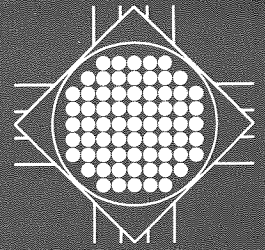


Nuclear definitions



Ontario Hydro, 700 University Avenue, Toronto, Ontario M5G 1X6

Alpha particle: A positively charged particle emitted during radioactive decay and composed of two protons and two neutrons.

Atoms: Atoms are the basic building blocks of all substances and cannot be broken down further by chemical means. Each has a nucleus surrounded by one or more orbital electrons. Each nucleus is made up of one or more protons and one or more neutrons except in the case of hydrogen. Elements have their own distinctive arrangement of electrons and protons.

Background radiation: The natural ionizing radiation of man's environment including cosmic rays from outer space, naturally radioactive elements in the ground, and naturally radioactive elements in a person's body.

Beta particle: An electron emitted from the nucleus of a radionuclide during the decay of a neutron into a proton.

Boiling water reactor (BWR): A nuclear power reactor cooled and moderated by light water and fueled with enriched uranium. The water is allowed to boil in the core to generate steam which passes directly to the turbine.

Calandria: The cylindrical reactor vessel which contains the heavy water moderator in a Candu reactor. Hundreds of tubes extend from one end of the calandria to the other containing the uranium fuel and the pressurized high temperature coolant. The reactor core consists of all of the components within the calandria.

Candu: A Canadian developed nuclear power reactor system. The name is derived from CANada Deuterium Uranium, indicating that the moderator is deuterium oxide or heavy water, and that the fuel is natural uranium. Pressure tubes containing the fuel and coolant run the length of the reactor or calandria.

Chain reaction: A reaction that initiates its own repetition. In nuclear fission, a neutron induces a nucleus to fission and releases neutrons which cause more fissions.

Containment: A virtually leak-tight shell around the reactor systems to contain radioactive products that could be released to the environment in the event of an accident.

Coolant: A liquid or gas circulated through the core of a reactor to transport the heat of the fission process from the fuel.

Cosmic rays: Radiation emanating from energy sources outside the earth's atmosphere.

Core: The heart of a reactor which contains the nuclear fuel.

Criticality: The instantaneous condition when a sufficient mass of fissile material assembled in the right shape and concentration begins a self-sustaining chain reaction.

Critical mass: The minimum amount of fissile material needed to sustain a chain reaction. It depends on the geometry and enrichment of the material and the presence of a moderator and reflector.

Curie: A measure of the rate at which a radioactive material disintegrates. A curie is the radioactivity of one gram of radium and is named after Pierre and Marie Curie, the discoverers of the radioactive elements radium, radon and polonium. One curie corresponds to 37 billion disintegrations per second.

Decay: The spontaneous transformation of a radioactive material from one nuclide to another or into a different energy state of the same nuclide.

Deuterium (D): A stable, naturally-occurring hydrogen isotope with a mass number of two. Its natural abundance is about one part in 7000 of hydrogen. In the form of heavy water (D_2O) it is an effective neutron moderator available for reactors.

Dose: The amount of ionizing radiation energy absorbed per unit mass.

Enriched fuel: Nuclear fuel containing more than the natural amount of fissile atoms.

Fast breeder reactor (FBR): A reactor in which fast neutrons sustain the fission chain reaction. The fuel is enriched and a "blanket" of fertile material which surrounds the core captures neutrons to become fissile.

Fertile material: Potential nuclear fuel which, while not initially fissile, can become so if its nuclei absorb neutrons. For example, a thorium nucleus absorbing a neutron decays to uranium (U) -233, a fissile material. Similarly uranium (U) -238 nuclei (over 99 per cent of natural uranium) absorb neutrons to decay to plutonium (Pu) -239, another fissile material.

Fissile material: Nuclear fuels in which the nuclei, when hit by neutrons, split and release energy plus further neutrons which can result in a chain reaction. U-233, U-235 and Pu-239 are examples of significant fissile materials, but only U-235 occurs naturally.

Fission: The splitting of a heavy nucleus into two parts (see Fission products) accompanied by the release of energy and more neutrons. It may occur spontaneously or be induced by capture of bombarding particles, particularly neutrons.

Fission products: The smaller nuclei formed by the fission of heavy elements. Over 300 different stable and radioactive fission products have been identified. They represent isotopes of some 35 different chemical elements ranging from zinc-72 to gadolinium-160.

Fuel bundle: In Candu reactors it is an assembly of zirconium alloy tubes containing nuclear fuel pellets.

Fuel pellets: Uranium dioxide, or other nuclear fuel in a powdered form, which has been pressed, sintered and ground to a cylindrical shape for insertion into the zirconium alloy tubes of the fuel bundle.

Fuel sheath: Zirconium alloy tubing into which fuel pellets are inserted and sealed to make a fuel element. A number of elements are assembled to make a fuel bundle.

Fuelling machine: Equipment used to load and unload fuel bundles from the reactor. Candu fuelling machines are remotely controlled and load the fuel while the reactor is operating.

Fusion: The formation of a heavier nucleus from two lighter ones with the simultaneous release of large amounts of energy. This is the process of energy production in the sun.

Gamma rays: High energy, highly penetrating, short wave length electromagnetic radiation emitted by the nuclei of many radioactive atoms during radioactive decay. The rays are absorbed by dense materials like lead.

Gas-cooled reactor: A nuclear reactor, usually graphite moderated, in which a gas, such as carbon dioxide, is used as the coolant.

Genetic effects: Effects that produce changes to egg or sperm cells and thereby affect the offspring.

Half life: The time for half the atoms of a radioactive substance to disintegrate; hence the time to lose half its radioactive strength. Each radionuclide has a unique half life ranging from millionths of a second to billions of years.

Heavy water: The moderator and heat transport medium used in the Candu nuclear power reactor system. (See Deuterium.)

Irradiated fuel: Nuclear fuel that has been irradiated in a reactor and hence becomes radioactive.

Isotope: Species of an atom with the same number of protons in their nuclei, hence belonging to the same element, but differing in the number of neutrons. The chemical qualities are practically the same but the nuclear characteristics may be vastly different — e.g., hydrogen (H-1) or U-235 compared to U-238.

Light water reactor (LWR): A term that covers both boiling water reactors (BWR) and pressurized water reactors (PWR). A reactor that uses enriched fuel with ordinary water as moderator and coolant.

Mass number: The total number of protons and neutrons in the nucleus of an atom — e.g., an atom of U-235 contains a total of 235 protons and neutrons in its nucleus.

Moderator: A material such as heavy water, graphite or light water used in a reactor to slow down or moderate the fast neutrons produced by fission, thus increasing the likelihood of further fission.

Natural uranium: Uranium whose isotopic composition as it occurs in nature has not been altered (0.17 per cent by weight of U-235).

Neutron: An uncharged (neutral) elementary particle with a mass nearly equal to that of the proton.

Plutonium (Pu): A heavy radioactive metallic element with an atomic number of 94 whose isotope Pu-239 is a major fissile material. It is produced artificially in reactors through neutron absorption by U-238. (See Fertile materials.)

Pressure tube reactor: A reactor in which the fuel is located inside hundreds of tubes designed to withstand the circulation of the high pressure coolant. The tubes are assembled in a calandria containing the moderator at low pressure. (See Candu.)

Pressurized water reactor (PWR): A nuclear power reactor cooled and moderated by light (ordinary) water and fueled with enriched uranium. Unlike the boiling water reactor, the coolant in the PWR transfers heat (via heat exchangers) to a secondary circuit, generating steam to drive the turbines.

Proton: An elementary particle with a charge equal and opposite to that of the electron. Its atomic mass is approximately 1837 times that of an electron. It comprises the nucleus of the ordinary hydrogen atom whose mass number is defined as one. It is a constituent of all nuclei.

Rad: The abbreviation for radiation absorbed dose, the unit of absorbed dose of ionizing radiation. One rad is absorbed when 100 ergs of energy are imparted to each gram of matter by ionizing radiation. (See Rem.)

Radiation: The emission and propagation of energy through space or matter in the form of electromagnetic waves and fast-moving particles such as gamma rays and beta particles.

Radioactivity: The spontaneous decay of an unstable atomic nucleus into one or more different elements or isotopes. It involves the emission of particles and/or electromagnetic radiation or spontaneous fission until a stable state is reached.

Rem: The abbreviation for Roentgen Equivalent Man, the unit of biological effect of ionizing radiation in matter. It is the absorbed dose in Rads multiplied by a factor which takes into account the particular damaging effect of each type of radiation.

Thorium (Th): A naturally occurring fertile material with the atomic number of 90. (See Fertile material.)

Tritium (T): A radioactive isotope of hydrogen with a mass number of three, it has one proton and two neutrons in its nucleus. It is produced in heavy water moderated reactors when deuterium captures a neutron.

Uranium (U): A heavy, slightly radioactive metallic element with an atomic number of 92. As found in nature, it is a mixture of the isotopes U-235 (0.7%) and U-238 (99.3%). The artificially-produced U-233 and the naturally-occurring U-235 are fissile; U-238 is fertile. (See Fertile material.)

Uranium dioxide (UO₂): A chemical form of uranium, used in the ceramic form with the natural concentration of U-235 unchanged as the fuel in Candu power reactors. UO₂ is used in power reactors because of its chemical and radiation stability, good gaseous fission product retention and high melting point.

Zirconium (Zr): A naturally-occurring metallic element with an atomic number of 40. The material is used extensively in the construction of in-core reactor components because it absorbs few neutrons while having high corrosion resistance and good mechanical properties.