# RTM-96: Response Technical Manual(NUREG/BR-0150, Vol. 1, Rev. 4)

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**Document Outline**

**Contents**

Publication Information

Figures

Tables

Acknowledgements

Before You Begin

Overview of Assessment Process

LWR Accident Assessment

Generic Accident Assessment (for Non-LWR Accidents)

## Publication Information

[ View in Frames | Document Outline ]

**Response Technical Manual**

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[ NRC Home Page | Top of file | Contents ]

# Section Q: Glossary

[ View in Frames | Document Outline ]

*Absolute pressure*. The total pressure of a gas system measured with respect to zero pressure.

*Absorbed dose*. A measure of energy deposition in any medium by all types of ionizing radiation (unit is usually rad or gray).

*Activity*. The number of nuclear disintegrations occurring in a given quantity of material per unit time. Becquerel and curie are the usual units for expressing activity.

*Acute dose/dose equivalent*. Radiation dose/dose equivalent received over a short period of time (hours-weeks), as opposed to a chronic dose.

*Advisory Team for Environment, Food, and Health*. A multi-agency team formed during a response to assist the NRC in preparing coordinated Federal recommendations on protective actions. The Advisory Team contains, at a minimum, representation from EPA, HHS, and USDA.

*Aerosol*. The suspension of very fine particles of a solid or droplets of a liquid in a gaseous medium.

*Alert*. The third most serious of the four NRC emergency classes. Classification as an "Alert" indicates that events are in progress or have occurred which involve an actual or potential substantial degradation of the level of safety of the plant. Any releases are expected to be limited to small fractions of the EPA Protective Action Guide exposure levels.

*Alpha decay*. A form of radioactive decay in which an alpha particle is emitted from the nucleus of an atom with atomic number Z and atomic mass A, leaving a daughter atom with atomic number Z-2 and mass number A-4.

*Alpha particle* ($\alpha$). A particle consisting of two protons and two neutrons (a $^4He$ nucleus) emitted from the nucleus of an atom.

*Alternating current* (AC). An electric current that reverses direction in a circuit at regular intervals (e.g., normal household electrical service in U.S.). Alternating current is necessary to run such reactor components of the emergency core cooling system such as pumps and motor-operated valves.

*Antineutrino* ($\bar{\nu}$). A weakly interacting particle, with no rest mass and no charge, emitted along with an electron in $\beta^-$ decay. An antineutrino is the antiparticle to the neutrino.

*Atmospheric boundary layer*. The lowest part of the earth's atmosphere in which considerable mixing occurs, extending from the earth's atmosphere to about 1 km (also called the mixing layer).

*Atom*. The smallest amount of an element retaining the characteristics of that element.

*Atomic mass number* (A). The sum of the number of protons plus the number of neutrons in the atom.

*Atomic number* (Z). The number of protons in an atom. The number of protons defines the chemical properties of the element and thus defines the element.

*Atto* (a). SI prefix corresponding to multiplication by $10^{-18}$.

*Automatic depressurization system*. A system for rapidly relieving primary system pressure by dumping steam to the suppression pool in a boiling water reactor containment.

*Background (radiation)*. Ionizing radiation normally present in the region of interest and coming from sources other than that of primary concern.

*Basemat*. The concrete base under the reactor containment structure.

*Batch*. Portion of nuclear material handled as a unit for accounting purposes. A batch of reactor fuel is usually one-third of the reactor fuel in the core, the amount typically used during refueling.

*Beta decay*. A family of radioactive decay processes including $\beta^-$ decay, $\beta^+$ decay, and electron capture.

$\beta^-$ *decay*. One of the beta decay processes in which an electron and an antineutrino are emitted from the nucleus as a result of the transformation of a neutron into a proton. The atomic number Z increases by one, while the mass number A remains the same.

$\beta^+$ *decay*. One of the beta decay processes in which a positron and a neutrino are emitted from the nucleus as a result of the transformation of a proton into a neutron. The atomic number Z decreases by one, while the mass number A remains the same.

*Beta particle* ($\beta$). An electron or positron emitted from the nucleus during beta decay.

*Beta skin dose*. Radiation dose to the skin from beta-emitters, usually from contamination on the surface of the skin or on clothing.

*Boiling water reactor (BWR)*. A light-water reactor in which water, used as both coolant and moderator, and allowed to boil under pressure in the core to steam, which drives the turbine directly.

*Bone marrow*. Soft material that fills the cavity in most bones; it manufactures most of the formed elements of the blood.

*British Thermal Unit* (BTU). The amount of heat required to raise the temperature of 1 lb of water by 1°F.

*Building wake.* Distortions in the wind patterns which are caused by a building. This effect, which is most pronounced immediately downwind of a building, alters the distribution of material within an atmospheric plume released from a source at or near the building.

*BWR containment drywell release.* See *drywell release.*

*BWR containment wetwell release.* See *wetwell release.*
*BWR/PWR containment bypass release.* See *containment bypass release.*

*Catastrophic failure.* Failure of the reactor containment in a manner that releases most of the fission products in the containment into the environment in a short time.

*Centerline* (plume). An imaginary line drawn in the middle of the plume along its downwind travel direction with a straight-line Gaussian approximation model. The plume concentrations and deposition are assumed to be the highest along the centerline.

*Centi* (c). SI prefix corresponding to multiplication by $10^{-2}$.

*Chemical toxicity.* The degree to which a material is poisonous or harmful because of its chemical nature (not because of radioactivity).

*Chronic dose.* Radiation dose received over a long period of time (years).

*Cladding.* The outer coating (usually zirconium alloy, aluminum, or stainless steel) which covers the nuclear fuel elements to prevent corrosion of the fuel and the release of fission products into the coolant.

*Cloudshine.* Gamma radiation from the radioactive materials in an airborne plume. In this document, the dose from cloudshine is the dose from immersion in the plume, assumed to be a semi-infinite cloud.

*Coherent system of units.* A system of units of measurement in which a small number of base units, defined as dimensionally independent, are used to derive all other units in the system by rules of multiplication and division with no numerical factors other than unity.

*Cold leg.* In a pressurized water reactor, the part of the reactor coolant system from the exit of the steam generator to the reactor vessel; in a boiling water reactor, the reactor coolant system from the feedwater containment penetration to the reactor vessel.

*Combustion.* A rapid chemical reaction accompanied by the evolution of light and the rapid production of heat.

*Committed dose.* The radiation dose resulting from radionuclides in the body over a time period

following their inhalation or ingestion.

*Committed dose equivalent*. The total dose equivalent (averaged over a particular tissue) deposited over a time period following the intake of a radionuclide.

*Committed effective dose equivalent* (CEDE). The effective dose equivalent resulting from radionuclides in the body over a time period (50 years in this document) following their inhalation or ingestion.

*Compound*. Two or more elements chemically linked in definite proportions.

*Condenser*. A large heat exchanger designed to cool exhaust steam from a turbine 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 vessel. The heat removed from the system 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.

*CONDOS II*. A computer program used to compute doses from consumer products. It computes doses from radioactive objects of various geometries, including the effects of up to five layers of different shielding materials.

*Containment*. A gas-tight shell or other enclosure around a reactor to confine fission products that otherwise might be released to the environment.

*Containment bypass release*. A release from a boiling water reactor or pressurized water reactor through a dry pathway from the primary system to the outside of the containment.

*Containment spray*. The water system inside containment used to relieve pressure and temperature buildup by steam released (loss of coolant accident, main steam line rupture, or feedwater line rupture) in the containment structure.

*Coolant*. The medium, often water, used to remove heat from the reactor core to the heat sink.

*Core*. See *reactor core*.

*Core release fraction*. The fraction of each isotope in the core inventory that is assumed to be released from the core under given core conditions.

*Criticality (critical)*. A condition in which the number of neutrons release 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.

*Critical organ*. For a specific radionuclide, solubility class, and mode of intake, the organ that limited the maximum permissible concentration in air or water.

*Critical pressure*. The pressure of a substance at its critical temperature.

*Critical safety function*. Functions that must be performed during normal reactor operations and following an accident to protect the integrity of the fission product barriers and prevent the release of radioactive materials into the environment.

*Critical temperature*. The temperature above which a substance has no transition from the liquid to the gaseous phase; i.e., the highest pressure at which the gas can be liquified regardless of the pressure applied.

*Curie* (Ci). A unit of radioactivity equal to $3.7 \times 10^{10}$ disintegrations per second.

*Daughter isotope*. Isotopes that are formed by the radioactive decay of some other isotope.

*Daughter, radioactive.* A radioactive isotope formed by radioactive decay.

*Daylight Saving Time* (DST). Time during which clocks are set ahead of standard time (usually by 1 h) to provide more daylight at the end of the working day during the late spring, summer, and early fall.

*Decay, radioactive.* See *radioactive decay.*

*Decay heat.* The heat produced by the decay of radioactive fission products after the reactor has been shut down or in spent fuel that has been removed from the reactor.

*DECAY model*. One of the tools in the RASCAL software that allows the user to compute the activities of radionuclides at a given time, allowing for radioactive decay and ingrowth.

*Decay product(s)*. A radionuclide or a series of radionuclides formed by the nuclear transformation of another radionuclide which, in this context, is referred to as the parent.

*Deci* (d). SI prefix corresponding to multiplication by $10^{-1}$.

*Decontamination*. The reduction or removal of radioactive contamination 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.

*Deka* (da). SI prefix corresponding to multiplication by $10^{1}$.

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

*Delta T*. The difference in temperatures between the hot and cold legs of the reactor cooling system. "Delta T" is also used to denote temperature difference in atmospheric mixing.

*Depleted uranium*. Uranium from which part of the $^{235}U$ has been removed by the enrichment process.

*Depletion*. Reduction of the concentration of one or more specified isotopes in a material or one of its constituents.

*Deposition*. The material, such as radioactive material, deposited on the ground and other surfaces when an atmospheric plume passes over them.

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

*Direct current* (DC). An electric current that flows in one direction only. Direct current is used to operate essential reactor safety systems such as circuit breakers, solenoid-operated valves, and instruments and permits control of many components from remote locations.

*Disintegration, radioactive*. A spontaneous nuclear transformation characterized by the emission of energy and/or mass from the nucleus.

*Dose commitment*. See *committed dose*.

*Dose conversion factor* (DCF). A number that relates a dose equivalent or dose equivalent rate from a given isotope under a particular set of assumptions to an environmental measurement (the concentration of that isotope in air or to the amount of that isotope deposited on the ground). With a point source, this number represents the dose equivalent from a unit source with no shielding at 1 m distance.

*Dose equivalent*. The product of the absorbed dose (in rad or gray), a quality factor related to the biological effectiveness of the radiation involved and any other modifying factors. The unit of dose equivalent is rem or sievert.

*Drywell*. The primary containment structure in a BWR system. The drywell houses the reactor and the recirculating loop.

*Drywell release*. A release from the core of a boiling water reactor that enters the containment and then leaks to the environment.

*Early health effects*. Prompt radiation effects (observable within a short period of time) for which the severity of the effect varies with the dose and for which practical thresholds exist.

*Early phase*. The period at the beginning of a nuclear incident when immediate decisions for effective use of protective actions are required, and must therefore usually be based primarily on the status of the nuclear facility (or other incident site) and the prognosis for worsening conditions. This phase may last from hours to days. For the purpose of dose projection in this document, it is assumed to last for 4 days.

*Effective dose equivalent* (EDE). The sum of the products of the dose equivalent (H) to each organ or tissue (T) and a weighting factor (w) (i.e., $H_E = w_T H_T$), where the weighting factor is the ratio of the risk

of mortality from delayed health effects arising from irradiation of a particular organ or tissue to the total risk of mortality from delayed health effects when the whole body is irradiated uniformly to the same dose.

*Effective dose equivalent conversion factor*. The committed effective dose equivalent per unit intake of radionuclide.

*Electron*. A fundamental particle from which an atom is constructed, with a single negative electrical charge and a mass of 1/1840 atomic mass units (usually neglected in determining the mass of the atom). An electron is the antiparticle to the positron.

*Electron capture*. One of the beta decay processes in which an atomic electron is captured by the nucleus. This transforms a proton into a neutron and a neutrino is emitted. Like $\beta^+$ decay, the atomic number Z decreases by one, and the mass number A remains the same.

*Element*. A substance which cannot be broken down by ordinary chemical processes into simpler substances.

*Elevated release*. A release of materials to the atmosphere through a stack or opening well above ground level.

*Emergency*. Any unplanned situation that results in or may result in substantial injury or harm to the population or substantial damage to or loss of property.

*Emergency Action Level* (EAL). Observable indicators, such as instrument readings, which if exceeded initiate classification of an event and appropriate response actions.

*Emergency Broadcast System* (EBS). Broadcasting facilities that have been authorized by the Federal Communications Commission to operate in a controlled manner during a war, state of public peril or disaster, or other national emergency as provided by the EBS plan (will be replaced by the Emergency Alert System).

*Emergency core cooling system* (ECCS). An emergency system that provides for removal of residual heat from a reactor following loss of normal heat removal capability or a loss of coolant accident.

*Emergency Operations Facility* (EOF). A licensee facility, usually eslished within about 20 miles of a reactor site, to manage the licensee emergency response.

*Emergency Planning Zone* (EPZ). An area defined around a nuclear or other facility to facilitate offsite planning and develop a significant response base. EPZs are defined around power reactors for both the plume and ingestion exposure pathways.

*Emergency Protective Action Guide*. The projected dose commitment value at which responsible officials should isolate food containing radioactivity to prevent its introduction into commerce and at which the responsible officials should determine whether condemnation or another disposition is

appropriate. At the emergency PAG, higher impact actions are justified because of the projected health hazards.

*Emergency Response Planning Guideline-1* (ERPG-1). The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 h without experiencing other than mild, transient adverse health effects or without perceiving a clearly defined objectionable odor.

*Emergency Response Planning Guideline-2* (ERPG-2). The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 h without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective actions.

*Emergency Response Planning Guideline-3* (ERPG-3). The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 h without experiencing or developing life-threatening health effects.

*Emergency worker*. A person who performs emergency services and may be unavoidably exposed to radiation under emergency conditions (e.g., law enforcement, fire fighting, health services, animal care).

*Erythema*. Redness of the skin.

*Escape fraction*. Fraction of reactor containment volume or primary system coolant released in 1 h during an accident.

*Evacuation*. The urgent removal of people from an area to avoid or reduce high-level, short-term exposure to a hazard. Evacuation may be a preemptive action taken in response to a facility condition or a probably release of a hazardous material rather than an actual release.

*Exa* (E). SI prefix corresponding to multiplication by $10^{18}$.

*Executive Team* (ET). The NRC headquarters team, led by the chairman or another commissioner, that directs the agency's response to significant events from the Operations Center. The Executive Team is supported by the Reactor Safety, Safeguards, Operations Support, Liaison, and Protective Measures teams.

*Exposure*. A measure of the ionization produced in air by X-rays or gamma radiation. It is the sum of the electrical charges on all of the ions of one sign produced in air when all electrons liberated by photons in a volume element of air are completely stopped in the air, divided by the mass of the air in the volume element. The special unit of exposure is the roentgen. In SI units, exposure is given in coulombs per kilogram (C/kg).

*Exposure conversion factor*. A number that relates the external exposure rate (instrument reading) in a gamma or X-ray field from a given isotope under a particular set of assumptions to the concentration of that isotope in air or to the amount of that isotope deposited on the ground. With a point source, this number represents the exposure rate from a unit source with no shielding at 1 m distance.

*Exposure rate*. The exposure per unit time.

*Exponent*. A symbol or number, usually written to the right of and above another symbol or number, that indicates how many times the latter number should be multiplied by itself.

*External dose*. The radiation dose resulting from radioactive materials outside the body (radiation must penetrate the skin).

*External radiation*. Radiation incident on a body from an external source.

*Extraordinary nuclear occurrence*. A radiological event which the Nuclear Regulatory Commission has determined to be an extraordinary nuclear event as defined in the Atomic Energy Act of 1954, as amended (10 CFR 140, Subpart E).

*Federal Radiological Monitoring and Assessment Center* (FRMAC). An operating center usually eslished near the scene of a radiological emergency from which the Federal field monitoring and assessment assistance is directed and coordinated.

*Femto* (f). SI prefix corresponding to multiplication by $10^{-15}$.

*Field measurement to dose model* (FM-DOSE). One of the tools in the RASCAL software that allows the user to estimate doses based on isotopic concentrations of radionuclides on the ground or in the air.

*Filtering*. Passing a liquid or a gas through porous substance to remove constituents such as suspended matter.

*Fissile*. Capable of undergoing fission by interaction with thermal neutrons.

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

*Fission products*. The nuclei (fission fragments) formed by the fission of heavy elements or by subsequent radioactive decay of the fission fragments.

*Fissionable*. Capable of undergoing fission by any process.

*Flammability*. Ability to be ignited and propagate a flame.

*Fuel cladding*. See *cladding*.

*Fuel rod (fuel pin)*. 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 cycle*. The 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 reprocessing*. The processing of reactor fuel to recover the unused fissionable material from the fission products.

*Gamma* ($\gamma$). Electromagnetic radiation emitted from the nucleus of the atom in gamma decay.

*Gamma decay*. Radioactive decay by the emission of a energetic photon (electromagnetic radiation).

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

*Gap release*. The release into containment of all the fission products in the fuel pin gap.

*Gaussian plume dispersion model*. A plume model based on the assumption that the concentration profiles in the crosswind direction (horizontal and vertical) are characterized by a Gaussian or normal distribution. Gaussian plume models have some important limitations: they do not deal well with complex terrain, light or calm winds, heavier-than-air gases, or materials that began as heavier-than-air and transform into neutrally buoyant gases, such as some cryogenically-stored materials.

*General Emergency*. The most serious of the four NRC emergency classes. Classification as a "General Emergency" indicates that events are in progress or have occurred which involve actual or imminent substantial core degradation or melting with potential for loss of containment integrity. Releases can be reasonably expected to exceed EPA Protective Action Guide exposure levels offsite for more than the immediate site area.

*Genetic effect*. An effect in a descendent resulting from the modification of genetic material in a parent.

*Giga* (G). SI prefix corresponding to multiplication by $10^9$.

*Ground concentration factor*. An estimate of the activity deposited as a function of distance downwind on the centerline from a ground level release. Calculation of ground concentration factors requires assumptions in meteorology and deposition velocity.

*Ground level release*. A release of materials to the atmosphere from a source or opening near ground level.

*Ground roughness correction factor*. A factor (assumed to be 0.7) in this document used to reduce the estimated dose because the radioactive material has been deposited on a rough surface which provides some shielding instead of a smooth plane.

*Groundshine*. Gamma radiation from radioactive materials deposited on the ground.

*Half-life, biological*. The time for the activity of radionuclide to diminish by a factor of a half because of biological elimination of the material.

*Half-life, effective*. The time for the activity of radionuclide to diminish by a factor of a half because of a combination of nuclear decay events and biological elimination of the radionuclide.

*Half-life, radiological*. The time for the activity of radionuclide to diminish by a factor of a half because of nuclear decay events.

*Hecto* (h). SI prefix corresponding to multiplication by $10^2$.

*Hold-up time*. The time that a release of radioactive material is held in the containment structure of the reactor before it is released to the environment.

*Hot*. A colloquial term meaning highly radioactive.

*Hot leg*. In a PWR, the reactor coolant system from the reactor vessel, past the pressurizer to the entrance of the steam generator; in a BWR, the reactor coolant system from the reactor vessel to the penetration exiting containment.

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

*Ice bed*. Part of the passive containment system for some pressurized water reactors. During an accident, steam is directed through the ice bed to a containment compartment. The ice cools and condenses the steam, decreasing the volume and thus limiting the maximum containment pressure.

*Ice condenser*. See *ice bed*.

*Ice condenser containment release*. A release from the core of a pressurized water reactor that passes through an ice bed one or more times before leaking to the environment.

*Immediately Dangerous to Life and Health* (IDLH). The maximum concentration from which, in the event of respirator failure, one could escape within 30 min without a respirator and without experiencing any escape-impairing (e.g., severe eye irritation) or irreversible health effects.

*Immersion*. The condition of being covered completely by a liquid or a gas.

*Inadequate core cooling*. A condition which may occur during a reactor cooling system failure that results in a heat buildup in the core. Indications of inadequate core cooling include the first indication of saturation, core uncovery, and increase in fuel cladding temperature, finally exceeding the maximum value for normal recovery from a small loss-of-cooling accident.

*Incident phase*. EPA protective action guidance distinguishes three phases of an incident or accident: (1) *early phase*, (2) *intermediate phase*, and (3) *late phase*.

*Indemnity agreement*. A legal exception from liability damage.

*Ingestion*. Entry of a material (e.g., radioactive material) into the body through the mouth.

*Ingrowth, radioactive*. The increase in activity of a daughter radioactive isotope over time (when its half-life is longer than that of the parent).

*Inhalation*. The process of breathing in. Radioactive contamination in the atmosphere may enter the body by being breathed into the lungs. Some of the material will remain in the lung; some will pass into the blood stream; some will leave the lungs and be swallowed; and the remainder will be exhaled.

*Inhalation dose.* The committed dose (or committed dose equivalent) resulting from inhalation of radioactive materials and subsequent deposition of these radioisotopes in body tissues.

*Inhalation organ dose*. The committed dose equivalent to a particular organ as a result of breathing in radioactive material.

*Initiating Condition* (IC). A symptom or event that indicates actual or potential safety problems with a reactor, used in emergency classification systems.

*Intensity*. Amount of energy per unit time passing through a unit area perpendicular to the line of propagation at the point in question.

*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 1 year.

*Internal radiation*. Radiation emitted from nuclides distributed within the body.

*International System of Units* (SI). Officially Le Système International d'Unités, a rationalized selection of units from the metric system. SI is a coherent system with seven base units and two supplementary units for which names, symbols, and precise definitions have been eslished.

*In-vessel core melt.* A condition during a reactor accident in which some of the cladding or reactor fuel melts as a result of overheating the fuel and remains inside the reactor vessel.

*In-vessel core melt release.* A release into containment from the reactor vessel which assumes the entire core has melted, releasing a representative mixture of radioisotopes.

*Isobars*. Nuclides which have the same atomic mass number but different atomic numbers (different elements).

*Isolation failure.* Failure to isolate fission products within the containment; as a result, leakage of fission

products to the environment occurs.

*Isomeric transition*. Radioactive decay of long-lived excited states of a nucleus to states of lower energy in the same nucleus (same atomic number and same mass number), usually accompanied by the emission of a gamma ray or an internal conversion electron.

*Isotopes*. Nuclides of a particular element that contain the same number of protons but different numbers of neutrons.

Isotopic composition. The composition of a material in terms of the amounts of different isotopes present.

*Kilo (k)*. SI prefix corresponding to multiplication by $10^3$.

*Large, dry containment release.* A release from the core of a pressurized water reactor that passes into the containment before leaking to the environment.

*Late phase*. The period beginning when recovery actions designed to reduce radiation levels in the environment to permanently acceple 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.)

*Light water reactor* (LWR). A nuclear reactor using slightly enriched uranium as fuel and water as both moderator and coolant.

*Linear energy transfer (LET)*. Average energy lost by ionizing radiation per unit distance of its travel through a medium. High LET is generally associated with protons, alpha particles, and neutrons, while low LET is associated with X-rays, electrons, and gamma rays.

*Loss of coolant accident (LOCA).* Accidents that would result in a loss of reactor coolant at a rate in excess of the capability of the reactor makeup system. The coolant losses are from breaks in the reactor coolant pressure boundary, up to and including a break equivalent in size to the double-ended rupture of the largest pipe of the reactor coolant system.

*Lung clearance class* (D, W, or Y). A classification scheme for inhaled material according to its clearance half-time, on the order of days, weeks, or years, from the pulmonary region of the lung to the blood and the gastrointestinal tract.

*Main steam isolation valve* (MSIV). The valve that closes the main steam line where it penetrates the reactor containment.

*MARK I, II, III.* Three different containment designs used with boiling water reactors. (Fig. A-4 contains sketches of these designs.)

*Mega* (M). SI prefix corresponding to multiplication by $10^6$.

*Metasle state*. An excited nuclear state that has a half-life long enough to be observed.

*Meteorology*. The science dealing with the phenomena of the atmosphere, especially weather and weather conditions.

*Micro* (μ). SI prefix corresponding to multiplication by $10^{-6}$.

*Milli* (m). SI prefix corresponding to multiplication by $10^{-3}$.

*Mitigation*. A safety system or action that reduces the consequences of an event.

*Mix*. See *relative abundance*.

*Mixing level*. The height of the atmospheric boundary layer.

*Model*. A simplified representation of natural processes used to project expected outcomes of a set of conditions.

*Moderation control* ($UF_6$). A hydrogen-to-uranium atomic ratio of less than 0.088, which is equivalent to the purity specification of 99.5% for $UF_6$.

*Moderator*. A material used to slow neutrons in a reactor (by neutron scattering without appreciable neutron capture.)

*Molecular weight*. The weight of one molecule of a material, obtained by summing the atomic weights of the atoms in the molecule.

*Monitoring (radiation)*. Periodic or continuous determination of the amount of ionizing radiation or radioactive contamination present in an occupied region, as a safety measure, for the purpose of health protection.

*Nano* (n). SI prefix corresponding to multiplication by $10^{-9}$.

*Neutron*. A close combination of a proton and electron, usually treated as a single fundamental particle. A neutron is electrically neutral and has a mass of approximately one atomic mass unit.

*Neutrino* ($\nu$). A weakly-interacting particle, with no rest mass and no charge, emitted along with the positron in $\beta^+$ decay or emitted as a result of electron capture. A neutrino is the antiparticle to the antineutrino.

*Noble gas*. A gas that is unreactive (inert) or reactive only to a limited extent with other elements (i.e., helium, neon, argon, krypton, xenon, and radon).

*Nomogram*. A chart representing numerical relationships.

*Non-isolable*. Unable to be isolated.

*Non-stochastic effects*. Health effects for which the severity of the effect in affected individuals varies with the dose, and for which a threshold is assumed to exist, e.g., radiation-induced cataracts or nausea.

*Normal coolant release*. The release into containment of the fission products found in the reactor coolant system under normal operating conditions.

*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.

*Nucleus*. The central core of the atom, around which the electrons rotate in various orbits.

*Nuclide*. Any isotope of an atom, a nuclear species.

*Offsite*. The area outside the boundary of the onsite area. For emergencies at a fixed nuclear facility, "offsite" generally refers to the area beyond the facility boundary. For emergencies that do not occur at fixed nuclear facilities and for which no physical boundary exists, the circumstances of the emergency will dictate the boundary of the offsite area.

*Onsite*. The area within (a) the boundary eslished by the owner or operator of a fixed nuclear facility, (b) the area eslished as a National Defense Area or National Security Area, (c) the area eslished around a downed/ditched U.S. spacecraft, or (d) the boundary eslished at the time of the emergency by the State or local government with jurisdiction for a transportation accident not occurring at a fixed nuclear facility and not involving nuclear weapons.

*Operating basis earthquake* (OBE). The earthquake that could reasonably be expected to affect a nuclear power plant site during the operating life of the plant; it is the earthquake that produces the vibratory ground motion for which those features of the plant necessary for continued operations without undue risk to the health and safety of the public are designed to

remain functional.

*Parent isotope*. A radioisotope, that upon nuclear disintegration, yields a specified isotope, the daughter, either directly or as a later member of a radioactive series.

*Partial occupancy*. The use of a building or structure for part of the period in question.

*Partitioning*. See *steam generator partitioning*.

*Particulate*. Material composed of separate and distinct particles.

*Peta* (P). SI prefix corresponding to multiplication by $10^{15}$.

*Pico* (p). SI prefix corresponding to multiplication by $10^{-12}$.

*Plateout.* Deposition of some isotopes on solid surfaces before they reach the environment.

*Plume, atmospheric.* The airborne "cloud" of material released to the environment, which may contain radioactive materials and may or may not be invisible. In a plume release (as opposed to a "puff release"), the release and sampling times are long compared with travel time from the source.

*Poison, nuclear.* A substance which, because of its ability to absorb neutrons, can reduce the ability to sustain a nuclear reaction.

*Positron.* A particle having the same mass as an electron with one unit of positive charge. A positron is the antiparticle to the electron.

*Power-operated relief valve (PORV).* A valve placed on a tank that is operated electrically, hydraulically, or pneumatically to relieve a pressure buildup inside the tank. The relief valves are set to open before the self-actuating safety valves in the tank.

*Pressure vessel.* See *reactor vessel.*

*Pressurized water reactor* (PWR). A light water reactor, in which the uranium fuel elements are cooled and moderated by water under pressure to keep it from boiling. Water heated in the reactor vessel is pumped to the steam generators to provide the heat for production of steam to drive the turbines.

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

*Preventive Protective Action Guide.* The projected dose commitment value at which responsible officials should take protective actions having minimal impact to prevent or reduce the radioactive contamination of human food or animal feeds.

*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.

*Projected dose commitment.* The dose commitment that would be received in the future by individuals in the population group from the contaminating event if no protective action were taken.

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

*Protective action (ingestion).* An action or measure taken to avoid most of the radiation dose that would occur from future ingestion of foods contaminated with radioactive materials.

*Protective Action Guide* (PAG). The projected dose commitment to individuals in the general population that warrants protective action following a release of radioactive material. Protective action would be

warranted if the expected individual dose reduction is not offset by negative social, economic, or health effects. The PAG does not include the dose that has unavoidably occurred before the assessment.

*Protective measure*. See *protective action*.

*Proton*. A fundamental particle found in the nucleus or central core of the atom. The proton has a single positive charge and a mass of approximately one atomic mass unit.

*PWR large, dry containment release*. See *large, dry containment release*.

*PWR subatmospheric containment release*. See *subatmospheric containment release*.

*PWR ice condenser containment release*. See *ice condenser containment release*.

*PWR steam generator tube rupture release*. See *steam generator tube rupture release*.

*Quality factor*. A factor (Q) used in the determination of the radiation dose equivalent that reflects the ability of a particular type of radiation to cause radiation damage. Usual values for Q include 1 for X-rays, gamma rays, and electrons; 2.3 for thermal neutrons; 10 for fast neutrons and protons; and 20 for alpha particles.

*Rad*. A unit of absorbed dose that is equivalent to an energy deposition of 0.01 J/kg.

*Radiation, internal*. Radiation emitted from radionuclides distributed within the body.

*Radiation, ionizing*. Any radiation capable of displacing electrons from atoms or molecules, thereby producing ions.

*Radiation, external*. Radiation incident upon the body from an external source.

*Radiation sickness*. Nausea and vomiting that occur within a few hours after a person receives a large acute radiation dose (usually greater than 100 rem).

*Radioactive decay*. Transformation of an unsle substance into a more sle form, usually accompanied by the emission of charged particles and gamma rays.

*Radioiodine*. One or more of the radioactive isotopes of iodine.

*Radioisotope*. A radioactive isotope of a specific element.

*Radiological Assessment System for Consequence Analysis* (RASCAL). An NRC software package containing a calculational model used to assist in estimating radiological doses from reactor or fuel cycle facility accidents based on source term information or assumptions or field measurements.

*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 heat removal, measuring and controlling instruments, and protective devices.

*Reactor coolant pump*. One of the pumps that circulate water through the reactor core and the rest of the primary coolant system.

*Reactor coolant system* (RCS). The system within a nuclear reactor containing coolant material for cooling the reactor core by the transfer of heat.

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

*Reactor vessel*. A strong metal container that contains the reactor core and reactor coolant under pressure (in LWRs).

*Recognition Categories*. Categories of events or symptoms used to develop Emergency Action Levels in the NUMARC/NESP-007 emergency classification system. The four recognition categories are A, Abnormal Rad Levels/Radiological Effluent; F, Fission Product Barrier Degradation; H, Hazards and Other Conditions Affecting Plant Safety, and S, System Malfunction.

*Reduction factor (source term)*. The ratio of the radioactivity available for release after reduction mechanism is considered to the radioactivity available for release before the reduction mechanism.

*Reduction mechanisms*. Chemical or physical mechanisms that act to reduce the amount of radioactive material that escapes to the environment during an accident.

*Reentry*. Temporary entry into a restricted zone under controlled conditions.

*Relative abundance*. The isotopic ratio of the radionuclides in a sample or deposited on the ground.

*Release conversion factor* (RCF). A number that relates a dose equivalent from a given isotope under a particular set of assumptions to the amount (activity) of that isotope released.

*Release fraction*. See *core release fraction*.

*Release rate*. The rate (e.g., Ci/s) at which radioactive isotopes are released.

*Release pathway*. A mechanism or pathway through which radioactive materials are released to the environment.

*Rem*. A unit of dose equivalent. The dose equivalent in rem is numerically equal to the absorbed dose in rad multiplied by the quality factor, the distribution factor, and any other necessary modifying factors.

*Restricted zone*. An area with controlled access from which the population has been relocated.

*Reprocessing*. See *fuel reprocessing*.

*Resuspension*. Reintroduction into the atmosphere of material originally deposited on the ground or other surfaces.

*Roentgen* (R). The unit of exposure which corresponds to the production of ions (of one sign) carrying a charge of $2.58 \times 10^{-4}$ coulombs per kilogram (C/kg) of air.

*Safe shutdown earthquake* (SSE). The earthquake that is based on an evaluation of the maximum earthquake potential considering regional and local geology and seismology and specific characteristics of local subsurface material. It is the earthquake that produces the maximum vibratory ground motion for which certain structures, systems, and components of a nuclear power plant are designed to remain functional so that the plant can be brought to a safe shutdown.

*Safety relief valve.* A valve in a pressurized tank that opens automatically to relieve the pressure before it reaches a dangerous level.

*Saturated vapor*. Vapor that is sufficiently concentrated to be able to exist in equilibrium with the liquid form of the same substance.

*Saturation*. A condition in the atmosphere corresponding to 100% relative humidity.

*Saturation temperature*. The temperature at which the liquid and vapor phases are in equilibrium at some given pressure.

*Scientific notation.* A form of mathematical notation in which the number is expressed as a number between 1 and 10 multiplied by a power of 10.

*Screening level*. An exposure, dose, or contamination level, below which no further scrutiny is required.

*Sheltering*. An immediate protective action where people go indoors, close all doors and windows, turn off all sources of outside air, listen to radio or television for information, and remain indoors until officially notified that it is safe to go out.

*Shield building.* A structure surrounding the containment that provides an additional barrier against the escape of radioactive material.

*Shielding.* Material intended to reduce the intensity of radiation entering an area.

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

*Shutdown time*. Amount of time since the reactor has been shut down.

*Site Area Emergency*. The second most serious of the four NRC emergency classes. Classification as a

"Site Area Emergency" indicates that events are in progress or have occurred which involve actual or likely major failures of plant functions needed for protection of the public. Any releases are not expected to exceed EPA Protective Action Guide exposure levels, except near the site boundary.

*Slump*. Relocation of molten reactor core during an accident.
*Source term.* The amount and isotopic composition of material released or the release rate, used in modeling releases of material to the environment.

*Source term to dose model* (ST-DOSE). One of the tools in the RASCAL software that allows the user to estimate doses based on source terms and meteorological conditions.

*Specific activity*. The activity per unit weight of a sample of radioactive material.

*Spent fuel*. Reactor fuel removed from a reactor following irradiation, or which is no longer usable because of depletion of fissile material, poison buildup, or radiation damage.

*Spent fuel pool.* A large pool of water used to store and cool spent fuel and other radioactive elements before they are shipped for storage or disposal.

*Spent fuel pool release (BWR/PWR).* Release from fuel in storage in a spent fuel pool from either a Zircoloy fire or a gap release from ruptured cladding when fuel heats up.

*Spiked coolant.* Reactor coolant containing increased concentrations of non-noble isotopes, sometimes seen with rapid shutdown or depressurization of primary system.

*Spiked coolant release*. The release into containment of 100 times the non-noble gas fission products found in the coolant.

*Spontaneous fission*. Radioactive decay by fission that is not induced by the addition of energy, such as bombardment with neutrons.

*Spray*. See *containment spray*.

*Sility class.* One of several atmospheric turbulence types determined by meteorological conditions such as wind speed, time of day, and amount of sunlight (e.g., Pasquill sility classes, les F-8 and F-9) used to indicate the intensity of mixing in the atmosphere.

*Standby gas treatment system* (SGTS). A system to filter and remove particulates from the air in the containment before it is released to the environment.

*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.

*Steam generator partitioning.* The presence of a water-steam interface in the steam generator. When the

steam generator is partitioned, particulates are retained in the steam generator water and are not released.

*Steam generator tube rupture (SGTR) release.* A release from a ruptured steam generator tube releasing radioisotopes characteristic of normal (typical) coolant, spiked (non-noble fission products increased by factor of 100) coolant, or coolant contaminated by a gap release from the core or an in-vessel core melt.

*Steam jet air ejector.* A system in a reactor to remove noncondensable gases from the main condenser and vent them to the offgas system.

*Stochastic effects*. Health effects for which the probability of the effect varies with dose (e.g., radiation-induced cancer). It is generally assumed that there is no threshold below which stochastic effects do not occur.

*Subatmospheric containment release.* A release into a pressurized water reactor containment (normally maintained at subatmospheric pressure) that leaks to the atmosphere.

*Sub-cooling margin*. The amount (in a PWR) by which the saturation temperature at the given primary system pressure exceeds the coolant temperature. When the coolant temperature exceeds the saturation temperature (negative sub-cooling margin), the coolant water is boiling.

*Subcritical*. The reactor condition when the number of neutrons released by fission is not sufficient to achieve a self-sustaining nuclear chain reaction.

*Suppression pool*. A pool of water in the wet well of a BWR containment that is designed to condense steam. Steam vents to the wet well after a loss of coolant accident. Condensing the steam reduces the pressure inside the containment after an accident.

*Tera* (T). SI prefix corresponding to multiplication by $10^{12}$.

*Thermocouple*. A temperature-measuring device consisting of two different metals joined together at both ends. The temperature difference across the two metals produces a thermoelectric current proportional to the difference.

*Thyroid blocking*. The use of sle iodine (usually in the form of potassium iodide) to block the uptake of radioactive iodine by the thyroid.

*Tort*. Any wrongful act, damage, or injury done willfully, negligently, or in circumstances involving strict liability, but not involving breach of contract, for which a civil suit can be brought.

*Total acute bone dose (D)*. The dose to the bone marrow received in the first 24 h after the release. D includes the dose from immersion in the plume during plume passage, the groundshine from deposition to an adult outside, and the committed effective dose equivalent from inhalation of plume.

*Total effective dose equivalent* (TEDE). The sum of the effective dose equivalent from external radiation while immersed in the plume, the effective dose equivalent from 4-days exposure to deposition, the

committed effective dose equivalent from inhalation for 4 days of resuspended material that was deposited on the ground, and the committed effective dose equivalent from inhalation of the material in the plume.

*Transuranic elements*. Artificially produced elements with atomic numbers greater than that of uranium (92).

*Turbulence*. Atmospheric turbulence is essentially the motion of the wind over the time scales smaller than the averaging time used to determine the mean wind. Turbulence consists of circular whirls or eddies of all possible orientations.

*Ullage*. The gas volume above the liquid in a container, e.g., a $UF_6$ cylinder.

*Universal Time Coordinated* (UTC). Mean solar time for the meridian at Greenwich, England, formerly known as Greenwich Mean Time (GMT) or Z time. (Eastern Standard Time is 5 hours behind UTC; Eastern Daylight Time is 4 hours behind UTC.)

*Unusual Event*. The least serious of the four NRC emergency classes. This classification indicates that unusual events are in progress or have occurred which indicate a potential degradation of the level of safety of the plant. No releases of radioactive material requiring offsite response or monitoring are expected unless further degradation of safety systems occurs.

*Vessel melt-through release*. A reactor release which assumes that the melted core melts through the reactor vessel, releasing additional fission products as the core interacts with the containment basemat concrete.

*Volatile*. Readily vaporizable at a relatively low temperature.

*Volatile fission products*. Isotopes resulting from nuclear fission that are gaseous or can easily be vaporized.

*Weathering*. The reduction of the amount of deposited radioactive material in the environment resulting from exposure to weather.

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

*Wetwell*. The volume of a BWR containment that holds the suppression pool.

*Wetwell release*. Release from a boiling water reactor that passes through a suppression pool in containment before leaking to the environment.

*Yarway instrument*. An instrument for water level indication that uses differential pressure through the use of an external-to-vessel variable leg and an adjacent reference leg. The term "Yarway" implies a mechanical transducer with local level readouts or transmission by capillary pressure to a remote

reading, requiring no electrical power for operation.

*Yocto* (y). SI prefix corresponding to multiplication by $10^{-24}$.

*Yotta* (Y). SI prefix corresponding to multiplication by $10^{24}$.

*Zepto* (z). SI prefix corresponding to multiplication by $10^{-21}$.

*Zetta* (Z). SI prefix corresponding to multiplication by $10^{21}$.

*Zircaloy*. An alloy consisting of approximately 98% zirconium that is used in the cladding of fuel for light-water power reactors.

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[ **NRC Home Page** | **Top of file** | **Contents** ]