Nuclear thesaurus

The most frequently used terms in nuclear technology

This compilation consists and defines the most common terms found in nuclear energetics and in the news about it.

Active zone: The volume of the reactor where the chain reaction is created.

Alpha radiation: A very short-range (with a path in air of a few centimetres), strongly ionized radiation. As a matter of fact, it is a flow of high-speed helium nuclei.

Becquerel, Bq: The activity of a radioactive material is defined by the quantity of the decayed nuclei per second. The becquerel is the unit of the activity. 1 Bq is defined as the activity of a quantity of material in which one nucleus decays per second.

Beta decay: The transmutation of certain nuclei, where the neutron in the nucleus transmutes into a proton, simultaneously creating an electron, which is emitted with high speed. Beta radiation is created by the series of beta decays in the radioactive material. Beta decay is the typical decay process of nuclei with too many neutrons. Fission products have too many neutrons, so they can undergo beta decay. This explains the strong radiation of the burnt-out fuel elements.

Beta radiation: A short-range (but higher than the alpha radiation) radiation, which contains high-speed electrons. The result of the nuclei's beta decay.

Bubbling tower: Representing a part of the containment passive safety features, it is designed to reduce inside the air-tight space. It contains a very large volume of water, which facilitates condensation of the steam released in case of a fracture of the primary coolant pipe, thus preventing the development of pressure to a level higher than allowed.

Burnout: When the uranium-235 diminishes from the reactor because of the nuclear fission, that process is the burnout. Burnout doesn't mean chemical burning.

Containment:This is a pressurized sealed structure - housing the nuclear reactor and the patrs and components - which are directly connected to the reactor pressure vessel. It is designed to prevent or limit the release of radioactive materials to the environment during normal operation, anticipated operational occurences and design-bases accidents. There are several types of cantainment system in terms of design, such as reinforced concrete, pretensioned reinforced concrete, steel, single and double-walled, full or reduced-pressure containments. The containmnet of the Paks NPP has a reinforced concrete box-like design.

Control rod: A rod (cassette in the PNPP) which contains material that absorbs neutrons, usually boron. The control rod is inserted into the reactor's active zone, its position in the active zone can be varied to change the number of the neutrons and the fission, therefore the amount of energy produced.

Critical condition: (Caution! A misleading expression!) The critical condition is the condition of the reactor when from every 2-3 created by the nuclear fission, on average only one neutron creates a new fission. In this case, the number of fissions and the produced energy is constant. The reactor is in constant critical condition during the production of energy.

Decontamination: The removal of radioactive materials from contaminated instruments, floor, walls, devices or from the surface of the human body in order to minimize the effect of radiation.

Delayed somatic radiation effect: A radiation effect that may occur during the exposed being's lifetime.

Depleted uranium: During the enrichment of the uranium, the enriched uranium (which contains uranium-235 isotopes in a higher amount than natural uranium) is accompanied by depleted uranium, which contains uranium-235 isotopes in a smaller amount than natural uranium. Depleted uranium is not usable in a nuclear power plant because of its density (it is heavier than lead), but it can be used in the manufacture of heavy-duty ammunition. It is possible that the US Army used such ammunition during the Yugoslav War. The ammunition doesn't utilize the uranium's radioactivity, just its bigger mass.

Dose limit: The highest quantity for a given time or at given conditions of the radioactive radiation deposited by one person. For example, a person can't deposit more radiation in a "radiated" workplace than 50 mSv per year. The dose limit at the Paks Nuclear Power Plant is 20 mSv/year.

Dose: the quantity of the deposited radiation. See Effective dose.

Effective dose: The amount of radiation which takes notice of the radiation's biological hazard, not just the physical radiation. Its unit is mSv (millisievert). Its one millionth part is also used, nSv (nanosievert).

Electron: A particle that carries a negative electric charge and its mass is approximately 1/2000 of a proton or a neutron. In normal conditions, a nucleus doesn't contain an electron, it is created during the process of beta decay. During the decay, the electron is instantly emitted (the flow of the emitted electrons creates beta radiation).

Enrichment: Enrichment is a complicated and energy-consuming process which is used to increase the percentage composition of uranium-235 isotope in natural uranium, which has only 0.7 % uranium-235 isotope. Most of the reactors work only with enriched uranium (the PNPP's uranium is enriched to 3.8-4.2 %).

Fission products: Atomic fragments left after a large nucleus fission. Typically, after fission, a large nucleus splits into two medium-large nuclei. Those nuclei are the fission products.

Fission: See Nuclear fission.

Fuel cell, fuel cassette: The fuel rods, which contains the uranium pastilles are placed in a cell (cassette). In a nuclear power plant, the fuel is handled and moved in these fuel cells.
Fuel transfer: The changing of depleted fuel elements to new ones in a reactor.

Fusion: See Nuclear fusion.

Gamma radiation: Electromagnetic radiation, just like light or heat radiation, but "harder" with a shorter wavelength. While visible light or X-ray radiation is created by changes in the atom's electron shell, gamma radiation is the result of the changes in the nucleus; thus it originates from processes with higher energy. Emission of gamma radiation is the result when a nuclide gains energy by going from an excited state to a lower state. Due to that, gamma radiation doesn't produce nucleus transmutation. (It doesn't create another nuclide. After alpha and beta decay, the created nucleus is different from the original.)

Genetic effects of radiation: Those effects which do not affect the exposed person's body, but affect the person's later born children.

Half-life: The time required for half the nuclei of a radioactive isotope to undergo radioactive decay and lose half of its activity. For a specific radioactive isotope this is constant, e.g. in the case of the radium it is 1,620 years. Half-lives of arbitrary isotopes can vary from a very small fragment of a second to billions of years.

International Nuclear Event Scale: A seven-level scale introduced by the International Atomic Energy Agency. It is a tool to give straight-forward information to the public about incidents or accidents which have happened in a nuclear power plant. The scale differentiates 3 incident and 4 accident levels. Level 1: Not an incident, just an anomaly beyond the authorised operating regime. Involves no threat to the power plant personnel or to residents. Level 2: Incident with significant failure in safety provisions, but the personnel are not overexposed. Level 3: Serious incident, resulting in doses to workers sufficient to exceed the occupational exposure limit. The amount of radioactivity which got into the environment is low. Level 4: Accident with significant damage to the nuclear facility, due to partial core melting. External release of radioactivity resulting in a dose to the most exposed worker of the order of a few milisieverts. Irradiation of a small part of operating personnel can result in an overexposure which causes acute health effects. Doesn't affect off-site residents. Level 5: Accident with off-site risk, may involve severe damage to a large fraction of the core, releasing large quantities of radioactivity which can threaten off-site individuals. Partial implementation of countermeasures covered by emergency plans is necessary. Level 6: Serious accident with external release of radioactive material in large quantities. Such a release would be likely to result in full implementation of countermeasures covered by emergency plans to lessen the likelihood of health effects. Level 7: Major accident, with external release of radioactive materials from the reactor, danger of early radiation accident in the power plant and in its neighbourhood. Delayed health effects can involve one or more country. (The Chernobyl disaster was categorised in this level.)

Iodine profilaxis: In the case of a reactor accident, a large amount of iodine spreads into the environment, which can easily get into the human body, concentrating in the thyroid, which can easily lead to a local high exposure. Therefore, in the case of an accident, iodine pills are given to the threatened civilians to saturate their bodies with iodine to decrease the thyroid's radio-iodine intake.

Ion: If a steady-state atom with neutral charge loses or gains one or more electrons, a positive or negative ion is created. The process which results in an ion is the ionization.

Ionizing radiation: Radiation, which is able to create ions in matter while penetrating into it. The most important types of ionizing radiation are alpha, beta, gamma, X-ray and neutron radiation. (Visible light and UV radiation don't belong here.)

Isotopes: For a given chemical element (explicitly defined by the number of protons) its isotope differs only in the number of neutrons in the nucleus. Therefore, isotopes have different mass. A chemical element's occurrence in nature can be found in the form of the mix of its isotopes.

Light water – heavy water: Light water is the most common type of water, built by the most common form of hydrogen with one proton in its nucleus. In heavy water, the hydrogen is present in its so-called heavy form, which contains one or more neutron (deuterium and tritium) besides the proton. Heavy water is much more expensive than light water, but its neutron absorption is not as high as that of light water. In view of that, some reactors use heavy water (with deuterium). (Note! The PNPP does not use heavy water!)

Liquid waste: The secondary product of the utilization of nuclear energy, in the form of not usable radioactive liquid.

Moderator: A material that slows down the neutrons created by nuclear fission in the nuclear reactor. See Slow neutron – fast neutron.

Monitor: A device that is used to detect and measure ionizing radiation or radioactive material and, as far as possible, giving a warning signal if the radiation is higher than a pre-defined value.

Multiplication factor, (k): This is the number which, after a nuclear fission, shows how much new fission the created neutrons cause. If $k=1$, the number of fissions is constant, energy production is uniform (critical condition). If $k<1$, the number of the fissions is decreasing, then the chain reaction stops (sub-critical condition). If $k>1$, the number the fissions and the reactor's performance is increasing (super-critical condition).

Natural background radiation: An omnipresent ionizing radiation that is independent of all human activity. Its main sources are outer space and the Earth's crust.

Natural radioactivity: The radioactivity of nuclides that are present in nature.

Natural uranium: Uranium with the same isotopic ration as found in nature. Most of it is uranium-238, and it contains only 0.7 % uranium-235, which is crucial in terms of atomic energy.

Neutron: A subatomic particle without electric charge and with approximately equal mass to a proton (roughly bigger by 0.1 %). The nuclei of all atoms consist of protons and neutrons.

Nuclear chain reaction: A series of reactions, where single reactions create the conditions of further reactions. In the utilization of nuclear energy the fission chain reaction is crucial. In the case of fission chain reaction, the newly created neutrons create further fission.

Nuclear energy: The energy due to nuclear reactions and nuclear transmutations.

Nuclear fission (fission): The splitting of a heavy nucleus into two parts, which have approximately the same mass. This process is usually accompanied by neutron or gamma radiation, rarely with the emission of charged atomic fragments. Fission is commonly created by a neutron that penetrates the nucleus, but spontaneous fission is also possible, although with very low probability.

Nuclear fuel: A material capable of undergoing nuclear fission chain reaction (mostly uranium), which is used in fuel elements in nuclear reactors after appropriate technological modifications.

Nuclear fusion (fusion): A possible method of energy production. During nuclear fusion, lighter nuclei join together to form heavier nuclei, while energy is released. This process characterises the energy of the Sun and the hydrogen bomb. In laboratory conditions, controlled, energy-producing fusion chain reactions haven't been realized. In nuclear reactors fission, not fusion creates the chain reaction.

Nuclear safety: Arrangements to protect individuals and their assets against ionizing radiation and the effects of radioactive contamination.

Nuclear transmutation: The conversion of one nuclide into another.

Nuclide: A nucleus which is characterized by the number of protons and neutrons. Nothing other than the nucleus of a chemical element's isotope.

Occupational Exposure: The deposited dose of radiation of the workers at a workplace.

Power Plant: A plant which produces electrical (infrequently thermal) energy by using one or more nuclear reactors.

Pressurized water reactor: A reactor where the primary circuit water is kept at a very high pressure and therefore does not boil, even at high operating temperature (in Paks approx. 300 degrees Celsius).

Primary circuit: The collective name of the reactor and its coolant loops. The medium inside the primary circuit is intensely radioactive; preventing external release is an essential engineering task.

Prompt critical: Rapid increase of the performance of the reactor and exceeding the normal level (probability of accident).

Proton: Stable subatomic particle, one the components of a nucleus. Its electric charge is $1.60219*10^{-19}$ Columb and its mass is $1.7265*10^{-27}$ kg. These numbers are known more precisely than the quantity of active substance in an average pill!

Radiation accident: An extraordinary event related to the utilization of radioactive material or to the application of ionizing radiation. During this event, operating personnel or on-site individuals are threatened by overexposure or contaminated with radioactive material resulting in the exceeding of the occupational exposure limit.

Radiation contamination: See Radioactive contamination.

Radiation poisoning, radiation sickness: A form of sickness due to excessive exposure to the whole body or to a large part of it.

Radiation source: A material or device which is able to emit ionizing radiation.

Radioactive contamination: Radioactive material in a place or in another material where it is not desirable.

Radioactive decay: A spontaneous nuclear transmutation, which is accompanied by the emission of particles or gamma radiation.

Radioactive materials: Materials which are able to undergo nuclear fission.

Radioactive materials: Materials which contain unstable, radioactive nuclei, and therefore radiate permanently. These materials can be natural or artificial radioactive materials. The decrease of their mass and intensity is shown by their half-lives.

Radioactive source: A radioactive material that emits ionizing radiation. See Radiation source.

Radioactive waste: By-products of the utilization of atomic energy that can't be recycled.

Radioactivity: Certain nuclei are decaying while emitting radiation (specifically, emitting one or more "radiation particles") and transforming into another nucleus. The nucleus of a given chemical element (potassium, iron, etc.) is usually in a stable state, but unstable, radioactive versions also can be found in nature.

Radiological protection: The arrangements to restrain the harmful effects on humans of ionizing radiation. For example, restraining the amount of this radiation that can be deposited by a human, or restraining the incorporation of radionuclides and preventing injuries caused by the previously mentioned effects.

Self-sustaining nuclear chain reaction: A chain reaction where the number of new reactions triggered by other reactions is increasing by one. Thus the process is self-sustaining. For nuclear energy, the self-sustaining chain reaction is crucial.

Slow neutron – fast neutron: During nuclear fission, fast neutrons are created. To create more fission with better efficiency, fast neutrons must be slowed down. This deceleration is realised with collisions in the moderator (in the PNPP the moderator is common water). Neutron deceleration and neutron absorption should not be confused. The latter is realised by boron – in the form of boron steel or boron tincture. The moderator is not used to slow down the chain reaction, but because of the decelerated neutrons can maintain the chain reaction.

Solidifying: The transformation of liquid radioactive waste into a stable, solid-state material with evaporation and embedding into a solid-state material.

Straddle carrier: A high precision, computer-controlled device that transfers fuel elements from one place to another without the need of physical human intervention.

Unit Simulator: A computer-aided device used to simulate the behaviour of a nuclear power plant's unit. It plays a major role in the training and education of operational personnel.

Whole body counter: A device which measures the gamma and X-ray radiation radiated by the human body. The whole body counter is well shielded against natural background radiation. It is used to detect radiating materials in the human body. In a nuclear power plant it is frequently used to check the potentially threatened power plant personnel.

X-ray radiation: A penetrating electromagnetic radiation that originates from changes of the inner layers of the electron shell of heavy atoms. X-ray radiation has a much shorter wavelength (therefore, its energy is higher) than visible light, which is produced by processes in outer layers of the electron shell.

Collected by István Vinnay