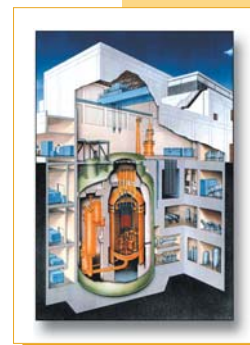


Glossary



A

ALARA

Acronym for "as low as reasonably achievable". Making every reasonable effort to minimise exposure to ionising radiation as far below regulatory or legal dose limits with economic and social considerations taken into account.

Alpha particle

A positively charged particle emitted from the nucleus of an atom during radioactive decay. Alpha particles consist of two protons and two neutrons.

B

Becquerel

The SI unit of measure of radioactivity equal to one disintegration of an atom per second. Because it is a very small unit, in practice, Gigabecquerel (GBq) or Terabecquerel (TBq) are the more common units.

Beta particle

A particle emitted from an atom during radioactive decay. Beta particles may be either electrons, negatively charged, or positrons, positively charged.

Boiling water reactor (BWR)

A very common type of light water reactor in use worldwide. Ordinary water, used as both coolant and moderator, is allowed to boil in the reactor core. The steam produced is then used to directly generate electricity.

Breeder reactor

A nuclear reactor designed to produce more fuel than it consumes. Typically these have fertile material placed in and around the reactor core in order to use neutrons produced during fission to transmute the fertile material into fissile material. For example, uranium-238 can be placed around a fast reactor and it will undergo transmutation to produce plutonium-239 which can then be recycled and used as fuel in the reactor.

C

CANDU reactor

CANDU is an acronym meaning Canadian deuterium uranium reactor. This type of reactor uses "heavy" water, i.e. deuterium oxide, as the coolant and moderator. The use of heavy water permits the use of natural uranium as the reactor fuel eliminating the need for enrichment of the uranium.

Closed fuel cycle

A fuel cycle that reprocesses spent fuel to recycle the unused fissile material. Once removed from the reactor the spent fuel is chemically processed to remove the uranium and plutonium which can then

be used to make new reactor fuel. As practised today, only the recovered plutonium is recycled, to make mixed-oxide fuel (MOX). Because of the buildup of plutonium isotopes that are unable to fission in the thermal neutron spectrum of a light water reactor and the buildup of undesirable isotopes, especially curium, the plutonium can only be recycled two or three times before it must be managed as a waste similar to the once-through cycle. Using recycled fissile materials in a fast reactor eliminates this limitation.

Control rods

Control rods are made of materials which absorb neutrons, for example boron, silver, indium, cadmium and hafnium. They are introduced into the reactor to reduce the number of neutrons and thus stop the fission process when required, or during operation to regulate the level and spatial distribution of power in the reactor.

Conversion

The chemical process used to turn solid uranium oxide received from a uranium mill into volatile uranium hexafluoride, which is a gas at certain temperatures and pressures, and therefore suitable for the enrichment process.

Coolant

A coolant absorbs and removes the heat produced by nuclear fission and maintains the temperature of the fuel within acceptable limits. The absorbed heat can then be applied so as to drive electricity-generating turbines. If water is used as the coolant, the steam it produces when heated can be transferred directly to the turbines; alternatively, it, or any other coolant, can be passed through a heat-exchanger which will remove the heat and produce the necessary steam. Other possible coolants are gases like helium, or liquefied metals such as sodium or lead. A coolant can also be a moderator; water is used in this dual way in most reactors.

Cosmic radiation

Radiation that originates in space and is generated through various processes, including the birth and death of stars. When cosmic radiation interacts with the nucleus of an atom it produces cosmogenic radionuclides with half-lives that range from thousands to millions of years. They can exist in the earth's atmosphere, on the solid surface of the earth and can also be produced in meteorites and other extraterrestrial materials, which then fall to earth. Examples include tritium (^3H), hydrogen with two extra neutrons, which forms part of all water on earth (12.3-year half-life) and carbon-14 (5730-year half-life), which exist in every living thing.

Criticality

The state of a nuclear reactor when enough neutrons are created by fission to make up for those lost by leakage or absorption such that the number of neutrons produced in fission remains constant.

Critical mass

The amount of fissionable material needed to maintain a fission chain reaction for a given set of conditions, e.g. shape of the fissionable material, amount and type of moderator or reflector.

D

Decommissioning

Administrative and technical actions taken to allow the removal of some or all of the regulatory controls from a nuclear installation. Decommissioning typically involves several stages: closeout, decontamination and dismantling, and demolition and site clearance.

Defence in depth

A design and operating philosophy used with regard to nuclear facilities that uses multiple layers of protection to prevent and mitigate the consequences of accidents. It includes the use of physical and administrative controls, physical barriers, redundant safety functions and emergency response measures.

Depleted uranium

Uranium having less than the natural occurring isotopic concentration of uranium-235 of about 0.711%. Depleted uranium is produced as a by-product of the enrichment process.

Design basis accidents

The range of conditions and events (e.g. rupture of piping, coolant pump failure) taken explicitly into account in the design of a nuclear facility such that the facility can withstand them without exceeding authorised safety limits. The ability to withstand design basis accidents presumes the functioning of engineered safety systems.

Deterministic effects

Deterministic effects are those effects that are sure to occur (e.g. measurable changes in blood) should a radiation exposure exceed the threshold for that effect. The magnitude of the effect is proportional to the exposure above the threshold.

Deterministic safety approach

The deterministic safety approach is a method of assessing the safety of a nuclear power plant using a defined set of initiating events, "design basis events". The design basis events are chosen to encompass a range of realistic possible initiating events that could challenge the safety of the plant. Examples include loss-of-coolant accidents, control rod ejection (for a PWR), control rod drop (for a BWR) and steam line break. Engineering analysis is used to predict the response of the plant and its safety systems to the design basis events and to verify that this response remains within prescribed regulatory limits.

Deuterium

A stable isotope of hydrogen having one proton and one neutron in its nucleus compared with the one proton in the nucleus of ordinary hydrogen.

Discount rate

The discount rate is an important element in economic analysis and the suitability of an economic decision can change depending on the value of the discount rate. In simple terms, if money can earn interest at a percentage rate per year (r) in real terms, then EUR 10 today will grow to $10(1+r)^t$ in t years time. Alternatively, an amount worth EUR 10 (t years in the future) can be discounted using the discount rate (d) such that it would be equivalent to EUR $10(1+d)^{-t}$ today.

Dry storage

Following an initial cooling period in a water-filled pool, spent fuel can be loaded into large, shielded casks in which natural air circulation maintains it at the required temperatures.

E

Electron volt

A unit of energy often used in the nuclear sciences. It represents a very small amount of energy that is equal to the amount of energy an electron would gain from the electric potential of one volt. Being so small it is often expressed in terms of mega-electron volts (MeV), that is a million (1×10^6 electron volts). An electron volt is equivalent to 1.602×10^{-19} joules.

Energy availability factor

The energy availability factor is a measure of operational performance of a nuclear reactor and is the percentage of the energy delivered to the electricity grid compared with the maximum energy generation that a reactor is capable of supplying.

Enriched uranium

Uranium in which the isotopic concentration of uranium-235 has been increased above the naturally occurring level of 0.711%.

Enrichment

The physical process of increasing the isotopic concentration of uranium-235 above the level found in natural uranium. Two processes are commercially used, gaseous diffusion and gas centrifugation.

Estimated additional resources – category I (EAR-I)

Uranium that is inferred to occur, based on direct geological evidence, in extensions of well-explored deposits, or in deposits in which geological continuity has been established but where specific data, including measurements of the deposits, and knowledge of the deposits' characteristics are considered to be inadequate to classify the resource as a "reasonably assured resource" (RAR). Estimates of tonnage, grade and cost of further delineation and recovery are based on such sampling as is available and on knowledge of the deposit characteristics as determined in the best-known parts of the deposit or in similar deposits.

Estimated additional resources – category II (EAR-II)

Uranium that is expected to occur in deposits for which the evidence is mainly indirect and which are believed to exist in well-defined geological trends or areas of mineralisation with known deposits. Estimates of tonnage, grade and cost of discovery, delineation and recovery are based primarily on knowledge of deposit characteristics in known deposits within the respective trends or areas and on such sampling, geological, geophysical or geochemical evidence as may be available. Less reliance can be placed on the estimates in this category than on those for EAR-I.

External costs

External costs are costs that are imposed on society and the environment that are not accounted for in the cost to producers and consumers of energy and omitted when calculating the market price. In energy production these are typically waste disposal, environmental impact or population health effects.

F

Fast neutrons

Fast neutrons are defined as those with a high kinetic energy above about 0.1 eV but typically less than 1 000 000 eV (1 MeV). Fast neutrons can cause fission in fissile materials but the probabilities are less than that for thermal neutrons. However, the number of isotopes that can fission increases as the energy of the neutron increases.

Fertile materials

A fertile material is one that is capable of becoming fissile through the capture of a neutron(s), possibly followed by radioactive decay. Important examples are uranium-238, which can transform into fissile plutonium-239, and thorium-232, which can transform into fissile uranium-233.

Fissile materials

A fissile material is a material that is capable of fission after the capture of a thermal (slow) neutron. In practice, the most important fissile materials are uranium-233, uranium-235 and plutonium-239.

Fission

The process through which an atomic nucleus splits into two or more fragments accompanied by the release of neutrons and significant amounts of energy. It is possible for a heavy nucleus to spontaneously fission though it is usually due to the nucleus absorbing a neutron.

Fissionable materials

A fissionable material is a material that is capable of undergoing fission, normally differentiated from fissile in that it will fission if it captures a fast neutron. An example of a fissionable material is uranium-238.

Fission products

When a nucleus undergoes fission, it splits into two fragments, releases neutrons and a great deal of energy. The fragments are called fission products, which may be stable or unstable, i.e. radioactive.

Important fission product isotopes (in terms of their relative abundance and high radioactivity) are bromine, caesium, iodine, krypton, rubidium, strontium and xenon. They and their decay products form a significant component of nuclear waste.

Fuel

The material in the reactor which, through fission, releases energy. Most reactors use uranium dioxide as their fuel. Most fuel for commercial reactors contains 2-5% uranium-235 (^{235}U) compared with the 0.711% found in nature; they are said to be enriched in ^{235}U . The remainder of the fuel, typically uranium-238 (^{238}U), can fission only when hit by fast neutrons; but when neutron capture occurs, it decays and gradually transforms into plutonium-239 (^{239}Pu). This fissile material is able to fission under the impact of thermal or fast neutrons, and its contribution to the energy output of the fuel gradually grows until it represents almost 30% of the power that is generated. Typically uranium dioxide powder is heated and pressed to produce dice-sized cylindrical pellets. These are loaded into hollow metal tubes (fuel rods) that are then bundled as fuel assemblies. Over 730 fuel assemblies, containing about 46 000 fuel rods would fuel a typical boiling water reactor. About 10% of reactors worldwide have been licensed to use mixed-oxide (MOX) fuel – a mixture of uranium dioxide and plutonium dioxide. The plutonium dioxide mainly results from the commercial recycling of spent fuel, though the Russian Federation and the United States are planning to use plutonium from surplus nuclear warheads. The production process for MOX is similar to that for uranium dioxide fuels. Other possible reactor fuels are thorium, which is a fertile material that produces fissile ^{233}U after neutron absorption and transmutation; uranium salts which can be used in liquid metal reactors; and other forms of uranium like uranium nitrides or uranium carbides.

Fuel cycle

The series of steps involved in creating, using and disposing of fuel for nuclear reactors. It can include mining and milling of uranium, conversion, enrichment, fabrication of fuel elements, use in a reactor, reprocessing and waste disposal. The precise steps defining a fuel cycle are dependent on a number of technological, economic and social factors. Early in the nuclear age, it was anticipated that fast breeder reactors would become the dominant design and a plutonium-based fuel cycle would exist. Thus the processes to produce and manage the nuclear fuel would be cyclical in the sense that the fuel would be recycled indefinitely. The term survives as the nomenclature for the processes used to produce and manage nuclear fuel even though the "once-through" fuel cycle does not recycle at all and the current "closed" fuel cycle does so only partially.

Fusion

Fusion is a nuclear reaction where light nuclei combine to form more massive nuclei with the release of energy. This process takes place continuously in the universe. In the core of the sun, at temperatures of 10-15 million degrees celsius, hydrogen is converted to helium, providing the energy that sustains life on earth.

G

Gamma rays

High-energy electromagnetic radiation, similar to X-rays, the difference being that they originate in the nucleus of an atom.

Gray

The SI unit of absorbed radiation dose equal to one joule per kilogram of absorbing medium.

H

Half-life

The time required for one-half of the atoms of a radioactive isotope to decay.

Heavy water

Water that contains significantly more deuterium atoms than normal water. Deuterium is an isotope of hydrogen that has one neutron and one proton compared with the one proton of ordinary hydrogen. Heavy water is used as a coolant and moderator in pressurised heavy water reactors (PHWRs) because its properties allow natural uranium to be used as fuel. Heavy water makes up less than 1% of water in nature and so must be separated and concentrated in dedicated plants for use in nuclear reactors.

Highly enriched uranium

Uranium enriched to at least 20% uranium-235.

High-level waste (HLW)

Radioactive waste is normally classified into a small number of categories to facilitate regulation of handling, storage and disposal based on the concentration of radioactive material it contains and the time for which it remains radioactive. The definitions of categories differ from country to country. However, in general, HLW contains long-lived radionuclides with high activity, which may also produce heat. It typically is concentrated as part of the process of reprocessing and solidified using vitrification to produce a glass-like substance suitable for interim storage and ultimately, disposal. Spent nuclear fuel that will not be reprocessed is included in this category. Geological disposal is foreseen for this type of waste.

I

Intermediate-level waste (ILW)

Radioactive waste is normally classified into a small number of categories to facilitate regulation of handling, storage and disposal based on the concentration of radioactive material it contains and the time for which it remains radioactive. The definitions of categories differ from country to country. However, in general, ILW needs specific shielding during handling and, depending on the specific content of long-lived radionuclides, it may need geological disposal or it may be suitable for surface or near-surface disposal.

Ion exchange

A chemical process that, in relation to nuclear energy, is often used in water purification or radioactive waste treatment. A waste solution containing ions (an atom or group of atoms with an electrical charge resulting from one or more electrons being added or removed) of waste is passed over an ion exchange medium where the waste ions are exchanged with acidic (H⁺) or basic (OH⁻) ions in the medium, thereby trapping the waste ions in the medium. Typically, the ion exchange medium is a granular resin. After a period of use the resin becomes saturated with waste ions and must be replaced. A saturated resin can either be recycled or disposed of. An ion exchange resin, in effect, concentrates the radioactive waste and thus the resins can become highly radioactive and be remotely handled.

Ionising radiation

When radiation, either particles or electromagnetic waves, has enough energy to remove the electrons of atoms with which it interacts from their orbits, causing the atoms to become charged, or ionised, it is called ionising radiation. The ions resulting from the interaction are capable of causing chemical changes damaging to human cells. Examples of ionising radiation include alpha particles, beta particles and gamma rays. If radiation, either particles or electromagnetic waves, has insufficient energy to ionise atoms, it is known as non-ionising radiation. Examples of non-ionising radiation include radio waves, light and microwaves.

Isotope

Different isotopes of an element have the same number of protons but different numbers of neutrons. For example, uranium-235 (²³⁵U) and uranium-238 (²³⁸U) are both isotopes of uranium with ²³⁵U having 143 neutrons and ²³⁸U, 146.

J

Justification

In the context of the nuclear industry, no public or worker exposure is allowed unless it is the result of an activity that has been "justified". Broadly, this means that risk incurred from the radiation exposure resulting from the activity is outweighed by the social benefit that the performance of the activity brings. The decision as to whether a particular activity is justified or not is principally a subjective value judgement, which uses as input scientific information regarding the absolute and relative values of the radiological risks involved. The decision regarding the justification of an activity will most likely be case-specific, and will be made by different levels of public official or public process, depending upon the situation and the national context.

K

Known conventional resources

The most readily accessible uranium resources; resources that are known to exist and are inexpensive to exploit using conventional mining techniques are classed as known conventional resources. These resources are categorised into two sub-groups: reasonably assured resources (RAR) and estimated additional resources – category I (EAR-I). Known conventional resources are reported in terms of the amount of uranium recoverable taking into account mining and milling process losses and are typically reported in cost categories of resources recoverable at less than USD 40/kilogram of uranium (kgU), USD 40-80/kgU and USD 80-130/kgU.

L

Light water reactor

A nuclear reactor type that is cooled and/or moderated by ordinary water, as opposed to heavy water.

Limitation

In the context of the nuclear industry, limitation is the process of assuring that planned, justified activities do not result in any individuals exceeding a pre-established regulatory level of exposure. The numerical level selected for the regulatory limit is a subjective value judgement that takes science and social judgement into account. The limit is fixed at a level above which regulatory authorities deem it to be socially justified to spend resources to reduce exposures.

Linear no-threshold hypothesis

There has been much scientific study of radiation exposures and their associated risks. However, at low exposure levels, biological science and the statistics of exposed populations have yet to conclusively identify whether there is or is not a risk. In the absence of scientific certainty as to the shape of the curve that relates the level of individual exposure to the probability of occurrence of a particular stochastic effect, it has been assumed that a linear curve, passing through zero, will not result in risks being underestimated. For this reason, it is standard practice to assume that any exposure, no matter how small, carries some risk, and to optimise radiological protection approaches accordingly.

Low enriched uranium

Uranium in which the isotopic concentration of uranium-235 has been increased above naturally occurring levels while remaining less than 20%. Typically, nuclear power reactors use low enriched uranium with 3-5% uranium-235.

Low-level waste (LLW)

Radioactive waste is normally classified into a small number of categories to facilitate regulation of handling, storage and disposal based on the concentration of radioactive material it contains and the time for which it remains radioactive. The definitions of categories differ from country to country. However, in general, LLW is a type of waste that does not need significant shielding for handling and,

because of the absence of long-lived radionuclides, is suitable for surface or near-surface disposal. About 90% of the radioactive waste volume produced in the world each year is LLW.

M

Megawatt (MW)

The international unit of power that is equal to 1×10^6 watts. A megawatt electric (MW_e) refers to the electrical output from a generator. A megawatt thermal (MW_{th}) refers to the heat output from a nuclear reactor. The difference is a measure of the efficiency of the power generation process. Typically, the heat output of a nuclear reactor is three times its electrical output, thus a reactor with a thermal output of 2 700 MW may produce about 900 MW of electricity.

Milling

The process through which mined uranium ore is chemically treated to extract and purify the uranium. It also reduces the volume of material to be transported and handled in fuel manufacture. Reflecting its colour and consistency, the solid product (U_3O_8) of milling is known as yellowcake.

Mill tailings

The remnant of a metal-bearing ore consisting of finely ground rock and process liquid after some or all of the metal, such as uranium, has been extracted.

Mixed-oxide fuel (MOX)

MOX is the abbreviation for mixed-oxide fuel, a fuel for nuclear power plants that consists of a mixture of depleted uranium oxide and plutonium oxide.

Moderator

A moderator slows neutrons down to the thermal energy range so as to increase their efficiency in causing fission. The moderator must be a light material that will allow the neutrons to slow down efficiently without there being a high probability of them being absorbed. Usually, ordinary water is used; an alternative in use is graphite, a form of carbon.

N

Natural uranium

Uranium that has the same isotopic composition as found in nature, 99.2745% uranium-238 (^{238}U), 0.711% ^{235}U , and 0.0055% ^{234}U .

Neutron

An elementary particle with no electric charge and a mass slightly greater than a proton found in the nucleus of all atoms except hydrogen-1.

Nuclear reactor

A device that uses the nuclear fission process to produce energy. Though there are many types of reactors, certain features are inherent to all, including fuel, coolant, moderator (unless the reactor uses fast neutrons) and control rods. Other common features include a reflector to conserve escaping neutrons, shielding to protect personnel from radiation exposure, instrumentation to measure and control the reactor, and devices to protect the reactor.

Nuclear Suppliers Group (NSG)

The Nuclear Suppliers Group is a group of nuclear supplier countries, 39 as of October 2002, which work together to prevent the proliferation of nuclear weapons. These countries pursue the aims of the NSG through adherence to consensus guidelines concerning nuclear and nuclear-related exports and through the exchange of information.

Nuclear Suppliers Guidelines

The Nuclear Suppliers Guidelines are a set of principles and lists of materials, equipment and products that could be used for designing, manufacturing and testing nuclear weapons that have been

developed by the Nuclear Suppliers Group. Two sets of guidelines have been developed: the Guidelines for the Export of Nuclear Material, Equipment and Technology and the Guidelines for Transfers of Nuclear-related Dual-use Equipment, Material and Related Technology.

Principles governing the use of the guidelines are:

- Suppliers should authorise transfers of identified items or related technology only upon formal governmental assurances from recipients explicitly excluding uses that would result in any nuclear explosive device.
- Suppliers should authorise transfers of identified items or related technology only when they are satisfied that the transfers would not contribute to the proliferation of nuclear weapons or other nuclear explosive devices.
- Suppliers should not be satisfied with an assurance from recipients if they have information or evidence, which leads them to believe that there is a risk that a transfer will contribute to nuclear weapons proliferation.

O

Once-through fuel cycle

A fuel cycle that does not recycle the spent fuel. Once removed from the reactor the spent fuel is conditioned and stored until a disposal repository becomes available.

Optimisation

In the context of radiation protection, optimisation is the process of assuring that the exposures of the public and/or workers resulting from the operation of a justified activity are as low as reasonably achievable, social and economic factors being taken into account. Both qualitative (e.g. stakeholder consensus discussions, common sense good work practice, best industrial practice) and quantitative (e.g. differential cost-benefit analysis, multi-attribute analysis) approaches are used to arrive at optimised solutions.

P

Partitioning and transmutation (P&T)

Partitioning is the separation of undesirable long-lived radioactive elements such as minor actinides (e.g. americium-243) and fission products from spent fuel. Transmutation is the transformation of these undesirable elements into short-lived or stable elements using nuclear reactions. Together these processes would, at least partly, eliminate those parts of high-level waste that contribute most to its heat generation and long-lived radioactivity. P&T therefore has the potential to reduce the time that waste needs to be kept isolated from several thousand to several hundreds of years.

Plasma

A state of matter (others are solid, liquid and gas) where all the electrons have been stripped from atoms leaving only the nuclei.

Pressurised water reactor (PWR)

A nuclear reactor maintained under a high pressure to keep its coolant water from boiling at the high operating temperature. The heat generated by the reactor is transferred from the core to a large heat exchanger that heats water in a secondary circuit to produce the steam needed to generate electricity.

Probabilistic safety assessment (PSA)

A PSA is a type of safety analysis that uses probabilistic risk assessment techniques during both the design and operation of a nuclear power plant to analyse the overall risk. Considering an entire set of potential events with their respective probabilities and consequences, the overall risk of a nuclear incident or accident can be assessed. For a power plant this risk is given in terms of a core melt frequency or the frequency of a large radioactive release. For existing power plants a value below about 1×10^{-4} per year for a core damage probability is generally accepted, while new designs should be even

less than 1×10^{-5} per year. The current practice is that the computed results are generally viewed as targets rather than absolute values that would serve for regulatory acceptance or refusal.

Proton

An elementary nuclear particle with a positive electric charge located in the nucleus of an atom.

R

Radiation

Energy travelling in the form of high-speed particles or electromagnetic waves. We encounter electromagnetic waves everywhere. They make up our visible light, radio and television waves, ultra violet (UV), and microwaves. These examples of electromagnetic waves do not cause ionisation of atoms because they do not carry enough energy to separate molecules or to remove electrons from atoms. "Ionising radiation" is radiation with enough energy so that it can, during an interaction with an atom, remove tightly bound electrons from their orbits, causing the atom to become charged or ionised. Examples are gamma rays and neutrons.

Radioactivity

The spontaneous change of an unstable atom, often resulting in the emission of radiation. This process is referred to as a transformation, a decay, or a disintegration of an atom. Radioactive atoms are often called radioactive isotopes or radionuclides.

Reasonably assured resources (RAR)

Uranium that occurs in known mineral deposits of delineated size, grade and configuration such that the quantities which could be recovered within the given production cost ranges with currently proven mining and processing technology can be specified. Estimates of tonnage and grade are based on specific sample data and measurements of the deposits and on knowledge of deposit characteristics.

Reprocessing

The process of treating used reactor fuel to recover the uranium and plutonium and to separate them from the fission products and other elements. In this way a larger percentage of the potential energy value of the uranium can be utilised and the volume of waste can be reduced.

S

Safeguards

The methods used to verify that the "peaceful use" commitments of non-proliferation agreements are honoured. Safeguards involve a country defining (i.e. declaring) what its inventory of nuclear materials is and where it is located. Safeguards consist of the verification of a nuclear installation's control of and accounting for nuclear materials within all the nuclear facilities that a signatory State has formally declared as subject to safeguards. Verification is performed using IAEA-installed monitoring instruments, some of which are sealed to prevent tampering. Physical inspection of nuclear installations on a random, yet pre-announced, basis is conducted at least annually to verify the operator's accounts and to ensure that all installed instruments are performing satisfactorily and that security seals have not been tampered with. Since 1997, IAEA inspections can also be carried out on a surprise or challenge basis once a State has ratified an additional safeguards protocol. The intended result of all inspections is that by verifying the inventories of nuclear material declared by a signatory government, the IAEA can announce that all nuclear material is being used for peaceful purposes.

Scram

A term used to describe the sudden shutting down of a nuclear reactor. It was originally an acronym meaning "safety control rod axe man" used with the first operating reactor in the United States, the Chicago pile.

Sievert (Sv)

The international unit indicating the biological effects caused by an exposure to radiation. The biological effects of radiation exposure vary depending on the type of radiation involved. For example, 1 joule of beta or gamma radiation per kilogram of tissue has 1 Sv of biological effect; 1 joule/kg of alpha radiation has 20 Sv effect; and 1 joule/kg of neutron radiation will cause 10 Sv of biological effect.

Speculative resources (SR)

Uranium that is thought to exist, mostly on the basis of indirect evidence and geological extrapolations, in deposits discoverable using existing exploration techniques. The location of deposits envisaged in this category could generally be specified only as being somewhere within a given region or geological trend. As the term implies, the existence and size of such resources are speculative.

Spent nuclear fuel (SNF)

Fuel that has been irradiated in and then permanently removed from a nuclear reactor.

Stochastic effects

Stochastic effects are those effects (e.g. cancer or leukaemia) whose probability of occurring is proportional to the radiation exposure received.

SWU

An acronym for separative work unit that is the standard measure of enrichment services. This is a complex unit used to measure the effort or energy required to separate uranium into two parts of unequal isotopic weight. Typically, about 100 000-120 000 SWU are required to provide the enriched uranium needed to fuel a 1000 MWe light water reactor for one year.

T

Terrestrial radiation

Radiation that comes from the earth itself and is produced by the decay of primordial and cosmogenic radionuclides. Most terrestrial radiation ultimately comes from uranium and thorium, common elements found in the earth's crust, as they decay gradually over millions of years eventually becoming lead, which is stable, does not decay and thus emits no radiation. The result is that the earth's crust is naturally full of not only uranium and thorium but also their radioactive decay products, such that the earth itself emits radiation. Additionally, the air we breathe also emits radiation naturally since one of the members of the uranium decay chain is radon. Radon is a gas, and if it is "born" near the surface of the earth, it enters into the atmosphere.

Technetium-99

A radioactive isotope of technetium, of which a particular form known as technetium-99m (^{99m}Tc) is extensively used in nuclear medicine for cancer diagnosis. Technetium-99m is normally formed from the radioactive decay of molybdenum-99 (^{99}Mo) which is produced by irradiating highly enriched uranium foil in a reactor. One of the fission products formed from the fission of the uranium in the foil is ^{99}Mo , which is then chemically separated for use as a generator of ^{99m}Tc .

Thermal neutrons

Thermal neutrons are those with a low kinetic energy, less than 0.1 electron volt (eV). Thermal neutrons have the greatest probability of causing fission in uranium-235 and plutonium-239.

Torus

A donut-shaped geometrical shape created by rotating a circle about a line. Fusion reactor research has focused on two types of containment of the plasma (fuel): magnetic and inertial. Magnetic containment can be spherical or torus-shaped. In a torus-type fusion reactor, torus-shaped magnetic fields are used to contain the plasma (fuel).

Transmutation

When a nucleus absorbs a neutron and changes the nucleus from one element into another. This process occurs in fission reactors and is the process by which some long-lived elements of radioactive waste are created. It is also a process being investigated as a means to transform long-lived elements of high-level radioactive waste into shorter-lived elements.

Tritium

A radioactive isotope of hydrogen having two neutrons and one proton. Tritium is being investigated for use as a fuel for fusion reactions. Because tritium is radioactive and can readily form water it has particular radiation protection concerns.

U

Undiscovered conventional resources

Uranium resources believed to exist and to be exploitable using conventional mining techniques but not yet physically confirmed are classed as undiscovered conventional resources. They include estimated additional resources – category II (EAR-II) and speculative resources (SR).

V

Vitrification

The process of producing glass. It is a technology commonly used to immobilise the high-level waste produced from the reprocessing of spent nuclear fuel. Typically this glass is of high durability, able to withstand the intense radiation and high heat associated with high-level waste and stable so as to be able to contain the radioactive isotopes over long periods of time.

X

X-ray

X-rays are electromagnetic waves emitted by energy changes in an atom's electrons. They are a form of high-energy electromagnetic radiation that interacts lightly with matter. Thick layers of lead or other dense materials stop them best.