

Glossary - Ionizing Radiation

ablation: The functional destruction of an organ through surgery or exposure to large doses of radiation.

absorbed dose: The amount of a substance (e.g., a chemical) that enters the body of an exposed organism. OR The energy imparted by *ionizing radiation* per unit of irradiated material. The units of absorbed dose are the rad and the gray (Gy).

absorber: Any material that absorbs or lessens the intensity of ionizing radiation. Neutron absorbers (like boron, hafnium, and cadmium) are used in control rods for reactors. Concrete and steel absorb gamma rays and neutrons in reactor shields. A thin sheet of paper or metal will absorb or weaken alpha particles and all except the most energetic beta particles

absorption: The movement of a substance (e.g., a chemical) through a membrane into the body after exposure has occurred. OR The process by which the number of particles or photons entering a body of matter is reduced or attenuated by interaction with the matter.

Access Hatch (air lock): An airtight door system that preserves the pressure integrity of a reactor containment building while allowing access to personnel and equipment.

accuracy: The quality of being free from error, or the degree of conformity of a measure to a standard or a true value.

activation: The process of making a material radioactive by bombardment with neutrons, protons, or other nuclear radiation.

activation products: *See induced radioactivity.*

activity: The rate of disintegration (transformation) or decay of radioactive material. The units of activity are the curie (Ci) and the becquerel (Bq).

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

acute exposure: Exposure over a short amount of time. OR The absorption of a relatively large amount of radiation (or intake of radioactive material) over a short period of time.

acute health effects: Prompt radiation effects (those that would be observable within a short period of time) for which the severity of the effect varies with the dose, and for which a practical threshold exists.

acute radiation sickness (syndrome): *See radiation sickness (syndrome).*

added filtration: Any filtration which is in addition to the inherent filtration.

adult: An individual 18 or more years of age.

agreement state: Any State with which the U.S. Nuclear Regulatory Commission or the U.S. Atomic Energy Commission has entered into an effective agreement under subsection 274b. of the Atomic Energy Act of 1954, as amended (73 Stat. 689).

airborne radioactive material: Radioactive material dispersed in the air in the form of dusts, fumes, particulates, mists, vapors or gases.

airborne radioactivity area: A room, enclosure, or area in which airborne radioactive materials exist in concentrations--

(1) In excess of the specified *derived air concentrations* (DACs)

(2) To such a degree that an individual present in the area without respiratory protective equipment could exceed, during the hours an individual is present in a week, an intake of 0.6 percent of the annual limit on intake (ALI) or 12 DAC-hours.

air lock: *See access hatch.*

air sampling: The collection and analysis of samples of air to measure its radioactivity or to detect the presence of radioactive substances, particulate matter or chemical pollutants.

alara (acronym for “as low as is reasonably achievable”): Making every reasonable effort to maintain exposure to radiation as far below the dose limits as is practical consistent with the purpose for which the licensed activity is undertaken, taking into account the same technology, the economics of improvements in relation to state of technology, the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to utilization of nuclear energy and licensed materials in the public interest.

alpha particle: A positively charged particle ejected spontaneously from the nuclei of some radioactive elements. It is identical to a helium nucleus that has a mass number of 4 and an electrostatic charge of +2.

aluminum equivalent: The thickness of type 1100 aluminum alloy^a affording the same attenuation, under specified conditions, as the material in question.

analytical x-ray equipment: Equipment used for x-ray diffraction or fluorescence analysis.

analytical x-ray system: A group of components utilizing x or gamma rays to determine the elemental composition or to examine the microstructure of materials.

anion: Negatively charged ion. (*See ionization.*)

annual limit on intake (ALI): The derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. ALI is the smaller value of intake of a given radionuclide in a year by the reference man that would result in a *committed effective dose equivalent* of 5 rems (0.05 Sv) or a *committed dose equivalent* of 50 rems (0.5 Sv) to any individual organ or tissue.

atom: The smallest particle of an *element* that cannot be divided or broken up by chemical means. It consists of a central core called the *nucleus*, which contains *protons* and *neutrons*. *Electrons* revolve in orbits in the region surrounding the nucleus.

atomic energy: Energy released in *nuclear reactions*. Of particular interest is the energy released when a *neutron* initiates the breaking up or *fissioning* of an *atom's nucleus* into smaller pieces (*fission*), or when two nuclei are joined together under millions of degrees of heat (*fusion*). It is more correctly called "*nuclear energy*."

atomic number: The number of positively charged *protons* in the *nucleus* of an *atom* and the number of electrons on an electrically neutral atom.

atomic weight: *See mass number.*

attenuation: The process by which a beam of radiation is reduced in intensity when passing through some material. It is the combination of absorption and scattering processes and leads to a decrease in flux density of the beam when projected through matter.

^a The nominal chemical composition of type 1100 aluminum alloy is 99.00% minimum aluminum, 0.12% copper.

attenuation coefficient: Of a substance, for a parallel beam of specified radiation: the quantity μ , in the expression μdx for the fraction removed by attenuation in passing through a thin layer thickness dx of that substance. It is a function of the energy of the radiation. As dx is expressed in terms of length, mass per unit area, moles or atoms per unit area, μ 's called the linear, mass, molar, or atomic attenuation coefficient respectively.

auxiliary building: Building at a nuclear power plant, frequently located adjacent to the reactor containment building, that houses most of the reactor auxiliary and safety systems, such as radioactive waste systems, chemical and volume control systems, and emergency cooling water systems.

auxiliary feedwater: Backup *feedwater* supply used during nuclear plant *startup* and *shutdown*; also known as *emergency feedwater*. (See *feedwater*.)

background radiation: Radiation from cosmic sources; naturally occurring radioactive materials, including radon (except as a decay product of *source* or *special nuclear material*) and global fallout as it exists in the environment from the testing of nuclear explosive devices. *Background radiation* does not include *radiation* from *source*, *byproduct*, or *special nuclear materials*.

beam limiting device: A device which provides a means to restrict the dimensions of the x-ray field.

beta particle: A charged particle emitted from a *nucleus* during *radioactive decay*, with a mass equal to 1/1837 that of a *photon*. A negatively charged beta particle is identical to an *electron*. A positively charged beta particle is called a *positron*. Large amounts of beta radiation may cause skin burns, and beta emitters are harmful if they enter the body. Beta particles are easily stopped by a thin sheet of metal or plastic.

becquerel: A unit, in the International System of Units (SI), of measurement of radioactivity equal to one transformation per second.

binding energy: The minimum energy required to separate a *nucleus* into its component *neutrons* and *photons*.

bioassay (radiobioassay): The determination of kinds, quantities or concentrations, and, in some cases, the locations of radioactive material in the human body, whether by direct measurement (in vivid counting) or by analysis and evaluation of materials excreted or removed from the human body.

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

biological shield: A mass of *absorbing* material placed around a *reactor* or *radioactive* source to reduce the *radiation* to a level safe for humans.

body burden: The amount of *radioactive* material which if deposited in the total body will produce the maximum permissible dose rate to the body organ considered the critical organ..

boiling water reactor (bwr): A *reactor* in which water, used as body *coolant* and *moderator*, is allowed to boil in the *core*. The resulting steam can be used directly to drive a *turbine* and electrical generator.

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

brachytherapy: A method of radiation therapy in which sealed sources are utilized to deliver a radiation dose at a distance of up to a few centimeters, by surface, intracavitary, or interstitial

breeder: A reactor that produces more nuclear fuel than it consumes. A *fertile material*, such as *uranium-238*, when bombarded by *neutrons*, is transformed into a *fissile material*, such as *plutonium-239*, which can be used as fuel. (See *fissile*, *fissionable* and *fertile material*.)

bremstrahlung: Secondary photon radiation produced by deceleration of charged particles through matter.

BTU: A British thermal unit. The amount of heat required to change the temperature of one pound of water one degree Fahrenheit at sea level.

buffer zone: An expanded portion of the restricted zone selected for temporary radiation protection controls until the stability of radioactivity levels in the area is confirmed.

buildup factor: In the passage of radiation through a medium, the ratio of the total value of a specified radiation quantity at any point to the contribution to that value from radiation reaching the point through the medium without having undergone a collision.

buildup factor, energy absorption, BA: A photon buildup factor in which the quantity of interest is the absorbed or deposited energy in the shield medium. The energy response function is that of absorption in the material.

buildup factor, exposure, B_D: A photon buildup factor in which the quantity of interest is exposure. The energy response function is that of absorption in air.

BWR: A *boiling water reactor*.

by product material: (1) Any radioactive material (except *special nuclear material*) yielded in, or made *radioactive* by, exposure to the radiation incident to the process of producing or utilizing special nuclear material; and (2) The tailings or wastes produced by the extraction or concentration of uranium or thorium from ore processed primarily for its source material content, including discrete surface wastes resulting from uranium solution extraction processes. Underground bodies depleted by these solution extraction operations do not constitute byproduct material within this definition.

cabinet radiography: Industrial radiography conducted in an enclosure or cabinet shielded so that radiation levels at every location on the exterior meet the limitations specified in the regulations.

cabinet x-ray system: An x-ray system with the x-ray tube installed in an enclosure independent of existing architectural structures except the floor on which it may be placed. The cabinet x-ray system is intended to contain at least that portion of a material being irradiated, provide radiation attenuation, and exclude personnel from its interior during generation of radiation. Included are all x-ray systems designed primarily for the inspection of carry-on baggage at airline, railroad, and bus terminals, and in similar facilities. An x-ray tube used within a shielded part of a building, or x-ray equipment which may temporarily or occasionally incorporate portable shielding, is not considered a cabinet x-ray system.

calibration: The check or correction of the accuracy of a measuring instrument to assure proper operational characteristics. (See *counter*.)

CANDU: Canadian Deuterium Uranium-heavy water moderated natural uranium fuel reactor manufactured by Canada.

carrier: A person engaged in the transportation of passengers or property by land or water as a common, contract, or private carrier, or by civil aircraft.

cask: A heavily *shielded* container used to store and/or ship radioactive materials. Lead and steel are common materials used in the manufacture of casks.

cation: A positively charged *ion*. (See *ionization*.)

cephalometric device: A device intended for the radiographic visualization and measurement of the dimensions of the human head.

certified components: Components of x-ray systems which are subject to regulations promulgated under Public Law 90-602, the Radiation Control for Health and Safety Act of 1968.

chain reaction: A reaction that stimulates its own repetition. In a fission chain reaction, a fissionable nucleus absorbs a neutron and fissions, releasing additional neutrons. These

in turn can be absorbed by other fissionable nuclei, releasing still more neutrons. A fission chain reaction is self-sustaining when the number of neutrons released in a given time equals or exceeds the number of neutrons lost by absorption in nonfissionable material or by escape from the system.

charged particle: An *ion*. An elementary particle carrying a positive or negative electric charge.

chemical compound: See *compound*.

chemical recombination: Following an *ionization* event, the positive and negatively charged *ion* pairs may or may not realign themselves to form the same chemical substance they formed before ionization. Thus, chemical recombination could change the chemical composition of the material bombarded by *radiation*.

china syndrome: The hypothetical result of a power reactor core melt accident in which molten fuel melts through the reactor pressure vessel and the bottom of the containment building and into the earth “all the way to China.”

chronic exposure: The absorption of radiation (or intake of radioactive materials over a long period of time (i.e., over a lifetime).

cladding: The thin-walled metal tube that forms the outer jacket of a nuclear *fuel rod*. It prevents corrosion of the fuel by the coolant and the release of *fission products* into the coolant. Aluminum, stainless steel and zirconium alloys are common cladding materials.

class (or lung class or inhalation class): A classification scheme for inhaled material according to its rate of clearance from the pulmonary region of the lung. Materials are classified as D, W, or Y, which applied to a range of clearance half-times; for Class D (Days) of less than 10 days, for Class W (Weeks) from 10 to 100 days, and for Class Y (Years) of greater than 100 days.

cleanup system: A system used for continuously filtering and demineralizing the *reactor coolant system* to reduce *contamination* levels and minimize corrosion.

cloudshine: Gamma radiation from radioactive materials in an airborne plume.

coastdown: An action that permits the reactor power level to decrease gradually as the fuel in the *core* is depleted.

cold neutrons: Neutrons in thermal equilibrium with an environment cooled well below 20°C, typically at 20-50° Kelvin.

cold shutdown: The term used to define a *reactor coolant system* at atmospheric pressure and at a temperature below 212°F following a reactor cooldown. (See *control rod*.)

collective dose: The sum of the individual *doses* received in a given period of time by a specified population from *exposure* to a specified source of radiation.

collimator: A device used to limit the size, shape, and direction of the primary radiation beam.

committed dose equivalent ($H_{T,50}$): The *dose equivalent* to organs or tissues of reference (T) that will be received from an intake of radioactive material by an individual during the 50-year period following the intake. The ICRP defines this as the *committed dose equivalent*.

committed effective dose: See *committed effective dose equivalent*.

committed effective dose equivalent ($H_{E,50}$): The sum of the products of the weighting factors applicable to each of the body organs or tissues that are irradiated and the committed dose equivalent to these organs or tissues

$$(H_{E,50} = \sum W_T H_{T,50})$$

The ICRP defines this as the *committed effective dose*.

committed equivalent dose: See *committed dose equivalent*.

compound: A chemical combination of two or more *elements* combined in a fixed and definite proportion by weight.

computed tomography: The production of a tomogram by the acquisition and computer processing of x-ray transmission data.

condensate: Water that has been produced by the cooling of steam in a condenser.

condenser: A large *heat exchanger* designed to cool exhaust steam from a *turbine* below the boiling point so that it can be returned to the heat source as water. In a *pressurized water reactor*, the water is returned to the *steam generator*. In a *boiling water reactor*, it returns to the *reactor core*. The heat removed from the steam by the condenser is transferred to a circulating water system and is exhausted to the *environment*, either through a *cooling tower* or directly into a *body of water*. (See *cooling tower*.)

contamination: The deposition of unwanted *radioactive* material on the surfaces of structures, areas, objects, or personnel..

containment: The provision of a gastight shell or other enclosure around a *reactor* to confine *fission products* that otherwise might be released to the atmosphere in the event of an accident..

control rod: A rod, plate or tube containing a material such as hafnium, boron, etc., used to control the power of a *nuclear reactor*. By absorbing *neutrons*, a control rod prevents the neutrons from causing further *fission*. (See poison.)

controlled area: An area outside of a *restricted area* but inside the site boundary, access to which can be limited by the licensee for any reason..

control room (building): The area in a nuclear power plant from which most of the plant power production and emergency safety equipment can be operated by remote control.

coolant: A substance circulated through a *nuclear reactor* to remove or transfer heat. The most commonly used coolant in the United States is water. Other coolants include *heavy water*, air, carbon dioxide, helium, liquid sodium and sodium-potassium alloy.

cooldown: The gradual decrease in reactor fuel rod temperature caused by the removal of heat from the *reactor coolant system*.

cooling tower: A *heat exchanger* designed to aid in the cooling of water that was used to cool exhaust steam exiting the turbines of a power plant. Cooling towers transfer exhaust heat into the air instead of into a body of water.

core: The central portion of a *nuclear reactor* containing the *fuel elements*, *moderator*, neutron *poisons* and support structures.

core melt accident: See *China syndrome*.

correction factor, shield tissue interface: A correction factor to be applied to the basic infinite-medium exposure buildup factor to correct for the scattering in a tissue phantom after emerging from a shield.

cosmic radiation: Penetrating *ionizing radiation*, both particulate and electromagnetic, originating in space. Secondary cosmic rays, formed by interactions in the earth's atmosphere, account for about 45 to 50 *millirem* annually..

counter: A general designation applied to *radiation detection instruments* or *survey meters* that detect and measure radiation. The signal that announces an *ionization* event is called a count. (See *Geiger-Mueller counter*.)

critical mass: The smallest mass of *fissionable material* that will support a self-sustaining *chain reaction*.

critical organ: The body organ receiving a radionuclide or radiation dose that results in the greatest overall damage to the body.

criticality: A term used in *reactor* physics to describe the state when the number of neutrons released by fission is exactly balanced by the neutrons being absorbed (by the fuel and poisons) and escaping the reactor core. A reactor is said to be “critical” when it achieves a self-sustaining nuclear *chain reaction*.

crud: A colloquial term for corrosion and wear products (rust particles, etc.) that become *radioactive* under a *radiation* flux. (See *induced radioactivity*.)

cumulative dose: The total dose resulting from repeated exposures of *radiation* to the same region, or to the whole body, over a period of time.

curie (Ci): The basic unit used to describe the intensity of *radioactivity* in a sample of material. The curie is equal to 37 billion disintegration’s per second, which is approximately the rate of *decay* of 1 gram of *radium*. A curie is also a quantity of any *radionuclide* that decays at a rate of 37 billion disintegration’s per second. Names for Marie and Pierre Curie, who discovered radium in 1898.

daughter products: Isotopes that are formed by the *radioactive decay* of some other isotope. In the case of *radium-226*, for example, there are 10 successive daughter products, ending in the *stable isotope* lead-206.

decay heat: The heat produced by the *decay* of *radioactive fission products* after the *reactor* has been shut down. (See *residual heat*.)

decay, radioactive: The decrease in the amount of any *radioactive* material with the passage of time, due to the spontaneous emission from the atomic nuclei of either *alpha* or *beta particles*, often accompanied by *gamma radiation*. (See *half-life; radioactive*.)

declared pregnant woman: A woman who has voluntarily informed her employer, in writing, of her pregnancy and the estimated date of conception.

decontamination: The reduction or removal of contaminating radioactive material from a structure, area, object, or person. Decontamination may be accomplished by (1) treating the surface to remove or decrease the *contamination*; (2) letting the material stand so that the *radioactivity* is decreased as a result of natural *decay*; and (3) covering the contamination to *shield* or *attenuate* the radiation emitted.

deep-dose equivalent (H_d): Which applies to external whole-body exposure, is the dose equivalent at a tissue depth of 1 cm (1000 mg/cm²).

delayed health effects: Radiation effects which are manifested long after the relevant exposure. The vast majority are stochastic, that is, the severity is independent of dose and the probability is assumed to be proportional to the dose, without threshold.

depleted uranium: *Uranium* having a percentage of uranium-235 smaller or the 0.7% found in *natural uranium*. It is obtained from *spent* (used) *fuel elements* or as by-product *tails*, or residues, from *uranium isotope separation*. (See *mill tailings*.)

deposition probability (in lung region): The fraction of the activity or mass of an inhaled aerosol which is deposited in a particular region of the lung.

derived air concentration (DAC): The concentration of a given radionuclide in air which, if breathed by the *reference man* for a working year of 2,000 hours under conditions of light work (inhalation rate 1.2 cubic meters of air per hour), results in an intake of one ALI.

derived air concentration-hour (DAC-hour): The product of the concentration of radioactive material in air (expressed as a fraction or multiple of the *derived air concentration* for each radionuclide) and the time of exposure to that radionuclide, in hours. A licensee may take 2,000 DAC-hours to represent one ALI equivalent to a *committed effective dose equivalent* of 5 rems (0.05 Sv).

derived response level (DRL): A level of radioactivity in an environmental medium that would be expected to produce a dose equal to its corresponding *Protective Action Guide*.

design-basis accident: A postulated accident that a nuclear facility must be designed and built to withstand without loss to the systems, structures and components necessary to assure public health and safety.

design-basis phenomena: Earthquakes, tornadoes, hurricanes, floods, etc., that a nuclear facility must be designed and built to withstand without loss to the systems, structures, and components necessary to assure public health and safety. (See *seismic Category 1*.)

detector: A material or device that is sensitive to radiation and can produce a response signal suitable for measurement or analysis. A *radiation detection instrument*. (See *counter*.)

deuterium: An *isotope* of hydrogen with one *proton* and one *neutron* in the nucleus. (See *heavy water*.)

deuteron: The *nucleus* of *deuterium*. It contains one *proton* and one *neutron*.

diagnostic x-ray system: An x-ray system designed for irradiation of any part of the human body for the purpose of diagnosis or visualization.

differential pressure (DP): The difference in pressure between two points of a system, such as between the inlet and outlet of a pump.

disintegration: See decay, radioactive.

doppler coefficient: See *fuel temperature coefficient of reactivity*.

dose or radiation dose: A generic term that means *absorbed dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, or total effective dose equivalent*, as defined elsewhere in this section.

dose conversion factor: Any factor that is used to change an environmental measurement to *dose* in the units of concern. Frequently used as the factor that expresses the *committed effective dose equivalent* to a person from the intake (inhalation or ingestion) of a unit activity of a given radionuclide.

dose equivalent (H_T): The product of the absorbed dose in tissue, *quality factor*, and all other necessary modifying factors at the location of interest. The units of *dose equivalent* are the rem and sievert (Sv). The ICRP defines this as the *equivalent dose*.

dose rate: The *radiation dose* delivered per unit of time. Measured, for example, in *rem* per hour.

dosimeter: A portable instrument for measuring and registering the total accumulated exposure to *ionizing radiation*. (See *dosimetry*.)

dosimetry: The theory and application of the principles and techniques involved in the measurement and recording of *radiation doses*. Its practical aspect is concerned with the use of various types of radiation instruments with which measurements are made. See *film badge; survey meter*.)

dosimetry processor: An individual or an organization that processes and evaluates individual monitoring equipment in order to determine the radiation dose delivered to the equipment.

drywell: The *containment* structure enclosing a *boiling water reactor* vessel and its recirculation system. The drywell provides both a pressure suppression system and a *fission product* barrier under accident conditions.

effective dose: See *effective dose equivalent*.

effective dose equivalent (H_E): The sum of the products of the dose equivalent to the organ or tissue (H_T) and the *weighting factors* (W_T) applicable to each of the body organs or tissues that are irradiated ($H_E = \sum W_T H_T$). The ICRP defines this as the *effective dose*.

effective half-life: The time required for the amount of a *radioactive* element deposited in a living organism to be diminished 50 percent as a result of the combined action of radioactive *decay* and biological elimination. (See *biological half-life*.)

efficiency, plant: The percentage of the total energy content of a power plant's fuel that is converted into electricity. The remaining energy is lost to the environment as heat.

electrical generator: An electromagnetic device that converts mechanical (rotational) energy into electrical energy. Most large electrical generators are driven by steam or water *turbine* systems.

electromagnetic radiation: A traveling wave motion resulting from changing electric or magnetic fields. Familiar electromagnetic radiations range from *x-rays* (and *gamma rays*) of short wavelength through the ultraviolet, visible, and infrared regions, to radar and radio waves of relatively long wavelength. All electromagnetic radiations travel in a vacuum with the velocity of light. (See *photon*.)

electron: An elementary particle with a unit negative charge and a mass 1/1837 that of the *photon*. Electrons surround the positively charged nucleus and determine the chemical properties of the atom. (See *beta particle*.)

element: One of the 103 known chemical substances that cannot be broken down further without changing its chemical properties. Some examples include hydrogen, nitrogen, gold, lead and *uranium*.

elimination: Removal of material from the body via urine, feces, sweat or exhalation. Excretion usually refers to elimination via urine or feces.

embryo/fetus: The developing human organism from conception until the time of birth. More accurately embryo; 2 wk (when implantation occurs) - 8 wk; fetus: end of wk 8-term.

emergency core cooling system [ECC(S)]: Reactor system components (pumps, valves, heat exchangers, tanks and piping) that are specifically designed to remove residual heat from the reactor *fuel rods* should the normal core cooling system (*reactor coolant system*) fail.

emergency feedwater: See auxiliary *feedwater*.

energy absorption coefficient: Of a substance, for a parallel beam of specified radiation: the quantity μ_{en} in the expression $\mu_{en}dx$ for the fraction removed by attenuation in passing through a thin layer of thickness dx of that substance. It is a function of energy of the radiation. As dx is expressed in terms of length, mass per unit area, moles per unit area, or atoms per unit area, μ_{en} is called the linear, mass, molar, or atomic energy

absorption coefficient. NOTE: It is that part of the attenuation coefficient resulting from energy absorption only, and is equal to the product of the energy transfer coefficient and $1-g$, where g is the fraction of the energy of secondary charged particles that is lost to bremsstrahlung in the material.

engineered barrier: A man-made structure or device that is intended to improve the land disposal facility's ability to meet performance objectives.

enrichment: See *isotopic enrichment*.

entrance exposure rate: The exposure per unit time at the point where the center of the useful beam enters the patient.

equivalent dose: See *dose equivalent*.

evacuation: The urgent removal of people from an area to avoid or reduce high-level, short-term exposure, usually from the plume or from deposited activity. Evacuation may be a preemptive action taken in response to a facility condition rather than an actual release.

excretion function: A function describing the time dependence of the quantity of material eliminated in urine or feces per day.

excursion: A sudden, very rapid rise in the power level of a *reactor* caused by *supercriticality*. Excursions are usually quickly suppressed by the *negative temperature coefficient*, the *fuel temperature coefficient* or the *void coefficient* (depending on reactor design), and by rapid insertion of *control rods*.

exposure: Being exposed to *ionizing radiation* or to radioactive material.

exposure: The quotient of dQ by dm where dQ is the absolute value of the total charge of the ions of one sign produced in air when all the electrons (negatrons and positrons) liberated by photons in a volume element of air having mass dm are completely stopped in air. The unit of *exposure* is the coulomb per kilogram (c/kg). One roentgen is equal to 2.58×10^{-4} coulomb per kilogram.

external dose: That portion of the dose equivalent received from radiation sources outside the body.

extremity: Hand, elbow, arm below the elbow, foot knee, or leg below the knee.

eye dose equivalent: Applies to the external exposure of the lens of the eye and is taken as the *dose equivalent* at a tissue depth of 0.3 centimeter (300 mg/cm^3).

fast fission: *Fission of a heavy atom (such as uranium-238) when it absorbs a high-energy (fast) neutron. Most fissionable materials need thermal (slow) neutrons in order to fission.*

fast neutron: *A neutron with kinetic energy greater than its surroundings released during fission.*

fast reactor: *A reactor in which the fission chain reaction is sustained primarily by fast neutrons rather than by slow-moving neutrons. Fast reactors contain little or no moderator to slow down the neutrons from the speeds at which they are ejected from fissioning nuclei.*

feedwater: *Water supplied to the reactor pressure vessel (in a BWR) or the steam generator (in a PWR) that removes heat from the reactor fuel rods by boiling and becoming steam. The steam becomes the driving force for the plant turbine generator.*

fertile material: *A material, which is not itself fissile (fissionable by thermal neutrons), that can be converted into a fissile material by irradiation in a reactor. There are two basic fertile materials, uranium-238 and thorium-232. When these fertile materials capture neutrons, they are converted into fissile plutonium-239 and uranium-233, respectively.*

film badge: *A pack of photographic film used for approximate measurement of radiation exposure for personnel monitoring purposes. The badge may contain two or three films of differing sensitivity and it may contain a filter that shields part of the film from certain types of radiation.*

fissile material: *Although sometimes used as a synonym for fissionable material, this term has acquired a more restricted meaning; namely, any material fissionable by thermal (slow) neutrons. The three primary fissile materials are uranium-233, uranium-235 and plutonium-239.*

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

fission gases: *Those fission products that exist in the gaseous state. Primarily the noble gases (krypton, xenon, radon, etc.).*

fission products: *The nuclei (fission fragments) formed by the fission of heavy elements, plus the nuclides formed by the fission fragments' radioactive decay.*

fissionable material: Commonly used as a synonym for *fissile material*, the meaning of this term has been extended to include material that can be fissioned by fast *neutrons*, such as *uranium-238*.

fluence: The number of radioactive particles, neutrons, or photons per unit cross-sectional area.

fluoroscopic imaging assembly: A subsystem in which x-ray photons produce a fluoroscopic image. It includes the image receptor(s) such as the image intensifier and spot film device electrical interlocks, if any and structural material providing linkage between the image receptor and diagnostic source assembly.

flux: A term applied to the amount of some type of *radiation* crossing a certain area per unit time. The unit of flux is the number of particles, energy, etc., per square centimeter per second.

flux density: The flux density at a point is the number of radioactive particles, neutrons, or photons passing per unit time, per unit area of the beam.

fuel assembly: A cluster of *fuel rods* (or plates). Also called a *fuel element*. Many fuel assemblies make up a *reactor core*.

fuel cycle: The series of steps involved in supplying fuel for *nuclear power reactors*. It can include mining, milling, *isotopic enrichment*, fabrication of fuel elements, use in a *reactor*, chemical reprocessing to recover the *fissionable material* remaining in the *spent fuel*, reenrichment of the fuel material, refabrication into new *fuel elements*, and waste disposal.

fuel element: See *fuel assembly*.

fuel reprocessing: The processing of reactor fuel to separate the unused *fissionable material* from waste material.

fuel rod A long, slender tube that holds *fissionable material* (fuel) for *nuclear reactor* use. Fuel rods are assembled into bundles called *fuel elements* or *fuel assemblies*, which are loaded individually into the *reactor core*.

fuel temperature coefficient of reactivity: The physical property of fuel *pellet* material (*uranium-238*) that causes the uranium to absorb more *neutrons* away from the *fission* process as fuel *pellet* temperature increases. This acts to stabilize *power reactor* operations. Also known as the *Doppler coefficient*.

fusion (thermonuclear reaction): A *nuclear reaction* characterized by joining together of light *nuclei* to form heavier nuclei, the energy for the reactions being provided by violent thermal agitation of particles at very high temperatures. If the colliding particles

are properly chosen and the agitation is violent enough there will be a release of energy from the reaction. The energy of the stars is derived from such reactions.

gap: The space inside a reactor *fuel rod* that exists between the fuel *pellet* and the fuel rod *cladding*.

gamma ray (gamma radiation): High-energy, short wavelength electromagnetic *radiation* (a packet of energy) emitted from the *nucleus*. Gamma radiation frequently accompanies *alpha* and *beta* emissions and always accompanies *fission*. Gamma rays are very penetrating and are best stopped or *shielded* against by dense materials, such as lead or *uranium*. Gamma rays are similar to *x-rays*, but are usually more energetic.

gas-cooled reactor: A *nuclear reactor* in which a gas is the *coolant*.

gases: Normally formless fluids that completely fill the space and take the shape of their container.

gaseous diffusion (plant): A method of *isotopic separation* based on the fact that gas *atoms* or *molecules* with different masses will diffuse through a porous barrier (or membrane) at different rates. This method is used to separate *uranium-235* from uranium-238; it requires large gaseous diffusion plants and enormous amounts of electric power.

geiger-mueller counter: A *radiation* detection and measuring instrument. It consists of gas-filled tube containing electrodes, between which there is an electrical voltage but no current flowing. When *ionizing radiation* passes through the tube a short, intense pulse of current passes from the negative electrode to the positive electrode and is measured or counted. The number of pulses per second measures the intensity of radiation. It was named for Hans Geiger and W. Mueller who invented it in the 1920s. It is sometimes called simply a Geiger counter, or a G-M counter.

general purpose radiographic x-ray system: Any radiographic x-ray system which, by design, is not limited to radiographic examination of specific anatomical regions.

genetic effect: An effect in a descendant resulting from the modification of genetic material in a parent.

gonad shield: A protective barrier for the testes or ovaries.

graphite: A form of carbon, similar to the lead used in pencils, used as a *moderator* in some *nuclear reactors*.

groundshine: Gamma radiation from radioactive materials deposited on the ground.

gray (gy): The SI unit of *absorbed dose*. One gray is equal to an *absorbed dose* 1 J kg^{-1} (100 rad).

half-life: The time in which half the *atoms* of a particular *radioactive* substance disintegrate to another nuclear form. Measured half-lives vary from millionths of a second to billions of years. Also called physical half-life.

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

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

half-thickness: The thickness of any given *absorber* that will reduce the intensity of a beam of *radiation* to one-half its initial value. (See *attenuation*; *shielding*.)

half-time, biological (T_b): The time in which half the quantity of a material in a compartment, in an organ or in the whole body is eliminated by biological processes.

half-time, effective (T_e): The time taken for the activity of a radioactive material in a compartment, in an organ or in the whole body to be reduced to half its value by a combination of biological elimination and radioactive decay.

half-time, physical (T_R): The time taken for the activity of radionuclide to lose half its value by radioactive decay.

head, reactor vessel: The removable top section of a reactor *pressure vessel*. It is bolted in place during power operation and removed during refueling to permit access of fuel-handling equipment to the *core*.

healing arts screening: The testing of human beings using x-ray machines for the detection or evaluation of health indications when such tests are not specifically and individually ordered by a licensed practitioner of the healing arts legally authorized to prescribe such x-ray tests for the purpose of diagnosis or treatment.

health physics: The science concerned with recognition, evaluation and control of health hazards from *ionizing* and *non-ionizing radiation*.

heat exchanger: Any device that transfers heat from one fluid (liquid or gas) to another fluid or to the environment.

heat sink: Anything that absorbs heat; usually part of the environment, such as the air, a river or outer space.

heatup: The rise in temperature of the reactor *fuel rods* resulting from an increase in the rate of fission in the *core*.

heavy water (D₂O): Water containing significantly more than the natural proportions (1 in 6500) of heavy hydrogen (*deuterium*) atoms to ordinary hydrogen atoms. Heavy water is used as a *moderator* in some *reactors* because it slows down neutrons effectively and also has a low probability for *absorption* of *neutrons*.

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

high radiation area: An area, accessible to individuals, in which radiation levels could result in an individual receiving a *dose equivalent* in excess of 0.1 rem (1 mSDv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

hot: A colloquial term meaning highly radioactive.

hot spot: The region in a *radiation/contamination* area in which the level of radiation/contamination is noticeably greater than in neighboring regions in the area.

image intensifier: A device, installed in its housing, which instantaneously converts an x-ray pattern into a corresponding light image of higher energy density.

image receptor: Any device, such as a fluorescent screen or radiographic film, which transforms incident x-ray photons either into a visible image or into another form which can be made into a visible image by further transformations.

incident phase: This guidance distinguishes three phases of an incident (or accident):
(1) *Early Phase:* The period at the beginning of a nuclear incident when immediate decisions for effective use of protective actions are required, and must be based primarily on predictions of radiological conditions in the environment. This phase may last from hours to days. For the purpose of dose projection, it is assumed to last for four days.
(2) *Intermediate Phase:* The period beginning after the incident source and releases have been brought under control and reliable environmental measurements are available for use as a basis for decisions on additional protective actions and extending until these protective actions are terminated. This phase may overlap the early and late phases and

may last from weeks to many months. For the purpose of dose projection, it is assumed to last for one year.

(3) *Late Phase*: The period beginning when recovery action designed to reduce radiation levels in the environment to permanently acceptable levels are commenced, and ending when all recovery actions have been completed. This period may extend from months to years (also referred to as the recovery phase).

individual: Any human being.

individual monitoring -:

(1) The assessment of *dose equivalent* by the use of devices designed to be worn by an individual;

(2) The assessment of *committed effective dose equivalent* by *bioassay* (see *Bioassay*) or by determination of the time-weighted air concentrations to which an individual has been exposed, i.e., DAC-hours; or

(3) The assessment of *dose equivalent* by the use of survey data.

individual monitoring devices (individual monitoring equipment): Devices designed to be worn by a single individual for the assessment of *dose equivalent* such as film badges, thermoluminescent dosimeters (TLDs), pocket ionization chambers and personal (“lapel”) air sampling devices.

induced radioactivity: *Radioactivity* that is created when stable substances are bombarded by *neutrons*. For example, the *stable isotope* cobalt-59 becomes the radioactive isotope cobalt-60 under *neutron* bombardment.

industrial radiography: The examination of the macroscopic structure of materials by nondestructive methods using sources of ionizing radiation to produce radiographic images.

inherent filtration: The filtration of the useful beam provided by the permanently installed components of the tube housing assembly.

intake: Quantity of material introduced into the body by inhalation, by ingestion or through the skin.

internal dose: That portion of the *dose equivalent* received from radioactive material taken into the body.

investigation level (for intake of radionuclides): Level of *committed dose equivalent* or intake above which the result is regarded as sufficiently important to justify further investigation. Investigation levels are defined for routine monitoring, IL_R , and for special or operational monitoring, IL_S . Derived investigation levels, DIL_R , and DIL_S , are values of body or organ content or elimination rate that correspond to investigation levels, IL_R ,

and IL_S . These values are calculated by means of defined models of *intake*, deposition, *uptake*, retention and elimination.

ion: An atom that has too many or too few electrons, causing it to be chemically active; an electron that is not associated (in orbit) with a *nucleus*. (See *ionization*.)

ionization: The process of adding one or more *electrons* to, or removing one or more electrons from, *atoms* or *molecules*, thereby creating *ions*. High temperatures, electrical discharges, or nuclear radiations can cause ionization.

ionization chamber: An instrument that detects and measures *ionizing radiation* by measuring the electrical current that flows when radiation ionizes gas in a chamber, making the gas a conductor of electricity. (See *counter*.)

ionizing radiation: Any radiation capable of displacing electrons from atoms or molecules, thereby producing *ions*. Examples: alpha, beta, gamma, X-rays, neutrons and ultraviolet light. High *doses* of ionizing radiation may produce severe skin or tissue damage.

irradiation: Exposure to *radiation*.

isotone: One of several different *nuclides* having the same number of neutrons in their nuclei.

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

isotope separation: The process of separating isotopes from one another, or changing their relative abundances, as by *gaseous diffusion* or electromagnetic separation. Isotope separation is a step in the *isotopic enrichment* process.

isotopic enrichment: A process by which the relative abundances of the *isotopes* of a given *element* are altered, thus producing a form of the element that has been enriched in one particular isotope and depleted in its other isotopic forms.

kerma (k): The quotient of dE_{tr} by dm , where dE_{tr} is the sum of the initial kinetic energies of all the charged ionizing particles liberated by uncharged ionizing particles in a material of mass dm . The SI unit is $J\ kg^{-1}$. The special name of this unit is the gray, Gy.

kilo: A prefix that multiplies a basic unit by 1000. Example: 1 kilometer = 1000 meters.

Kilovolt (kV): The unit of electrical potential equal to 1000 volts.

kinetic energy: The energy that a body possesses by virtue of its mass and velocity; the energy of motion.

kVp: (See *Peak tube potential*)

land disposal facility: The land, buildings, and equipment which is intended to be used for the disposal of wastes into the subsurface of the land.

LD 50/60: The *dose of radiation* expected to cause death within 60 days to 50 percent of those exposed. Generally accepted as 500 rad received over a short period of time.

leakage radiation: Radiation emanating from the diagnostic or therapeutic source assembly except for: (1) the useful beam, and (2) radiation produced when the exposure switch or time is not activated.

licensed material: *Source material, special nuclear material, or byproduct material* received, possessed, used, transferred or disposed of under a general or specific license issued by the Nuclear Regulatory Commission (or an Agreement State).

licensee: The holder of a license.

licensing state: Any State with regulations equivalent to the Suggested State Regulations for Control of Radiation relating to, and an effective program for, the regulatory control of NARM and which has been granted final designation by the Conference of Radiation Control Program Directors, Inc.

light-water: Ordinary water (H_2O) as distinguished for *heavy water* (D_2O).

light-water reactor: A term used to designate *reactors* using ordinary water as *coolant*, including *boiling water reactors* (BWRs) and *pressurized water reactors* (PWRs), the most common types used in the United States.

limits (dose limits): The permissible upper bounds of *radiation doses*.

linear energy transfer (LET): a measure of the ability of biological material to absorb *ionizing radiation*; specifically, for charged particles traversing a medium, the energy lost per unit length of path as a result of those collisions with electrons in which the energy loss is less than a specified maximum value. A similar quantity may be defined for photons.

lixiscopes: A portable light intensified imaging device using a sealed source.

loop: In a *pressurized water reactor*, the *coolant* flow path through piping from the reactor *pressure vessel* to the *steam generator*, to the reactor coolant pump, and back to the reactor pressure vessel. Large PWRs may have as many as four separate loops.

lost or missing licensed material: *Licensed material* whose location is unknown. It includes material that has been shipped but has not reached its destination and whose location cannot be readily traced in the transportation system.

low population zone (lpz): An area of low population density often required around a nuclear installation. The number and density of residents is of concern in emergency planning so that certain protective measures (such as notification and instructions to residents) can be accomplished in a timely manner.

lung class (D, W or Y): A classification scheme for inhaled material according to its rate of clearance from the pulmonary region of the lung.

mass-energy equation: The equation developed by Albert Einstein which is usually given as $E = mc^2$, showing that, when the energy of a body changes by an amount E (no matter what form the energy takes), the mass, m , of the body will change by an amount equal to E/c^2 . The factor c^2 , the square of the speed of light in a vacuum, may be regarded as the conversion factor relating units of mass and energy. The equation predicted the possibility of releasing enormous amounts of energy by the conversion of mass to energy. It is also called the Einstein equation.

mass number: The number of nucleons (*neutrons* and *protons*) in the *nucleus* of an *atom*. Also known as the *atomic weight* of an atom.

mega: A prefix that multiplies a basic unit by 1,000,000.

megacurie: One million curies. (See *curie*.)

mean free path: The average distance that photons of a given energy travel before an interaction in a given medium occurs. It is equal to the reciprocal of the attenuation coefficient. Thus, the distance x in ordinary units can be converted into the dimensionless distance μx , the number of *mean free path lengths (mfp)*.

mean lifetime: An average lifetime related to the biologic or the effective *half-time*, or the physical *half-life*. Effective *mean lifetime* = 1.443 x effective half-time..

member of the public: An individual in a controlled or unrestricted area. However, an individual is not a member of the public during any period in which the *individual* receives an occupational dose.

micro: A prefix that divides a basic unit into one million parts.

microcurie: A one-millionth part of a curie. (See *curie*.)

microsecond: A one-millionth part of a second..

mill tailings: Naturally *radioactive* residue from the processing of *uranium* ore into *yellowcake* in a mill. Although the milling process recovers about 93 percent of the uranium, the residues, or tailings contain several radioactive elements, including *uranium*, thorium, *radium*, polonium and *radon*.

mill: A prefix that divides a basic unit by 1000.

millirem: A one-thousandth part of a rem. (See *rem*.)

milliroentgen: A one-thousandth part of a roentgen. (See *roentgen*.)

minor: An *individual* less than 18 years of age.

moderator: A material, such as ordinary water, *heavy water*, or graphite, used in a *reactor* to slow down high-velocity *neutrons*, thus increasing the likelihood of *fission*.

moderator temperature coefficient of reactivity: The property of a reactor *moderator* to slow down fewer *neutrons* as its temperature increases. This acts to stabilize *power reactor* operations.

molecule: A group of *atoms* held together by chemical forces. A molecule is the smallest unit of a compound that can exist by itself and retain all its chemical properties.

monitoring (radiation monitoring, radiation protection monitoring): The measurement of radiation levels, concentrations, surface area concentrations or quantities of radioactive material and the use of the results of these measurements to evaluate potential *exposures* and *doses*.

nano: A prefix that divides a basic unit by one billion.

nanocurie: One billionth part of a *curie*.

NARM: Any naturally occurring or accelerator produced radioactive material. It does not include byproduct, source, or special nuclear material.²

²For the purpose of meeting the definition of a Licensing State by the Conference of Radiation Control Program Directors, Inc. (CRCPD), NARM only refers to discrete sources of NARM. Diffuse sources of NARM are excluded from consideration by the CRCPD for Licensing State designation purposes.

natural radiation: See *background radiation*.

natural uranium: *Uranium* as found in nature. It contains 0.7 percent uranium-235, 99.3 percent uranium-238 and a trace of uranium-234.

near surface disposal facility: A land disposal facility in which waste is disposed of within approximately the upper 30 meters of the earth's surface.

negative temperature coefficient: See *moderator temperature coefficient*.

neutron: An uncharged elementary particle with a mass slightly greater than that of the *proton*, and found in the *nucleus* of every *atom* heavier than hydrogen.

neutron capture: The process in which an atomic *nucleus* absorbs or captures a *neutron*.

neutron chain reaction: A process in which some of the neutrons released in one *fission* event cause other fissions to occur. There are three types of chain reactions:

(1) Nonsustaining chain reaction - An average of less than one fission is produced by the neutrons released by each previous fission (reactor *subcriticality*.)

(2) Sustaining chain reaction - An average of exactly one *fission* is produced by the neutrons released by each previous fission (reactor *criticality*).

(3) Multiplying chain reaction - An average of more than one fission is produced by the neutrons released by previous fission (reactor *supercriticality*.)

neutron generation: The release, *thermalization* and *absorption* of fission neutrons by a *fissile material* and the *fission* of that material producing a second generation of neutrons. In a typical reactor system, there are about 40,000 generations of neutrons every second.

neutron leakage: Neutrons that escape from the vicinity of the *fissionable material* in a reactor core. Neutrons that leak out of the fuel region are no longer available to cause fission and must be *absorbed* by *shielding* placed around the reactor *pressure vessel* for that purpose.

neutron, slow: See *neutron, thermal*.

neutron source: A *radioactive material* (*decays* by neutron emission) that can be inserted into a *reactor* to ensure that a sufficient quantity of neutrons is available to start a *chain reaction* and register on neutron detection equipment.

neutron, thermal: A *neutron* that has (by collision with other particles) reached an energy state equal to that of its surroundings. (See *thermalization*.)

noble gas: a gaseous chemical element that does not readily enter into chemical combination with other elements. An inert gas. (See *fission gases*.)

nonstochastic effect: Health effects the severity of which varies with the dose and for which a threshold is believed to exist. Radiation-induced cataract formation is an example of a *nonstochastic* effect (also called a deterministic effect).

non-vital plant systems: Systems at a nuclear facility that may or may not be necessary for the operation of the facility (i.e., power production), but that would have little or no effect on public health and safety should they fail. These systems are not *safety related*.

NORM: Naturally Occurring Radioactive Materials.

normal form radioactive material: Radioactive material which has not been demonstrated to qualify as *special form radioactive material*.

nozzle: As used in *PWRs* and *BWRs*, the interface for fluid (inlet or outlet) between reactor plant components (*pressure vessel, coolant pumps, steam generators, etc.*) and their associated piping systems.

nuclear disintegration: See *decay, radioactive*.

nuclear energy: The energy liberated by a *nuclear reaction (fission or fusion)* or by radioactive *decay*.

nuclear fission: See *fission*.

nuclear force: A powerful short-ranged attractive force that holds together the particles inside an atomic *nucleus*.

nuclear fusion: See *fusion*.

nuclear incident: An event or series of events, either deliberate or accidental, leading to the release, or potential release, into the environment of radioactive materials in sufficient quantity to warrant consideration of *protective actions*.

nuclear power plant: An electrical generating facility using a *nuclear reactor* as its power (heat) source.

nuclear radiation: See *radiation, nuclear*.

nuclear reaction: See *reaction, nuclear*.

nuclear reactor: See *reactor, nuclear*.

nucleon: Common name for a constituent particle of the atomic *nucleus*. At present, applied to *protons* and *neutrons* but may include any other particles found to exist in the nucleus.

nucleus (or Atomic Nucleus); nuclei (plural): The small, central, positively charged region of an *atom* that carries essentially all the mass. Except for the *nucleus* of ordinary (light) hydrogen, which has a single *proton*, all atomic nuclei contain both protons and *neutrons*. The number of protons determines the total positive charge, or *atomic number*; this is the same for all the atomic nuclei of a given chemical element. The total number of *neutrons* and *protons* is called the mass number. (See *isotope*.)

nuclide: A general term referring to all known *isotopes*, both *stable* (279) and unstable (about 5000), of the chemical *elements*.

occupational dose: The *dose* received by an *individual* in a *restricted area* or in the course of employment in which the individual's assigned duties involve *exposure* to *radiation* and to radioactive material from licensed and unlicensed sources of radiation, whether in the possession of the licensee or other person. *Occupational dose* does not include *dose* received from *background radiation*, as a patient from medical practices, from voluntary participation in medical research programs, or as a member of the general public.

operating basis earthquake: An earthquake that could be expected to affect the plant site, but for which the plant power production equipment is designed to remain functional without undue risk to public health and safety. (See *design-basis phenomenon*.)

open beam configuration: An analytical x-ray system in which an individual could accidentally place some part of his body in the primary beam path during normal operation.

oralloy: *Uranium* enriched in the *isotope* uranium-235. This material is an excellent *fission* fuel and is capable of sustaining a *chain reaction*.

packaging: The assembly of components necessary to ensure compliance with the packaging requirements. It may consist of one or more receptacles, absorbent materials, spacing structures, thermal insulation, radiation shielding, and devices for cooling or absorbing mechanical shocks. The vehicle, tie-down system, and auxiliary equipment may be designated as part of the packaging.

parent: A *radionuclide* that upon radioactive *decay* or disintegration yields a specific nuclide (the *daughter*).

particle accelerator: Any machine capable of accelerating electrons, protons, deuterons, or other charged particles in a vacuum and of discharging the resultant particulate or other radiation into a medium at energies usually in excess of 1 MeV

parts per million (ppm): Parts (*molecules*) of a substance contained in a million parts of air (or water) by volume.

peak tube potential: The maximum value of the potential difference across the x-ray tube during an exposure.

pellet, fuel: As used in PWRs and BWRs, a pellet is a small cylinder approximately 3/8-inch in diameter and 5/8-inch in length consisting of uranium fuel in a ceramic form--uranium dioxide, UO₂. Typical fuel pellet enrichments range from 2 to 3.5 percent uranium-235.

periodic table: An arrangement of chemical elements in order of increasing atomic number. Elements of similar properties are placed one under the other, yielding groups or families of elements. Within each group, there is a variation of chemical and physical properties, but in general there is a similarity of chemical behavior within each group.

person: (1) Any *individual*, corporation, partnership, firm, association, trust, estate, public or private institution, group, Government agency other than the Nuclear Regulatory Commission or the Department of Energy (except that the Department shall be considered a person within the meaning of the regulations in 10 CFR chapter I) to the extent that its facilities and activities are subject to the licensing and related regulatory authority of the Nuclear Regulatory Commission.

(2) Any legal successor, representative, agent, or agency of the foregoing.

personnel monitoring: The determination of the degree of radioactive *contamination* on individuals using *survey meters*, or the determination of *radiation* dosage received by means of *dosimetry* devices.

phantom: A volume of material behaving in a manner similar to tissue with respect to the attenuation and scattering of radiation.

photodosimetry: The determination of the cumulative *dose of ionizing radiation* by use of photographic film.

photon: A quantum (or packet) of energy emitted in the form of electromagnetic radiation. Gamma rays and x-rays are examples of photons.

phototimer: A method for controlling radiation exposures to image receptors by the amount of radiation which reaches a radiation monitoring device(s). The radiation monitoring device(s) is part of an electronic circuit which controls the duration of time the tube is activated.

pico: A prefix that divides a basic unit by one trillion.

picocurie: One trillionth part of a *curie*.

pig: A container (usually lead) used to ship or store radioactive materials. The thick walls protect the person handling the container from *radiation*. Large containers are commonly called casks.

pile: A nuclear reactor; called a pile because the earliest reactor were “piles” of graphite and uranium blocks.

planned special exposure: An infrequent *exposure* to *radiation*, separate from and in addition to the annual *dose limits*.

plutonium (pu): A heavy, radioactive, manmade metallic *element* with *atomic number* 94. Its most important *isotope* is *fissile* plutonium-239, which is produced by *neutron* irradiation of *uranium-238*.

pocket dosimeter: A small *ionization* detection instrument that indicates radiation exposure directly. An auxiliary charging device is usually necessary.

poison: In *reactor* physics, a material other than *fissionable material* in the vicinity of the reactor *core* that will absorb neutrons. The addition of poisons, such as *control rods* or boron, into the reactor is said to be an addition of negative *reactivity*.

pool reactor: A *reactor* in which the *fuel elements* are suspended in a pool of water that serves as the *reflector*, *moderator* and *coolant*. Popularly called a “swimming pool reactor,” it is used for research and training, not for electrical generation.

position indicating device: A device on dental x-ray equipment used to indicate the beam position and to establish a definite source-surface (skin) distance. It may or may not incorporate or serve as a beam limiting device.

positron: Particle equal in mass, but opposite in charge, to the *electron*; a positive electron.

power reactor: A *reactor* designed to produce heat for electric generation, as distinguished from reactors used for research, for producing *radiation* or *fissionable materials*, or for reactor component testing.

pressure vessel: A strong-walled contained housing the *core* of most types of *power reactors*; it usually also contains the *moderator*, *neutron reflector*, *thermal shield* and *control rods*.

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

pressurizer: A tank or vessel that acts as a head tank (or surge volume) to control the pressure in a *pressurized water reactor*.

primary system: See *reactor coolant system*.

prodromal effects: The forewarning symptoms of more serious health effects.

projected dose: Future dose calculated for a specified time period on the basis of estimated or measured initial concentrations of radionuclides or exposure rates and in the absence of *protective actions*.

proportional counter: An instrument in which an electronic detection system receives pulses that are proportional to the number of ions formed in a gas-filled tube by ionizing *radiation*.

protective action: An activity conducted in response to an incident or potential incident to avoid or reduce radiation dose to members of the public (sometimes called a protective measure).

protective action guide (pag): The *projected dose to reference man* (or standard man) or other defined individual, from an accidental release of radioactive material at which a specific *protective action* to reduce or avoid that dose is warranted.

protective barrier: A barrier of radiation absorbing material(s) used to reduce radiation exposure. The types of protective barriers are as follows:

- (1) *Primary Protective Barrier* means the material, excluding filters, placed in the useful beam, for protection purposes, to reduce the radiation exposure.
- (2) *Secondary protective barrier* means a barrier sufficient to attenuate the stray radiation to the required degree.

proton: An elementary nuclear particle with a positive electric charge located in the *nucleus* of an *atom*. (See *atomic number*.)

public dose: The *dose* received by a member of the public from *exposure to radiation* and to radioactive material released by a licensee, or to another source of radiation either within a licensee's *controlled area* or in *unrestricted areas*. It does not include *occupational dose* or *doses* received from *background radiation*, as a patient from medical practices, or from voluntary participating in medical research programs.

PWR: A *pressurized water reactor*.

quality factor (q): The modifying factor that is used to derive *dose equivalent* from *absorbed dose*.

quantum theory: The concept that energy is radiated intermittently in units of definite magnitude called quanta, and absorbed in a like manner. (See *photon*.)

quarter: A period of time equal to one-fourth of the year observed by the licensee (approximately 13 consecutive weeks), providing that the beginning of the first quarter in a year coincides with the starting date of the year and that no day is omitted or duplicated in consecutive quarters.

rad: The special unit of *absorbed dose*. One *rad* is equal to an *absorbed dose* of 100 ergs/gram or 0.01 J kg^{-1} (0.01 gray).

radiac: An acronym derived from “radioactivity detection indication and computation,” a generic term applying to radiological instruments or equipment.

radiation (ionizing radiation): *Alpha particles, beta particles, gamma rays, x-rays, neutrons*, high-speed electrons, high-speed protons, and other particles capable of producing ions. Radiation, as used in this part, does not include non-ionizing radiation, such as radio- or microwaves, or visible, infrared, or ultraviolet light.

radiation area: An area, accessible to *individuals*, in which radiation levels could result in an *individual* receiving a *dose equivalent* in excess of 0.005 rem (0.05 mSv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

radiation detection instrument: A device that detects and records the characteristics of *ionizing radiation*. (See *counter*.)

radiation machine: Any device capable of producing radiation except those which produce radiation only from radioactive material.

radiation monitoring: See *monitoring*.

radiation shielding: Reduction of *radiation* by interposing a shield of absorbing material between any radioactive source and a person, work area or radiation-sensitive device.

radiation sickness (syndrome): The complex of symptoms characterizing the disease known as radiation injury, resulting from excessive exposure of the whole body (or large part) to *ionizing radiation*. The earliest of these symptoms are nausea, fatigue, vomiting, and diarrhea, which may be followed by loss of hair (epilation), hemorrhage, inflammation of the mouth and throat, and general loss of energy. In severe cases, where the radiation exposure has been relatively large, death may occur within two to four weeks. Those who survive six weeks after the receipt of a single large dose of radiation may generally be expected to recover.

radiation source: Usually a manmade sealed source of *radiation* used in teletherapy, *radiography*, as a power source for batteries, or in various types of industrial gauges. Machines such as accelerators and radioisotope generators and natural *radionuclides* may be considered sources.

radiation standards: Exposure standards, permissible concentrations, rules for safe handling, regulations for transportation, regulations for industrial control of radiation and control of *radioactive* material by legislative means.

radiation syndrome: See *radiation sickness (syndrome)*.

radiation therapy simulation system: A radiographic or fluoroscopic x-ray system intended for localizing the volume to be exposed during radiation therapy and confirming the position and size of the therapeutic irradiation field.

radiation warning symbol: An officially prescribed symbol (a magenta trefoil) on a yellow background that must be displayed where certain quantities of *radioactive* materials are present or where certain *doses of radiation* could be received.

radioactive: Exhibiting *radioactivity* or pertaining to radioactivity.

radioactive contamination: Deposition of *radioactive* material in any place where it may harm persons or equipment.

radioactive isotope: A *radioisotope*.

radioactive series: A succession of *nuclides*, each of which transforms by radioactive *disintegration* into the next until a *stable* nuclide results. The first member is called the *parent*, the intermediate members are called *daughters*, and the final stable member is called the end product.

radioactive waste: See *waste, radioactive*.

radioactivity: The spontaneous emission of *radiation*, generally *alpha* or *beta particles*, often accompanied by *gamma rays*, from the *nucleus* of an unstable *isotope*.

radiographer: Any individual who performs or personally supervises industrial radiographic operations and who is responsible to the licensee or registrant for assuring compliance with the requirements of these regulations and all license and/or certificate of registration conditions.

radiographic exposure device: Any instrument containing a sealed source fastened or contained therein, in which the sealed source or shielding thereof may be moved, or otherwise changed, from a shielded to unshielded position for purposes of making a radiographic exposure.

radiograph: An image receptor on which the image is created directly or indirectly by an x-ray pattern and results in a permanent record.

radiographic imaging system: Any system whereby a permanent or semi-permanent image is recorded on an image receptor by the action of ionizing radiation.

radiography: The making of shadow images on photographic film by the action of *ionizing radiation*.

radioisotope: An unstable *isotope* of an *element* that *decays* or disintegrates spontaneously, emitting *radiation*. Approximately 5000 natural and artificial radioisotopes have been identified.

radiological survey: The evaluation of the *radiation* hazards accompanying the production, use, or existence of *radioactive materials* under a specific set of conditions. Such evaluation customarily includes a physical survey of the disposition of materials and equipment, measurements or estimates of the levels of *radiation* that may be involved, and a sufficient knowledge of processes affecting these materials to predict hazards resulting from unexpected or possible changes in materials or equipment.

radiology: That branch of medicine dealing with the diagnostic and therapeutic applications of radiant energy, including *x-rays* and *radioisotopes*.

radionuclide: A *radioisotope*.

radiosensitivity: The relative susceptibility of cells, tissues, organs, organisms, or other substances to the injurious action of *radiation*.

radium (ra): A radioactive metallic *element* with *atomic number* 88. As found in nature, the most common *isotope* has a mass number of 226. It occurs in minute quantities associated with uranium in pitchblende, carnotite and other minerals.

radon (rn): A *radioactive element* that is one of the heaviest gases known. Its *atomic number* is 86, and its *mass number* is 222. It is a *daughter* of *radium*.

reaction: Any process involving a chemical or nuclear change.

reactivity: A term expressing the departure of a *reactor* system from *criticality*. A positive reactivity addition indicates a move toward *supercriticality* (power increase). A negative reactivity addition indicates a move toward *subcriticality* (power decrease).

reactor coolant system: The cooling system used to remove energy from the reactor core and transfer that energy either directly or indirectly to the steam turbine.

reactor, nuclear: A device in which nuclear fission may be sustained and controlled in a self-supporting nuclear *reaction*. The varieties are many, but all incorporate certain features, including *fissionable material* or fuel, a *moderating* material (unless the reactor is operated on *fast neutrons*), a *reflector* to conserve escaping neutrons, provisions for removal of heat, measuring and controlling instruments, and protective devices.

recording level (for intake of radionuclides): Level of committed dose equivalent or intake above which the result is of sufficient interest to be worth keeping and interpreting. Recording levels are defined for routine monitoring, RL_R , and for special or operational monitoring, RL_S . Derived recording levels, DRL_R and DRL_S , are values of body or organ content or elimination rate that correspond to recording levels, RL_R and RL_S . The values are calculated by means of defined models of intake, deposition, *uptake*, retention and elimination.

recovery: The process of reducing radiation exposure rates and concentrations of radioactive material in the environment to levels acceptable for unconditional occupancy or use.

recycling: The reuse of *fissionable material* after it has been recovered by chemical processing from *spent* or *depleted* reactor fuel, reenriched and then refabricated into new fuel elements.

reentry: Temporary entry into a restricted zone under controlled conditions.

reference man: A hypothetical aggregation of human physical and physiological characteristics arrived at by international consensus. These characteristics may be used by researchers and public health workers to standardize results of experiments and to relate biological insult to a common base..

reflector: A layer of material immediately surrounding a reactor core that scatters back (or reflects) into the core many *neutrons* that would otherwise escape. The returned neutrons can then cause more *fissions* and improve the neutron economy of the reactor. Common reflector materials are graphite, beryllium, water and *natural uranium*.

relocation: The removal or continued exclusion of people (households) from contaminated areas to avoid chronic radiation exposure.

rem: The special unit of any of the quantities expressed as *dose equivalent*. The *dose equivalent* in *rem* is equal to the absorbed *dose* in *rad* multiplied by the *quality factor* ($1 \text{ rem} = 0.01 \text{ sievert}$).

reprocessing: See *recycling*.

roentgen (r): A unit of exposure of *ionizing radiation*. It is that amount of *gamma* or *x-rays* required to produce *ions* carrying 1 electrostatic unit of electrical charge in 1 cubic centimeter of dry air under standard conditions. Named after Wilhelm Roentgen, German scientist who discovered X-rays in 1895.

respiratory protective device: An apparatus, such a respirator, used to reduce the individual's *intake of airborne radioactive materials*.

restricted area: An area, access to which is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to *radiation* and *radioactive materials*. *Restricted area* does not include areas used as residential quarters, but separate rooms in a residential building may be set apart as a restricted area.

restricted zone: An area with controlled access from which the population has been relocated.

retained quantity: The quantity of a deposited material in a compartment, in an organ or in the whole body at a given time after *intake*, deposition or *uptake*.

retention function: A function describing the time dependence of the retained quantity.

return: The reoccupation of areas cleared for unrestricted residence or use.

roentgen equivalent man (or mammal): See *rem*.

safeguards: The protection of *special nuclear material* (SNM) to prevent theft, loss or sabotage. (See *special nuclear material*.)

safe shutdown earthquake: A design-basis earthquake. (See *design-basis phenomenon*.)

safety injection: The rapid insertion of a chemically soluble neutron *poison* (such as boric acid) into the *reactor coolant system* to ensure reactor shutdown. (See *shutdown*.)

safety related: The managerial controls, administrative documents, operating procedures, systems, structures and components that have been designed to mitigate the consequences of postulated accidents that could cause undue risk to public health and safety.

safety rod: See *control rod*; *scram*.

sanitary sewerage: A system of public sewers for carrying off waste water and refuse, but excluding sewage treatment facilities, septic tanks, and leach fields owned or operated by the licensee.

scattered radiation: *Radiation* that, during its passage through a substance, has been changed in direction. It may also have been modified by a decrease in energy. It is one form of *secondary radiation*.

scattered radiation: Radiation that, during passage through matter, has been deviated in direction.

scintillation detector or counter: The combination of phosphor, photomultiplier tube, and associated electronic circuits for counting light emissions produced in the phosphor by *ionizing radiation*. (See *counter*.)

scram: Sudden shutting down of a *nuclear reactor*, usually by rapid insertion of *control rods*, either automatically or manually by the reactor operator.

sealed source: Radioactive material that is permanently bonded or fixed in a capsule or matrix designed to prevent release and dispersal of the radioactive material under the most severe conditions which are likely to be encountered in normal use and handling.

secondary radiation: *Radiation* originating as the result of absorption of other radiation in matter. It may be either electromagnetic or particulate in nature.

secondary system: The *steam generator* tubes, *steam turbine*, *condenser* and associated pipes, pumps and heaters used to convert the heat energy of the *reactor* coolant system into mechanical energy for electrical generation. Most commonly used in reference to *pressurized water reactors*.

seismic category I: A term used to define structures systems and components that are designed and built to withstand the maximum potential (earthquake) stresses for the particular region that a nuclear plant is sited.

shallow-dose equivalent (H_S): Which applies to the external exposure of the skin or an extremity, is taken as the dose *equivalent* at a tissue depth of 0.007 centimeter (7 mg/cm²) averaged over an area of 1 square centimeter.

sheltering: The use of a structure for radiation protection from an airborne plume and/or deposited radioactive materials.

shielded room radiography: Industrial radiography conducted in a room shielded so that radiation levels at every location on the exterior meet the limitations specified in the regulations.

shielding: Any material or obstruction that absorbs radiation and thus tends to protect personnel or materials from the effects of ionizing radiation.

short-lived daughters: Radioactive progeny of radioactive isotopes that have half-lives on the order of a few hours or less.

shutdown: A decrease in the rate of fission (and heat production) in a reactor (usually by the insertion of *control rods* into the core). (See *subcriticality*.)

SID: See Source image receptor distance.

sievert: The SI unit of any of the quantities expressed as *dose equivalent*. The *dose equivalent* in *sieverts* is equal to the *absorbed dose* in *gray* multiplied by the *quality factor* ($1\text{ Sv} = 100\text{ rem}$).

site boundary: That line beyond which the land or property is not owned, leased or otherwise controlled by the licensee.

site closure and stabilization: Those actions that are taken upon completion of operations that prepare the disposal site for custodial care and that assure that the disposal site will remain stable and will not need ongoing active maintenance.

somatic effects of radiation: Effects of radiation limited to the exposed individual, as distinguished from genetic effects, which may also affect subsequent unexposed generations.

source image receptor distance: The distance from the source to the center of the input surface of the image receptor.

source material: (1) Uranium or thorium or any combination of uranium and thorium in any physical or chemical form; or (2) Ores that contain, by weight, one-twentieth of one percent (0.05 percent), or more, of uranium, thorium, or any combination of uranium and thorium. *Source material* does not include *special nuclear material*.

special form radioactive material: Radioactive material which satisfies the following conditions: (1) It is either a single solid piece or is contained in a sealed capsule that can be opened only by destroying the capsule; (2) The piece or capsule has at least one dimension not less than 5 millimeters (0.197 inch); and (3) It satisfies the test requirements specified by the U.S. Nuclear Regulatory Commission.

special nuclear material: (1) Plutonium, uranium-233, uranium enriched in the isotope 233 or in the isotope 235, and any other material that the Nuclear Regulatory Commission determines to be *special nuclear material*, but does not include *source material*; or (2) Any material artificially enriched by any of the foregoing but does not include *source material*.

specific absorption rate (sar): The time derivative of the incremental energy (dW) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dV) of a given density (ρ).

The *specific absorption* rate is expressed in units of watt per kilogram (W/kg). In view of the proliferation of terms for describing the *electromagnetic radiation* conditions in biological materials and the discipline-oriented interpretation of these terms, it is recommended that the name *specific absorption rate* be used for the quantity defined here, rather than such names as “absorbed power density per unit mass.”

spectral irradiance: *Irradiance* per unit wavelength interval. *Spectral irradiance* is expressed in units of watt per square meter ($\text{W/m}^2\text{m}$).

spent (depleted) fuel: *Nuclear reactor* fuel that has been used to the extent that it can no longer effectively sustain a *chain reaction*.

spent fuel pool: An underwater storage and cooling facility for *fuel elements* that have been removed from a *reactor*.

spherical wave: See wave, spherical.

SSD: The distance between the source and the skin of the patient.

stable isotope: An *isotope* that does not undergo radioactive *decay*.

standing wave: The field pattern generated by two equal-amplitude propagating waves traveling in opposite directions. A *standing wave* pattern is characterized by spatial points or planes of maximum field amplitude and other spatial points or planes of zero field amplitude displaced along the direction of propagation.

standing wave ratio: The ratio of maximum field strength to minimum field strength along the direction of propagation of two waves traveling in opposite directions.

startup: An increase in the rate of *fission* (and heat production) in a reactor usually by the removal of control rods from the core). (See *supercriticality*.)

stay time: The period during which personnel may remain in a *restricted area* before accumulating some permissible *dose*.

steam generator: The *heat exchanger* used in some *reactor* designs to transfer heat from the primary (*reactor coolant*) system to the secondary (steam) system. This design permits heat exchange with little or no contamination of the secondary system equipment.

stochastic effects: Health effects that occur randomly and for which the probability of the effect occurring, rather than its severity, is assumed to be a linear function of dose

without threshold. Hereditary effects and cancer incidence are examples of *stochastic effects*.

subcriticality: The condition of a *nuclear reactor* system when the rate of production of *fission neutrons* is lower than the rate of production in the previous generation due to increased *neutron leakage* and *poisons*.

subcritical mass: An amount of *fissionable material* insufficient in quantity or of improper geometry to sustain a *fission chain reaction*.

supercriticality: The condition for increasing the level of operation of a *reactor*. The rate of fission *neutron* production exceeds all neutron losses, and the overall neutron population increases (See *critical mass*; *criticality*.)

subcritical reactor: A *reactor* in which the power level is increasing.

superheating: The heating of a vapor, particularly steam, to a temperature much higher than the boiling point at the existing pressure. This is done in some power plants to improve efficiency and to reduce water damage to the *turbine*.

survey: An evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, or presence of radioactive material or other sources of *radiation*. When appropriate, such an evaluation includes a physical survey of the location of radioactive material and measurements or calculations of levels of radiation, or concentrations or quantities of radioactive material present.

survey meter: Any portable *radiation detection instrument* especially adapted for inspecting an area to establish the existence and amount of *radioactive* material present. (See *counter*.)

tailings, tails: See *mill tailings*.

technique factors: The following conditions of operation: (1) For capacitor energy storage equipment, peak tube potential in kV and quantity of charge in mAs; (2) For field emission equipment rated for pulsed operation, peak tube potential in kV, and number of x-ray pulses; (3) For CT x-ray systems designed for pulsed operation, peak tube potential in kV, scan time in seconds, and either tube current in mA, x-ray pulse width in seconds, and the number of x-ray pulses per scan, or the product of tube current, x-ray pulse width, and the number of x-ray pulses in mAs; (4) For CT x-ray systems not designed for pulsed operations, peak tube potential in kV, and either tube current in mA and scan time in seconds, or the product of tube current and exposure time in mAs and the scan time when the scan time and exposure time are equivalent; and (5) For all other equipment, peak tube potential in kV, and either tube current in mA and exposure time in seconds, or the product of tube current and exposure time in mAs.

technologically enhanced: Substance which because of processing contains more naturally occurring radioactive material than originally.

teletherapy: Therapeutic irradiation in which the source of radiation is at a distance from the body.

tenth thickness: The thickness of a given material that will decrease the amount (or *dose*) of radiation to one-tenth of the amount incident upon it. Two-tenth thickness will reduce the dose received by a factor of 10 x 10; i.e., 100, and so on. (See *shielding*.)

terrestrial radiation: The portion of *natural radiation* (background) that is emitted by naturally occurring *radioactive* materials in the earth.

thermal breeder reactor: A *breeder reactor* in which the *fission chain reaction* is sustained by thermal neutrons. (See *neutron, thermal*.)

thermal effect: A change in a medium or system that is directly associated with heat production when electromagnetic energy is absorbed.

thermalization: The process undergone by high-energy (fast) neutrons as they lose energy by collision. (See *neutron, thermal*.)

thermal neutron: See *neutron, thermal*.

thermal reactor: A reactor in which the *fission chain reaction* is sustained primarily by thermal neutrons. Most current reactors are thermal reactors.

thermal shield: A layer or layers of high-density material located within a reactor *pressure vessel* or between the vessel and the biological shield to reduce radiation heating in the vessel and the *biological shield*.

thermogram: A spatial representation of the temperature distribution within a medium.

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

TLD: Thermoluminescent Dosimeter, crystalline materials (for example CaF₂ with a Mn impurity or LF) that emit light if they are heated after having been exposed to radiation.

tomogram: The depiction of the x-ray attenuation properties of a section through the body.

total effective dose equivalent (tede): The sum of the *deep-dose equivalent* (for external exposures) and the *committed effective dose equivalent* (for internal exposures).

transmission coefficient: The ratio of the electric or magnetic field strength phasors associated with a transmitted wave to that associated with an incident wave.

transmission line: A physical structure for guiding electromagnetic energy. Common examples are: wire pairs, coaxial lines, strip lines, and waveguides.

transport index: The dimensionless number, rounded up to the first decimal place, placed on the label of a package to designate the degree of control to be exercised by the carrier during transportation. The transport index is the number expressing the maximum radiation level in millirem per hour at 1 meter from the external surface of the package.

transient: A change in the *reactor coolant* system temperature and/or pressure due to a change in power output of the *reactor*. Transients can be caused by adding or removing neutron *poisons*, by increasing or decreasing the electrical load on the *turbine generator*, or by accident conditions.

transition: A nuclear change from one energy state to another, generally accompanied by the emission of particles. Often called a decay, or a disintegration.

trip, reactor: See *scram*.

tritium: A radioactive *isotope* of hydrogen (one *proton*, two *neutrons*). Because it is chemically identical to natural hydrogen, tritium can easily be taken into the body by any ingestion path. *Decays* by *beta* emissions. Its radioactive *half-life* is about 12 1/2 years.

tube: An x-ray tube, unless otherwise specified.

turbine: A rotary engine made with a series of curved vanes on a rotating shaft. Usually turned by water or steam. Turbines are considered to be the most economical means to turn large electrical generators.

turbine generator (tg): A steam (or water) *turbine* directly connected to an electrical generator. The two devices are often referred to as one unit.

type a quantity: A quantity of radioactive material, the aggregate radioactivity of which does not exceed A_1 for special form radioactive material or A_2 for normal form radioactive material.

type b quantity: A quantity of radioactive material greater than a *Type A quantity*.

ultraviolet: *Electromagnetic radiation* of a wavelength between the shortest visible violet and low-energy *x-rays*.

unstable isotope: A radioisotope.

unrestricted area: An area, access to which is neither limited nor controlled by the licensee.

uptake: Quantity of material taken up into the extracellular fluids. It is usually expressed as a fraction of the deposition in the organ from which *uptake* occurs.

uranium (u): A radioactive element with the *atomic number* 92, and as found in natural ores, an *atomic weight* of approximately 238. The two principal natural isotopes are uranium-235 (0.7 percent of natural uranium), which is *fissile*, and uranium-238 (99.3 percent of natural uranium), which is *fissionable* by fast neutrons and is *fertile*. *Natural uranium* also includes a minute amount of uranium-234.

uranium enrichment: See *isotopic enrichment*.

uranium fuel cycle: The operations of milling of uranium ore, chemical conversion of uranium, isotopic enrichment of uranium, fabrication of uranium fuel, generation of electricity by a light-water-cooled *nuclear power plant* using uranium fuel, and reprocessing of spent uranium fuel to the extent that these activities directly support the production of electrical power for public use. *Uranium fuel* cycle does not include mining operations, operations at waste disposal sites, transportation of radioactive material in support of these operations, and the reuse of recovered non-uranium *special nuclear* and byproduct materials from the cycle.

uranium millings (tails): See *mill tailings*.

vapor: The gaseous form of substances that are normally in liquid or solid form.

very high radiation area: An area, accessible to *individuals*, in which radiation levels could result in an individual receiving an *absorbed dose* in excess of 500 rads (5 grays) in 1 hour at 1 meter from a radiation source or from any surface that the radiation penetrates. (**Note:** At very high doses received at high dose rates, units of absorbed dose (e.g., *rad* and *gray*) are appropriate, rather than units of *dose equivalent* (e.g., *rem* and *sieverts*)).

vessel: See *pressure vessel*.

vital plant systems: See *safety related*.

void: An area of lower density in a moderating system (such as steam bubbles in water) that allows more *neutron leakage* than does the more dense material around it. (See *moderator*; *void coefficient*; *neutron leakage*.)

void coefficient of reactivity: Property of a reactor plant moderating system where, as temperature increases in the system, *neutron leakage* increases due to an increase in the number and size of *voids* (steam bubbles) in the *moderator*.

waste, radioactive: Solid, liquid and gaseous materials from nuclear operations that have radioactive or become radioactive and for which there is no further use. Wastes are generally classified as high level (having radioactivity concentrations of hundreds of thousands of *curies* per gallon or cubic foot), low level (in the range of 1 *microcurie* per gallon or cubic foot), or intermediate level (between these extremes).

wave, electromagnetic: A wave characterized by variations of electric and magnetic fields.

wave, incident: A wave, traveling through a medium in a specified direction, directed toward a reference point, toward a discontinuity in the medium, or toward a medium of different propagation characteristics.

wave impedance: See *impedance, wave*.

wave, plane: A wave with parallel planar surfaces of constant phase.

wave, reflected: A wave in a medium produced by a wave in that medium incident on a discontinuity in the medium or on a boundary of a different medium, excluding the incident wave.

wave, spherical: a wave with concentric spherical surfaces of constant phase.

wave, standing: See *standing wave*.

wave, transmitted (refracted wave): A wave produced by an incident wave that continues beyond a discontinuity in a medium or beyond a boundary between two different media.

wave, transverse electric (te): An *electromagnetic wave* in which the *electric field strength* is everywhere perpendicular to the direction of propagation.

wave, transverse electromagnetic (tem): An *electromagnetic wave* in which the *electric field strength* is everywhere perpendicular to the *magnetic field strength* and both lie in a plane perpendicular to the direction of propagation.

wave, transverse magnetic (tm): An *electromagnetic wave* in which the *magnetic field strength* is everywhere perpendicular to the direction of propagation.

waveguide: An enclosed system capable of guiding *electromagnetic waves* from one place to another. Usually it consists of a hollow metallic tube or a solid dielectric material.

weathering factor: The fraction of radioactivity remaining after being affected by average weather conditions for a specified period of time.

week: Seven consecutive days starting on Sunday.

weighting factor W_1 : For an organ or tissue (5) is the proportion of the risk of *stochastic effects* resulting from irradiation of that organ or tissue to the total risk of *stochastic effects* when the whole body is irradiated uniformly. Presently, the organ dose weighting defined by the NRC and ICRP differ.

well bore: A drilled hole in which wireline service operations or subsurface tracer studies are performed.

well logging: All operations involving the lowering and raising of measuring devices or tools which may contain sources of radiation into well bores or cavities for the purpose of obtaining information about the well or adjacent formations.

whole body: For purposes of external exposure, head, trunk (including male gonads), arms above the elbow, or legs above the knee.

whole-body counter: A device used to identify and measure the *radiation* in the body (*body burden*) of human beings and animals; it uses heavy *shielding* to keep out *background radiation* and ultrasensitive radiation detectors and electronic counting equipment.

whole-body exposure: An exposure of the body to radiation, in which the entire body rather than an isolated part is irradiated. Where a *radioisotope* is uniformly distributed throughout the body tissues, rather than being concentrated in certain parts, the irradiation can be considered as a whole-body exposure.

wireline: A cable containing one or more electrical conductors which is used to lower and raise logging tools in the well bore.

References:

National Council on Radiation Protection and Measurements. Radiofrequency Electromagnetic Fields: Properties, Quantities and Units, Biophysical Interaction, and Measurements, NCRP Report No. 67; Washington, DC 20014; 1981.