard deviation (SD):** Square root of the variance. [164]

**standard deviation (SD):** Square root of the variance. In a set of  $\underline{n}$  measurements, the variance ( $\underline{s}^2$ ) is the sum of the squared deviations from the mean divided by ( $\underline{n} - 1$ ) (see mean). [160]

**standard deviation of the mean:** The standard deviation of the mean is the square root of the variance divided by the number of observations:  $(\underline{SD}^2/\underline{n})^{1/2}$ . An equivalent definition is that the standard deviation of the mean is the standard deviation divided by the square root of the number of observations:  $\underline{SD}/\underline{n}^{1/2}$ . [164]

**standard deviation (error) of the mean:** The square root of the variance divided by the number of observations:  $(\underline{s}^2 / \underline{n})^{1/2}$ . An equivalent definition is that the standard deviation of the mean is the standard deviation divided by the square root of the number of observations ( $\underline{s} / \underline{n}^{1/2}$ ). [160]

**standard deviation of the mean** (also called standard error): The square root of the variance (var) of a set of observations divided by the number of observations:  $(\text{var} / \underline{n})^{1/2}$ . [158]

**standard error:** The standard deviation of an estimate considered as a random variable. The standard deviation of the mean is often known as the standard error. [164]

**standard error:** Standard deviation of the sample mean. [158]

**standard error of the mean:** The square root of the variance ( $\underline{\sigma}^2$ ) divided by the number of observations ( $\underline{n}$ ) [i.e.,  $(\underline{\sigma}^2 / \underline{n})^{1/2}$ ]. [163]

**standardized mortality rate (SMR):** The ratio of the mortality rate from a disease in the population being studied to the comparable rate in a standard population. [159]

**standard precautions:** Previously known as Universal Precautions; an approach to infection control in which human blood and most human body fluids are treated as if infectious for human immunodeficiency virus, hepatitis B virus, or other blood-borne pathogens. [166]

**standards:** A variety of activities established by legislative, regulatory or consensus means for the safe use and application of ionizing and nonionizing radiation. Examples include: dose and dose-rate limits, -permissible concentrations, rules for handling, regulations for transportation, regulations for industrial control of radiation, electronic product performance requirements, and control of radioactive material and recommended practice documents (e.g., NCRP reports, American National Standards, good practice documents). [161]

**standards:** A variety of activities established by legislative or regulatory means for the safe use and application of ionizing and nonionizing radiation. Examples include: dose and dose-rate limits, permissible concentrations, rules for handling, regulations for transportation, regulations for industrial control of radiation, electronic product performance requirements, and control of radioactive material. [157]

**standard uptake value:** A measure of relative concentration used in PET imaging. Standard uptake value is defined as the concentration in a particular anatomical region of interest divided by the concentration over the whole body (the latter is estimated as the amount administered divided by patient mass). [164]

**standing-wave ratio:** The ratio of  $E_{\text{max}}$  to  $E_{\text{min}}$ , where  $E_{\text{max}}$  is the maximum value of the magnitude of the electric field strength anywhere along the path of a wave, and  $E_{\text{min}}$  is the minimum value of the magnitude of the electric field strength along the path of the wave. A similar definition holds for other quantities that have wave properties. [119]

**stasis:** Stoppage or diminution of flow, as of blood or other body fluids. [156]

**state compacts:** Groups of two or more states that, when approved by Congress under authority of the Low-Level Radioactive Waste Policy Act of 1980, as amended, join together to develop a disposal facility for low-level waste generated within those states. [152]

**statistical interval:** An interval usually used to identify the location of a parameter in a distribution (e.g., a confidence interval), the proportion of a distribution contained within the interval (a tolerance interval), or an interval that will, with a specified degree of confidence, contain a prespecified future (often the next) randomly- selected observation (a prediction interval). [158]

**steady state:** The situation where inputs to a compartment equal losses from the compartment, so that changes with time are zero or very small (sometimes referred to as equilibrium). [164]

**steady state:** Constant in time. [152]

**steady-state model:** A mathematical model that assumes steady-state or equilibrium conditions, where inputs balance losses and temporal changes are small. [164]

**steel:** When used in the iron and steel industries, refers to an elemental iron-based metal in which the carbon content is less than 1 %. [141]

**steppe:** A grassland or ecosystem with grass as a major vegetation type and lacking trees. [154]

**stepwedge:** A device consisting of increments of an absorber through which a radiographic exposure is made on film to permit determination of the amounts of radiation reaching the film by measurements of film density. [145]

**step-wise regression:** Procedure that fits a multiple linear regression model to data in an iterative manner. Procedure begins by including variables that explain most of the variation in outcomes, and progressively adds more variables until a specified significance level is achieved. [152]

**stereotactic breast biopsy:** Breast biopsy performed with location of the area to be biopsied determined by utilizing two x-ray images in parallax. [149]

**stochastic:** Of, pertaining to, or arising from chance; involving probability; random. [168]

**stochastic:** Describes random events leading to effects whose probability of occurrence in an exposed population (rather than severity in an affected individual) is a direct function of dose; these effects are commonly regarded as having no threshold; heritable effects are regarded as being stochastic; some somatic effects, especially carcinogenesis are regarded as being stochastic. [167]

**stochastic (health effect):** Of, pertaining to, or arising from chance; involving probability; random. A stochastic health effect is one where the probability of occurrence, rather than their severity, is assumed to be a function of dose without a threshold. For example, cancer and hereditary effects are regarded as being stochastic. [163]

**stochastic:** Health effects, the probability of which, rather than their severity, is assumed to be a function of dose without a threshold. [159]

**stochastic effects:** Effects, the probability of which, rather than their severity, is assumed to be a function of dose without a threshold. For example, cancer and heritable effects of radiation are regarded as being stochastic. [168]

**stochastic effects:** Health effects, the probability of which, rather than their severity, is assumed to be a function of radiation dose without a threshold. [165]

**stochastic effects:** Adverse effects in biological organisms for which the probability, but not the severity, is assumed to be a function of dose of ionizing radiation (or other contaminant) without threshold. [156]

**stochastic effects:** Effects, the probability of occurrence which, rather than their severity, is a function of radiation dose without threshold (e.g., cancer). [153]

**stochastic methods:** Methods of exercising mathematical models in which distributions of input parameters are propagated through a model to estimate distributions in outputs. [152]

**stochastic model:** A model whose input values are selected randomly from defined distributions and run many times to generate a distribution of possible output values (contrast with deterministic model and see Monte-Carlo analysis). [154]

**stochastic model:** Any model whose input and output are expressed as random variables. Contrast with deterministic model. [129]

**stochastic response:** An adverse effect on organisms for which the probability of occurrence, but not the severity, is a function of dose without threshold (e.g., cancer). In humans, stochastic responses may not occur for many years after an exposure. [146]

**stochastic risk:** Probability for adverse effects in biological organisms for which the probability, but not the severity, is assumed to be a function of dose of ionizing radiation (or other contaminant) without threshold. [166]

**stochastic variation:** Random variability attributed to a property of a system based on repeated measurement or observation. [154]

**stopping power (of charged particles):** A measure of the average energy loss of a charged particle passing through a material. Linear stopping power is specified as energy loss per unit distance traveled. Mass stopping power is specified as energy lost per unit distance traveled divided by the density of the material. [163]

**stopping power (lineal stopping power):** The quotient of the energy lost (dE) by a charged particle in traversing a distance (dx) in a material. Can also be expressed as mass stopping power by dividing the lineal stopping power by the density ( $\rho$ ) of the material. [153]

**stopping power (of electrons or ions):** A measure of the average energy loss of a charged particle passing through a material. Linear stopping power is specified as energy loss per unit distance traveled. Mass stopping power is specified as energy lost per unit distance traveled, divided by the density of the material. [144]

**storage:** Retention of waste with the intent to retrieve it for subsequent use, processing or disposal. [152]

**straddle carrier:** A mobile transport used for straddling and lifting cargo containers at seaports. [Comm20]

**straggling (of electrons or ions):** The random variation or fluctuation of a property associated with charged particles passing through matter, as applied especially to range or penetration distance. [158]

**strain:** Relative change in dimensions of an object in response to an applied force. [152]

**strain-dependent differences:** Usually refers to differences in responses between or among different genetic lines (*i.e.*, strains) of the same species, but it sometimes includes differences between different species; context determines which usage is intended. Sometimes referred to as host factor differences. [150]

**stratum corneum:** The outermost layer of the epidermis. [156]

**stray radiation:** The sum of leakage and scattered radiation. [133]

**strength:** A task, process or program that clearly results in positive performance beyond what is normally expected. [162]

**stress:** External force acting on a material that tends to change dimensions of the material by compressing it, stretching it, or causing it to shear. [152]

**stroma:** The tissue forming the ground substance, framework, or matrix of an organ. [156]

**subcutis:** Loose connective tissue between the skin and muscle. [156]

**subharmonic:** A spectral component whose frequency is  $(1/n)$  times the fundamental frequency, where  $n$  is a positive non-zero integer. [140]

**subjective probability:** A probability assigned by an investigator based on judgment that relies on data and information that is either incomplete or that is not entirely relevant for the assessed quantity. [164]

**subjective probability:** A probability that cannot be determined by measurement or objective reasoning but must be estimated based to a significant extent on often untestable judgment. [158]

**substantial radiation dose level (SRDL):** An appropriately-selected reference value used to trigger additional dose-management actions during a procedure and medical follow-up for a radiation level that might produce a clinically-relevant injury in an average patient. There is no implication that radiation levels above an SRDL will always cause an injury or that radiation levels below an SRDL will never cause an injury. The quantities and their SRDLs recommended are provided in Table 4.7. [168]

**suction pressure:** Negative pressure head in an unsaturated medium. [152]

**Superfund Amendments and Reauthorization Act (SARA):** Amendments to CERCLA (Superfund) passed in 1986, which also include free-standing provisions in Title III (the Emergency Response and Community Right-To-Know Act) and Title IV (the Radon Gas and Indoor Air Quality Research Act), and Title V amending the Internal Revenue Code (the Superfund Revenue Act). [141]

**superior:** Situated above or directed upward; opposite of inferior. [159]

**supernatant:** The usually clear liquid overlying material deposited by settling, precipitation or centrifugation. [154]

**surface area median diameter (SAMD):** Diameter of particles having a median surface area (i.e., 50 % of particles have a surface area above and 50 % below this diameter). [125]

**surface water:** Water on or above the land surface (e.g., rivers, streams, lakes, ponds, oceans). [164]

**surfactant:** Agent that lowers surface tension. [125]

**surveillance:** Inspection of all or part of a waste disposal facility, usually for the purpose of ascertaining its integrity or normal or expected functioning. [152]

**survey:** An evaluation of the presence of radiation or radioactive contamination under a specific set of conditions to determine actual or potential radiation hazards. [166]

**survey:** An evaluation of the production, use, release, disposal or presence of radioactive materials under a specific set of conditions to determine actual or potential radiation hazards. [141]

**survey meter:** An instrument or device, usually portable, for monitoring the level of radiation or of radioactive contamination in an area or location. [166]

**suspension:** A chemical mixture in which particles are dispersed in a medium. [161]

**suspension:** Transfer of material from the Earth's surface, including surface water and the land surface, to the atmosphere. [152]

**S value:** The mean absorbed-dose rate to target tissue  $\bar{r}_T$  at time  $t$  post-administration per unit activity present in source tissue  $\bar{r}_S$ . The S value is characteristic of the radionuclide as well as the age- and gender-specific anatomical model chosen to represent the patient or tissue of interest. [164]

**syndrome:** The aggregate of signs and symptoms associated with any morbid process. [159]



**synergistic effect:** Increased effectiveness resulting from an interaction between two agents, so that the total effect is greater than the sum of the effects of the two agents acting alone. [159]

**syringe shield:** A cylinder made of lead-containing glass that absorbs radiation emitted from radioactive material in a syringe, thereby reducing the radiation dose to personnel. [124]

**systematic error:** An error of a nonrandom nature and associated with one or more biasing influences in the measurement process. Individual systematic errors may produce either high or low results. Systematic errors may at times be eliminated by proper correction of an observed defect in the procedure or evaluated by careful analysis sometimes involving comparative measurements with other laboratories/facilities. [164]

**systematic error:** A bias that applies in the same way to a group of measurements or a group of individuals. [163]

**Systeme Internationale (SI):** The International System of Quantities and Units as defined by the General Conference of Weights and Measures in 1960 and periodically revised since. These units are generally based on the meter/kilogram/second units, with special quantities for radiation including the becquerel, gray and sievert. [168]

**Systeme Internationale (SI):** A system of scientific units designed to foster uniformity in measurements. In nuclear medicine the SI units of becquerel, gray and sievert have replaced the conventional units of curie, rad and rem. [156]

**Systeme Internationale (SI):** A system of scientific units designed to foster uniformity in measurements. In medicine and radiation protection the new SI units of becquerel, gray and sievert have replaced the conventional units of curie, rad and rem. [124]

**Systeme Internationale (SI) d'Unités:** A system of scientific units agreed upon internationally that is designed to foster uniformity in measurements. In medicine and radiation protection the SI units of becquerel, gray and sievert have replaced the previous units of curie, rad and rem. [164]

**systemic:** Pertaining to or affecting the body as a whole. [161]

**tailings:** Waste or refuse left in various processes of milling or mining. Tailings often contain a significant portion of the radioactive material present in the undisturbed ore. [160]

**target:** The part of an x-ray tube anode assembly impacted by the electron beam to produce the useful x-ray beam. [147]

**target organ (or region):** An organ for which the radiation absorbed dose is calculated. [164]

**target organ or region:** An organ for which the radiation absorbed dose is calculated. [128]

**taxa:** Refers to a group of plants or animals within a certain taxonomic classification. [154]

**T-cell lymphomas:** An acute or subacute disease associated with the human T-cell virus. [150]

**t-distribution:** A probability distribution that arises in the problem of estimating the mean of a normally distributed population when the sample size is small or when the standard deviation of the population is not known. Values of the distribution of the t statistic (also known as the t score), are given by:

$$t = \frac{\bar{x} - \mu}{(s/\sqrt{n})}$$

where  $\bar{x}$  is the sample mean,  $\mu$  is the population mean,  $s$  is the standard deviation of the sample, and  $n$  is the sample size. The distribution of the t-statistic is the basis of the popular student's t-tests for the statistical significance of the difference between two sample means, and for confidence intervals for the difference between two population means. The t-distribution is a special case of the generalized hyperbolic distribution. [158]

**team leader:** An individual whose experience and training qualifies the person to direct an assessment and report assessment results. [162]

**technical quality control (TQC):** The routine performance of equipment function tests and tasks, the interpretation of data from the tests, and the corrective actions taken. [168]

**technologically-enhanced naturally-occurring radioactive material (TENORM):** Naturally-occurring radioactive material whose concentrations of radionuclides are increased by or as a result of past or present human practices. TENORM does not include background radiation or the naturally-occurring radionuclides in rocks or soils. TENORM also does not include uranium or thorium in source material as defined in the Atomic Energy Act of 1954 and NRC regulations. [160]

**telangiectasia:** Dilation of capillary vessels and very small arteries. [167]

**tensile strength:** Greatest stress that a material can bear without failure. [152]

**tension:** A force that causes the stretching of an object or surface.

**tenth-value distance (TVD):** The distance that radiation must traverse in order to reduce the radiation field quantity to one-tenth of its original value. [151]

**tenth-value layer (TVL):** The thickness of a specified substance which, when introduced into the path of a given beam of radiation, reduces the radiation field quantity to one-tenth of its original value. [151]

**teratogen:** A substance or agent that tends to produce abnormal development and congenital malformations. [167]

**teratogenesis:** The production of physical defects in offspring in utero. [167]

**terrestrial:** Of or relating to Earth or its inhabitants; of or relating to land as distinct from air or water. [163]

**terrestrial:** Of or relating to Earth or its inhabitants; of or relating to land as distinct from air or water; living on or in or growing from land. [160]

**terrorism:** The unlawful use of force against individuals or property to intimidate a government, the civilian population, or any segment thereof, in the furtherance of political objectives. [165]

**tetravalent:** Having a valence of four. [156]

**therapeutic protective source housing (or therapeutic source assembly):** An enclosure or assembly so constructed that the leakage radiation from the housing or assembly does not exceed specified limits. [148]

**therapy:** The practical treatment for remediation of diseases or disorders. [165]

**thermal neutrons:** Neutrons in thermal equilibrium with their surroundings. Neutrons with energies of 1 eV or lower are considered thermal (see neutron). [163]

**thermal neutrons:** Neutrons in thermal equilibrium with their surroundings. [144]

**thermography:** A breast imaging technique that measures body heat at the skin surface to identify hot spots caused by inflammation or cancer. [149]

**thermoluminescent dosimeter:** A dosimeter containing a phosphor for measuring dose. When heated or otherwise stimulated (e.g., laser), a thermoluminescent dosimeter that has been exposed to ionizing radiation gives off light proportional to the energy absorbed. When used for personal monitoring, filters (absorbers) are included to help characterize the types of radiation. [168]

**thermoluminescent dosimeter (TLD):** A dosimeter containing a phosphor for measuring dose, plus filters (absorbers) to help characterize the types of radiation. When heated, TLDs that have been exposed to ionizing radiation give off light proportional to the energy absorbed. [163]

**thermoluminescent dosimeter (TLD):** A dosimeter containing a crystalline material (phosphor) for measuring radiation dose, plus filters (absorbers) to help characterize the types of radiation encountered. When heated, TLD crystals that have been exposed to ionizing radiation give off light proportional to the energy they received from the radiation. [161]

**thermoluminescent dosimeter (TLD):** A dosimeter containing a phosphor for measuring dose. When used for personal dosimetry, filters (absorbers) are included to help characterize the types of radiation. When heated, TLDs that have been exposed to ionizing radiation give off light proportional to the energy absorbed. [160]

**thick electron target:** A target with a thickness equal to or greater than the range of electrons in the material. [Comm20]

**thickener:** A dewatering process for dust slurry removed by scrubbers. The thickener allows for the sedimentation of the dust from the slurry. The overflow from the thickener process is normally discharged to a body of surface water. Thus, the dust discharged to the environment could contain residual radioactive materials. [141]

**thick target:** Target whose dimension in the direction of incident particulate radiation is equal to or greater than the range of the incident particles. [144]

**thoracic lymphatic system:** Structures involved in the lymph system which include lymph capillaries, lacteals, lymph nodes, lymph vessels and main lymph ducts. [125]

**thorium:** A naturally-radioactive element. Thorium-232 is the parent of one radioactive series, and specific thorium nuclides are members of three naturally-occurring radionuclide series. [163]

**thoron (and thoron progeny):** Thoron is the common name for the specific radionuclide  $^{220}\text{Rn}$  and is used throughout this Report. Thoron progeny are short-lived decay products of  $^{220}\text{Rn}$  (i.e.,  $^{216}\text{Po}$ ,  $^{212}\text{Pb}$ ,  $^{212}\text{Bi}$ , and  $^{212}\text{Po}$ ). [160]

**Thorotrast<sup>®</sup>:** A proprietary contrast medium for roentgenography that contained a colloidal suspension of thorium dioxide (VanHeyden Company, Dresden-Radebeul, Germany). [161]

**thorotrastoma:** A granuloma at the site of Thorotrast<sup>®</sup> injection; frequently associated with a malignancy such as sarcoma. [156]

**threshold:** The point at which a stimulus first produces an effect (response). [165]

**threshold dose:** The minimum absorbed dose (or equivalent dose) of radiation that will produce a specified effect or a specified type of damage to the irradiated material. [161]

**threshold hypothesis:** The assumption that no radiation injury occurs below a specified dose, the threshold dose. [167]

**threshold, nuclear-reaction:** The minimum particle or photon energy required to initiate a specific endothermal (endoergic) nuclear reaction. [158]

**threshold, radiation-effect (or radiation-damage):** The minimum absorbed dose (or dose equivalent) of radiation that will produce a specified effect or a specified type of damage to the irradiated material. [151]

**thrombin:** An enzyme resulting from activation of prothrombin, which catalyzes the conversion of fibrinogen to fibrin. [156]

**thromboxane:** An intermediate in the metabolic pathway of arachidonic acid, released from stimulated platelets; one form, thromboxane  $A_2$  is a potent inducer of platelet aggregation and constrictor of arterial smooth muscle. [156]

**thyroglobulin:** A thyroid hormone-containing protein, usually stored in the colloid within the thyroid follicles. [159]

**thyroid:** Resembling a shield; denoting a gland (thyroid gland) and a cartilage of the larynx (thyroid cartilage) having such a shape. [159]

**tidal volume:** Volume of air that enters and leaves the lung during normal breathing. [125]

**time averaged dose-equivalent rate (TADR):** The barrier attenuated dose-equivalent rate averaged over a specified time or period of accelerator operation. TADR is proportional to instantaneous dose-equivalent rate (IDR), and depends on the values of workload (W) and use factor (U). [151]

**time-integrated activity** [ $\tilde{A}(r_S, T_D)$ ]: Total number of nuclear transformations in source tissue  $r_S$  over dose-integration period  $T_D$  such that:

$$\tilde{A}(r_S, T_D) = \int_0^{T_D} A(r_S, t) dt$$

This is often referred to as “cumulated or cumulative activity.” [164]

**time-integrated activity coefficient** [ $\tilde{a}(r_S, T_D)$ ]: The cumulative number of nuclear transformations (Bq s) occurring in source tissue  $r_S$  over a dose-integration period  $T_D$  per unit administered activity  $A_0$  (Bq). [164]

**time-to-vomiting:** A symptom of acute radiation syndrome; the time lapse from radiation exposure to when vomiting initially occurs. [165]

**tinea capitis**: A common form of fungus infection of the scalp caused by various species of Microsporum and Trichophyton on or within hair shafts, occurring almost exclusively in children and characterized by irregularly placed and variously sized patches of apparent baldness because of hairs breaking off at the surface of the scalp. [159]

**tissue at risk**: Cells endangered from exposure to radionuclides.

**tissue depth**: Depth of tissues lining the respiratory tract including the mucus and cells lining the trachea, main bronchus or bronchial airway. [125]

**tissue equivalent** [as in tissue-equivalent proportional counter (TEPC)]: Denotes a substance with absorbing and scattering properties for a given radiation that sufficiently match those of a particular biological tissue. [158]

**tissue weighting factor ( $w_T$ )**: A factor that indicates the ratio of the risk of stochastic effects attributable to irradiation of a given organ or tissue (T) to the total risk when the whole body is uniformly irradiated. When calculating effective dose equivalent, tissue weighting factor represents the risk of fatal cancers or severe heritable effects. When calculating effective dose, tissue weighting factor represents total detriment. [168]

**tissue weighting factor ( $w_T$ )**: A factor representing the ratio of risk of stochastic effects attributable to irradiation of a given organ or tissue to the total risk when the whole body is irradiated uniformly. The factor is assumed to be independent of the type of radiation or energy of the radiation. [164]

**tissue weighting factor ( $w_T$ )**: A factor that indicates the ratio of the risk of stochastic effects attributable to irradiation of a given organ or tissue (T) to the total risk when the whole body is uniformly irradiated. When calculating effective dose equivalent, the  $w_T$  values relate to the risk of fatal cancers or severe hereditary effects (ICRP, 1977). When calculating effective dose, the  $w_T$  values relate to total detriment (ICRP, 1991a). The  $w_T$  values are independent of the type of radiation or energy of the radiation. [163]

**tissue weighting factor ( $w_T$ )**: Dimensionless factor that represents ratio of the stochastic risk attributable to a specific organ or tissue (T) to total stochastic risk attributable to all organs and tissues when the whole body receives a uniform exposure to ionizing radiation. When calculating effective dose equivalent of ICRP Publication 26 (ICRP, 1977), tissue weighting factor ( $w_T$ ) represents the risk of fatal cancers or severe hereditary effects. When calculating effective dose of ICRP Publication 60 (ICRP, 1991a),  $w_T$  represents total detriment. The  $w_T$  is independent of the type of radiation or energy of the radiation as it is applied to equivalent dose. [161]

**tissue weighting factor ( $w_T$ )**: Dimensionless factor that represents ratio of the stochastic risk attributable to a specific organ or tissue (T) to total stochastic risk attributable to all organs and tissues when the whole body receives a uniform exposure to ionizing radiation. When calculating effective dose equivalent, tissue weighting factor ( $w_T$ ) represents the risk of fatal cancers or severe hereditary effects. When calculating effective dose,  $w_T$  represents total detriment. The  $w_T$  is independent of the type of radiation or energy of the radiation. [158]

**TNT equivalent**: A measure of the energy released in the detonation of a nuclear (or atomic) weapon, or in the explosion of a given quantity of fissionable material, expressed in terms of the mass of TNT which would release the same amount of energy when exploded. The TNT equivalent is usually stated in kilotons or megatons. The basis of the TNT equivalence

is that the explosion of one ton of TNT is assumed to release  $10^9$  calories of energy (see kiloton energy, megaton energy, yield). [159]

**tolerance interval:** The proportion of a distribution contained within a defined interval (see confidence interval and statistical interval). [158]

**tomography:** A special technique to show in detail images of structures lying in a predetermined plane of tissue, while blurring or eliminating detail in images of structures in other planes. [168]

**tonsillitis:** Inflammation of a tonsil, especially of the palatine tonsil. [159]

**top pick:** A mobile lifting unit that grabs the tops of cargo containers and moves them around seaports. [Comm20]

**total effective dose:** Integral of an effective dose rate over a specified finite period of time following an external radiation dose or an intake of a radionuclide by ingestion, inhalation, or dermal absorption or any combination of the three. [166]

**total effective dose equivalent (TEDE):** The sum of the deep dose equivalent (for external exposures) and the committed effective dose equivalent (from intakes of radionuclides) (NRC, 2007a). TEDE accumulates over a period of time that includes external irradiation as well as committed doses due to radionuclide intakes during that period of time. [160]

**total effective dose equivalent (TEDE):** U.S. Nuclear Regulatory Commission's definition from 10 CFR Part 20.1003: "The sum of the deep-dose equivalent (for external exposures) and the committed effective dose equivalent [from intakes of radionuclides]". TEDE accumulates over a period of time that includes external irradiation as well as committed doses due to radionuclide intakes during that period of time. [146]

**total skeletal spongiosa volume (TSSV):** The total volume of trabecular bone, associated active and inactive bone marrow. [164]

**toxic:** (1) Capable of producing injury, illness or damage to living organisms through ingestion, inhalation or absorption through any body surface. (2) A characteristic of solid hazardous waste regulated under RCRA and defined in 40 CFR Part 261.24. A solid waste is toxic if, when using the Toxicity Characteristic Leaching Procedure, the extract from a representative sample of the waste contains any of 40 contaminants (seven metals and 33 organic compounds) at a concentration equal to or greater than specified values. When the waste contains less than 0.5 % filterable solids, the waste itself, after filtering, is considered to be the extract for the purpose of determining whether it is toxic. [141]

**toxicity ratio method:** Relative effectiveness per gray of average skeletal dose. [150]

**Toxic Substances Control Act (TSCA):** Law passed in 1976 that governs regulation of toxic substances in commerce, with objective of preventing human health and environmental problems before they occur. Manufacturing, processing or distribution in commerce of toxic substances may be limited or banned if U.S. Environmental Protection Agency finds,

based on results of toxicity testing and exposure assessments, that there is an unreasonable risk of injury to health or the environment. Hazardous chemicals regulated under TSCA include, for example, dioxins, PCBs and asbestos. [152]

**trabecular active (bone) marrow (TAM):** The volume of tissue consisting of proliferative hematopoietic cells contained within trabecular bone. [164]

**trabecular bone:** Any bone with a surface/volume ratio  $>60 \text{ cm}^{-2} \text{ cm}^{-3}$ ; it has a spongy, honeycomb -structure. [164]

**trabecular bone surface (TBS):** The surface of trabecular bone. [164]

**trabecular bone volume (TBV):** The volume of trabecular bone [164]

**tracer:** A radionuclide added to a material to follow the location of the substance in the environment or to detect any physical or chemical changes it undergoes. In nuclear medicine, any radioactive isotope introduced into the body to study metabolism or other biological processes without perturbing them. [164]

**tracer:** A substance that behaves like and thus tracks the movement of another material. [154]

**tracer:** A radiopharmaceutical used to trace a physiological or biochemical process without affecting it. [Strictly speaking, a tracer does not have to be radioactive (e.g., it could be a stable isotope), but in common usage it is.]

**tracer level:** An amount of a radionuclide that may be detected but that does not perturb the metabolism or other biological process of the system being studied. [164]

**trachea:** Air tube extending from the larynx to the major bronchi whose membranous wall contains cartilage and muscular fibers. [164]

**tracheobronchial region:** Area of the trachea and bronchi down to the terminal bronchioles which functions in gas transport. [164]

**transfer coefficient:** The ratio of the concentration of material in a food product from an animal (milk, meat, eggs) at equilibrium, to the rate at which the material is ingested by the animal. It is expressed in units of  $\text{d L}^{-1}$  or  $\text{d kg}^{-1}$  for a specified animal product. [164]

**transfer coefficient to meat ( $F_{\text{meat}}$ ):** The fraction of an element ingested daily by an herbivore that can be measured in 1 kg of animal product at steady-state or equilibrium. [129]

**transfer coefficient to milk ( $F_{\text{milk}}$ ):** The fraction of an element ingested daily by a cow that is secreted in milk at steady-state or equilibrium. [129]

**transfer coefficient to other animal product (e.g., meat, eggs) ( $F_i$ ):** The fraction of element (i) ingested daily by an herbivore that can be measured in 1 kg of animal product at steady-state or equilibrium. [123]



**transfer factor:** Factor representing intake of a radionuclide by an exposed individual per unit concentration in an environmental medium (air, water or soil); not relevant for external exposure pathways. [161]

**transferrin:** A serum globulin that binds and transports iron. [156]

**transfer standard:** An instrument or radioactive source that has been standardized (calibrated) in terms of response (for an instrument) or activity content, radiation emission rate or dose rate (for a source) by measurements made against a national standard or a standard maintained by a secondary calibration laboratory. [158]

**transformed cells:** Tissue culture cells changed in vitro from growing in an orderly pattern and exhibiting contact inhibition to growing in a pattern more like that of cancer cells, due to the loss of contact inhibition. Transformed cells injected back into a host animal can give rise to cancer. [126]

**transillumination:** A noninvasive breast imaging technique that uses visible or near-visible light to visualize breast masses. [149]

**transition:** A nuclear change from one energy state to another, generally accompanied by the emission of particles or photons. Often called a decay, or disintegration. [156]

**transition group metal:** Any of the 38 elements in groups 3 through 12 of the periodic table (i.e., atomic numbers 21 through 30, 39 through 48, 72 through 80, and 104 through 112). [156]

**translocation:** The movement of water and other substances within the plant. [164]

**translocation:** The redistribution of radionuclides from the initial sites of deposition to other tissues and organs in the body. [161]

**translocation factor:** Typically, the mass activity density of a contaminant in a given plant tissue divided by the mass activity density in another tissue of the same plant. [154]

**translocation factor:** Fraction of material deposited from the atmosphere onto surfaces of vegetation that is transferred to edible parts of the plant. [152]

**transmission factor (or barrier transmission) (B):** For a given radiation type and quality, B is the ratio of any radiation field quantity at a location behind the barrier on which radiation is incident to the field quantity at the same location without the presence of the barrier. B is a measure of the shielding effectiveness of the barrier. [151]

**transmissivity:** Rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient, given by product of the hydraulic conductivity and aquifer thickness. [152]

**transpiration:** The loss of water from soil to the atmosphere via the photosynthetic activity of green plants. [154]

**transpiration:** Giving off of water through surfaces of leaves and other parts of plants. [152]

**transport:** (see migration). [152]

**transuranic:** Having an atomic number greater than that of uranium (92); same as transuranium element. [161]

**transuranic waste:** Radioactive waste containing more than 4 kBq g<sup>-1</sup> of alpha-emitting transuranium isotopes, with half-lives >20 y, except for (1) high-level waste, (2) radioactive waste that the Secretary of Energy has determined, with concurrence of the Administrator of the U.S. Environmental Protection Agency, does not need the degree of isolation required by disposal regulations in 40 CFR Part 191, or (3) radioactive waste that the U.S. Nuclear Regulatory Commission has approved for near-surface disposal on a case-by-case basis in accordance with 10 CFR Part 61. [152]

**transuranium element:** Chemical element with an atomic number greater than that of uranium (92). Same as transuranic element. [161]

**trapezoidal distribution:** A probability density function that is essentially a uniform distribution to which a tail, in the form of a triangle, has been added to each side. [164]

**treatment:** Any method, technique or process designed to change the physical or chemical character of a hazardous material to render it less hazardous, safer to transport, store or dispose of, or to reduce its volume. [152]

**trench:** In the context of this Report, a ditch dug to receive liquid waste. The ditch is normally back-filled with soil or other material after receiving the liquid waste. [154]

**triage:** Medical screening of patients prior to treatment to determine their relative priority for treatment, with separation into one of three groups: (1) those who cannot be expected to survive even with treatment; (2) those who will recover without treatment; and (3) the highest priority, those who will or may survive with treatment. Triage is also used as a tool to sort individuals who may have been exposed to large doses of radiation. The triage for persons exposed to radiation is to sort them into categories of high, intermediate and low, and is associated with acute radiation syndrome. [165]

**triangular distribution:** A bounded probability density function in the shape of a triangle that may be either asymmetric or symmetric. It is usually characterized by three parameters; minimum value, mode (or apex), and maximum value. In a symmetrical distribution the mean, median and mode are all equal. [164]

**triangular distribution:** A bounded probability density function that may be either asymmetric or symmetric, usually characterized by three parameters: the mean, median and mode. A triangular distribution is frequently used when the true distribution is unknown but the extremes and a mean or modal value of the distribution can be estimated. [163]

**trivalent:** Having a valence of three. [156]

**trophic level:** Refers to feeding position in the food chain. Examples include herbivores, carnivores, predator, prey, etc. [154]

**trophoblast:** (1) Extraembryonic ectoderm other than that lining the amniotic cavity and chorioamniotic duct. (2) Cytotrophoblast cell, including trophoblastic giant cells. [128]

**trophoblastic cell:** Giant cells derived from trophoblast; they are usually mononucleate, but sometimes multinucleate. [128]

**true value:** An approximation of the true value of a quantity. Errors must be approximated because the true value cannot be known. [163]

**tumor suppressor gene:** A gene that reduces the probability that a normal cell will turn into a tumor cell. A mutation or deletion of a tumor suppressor gene could increase the probability of formation of a tumor. [159]

**tumulus:** An artificial mound. The tumulus concept for waste disposal involves construction of a pad (normally concrete) on or below the ground surface, placement of individual waste containers or packages on the pad (normally in stacks), and placement of earthen materials above the waste to form a cap. [152]

**turnover:** Refers to the replacement of the contents of a compartment, such as the water in a lake or the air in a confined space. Often of interest, is the rate of replacement or turnover. [154]

**two-source rule:** This phrase refers to the conservatively safe, and often used, guideline that, when a location is to be shielded from two different sources of radiation, each passing through the same barrier, the resultant thickness of the barrier should be equal to the greater of the two individual thicknesses if they differ from one another by more than a TVL, or else it should be equal to the greater thickness plus one added HVL, as determined by the more penetrating of the two radiation sources. [151]

**Type I cells:** Large, flattened cells that line the alveoli covering about 97 % of the lung surface; they maintain the barrier between the air and blood of the lung. [125]

**Type-I error:** An error made when a null hypothesis is rejected when it is in fact true. [158]

**Type II cells:** Cuboidal cells of the alveoli that synthesize, secrete and recycle components of pulmonary surfactant. [125]

**Type-II error:** An error made when a null hypothesis is not rejected when in fact it is false. [158]

**Type-A assessment endpoint:** A frequency distribution describing inter-individual variability of true doses in a population, as an assessment endpoint. [164]

**Type-A uncertainty:** Uncertainty arising from the true stochastic inter-individual variability of a quantity used in an internal dose calculation. [164]

**Type-A uncertainty:** Uncertainty arising from the true stochastic inter-individual variability of a quantity used in a dose calculation. Type-A uncertainty exists only when the assessment endpoint is the assessment of a true frequency distribution of true values. [163]

**Type-B assessment endpoint:** Probability distribution describing lack of knowledge about a fixed but unknown dose to an individual, as an assessment endpoint [164]

**Type-B uncertainty:** Uncertainty arising from the lack of knowledge about a fixed but unknown quantity used in an internal dose calculation [164]

**Type-B uncertainty:** Uncertainty arising from the lack of knowledge about a fixed but unknown a quantity used in a dose calculation. [163]

**Types F, M, and S:** Refers to “absorption types” of inhaled material as defined by ICRP (1994a) and represent material that dissolves at fast, moderate or slow rates in the respiratory tract and is absorbed to blood at relatively-low, moderate or high rates, respectively. [161]

**type test:** (1) A test executed on one or a group of identical systems that is representative of a class of tests and which is taken as sufficient evidence of the performance of the system to be representative of all such systems. (2) A specialized radiation-generating machinery performance test designed to ensure all aspects of the machine’s function meet the specifications provided by the contracting agency. [Comm20]

**typical path lung model (TPLM):** Lung model using a single unique pathway to represent either the total lung or a portion of the lung. [125]

**ubiquitous background radiation:** Includes external exposure from space radiation (solar particles and cosmic rays), external exposure from terrestrial radiation (primarily  $^{40}\text{K}$  and the  $^{238}\text{U}$  and  $^{232}\text{Th}$  decay series), internal exposure from inhalation of radon and thoron and their progeny, and internal exposure from radionuclides in the body. [160]

**ultrafilterable:** Small enough to pass through a micropore filter. [156]

**ultrasonography:** The use of sonic energy (sound) to produce a pictorial representation of the internal structure of the breast. The image is produced by pulse-echo techniques, with detection and display of tissue interfaces rather than densities. [149]

**umbilical cord:** Vascular cord that connects a fetus to its placenta. [128]

**uncertainty:** Lack of sureness or confidence in predictions of models or results of measurements. Uncertainties may be categorized as those due to stochastic variation, or as those due to lack of knowledge founded on an incomplete characterization, understanding or measurement of a system. [168]

**uncertainty:** A quantitative measure of the lack of sureness or confidence in predictions of models or results of measurements. Uncertainties are taken into account in: measurements of input parameters for breath, urine, feces, blood and tissue samples; assumptions in modeling of radionuclide retention and distribution in the body; and assumptions in parameter values used in biokinetic and dosimetric models. Uncertainty can arise from stochastic variability (Type A or aleatory) or from lack of relevant information or knowledge (Type B or epistemic). [164]

**uncertainty:** (1) The general concept of lack of sureness or confidence in predictions of models or results of measurements. Uncertainties may be due to stochastic variation, or due to lack of knowledge founded on an incomplete characterization, understanding or measurement of a system (see aleatory, epistemic, Type-A uncertainty, Type-B uncertainty); or (2) specific quantities that provide quantitative measures of the general concept, for example, the standard deviation. [163]

**uncertainty:** Lack of sureness or confidence in predictions of models or results of measurements. Uncertainties may be categorized as Type A (or aleatory), which are those due to stochastic variation, or Type B (or epistemic), which are those due to lack of knowledge founded on an incomplete characterization, understanding or measurement of a system. [160]

**uncertainty:** Lack of sureness or confidence in predictions of models or results of measurements. Uncertainties may be categorized as Type A (or aleatory), which are those due to stochastic variation, or Type B (or epistemic), which are those due to lack of knowledge founded on an incomplete characterization, understanding or measurement of a system. Type-B uncertainties generally are the most important in assessing the long-term performance of waste disposal systems. [152]

**uncertainty analysis:** Analysis of variability in model predictions due to uncertainty in input parameters or other assumptions. [164]

**uncontrolled area:** Any space not meeting the definition of controlled area (see controlled area). [168]

**uncontrolled (noncontrolled) area:** Any space not meeting the definition of controlled area. [147]

**undercutting:** Penetration of radiation through cracks of shielding barriers or through thin sections of such barriers (e.g., edges of structures), resulting in a greater dose-equivalent rate than that resulting from passage of radiation through the bulk of the shielding barrier. [144]

**undisturbed performance:** Projected performance of a waste disposal system absent human intrusion. [152]

**uniform distribution:** A bounded probability density function in a shape of a rectangle. It is usually characterized by two parameters: the minimum and maximum values. It is used to represent a uniform or equal probability between the minimum and the maximum values. [164]

**uniform distribution:** Refers to the condition in which radionuclides are dispersed throughout a tissue, organ or body in contrast to radionuclides being concentrated within small volumes of tissue, perhaps as particles. [161]

**uniform distribution:** The uniform distribution assigns equal likelihood to all values within the range of the distribution. [126]

**uniform distribution:** A probability density function that assigns equal likelihood to all values within a specified range. [158]

**unit dosage:** A precalibrated single dosage of a radiopharmaceutical in an individual container, intended for use in only one patient. [124]

**universal precautions:** An approach to infection control in which all human blood and certain human body fluids are treated as if known to be infectious for human immunodeficiency virus, hepatitis B virus, and other blood-borne pathogens. Other potentially infectious materials include semen, vaginal secretions, cerebrospinal fluid, peritoneal fluid, amniotic fluid, saliva, any body fluid that is visibly contaminated with blood, and all body fluids in situations where it is difficult or impossible to differentiate between body fluids. [145]

**unsaturated zone:** Portion of subsurface zone, usually starting at the land surface, in which openings (voids and pores) are not completely filled with water. [152]

**unsharpness:** The inability of an x-ray imaging system to clearly define an edge on the final image (also called blur). [149]

**unspecified individual:** A hypothetical individual with a realistic exposure history, and realistic physiological and anatomical characteristics (e.g., adult worker, pregnant woman, member of the public exposed in childhood, at a given age, or maximally-exposed individual). An unspecified individual has certain defined biokinetic and dosimetric parameters which have fixed values with no uncertainty, while the remaining parameters have an uncertainty given at least by the variability of that parameter in the population. [164]

**upregulate:** The function of increasing the rate or product of a biological process.

**uptake:** Refers to the process of radionuclide transport from the environment into biological tissues (e.g., soil to plants, water to fish, etc.). In the medical use of radioactivity, uptake refers to the accumulation of administered radioactivity to a particular organ or tissue at a particular time after administration. [164]

**uptake:** Quantity of a radionuclide taken up by the systemic circulation (e.g., by injection into the blood, by absorption from compartments in the respiratory or gastrointestinal tracts, or by absorption through the skin or through wounds in the skin). [161]

**uptake:** Quantity of a radionuclide taken up by the systemic circulation (e.g., by absorption from compartments in the respiratory or gastrointestinal tracts). [156]

**uptake:** The process of radionuclide transport from the environment into biological tissues (e.g., soil to plants, water to fish, etc.). [154]

**uranium:** A naturally-radioactive element. In natural ores, it consists of 0.7 %  $^{235}\text{U}$ , 99.3 %  $^{238}\text{U}$ , and a small amount of  $^{234}\text{U}$ . [163]

**uranium fuel cycle:** Normal life cycle of uranium used as fuel in nuclear reactors including: mining of uranium ore; milling of uranium ore to produce  $\text{U}_3\text{O}_8$  concentrate; refining of that concentrate to remove impurities; chemical conversion of that concentrate to  $\text{UF}_6$ ; enrichment of the  $^{235}\text{U}$  content by gaseous diffusion; fabrication of nuclear fuel (usually by chemical conversion to  $\text{UO}_2$  and sintering into fuel rods); burning of fuel in a nuclear reactor for electricity generation, defense plutonium production, production of other isotopes, or research and development; chemical reprocessing of spent nuclear fuel to recover the remaining uranium and plutonium (commercial spent nuclear fuel is not currently reprocessed); consolidation of spent nuclear fuel rods or encapsulation of liquid reprocessing wastes in borosilicate glass or other suitable waste form preparatory to disposal; and storage and disposal of spent nuclear fuel and solidified reprocessing waste. [152]

**urban canyon:** An artifact of an urban environment similar to a natural canyon. It is caused by streets cutting through dense blocks of structures, especially skyscrapers, which cause a canyon effect that channels the wind. [165]

**usage factor:** Factor representing intakes of contaminated material by humans or livestock or residence time in a contaminated area leading to external exposure. [164]

**use factor (U) (beam direction factor):** Fraction of the workload during which the useful beam is directed at the barrier under consideration. [155]

**useful beam (or radiation):** That part of the radiation from a target which emerges from the source and its housing through an aperture, diaphragm or collimator. [144]

**user (of a radiation source):** Any individual who personally utilizes or manipulates a source of radiation. [148]

**utisol:** A classification name for soils in certain areas of the warm, humid southeastern United States. [154]





**vadose zone:** Portion of subsurface zone, usually starting at the land surface, in which openings (voids and pores) are not completely filled with water. This zone is often referred to as the unsaturated zone. [154]

**variability:** A stochastic heterogeneity, diversity or range that characterizes a measured value or parameter (e.g., differences in body weight in a population). Further study cannot reduce variability but it may explain the sources of variability.

Stochastic variability is one of the important sources of uncertainty in internal dosimetry (see uncertainty). [164]

**variability:** A heterogeneity, diversity or range that characterizes a measured value or parameter (e.g., differences in body weight in a population) or response (e.g., differences in sensitivity to a hazardous agent in a population). Further study cannot reduce variability but may provide additional information that may explain the reasons why variability exists and through this additional information the amount of variability assumed to be stochastic (unexplained) variability can be reduced. [163]

**variability:** A heterogeneity, diversity or range that characterizes a measured value or parameter (e.g., differences in body weight in a population). Further study cannot reduce variability but may provide greater confidence in quantitative characterizations of variability (see uncertainty). [160]

**variability:** The variation of a quantity among members of a population. Such variation is inherent in nature and is often assumed to be random; it can then be represented by a frequency distribution. [159]

**variability:** A heterogeneity, diversity or range that characterizes a measured value or parameter (e.g., differences in body weight in a population) or response (e.g., differences in sensitivity to a hazardous agent in a population). Further study cannot reduce variability but may provide greater confidence in quantitative characterizations of variability (see uncertainty). [158]

**variability:** A heterogeneity, diversity or range that characterizes a parameter (e.g., differences in body weight in a population) or response (e.g., differences in sensitivity to a hazardous agent in a population). Further study cannot reduce variability but may provide greater confidence in quantitative characterizations of variability (see uncertainty). [146]

**variance:** In a set of measurements  $\underline{n}$ , the sum of the squares of the deviations of individual values from the mean value, divided by  $(\underline{n} - 1)$ , the variance is usually denoted  $\underline{s}^2$ . [164]

**variance ( $\underline{\sigma}^2$ ):** In a set of  $\underline{n}$  measurements, the sum of the squares of the deviations from the mean,  $\sum(\underline{x}_i - \underline{\mu})^2$ , divided by  $(\underline{n} - 1)$ . [163]

**variance:** In a set of  $\underline{n}$  measurements, the sum of the deviations from the mean  $(\underline{x}_i - \underline{m})$ , divided by  $(\underline{n} - 1)$ . The variance is usually denoted  $\underline{s}^2$ . [158]

**variance:** The variance of a set of measurements is the average value of the squares of the deviations of individual values from the mean value. The individual deviations from the mean:  $(\underline{x}_1 - \underline{m})$ ,  $(\underline{x}_2 - \underline{m})$ ,  $(\underline{x}_3 - \underline{m})$ , ...  $(\underline{x}_n - \underline{m})$ . When all the deviations are squared, added together, and divided by  $(\underline{n} - 1)$ , the result is the variance, usually denoted  $\underline{s}^2$ . [156]

**vasoactive:** Exerting an effect on the caliber of blood vessels. [156]

**vault:** A shielded room in which a high-intensity radiation source is housed. [151]

**vector:** A quantity having both a magnitude and a direction. Velocity is an example of a vector; the direction of motion is the direction of the velocity vector and the speed is the magnitude of the velocity vector. [164]

**velocity of propagation:** Velocity at which a wave propagates. It is equal to the distance that a given point on a wave, such as the crest or trough, travels in 1 s. The unit is meter per second ( $\text{m s}^{-1}$ ). [119]

**ventral cavity:** A human body cavity that is in the anterior aspect of the human body and composed of the thoracic cavity, and the abdominopelvic cavity. The abdominopelvic cavity is further separated into the abdominal cavity and pelvic cavity, but there is no physical barrier between the two. The abdominal cavity contains digestive organs; the pelvic cavity contains the urinary bladder, internal reproductive organs, and rectum. [164]

**verification:** Determination that a computer (or any other) implementation of a mathematical equation or set of equations is without significant error. [163]

**vermiculite:** Any of various micaceous minerals that are hydrous silicates resulting usually from expansion of the granules of mica at high temperatures to give a lightweight material that is highly absorbent for water and other substances. [154]

**vertebrates:** Animals possessing an internal skeletal structure. [154]

**veterinary medicine:** The branch of medicine that deals with the diagnosis and treatment of diseases and injuries of animals by a licensed veterinarian. [160]

**view (radiographic):** The image on film resulting from projection of the x-ray beam through a patient, usually named according to the direction of the x-ray beam relative to the body (e.g., antero-posterior). [168]

**view:** The image of the breast on the film resulting from projection of the x-ray beam and the breast-positioning maneuvers performed by the radiologic technologist; usually named according to the direction of the x-ray beam relative to the breast (e.g., mediolateral, craniocaudal). [149]

**viewbox:** A device providing a relatively uniform surface luminance for viewing mammographic films. Mammographic viewboxes should have a luminance level of at least 3,000 candela per square meter ( $\text{cd m}^{-2}$ ). [149]

**VIP-Man:** A three-dimensional CT data set of an individual that is used as a phantom in dosimetry and imaging studies. Individual organs in the data set are discriminated by the value assigned to all voxels common to the chosen organ. [164]

**viscosity:** Internal friction of a fluid, caused by molecular attraction, that makes it resist a tendency to flow. [152]

**vital capacity:** Maximum amount of air breathed in during inspiration. [125]

**vitreous:** The semifluid, transparent substance which lies between the retina and the lens of the eye. [153]

**vitriification:** The conversion of a material into glass or a glassy substance by heat and fusion. This is often done to reduce the mobility of contaminants in the material of concern. [154]

**vitronectin:** A glycoprotein found in blood plasma, associated with hemostasis. [156]

**volatile:** Readily vaporizable at a relatively low temperature. [154]

**volatilize:** To make volatile; to cause to pass off in vapor. [154]

**von Hippel-Lindau syndrome:** A type of phacomatosis, consisting of hemangiomas of the retina; associated with hemangiomas of the cerebellum and walls of the fourth ventricle; sometimes associated with cysts or hamartomas of the kidney, adrenal or other organs. [150]

**voxel:** A volume pixel that is the smallest distinguishable box-shaped part of a three-dimensional image. [164]

**voxel phantom:** A phantom based on computed tomographic x ray and/or magnetic resonance imaging data of a real individual. Medical-imaging technologies provide high-resolution digital images of internal anatomy in cross-sectional slices of the body (see phantom and voxel). [164]

**voxel phantom:** A computational model of the body based on computed-tomographic x-ray and/or magnetic-resonance-imaging data of a real individual. Medical-imaging technologies provide high-resolution digital images of internal anatomy in cross-sectional slices of the body. [161]

**wall effects:** Distortions of measurements by the surrounding material of an instrument detection volume, leading to an increased or decreased estimation of number and size of energy-deposition events relative to the number and size of events that would occur in the given volume if the surrounding matter were of the same density and composition as the detection volume. [158]

**wall effects:** Distortions of microdosimetric measurements leading to an increased or decreased estimation of number and size of energy deposition events relative to the number and size of events that would occur in a given volume if the surrounding matter were of the same density as the volume of interest. [137]

**washout:** Below-cloud scavenging of particles and gases by falling raindrops or ice crystals. [154]

**washout factor:** The ratio of the volumetric activity density of a radionuclide in rainwater to the volumetric activity density in air at the same time and location. [154]

**waste classification:** Any grouping of wastes having similar attributes. [152]

**waste classification system:** (1) System for classifying waste arising from operations of nuclear fuel cycle including spent nuclear fuel (if it is declared to be waste), high-level waste, transuranic waste, low-level waste, and uranium or thorium mill tailings; or (2) system for classifying radioactive waste that is generally acceptable for near-surface disposal developed by U.S. Nuclear Regulatory Commission in 10 CFR Part 61. [152]

**waste dilution factor:** Fraction of a disposal facility that is occupied by waste following closure of the facility. [152]

**waste form:** Radioactive waste materials and any encapsulating or stabilizing matrix. [152]

**waste management:** Activities associated with disposition of waste products after their generation, including treatment, storage, transportation and disposal, as well as actions to minimize production of waste. [152]

**waste minimization:** The reduction, to the maximum extent feasible, of waste volume that is generated or subsequently treated, stored or disposed of. It includes any source reduction or recycling activity undertaken by a generator that results in either (1) the reduction of total volume or quantity of waste, or (2) the reduction of the toxicity of the waste, or (3) both, so long as such reduction is consistent with the goal of minimizing present and future threats to human health and the environment. [141]

**waste package:** Waste form and any containers, shielding, packing and other absorbent materials immediately surrounding a waste form. [152]

**water column:** The imaginary vertical column of water above a specified point within an aquatic ecosystem. [154]

**watershed:** The geographic area that collects water which forms a stream and which is defined by a particular location on the stream. [154]

**water table:** Level in saturated zone at which water pressure is equal to atmospheric pressure. [152]

**waveform:** An expression of the temporal variation of the operating potential applied to the x-ray tube in the course of an exposure.

- **single-phase:** Produced by conventional alternating current line current.
- **half-wave rectified:** Producing a single 1/120 s pulse of x rays during each 1/60 s alternating current cycle.
- **full-wave rectified:** Producing two 1/120 s pulses of x rays during each 1/60 s alternating current cycle.
- **three-phase:** Produced by three-phase full-wave rectified current, providing 12 overlapping 1/120 s pulses during each 1/60 s alternating current cycle.
- **constant potential:** Produced by electronic manipulation of alternating line current to provide constant tube voltage and a beam energy spectrum that varies little or not at all during exposure. [145]

**wavelength:** The distance between two adjacent crests of a wave (or the distance between two adjacent troughs or any other two corresponding points). The unit is the meter (m). [119]

**weathering:** The process of loss of a contaminant from plant surfaces (e.g., by actions of wind, rain or other disturbance) . The time required for half the material deposited onto surfaces of vegetation from the atmosphere to be lost is referred to as the weathering half-time. This term is also used to describe the process of mineral aging (i.e., the weathering of mica to form other minerals such as illite). [154]

**weathering half-time:** Time required for half the material deposited onto surfaces of vegetation from the atmosphere to be lost from plants (e.g., by actions of wind or rain). [152]

**week, calendar:** Seven consecutive days. [151]

**week, work:** Any combination of time intervals adding up to 40 h within seven consecutive days. [151]

**weighted dose:** The dose, roughly adjusted to account for the increased effectiveness of the small neutron absorbed dose contribution. The weighted dose equals the gamma-ray dose to a specified organ plus the neutron absorbed dose multiplied by a weighting factor that has usually been set equal to 10 in analyses by the Radiation Effects Research Foundation. Unit: 1 Sv = 1 J kg<sup>-1</sup>. [159]

**weighted likelihood Monte-Carlo sampling (WeLMoS) method:** A technique of quantifying uncertainties in estimated doses which enables one to extend the power of these techniques to calculate the actual probability distribution of dose from a given set of measurement data for an individual. It is widely used by a large European multidisciplinary epidemiological study Alpha Risk. [164]

**weightless mount:** Material on which source material is mounted which results in negligible radiation scattering from the mount. [112]

**western (man, diet, population):** Refers to data representing a reference person or population derived primarily from the characteristics of Western Europeans and North Americans. [163]

**wet deposition:** The removal of atmospheric gases or particles through their incorporation into precipitation which then reaches the ground (see deposition; compare to dry deposition). [154]

**wetland:** A land area that is continuously or very often water-saturated or submerged and which supports certain species of plants and animals adapted to very wet environments. [154]

**wheels:** Any form of transport for moving cargo containers at seaports. [Comm20]

**Wilm's tumor syndrome:** A malignant renal tumor of young children. [167]

**work:** A defined task or activity such as operations; maintenance and repair; administration; safety software development, validation, testing and use; inspection; or data collection and analysis. [162]

**working level (WL):** A unit of air concentration of potential alpha energy released from radon and its short-lived progeny. One working level is any combination of short-lived radon daughter products in one liter of air that will result in the emission of  $1.3 \times 10^5$  MeV (million electron volts) of potential alpha energy. 1 WL will result in the emission of  $2.08 \times 10^{-5}$  joules of energy. When defined, it gave rise to the limiting annual dose of 50 mSv. [164]

**working level month (WLM):** A cumulative exposure, equivalent to exposure to 1 WL for a working month (170 h) (i.e.,  $2.08 \times 10^{-5} \text{ J h m}^{-3} \times 170 \text{ h} = 3.54 \times 10^{-3} \text{ J h m}^{-3}$ ). [164]

**workload (W):** The average absorbed dose of radiation produced by a source over a specified time (most often one week) at a specific location. In Report No. 151, the workload is defined as the absorbed dose from photons at the isocenter, at 1 m from the source over a one week period averaged over a year. [151]

**workload, leakage radiation ( $W_L$ ):** The workload arising from leakage radiation and measured at 1 m from the source of leakage radiation. [151]

**workload, primary ( $W_{pri}$ ):** The workload arising from the primary beam (or useful beam). [151]



**xeroderma pigmentosum:** An eruption of skin exposed to sunlight occurring in childhood and characterized by photosensitivity with severe sunburn in infancy and subsequent emergence of dermal anomalies, including atrophic lesions and solar keratoses that undergo malignant change at an early age. [150]

**x rays:** Penetrating electromagnetic radiation having a range of wavelengths (energies). X rays are usually produced by interaction of the electron field around certain nuclei or by the slowing down of energetic electrons. [168]

**x ray:** (1) Electromagnetic radiation emitted in de-excitation of bound atomic electrons, and frequently occurring in decay of radionuclides, referred to as characteristic x rays, or (2) electromagnetic radiation produced in deceleration of energetic charged particles (e.g., beta radiation) in passing through matter, referred to as continuous x rays or bremsstrahlung (see gamma ray and photon). [167]

**x rays:** Penetrating electromagnetic radiation having a range of wavelengths (energies) that are similar to those of gamma photons. X rays are usually produced by interaction of the electron field around certain nuclei or by the slowing down of energetic electrons. Once formed, there is no physical difference between gamma- and x-ray photons; however, there is a difference in their origin (see bremsstrahlung). [166]

**x ray:** Electromagnetic radiation with energy higher than ultraviolet radiation, the primary source of which is deceleration of electrons passing through matter. Referred to as continuous x rays or bremsstrahlung (see photon). [Comm20]

**x-ray converter:** Material in which electron energy is converted to x-ray energy (e.g., a thick target of high- $Z$  material). The term is usually applied to a target in which electron power is converted with a high degree of efficiency into x-ray power. [144]

**x-ray generator:** A type of electron accelerator in which the electron beam is used mainly for the production of x rays. [144]

**x-ray target:** The high-atomic number material used to convert an energetic electron beam into x rays by the bremsstrahlung process. [151]

**x-ray tube housing:** An enclosure constructed so that leakage radiation does not exceed specified limits. An x-ray tube housing so constructed that the leakage radiation measured at a distance of 1 m from the source cannot exceed 0.876 mGy air kerma (100 mR exposure) in 1 h when the x-ray tube is operated at its maximum continuous rated current for the maximum rated tube potential. [147]



**yard mule:** A small cab, low tractor-trailer truck used for moving cargo containers within seaports. [Comm20]

**years at risk:** The difference between the time that has elapsed between the exposure to the presumed causative agent and the time that the endpoint is observed minus the minimum latent period. [159]

**yellowcake:** A product of uranium mills, concentrated in uranium content and suitable for shipment for further processing into fuel for reactors. The product is often in the form of a uranium oxide ( $U_3O_8$ ). [118]

**yield:** The number of photons or particles of a given energy produced per decay of a radioactive radionuclide. [164]

**yield (or energy yield):** The total effective energy released in a nuclear (or atomic) explosion. It is usually expressed in terms of the equivalent tonnage of TNT required to produce the same energy release in an explosion. The total energy yield is manifested as nuclear radiation, thermal radiation, and shock (and blast) energy, the actual distribution being dependent upon the medium in which the explosion occurs (primarily) and also upon the type of weapon and the time after detonation (see TNT equivalent). [159]

**yield ( $\bar{Y}$ ):** The total radiation emitted per unit time from an accelerator target as measured over a particular solid angle divided by the beam current incident on the target. [144]

**yield strength:** Stress level at which a material attains a specified strain. [152]

**yolk sac:** In placental mammals, a membranous sac with walls composed of endoderm and mesoderm that is attached to the embryo. The structure has the primary nutritional function prior to the elaboration of the placenta, and is the initial source of the primitive hematopoietic and germinal cells. [128]



**Z dependence:** A physical effect under which the atomic number (Z) of a material plays a large predictive role in the outcome of some sort of event, such as the interaction of electromagnetic radiation with matter. [Comm20]

**Z; low-Z, high-Z:** The symbol for the atomic number of a nucleus (i.e., the number of protons contained in the nucleus). Low-Z describes nuclei with  $\underline{Z} < 26$ . High-Z describes nuclei with  $\underline{Z} > 26$ . Very high-Z describes nuclei with  $\underline{Z} > 73$ . [161]

**zeolite:** Any of a number of hydrous silicates of aluminum, sodium or calcium found in cavities of igneous rocks. It is sometimes used to adsorb radionuclides from solution. [154]

**zooplankton:** That portion of the plankton classified as being within the animal kingdom (see plankton). [154]

**Z score:** In this term, Z is the standard normal deviate and the Z score indicates how many standard deviations an observation is above or below the mean. [163]

**zygote:** Fertilized ovum from the time of intermingling of the contents of the male and female pronuclei. [128]