

# Glossary, Acronyms, and Abbreviations

---

actinides: elements with atomic numbers between 89 and 103 inclusive; all actinide isotopes are radioactive

activation: the process of making non-radioactive material radioactive by bombardment with neutrons, protons, or other nuclear particles

activity (radioactivity): the rate at which radioactive material emits radiation, given in terms of the number of nuclear disintegrations occurring in a unit of time; the common unit of radioactivity is the curie (Ci)

AEC: Atomic Energy Commission; most of its functions have been assumed by DOE and NRC

AFR: away-from-reactor storage

AGNS: Allied-General Nuclear Services, Inc.

ALARA: as low as reasonably achievable; the principle that specifies that all radiation doses are to be maintained as far below prescribed standards as is reasonably achievable. This is a requirement for all Nuclear Regulatory Commission licensees

alpha particle: a positively charged particle emitted by certain radioactive material, made up of two neutrons and two protons; it is identical to the nucleus of a helium atom, An alpha particle cannot penetrate clothing or the outer layer of human skin

aquifer: a water-bearing layer of permeable rock or soil

at-reactor: refers to storage in the originally designed basin or to another storage facility added later; usually the latter definition pertains

atomic number: the number of protons within the atomic nucleus of each chemical element

background radiation (natural): nuclear radiation due to the natural environment and to naturally occurring radioactivity within the body

banking (of sites): setting aside public lands for possible future use

basalt: a fine-grained igneous rock, usually formed by lava flows

beta particle: a negatively charged particle emitted in the radioactive decay of certain nuclides; a free electron; it has a short range in air and low ability to penetrate other materials

biosphere: the part of the earth in which life exists, including the lithosphere, hydrosphere, and atmosphere

BLM: Bureau of Land Management, DOI

burnup: a measure of reactor fuel consumption expressed as the percentage of fuel atoms that have undergone fission, or the amount of energy produced per unit weight of fuel

BWR: boiling water reactor

byproducts: 1) any radioactive material (except special nuclear material) yielded in, or made radioactive by, exposure to the radiation incident to the production or utilization of special nuclear material, i.e., fission products and/or activation products; 2) the tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content. This second category has been added by the Uranium Mill Tailings Act of 1978.

canister: a container for radioactive solid waste forms

cask: a container that provides shielding during transportation of canisters of radioactive materials

CFR: Code of Federal Regulations

cladding: the outer jacket of nuclear fuel elements which contains and supports the fuel material, protects the fuel from interaction with the coolant, and prevents the release of fission products into the coolant; commercial power reactors use a zirconium alloy for cladding, while special purpose reactors frequently use aluminum

Climax Spent Fuel Test Facility: this facility is at the 1,400-ft depth in the Climax Stock granite formation on the Nevada Test Site. Eleven encapsulated commercial spent fuel assemblies and 26 auxiliary electric heaters have been emplaced in three parallel shafts to simulate repository conditions. The test will determine the generic behavior of granite under the influence of heat and radiation

co-located: refers to location of facilities at a common site, thereby minimizing transportation needs

consolidation (compaction): reduction in the spacing of racks that hold spent fuel in a water storage basin so that the basin can hold more fuel and still remain subcritical

contamination: the deposition of radioactive material on a surface

criterion: a standard rule or test on which a judgment or decision may be based

critical mass: the minimum mass of fissionable material that, with appropriate geometrical arrangement and material composition, will sustain fission

criticality: state of being critical; a self-sustaining neutron chain reaction in which the number of neutrons lost by absorption or leakage just equals the number produced by the fission process

curie: the unit of radioactivity, abbreviated Ci. One curie equals  $3.700 \times 10^{10}$  nuclear transformations per second

daughter product: nuclides resulting from the radioac-

SOURCE: Adapted from U.S. Department of Energy, *Information Base for Commercial Radioactive Waste Management*, DOE/ET/401 10-1, July 1982.

- tive decay of other nuclides. A daughter product may be either stable or radioactive
- decommissioning: the process of removing a facility from operation; its contents may be entombed, decontaminated and dismantled, or converted to another use
- decontamination: the removal of unwanted material (especially radioactive material) from the surface or from within another material
- deep-well injection: pumping waste-containing slurries or liquids into subterranean voids or porous strata
- defense waste: radioactive waste due to research and development on weapons, the operations of naval reactors, the production of weapons materials, or the reprocessing of defense nuclear fuel
- DEIS: Draft Environmental Impact Statement
- deuterium: a natural isotope of hydrogen with one neutron and one proton in its nucleus (atomic weight = 2)
- disposal: operations designed to provide final isolation—with no provision for easy recovery of the emplaced waste—by relying on a combination of manmade and natural barriers rather than on continuous human control and maintenance to ensure the isolation of the waste; NWPA specifies emplacement in mined geologic repositories. While disposal sites and facilities must be designed to provide disposal, as just defined, they may also be used for storage or other activities prior to disposal
- DOE: U.S. Department of Energy
- DOI: U.S. Department of the Interior
- dome, salt: a diapiric or piercement structure with a central, nearly circular salt plug, generally one to two kilometers in diameter, that has risen through the enclosing sediments from a deep mother bed of salt
- DOT: U.S. Department of Transportation
- EA: Environmental Assessment
- EIS: Environmental Impact Statement
- emplacement medium: the material (e. g., granite or salt) in which a repository is built and into which the waste will be placed
- enriched uranium: uranium in which the percentage of the fissionable isotope U 235 has been increased above the 0.7 percent normally found in natural uranium
- EPA: U.S. Environmental Protection Agency
- ERDA: U.S. Energy Research and Development Administration, now DOE
- Federal repository: see repository
- FEIS: Final Environmental Impact Statement
- FEMA: Federal Emergency Management Agency
- fertile atoms: nonfissile isotopes, notably uranium-238, which after absorbing a neutron will subsequently decay to fissile isotopes like plutonium-239
- FGEIS: Final Generic Environmental Impact Statement
- final isolation: placement of radioactive material in a final resting place so that removal to another site is neither necessary nor expected for as long as it takes for the material to decay to a prescribed low level of radioactivity. Synonymous with permanent isolation and terminal isolation
- fissile material: one of several actinides which undergo fission when a thermal neutron is captured
- fission (nuclear): the splitting of a heavy nucleus into two or more radioactive nuclei, accompanied by the release of a large amount of energy and generally one or more neutrons. Fission is usually initiated by neutrons, but it can also occur spontaneously
- fission products: a general term for the complex mixture of nuclides produced as a result of nuclear fission. Most, but not all nuclides in the mixture are radioactive and decay, forming additional (daughter) products, with the result that the complex mixture of fission products so formed contains about 200 different isotopes of over 35 elements
- fissionable material: any material fissionable by neutrons, such as certain isotopes of uranium and plutonium
- fuel (nuclear reactor): fissionable material used as a source of power when placed in a critical arrangement in a nuclear reactor
- fuel assembly: a grouping of fuel rods which is not taken apart during the charging and discharging of a reactor core
- fuel cycle: the uranium fuel cycle to support the operation of light water reactors involves a number of stages, including: mining, milling, conversion (U308 to UFG), enrichment, fuel fabrication, nuclear reactor operation, fuel reprocessing, waste management, and transportation between stages
- fuel element: a tube, rod or other form into which fuel material is fabricated for use in a reactor
- fuel reprocessing plant: a chemical plant where irradiated fuel elements are processed to separate fission products from uranium and plutonium
- fuel residue waste: solid wastes consisting of the residue (fuel element hardware and chopped cladding material) after the bulk of fuel core material, including most of the actinides and fission products, has been dissolved in nitric acid in a chop and leach process. It is contaminated with low levels of actinides and fission products and contains nearly all the activation products formed in the hardware and cladding material
- full-core reserve: space reserved in the reactor basin to accommodate all of the fuel contained in the reactor
- full cost recovery: includes charges to the user that

compensate the government for budgetary spending, for capital and operating costs, for return on invested capital, and for costs to cover unusual hazards, e.g., insurance premiums, premium pay for hazardous work, workmen's compensation

FY: fiscal year

gamma rays: short-wavelength electromagnetic radiation emitted in the radioactive decay of certain nuclides. Gamma rays are highly penetrating

GEIS: Generic Environmental Impact Statement

geologic disposal: disposal in a repository constructed in a geologic formation

GESMO: Generic Environmental Statement on the Use of Recycle Plutonium in Mixed Oxide Fuel in Light Water Cooled Reactors, NUREG-0002

granite: a generally light-colored, coarse-grained igneous rock with substantial amounts of quartz and feldspars rich in sodium and potassium

groundwater: water that exists or flows in a zone of saturation between land surfaces

GWe: gigawatts electric, i.e., 1 billion ( $10^9$ ) watts or 1,000 megawatts

half-life: time required for a radioactive substance to lose 50 percent of its activity by decay. After a period equal to 10 half-lives, the radioactivity has decreased to about 0.1 percent of its original value

head end of the fuel cycle: mining, milling, enrichment, and fabrication of UO<sub>2</sub> fuel

high-level waste (HLW): highly radioactive material resulting from chemical processing of spent fuel to recover usable uranium and plutonium; contains fission products, traces of uranium and plutonium, and other TRU elements. Originally produced in liquid form, HLW must be solidified before disposal

high-level radioactive waste: high-level liquid wastes, products from solidification of high-level liquid waste, and irradiated (spent) fuel elements, if discarded without reprocessing

hydrofracture: a process of producing underground openings by injection of fluids (usually water) at pressures greater than the weight of the overlying rock and soil

IAEA: International Atomic Energy Agency—established as an autonomous member of the United Nations, the IAEA currently includes over 100 participating countries. It is located in Vienna, Austria

ICRP: International Commission on Radiological Protection—located in Sutton, Surrey, England

igneous: rock formed through solidification of partially molten materials

immobilization: treatment and/or emplacement of wastes to impede their movement

induced radioactivity: radioactivity produced in certain materials as a result of nuclear reactions, par-

ticularly the capture of neutrons, which are accompanied by the formation of radioactive nuclei

INEL: Idaho National Engineering Laboratory—near Idaho Falls, Idaho

INFCE: International Nuclear Fuel Cycle Evaluation—established in 1977, INFCE includes approximately 50 countries and four international agencies. The purpose of the INFCE was to prepare an evaluation of the nuclear fuel cycle. The final report was issued in March 1980

in-situ: in the natural or original location

interim storage: temporary storage with the intention and expectation that radioactive materials will be removed for subsequent treatment, transportation, or isolation. Limited interim storage is defined by the Nuclear Regulatory Commission (NRC) as 20 years renewable at the option of NRC. Extended interim storage would be such storage for a very long (30 + years) and relatively open-ended, undefined period.

IRG: Interagency Review Group on Nuclear Waste Management—established by President Carter (March 1978) to formulate recommendations for the management of radioactive waste. Chaired by DOE, the IRG included 14 Federal agencies

irradiation: exposure to any form of radiation

isolation: the placement of radioactive materials so that contact between the waste and humans or the environment is highly unlikely for a specified period of time

isotopes: atoms of the same element which contain different numbers of neutrons in their nucleus. Isotopes which decay spontaneously emitting radiation are called radioisotopes.

kilo: a prefix indicating 1,000 ( $10^3$ ) times the affixed unit, abbreviated (k)

kilogram: kg = 1,000 grams = 2.2 pounds

kwh: kilowatt-hour, a unit of energy generation or consumption in a given hour

leaching: the process of extracting a soluble component from a solid by the percolation of a solvent, such as water, through the solid

long-lived nuclides: radioactive isotopes with half-lives greater than 30 years

low-level waste (LLW): radioactive waste not classified as high-level radioactive waste, transuranic waste, spent nuclear fuel, or byproduct material as defined in Section 110(2) of the Atomic Energy Act of 1954, amended

LWR: light water reactor

metric ton (MT or tonne): unit of weight; 1 MT = 1,000 kilograms = 2,205 pounds

mill tailings: see uranium mill tailings

mrem: millirem, one-thousandth of a rem

MTHM: metric tons of heavy metal (nuclear fuel)

- MTU: metric tons of uranium
- monitoring: measuring the quantity and type of discharges or migration of radioactive waste from a waste management facility, chemical, or biological characteristics of the site and the surrounding area
- MOX: mixed oxide fuel (uranium and plutonium oxides)
- MRS: monitored retrievable storage
- multibarrier: a system using the waste form, container, canister, overpack, and emplacement medium as multiple barriers to isolate the waste from the biosphere
- MWe: megawatt electric (1 MW = 1 million watts), a unit of the rate of energy production or consumption
- MWt-d/MTHM: megawatt (thermal) days per metric ton of heavy metal, a measure of burnup
- nanocurie (nCi): one billionth of a curie ( $10^{-9}$  Ci), equivalent to 37 disintegrations per second
- NAS: National Academy of Sciences
- NASA: National Aeronautics and Space Administration
- NCRP: National Council on Radiation Protection and Measurement—located in Bethesda, Md., this is a nongovernmental not-for-profit council chartered by Congress
- NEPA: National Environmental Policy Act of 1969
- neutron: an uncharged particle in a nucleus; of slightly greater mass than a proton; highly penetrating. Unlike the absorption of alpha, beta, or gamma radiation, the capture of neutrons by a substance can cause this substance to become radioactive
- NFS: Nuclear Fuel Services, Inc.
- NRC: Nuclear Regulatory Commission
- NTS: Nevada Test Site
- nuclear radiation: particulate and electromagnetic radiation emitted from nuclei. Important nuclear radiations are ionizing radiations
- nuclear reaction: neutron reactions with materials that cause fission with the simultaneous release of energy
- nuclear safety: the application of technical knowledge and administrative control to prevent an unplanned, uncontrolled nuclear chain reaction
- nuclear waste: this term is usually used interchangeably with radioactive waste (see waste, radioactive)
- nucleus: the inner core of an atom, consisting primarily of neutrons and protons, which makes up almost the entire mass of the atom, but only a minute part of its volume**
- nuclide: an atom characterized by the number of neutrons and protons and sometimes by the energy state in its nucleus**
- OCRWM: Office of Civilian Radioactive Waste Management, DOE**
- ONWI: Office of Nuclear Waste Isolation, Battelle Memorial Institute, Columbus, Ohio**
- ORNL: Oak Ridge National Laboratory
- overpack: secondary or additional external containment of packaged radioactive waste
- partition: to separate one element from others; in processing operations, the separation of elements such as uranium and plutonium
- permanent storage: storage used as a means of providing final isolation, with no intentions of ever retrieving the waste
- plutonium: a radioactive element with an atomic number of 94. Its most important isotope is fissionable Pu-239, produced by neutron h-radiation of U-238
- PNL: Pacific Northwest Laboratory—operated by Battelle Northwest Laboratories at Richland, Wash.
- pool: a concrete chamber filled with water to provide shielding for irradiated fuel elements
- PWR: pressurized water reactor: a reactor system that uses a pressurized water primary cooling system; steam formed in a secondary cooling system drives turbines to generate electricity
- R&D: research and development
- rad: radiation absorbed dose: a unit of absorbed dose of ionizing radiation, equivalent to the absorption of 100 ergs of radiation energy per gram of absorbing material
- radioactive: unstable in a manner shown by spontaneous nuclear disintegration with accompanying emission of radiation and particles
- radioactive decay: the spontaneous transformation of one nuclide into another or into a different energy state of the same one, accompanied by the emission of alpha or beta particles and/or gamma rays
- radioactivity: the rate at which radioactive material is emitting radiation, given in terms of the number of nuclear disintegrations occurring in a unit of time. The common unit of radioactivity is the curie (Ci)
- radioisotope: a radioactive isotope of an element
- radionuclide: a radioactive nuclide**
- RD&D: research, development, and demonstration**
- reactor (nuclear): a device in which a fission chain reaction can be initiated, maintained, and controlled
- rem: roentgen equivalent man: a quantity used in radiation protection to express the effective dose equivalent for all forms of ionizing radiation; the dose equivalent in rems is numerically equal to the absorbed dose in rads multiplied by the quality factor, the distribution factor, and any other necessary modifying factors
- reprocessing: dissolving spent reactor fuel to recover useful materials such as thorium, uranium, and plutonium. Other radioactive materials are usually separated and treated as waste
- re-racking: the replacement of existing fuel storage racks in storage basins with racks of modified design**

- to increase the amount of spent fuel that can be stored in the basins
- repository (Federal): both a site and attached facilities designed for final isolation of radioactive materials
- retrievability: capability to remove waste from its place in storage; the method and rate of removal and the subsequent location of the waste must satisfy retrievability criteria
- risk: the product of an event's frequency and its consequence, yielding an estimate of the expected damage rate; e.g., population dose per year from a specified event
- roentgen: a unit for measuring gamma or X-ray radiation; the roentgen is defined by measuring the effect of the radiation on air. It is that amount of gamma or X-rays required to produce ions carrying 1 electrostatic unit of charge in 1 cubic centimeter of dry air under standard conditions
- seismicity: the tendency for the occurrence of earthquakes
- shale: laminated, easily fractured sedimentary rock produced from clay
- shielding: a material interposed between a source of radiation and personnel for protection against the danger of radiation; common shielding materials are concrete, water, and lead
- shipping cask: a specially designed container used for transporting radioactive materials
- short-lived nuclides: for purposes of waste isolation, a relative term generally defined as radioactive isotopes with half-lives no greater than about 30 years, e.g., CS-137, Sr-90, Kr-85, II-3
- spent nuclear fuel: nuclear reactor fuel that has been used to the extent that it can no longer be used in a nuclear power plant without reprocessing
- storage: operations designed to provide isolation and easy recovery of radioactive materials; storage relies on continuous human monitoring, maintenance, and protection from human intrusion for a specified period of time
- storage basin: a water-filled, stainless steel lined pool for the interim storage of spent fuel
- technologies: specific methods for implementing concepts; an example is storing spent fuel in a metal cask
- tectonics: a branch of geology dealing with the broad architecture of the upper part of the Earth's crust. Plate tectonics considers a small number (10 to 25) of large, broad, thick plates (blocks composed of areas of both continental and oceanic crust and mantle), each of which "floats" on some viscous underlayer in the mantle and moves more or less independently of the others and grinds against them like ice floes in a river
- terminal isolation (final isolation): placement of high-level wastes into a repository with no intention of recovering the emplaced material in the future
- ton: English unit of weight, 1 ton = 2,000 pounds (1 short ton)
- tonne: metric unit of weight, 1 tonne = 1,000 kg = 2,205 pounds (1 metric ton or 1 long ton)
- transmutation: conversion of one element into another by bombarding it with a nuclear particle
- transportation: movement of materials between sites (intrasite movement is not considered); this includes alternative methods for packing, handling, and transporting waste materials and plutonium compounds. Concepts include all conventional methods of land and water transport required by the waste management system
- transshipment: shipping spent fuel from one reactor basin to another reactor within the utility system with available space
- TRU: transuranic
- transuranic elements: elements with atomic numbers greater than 92, including, among others, neptunium, plutonium, americium, and curium
- transuranic waste (TRU waste): waste materials contaminated with U-233 (and its daughter products), certain isotopes of plutonium, and with nuclides with atomic number greater than 92. In order to be classified as TRU waste, the long-lived alpha activity from subject isotopes must exceed 100 nCi/g of waste material independent of the level of beta-gamma activity. This waste, which can vary greatly in its specific gamma activity, is produced primarily from reprocessing spent fuel and from the use of plutonium in the fabrication of nuclear weapons
- tritium: a radioactive isotope of hydrogen containing two neutrons and one proton in the nucleus, with an atomic weight of 3
- tuff: a rock formed of compacted volcanic ash and dust; it is usually porous and often soft
- USGS: U.S. Geological Survey, DOI
- uranium mill tailings: waste material resulting from the processing of ores for the extraction of uranium; the word tailings means the remaining portion of metal-bearing ore after some of the uranium has been extracted
- uranium: a naturally radioactive element with the atomic number 92 and an atomic weight of approximately 238. The two principal naturally occurring isotopes are the fissionable U-235 (0.7 percent of natural uranium) and the fertile U-238 (99.3 percent of natural uranium)
- uranium dioxide (UO<sub>2</sub>): stable chemical compound of uranium and oxygen; this is the compound for most power reactor fuel
- waste immobilization: the process of converting waste

to a stable, solid form that encases the radionuclides to prevent or slow their migration to the biosphere  
waste management: the planning, execution, and surveillance of essential functions related to the control of radioactive and nonradioactive waste, including treatment, solidification, initial or long-term storage, surveillance, and isolation  
waste, radioactive: equipment and materials (from nuclear operations) that are radioactive or have radioac-

tive contamination and for which there is no recognized use or for which recovery is impractical  
water basin: a specially designed and operated water pool for storing, cooling, and shielding spent fuel elements  
WIPP: Waste Isolation Pilot Plant: near Carlsbad, N. Mex., a non-NRC-licensed facility for disposal of TRU wastes resulting from national defense activities and programs