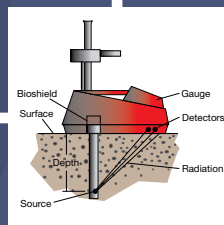




# GLOSSARY



## Glossary (Abbreviations, Definitions, and Illustrations)

### Advanced Reactors

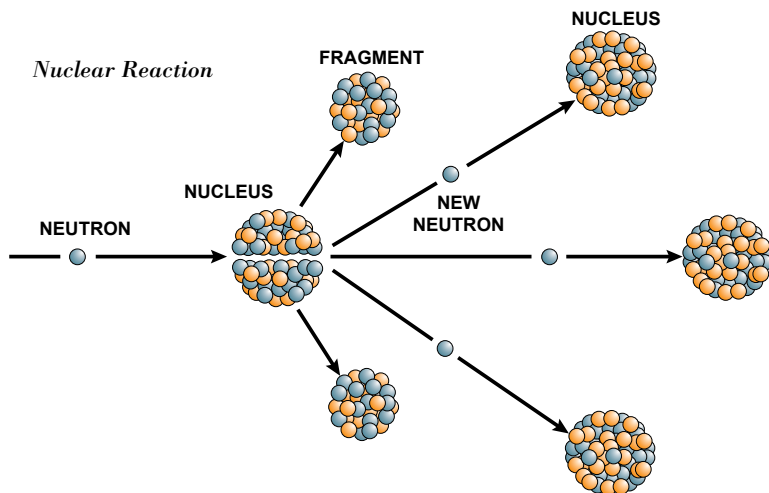
Reactors that differ from today's reactors primarily by their use of inert gases, molten salt mixtures, or liquid metals to cool the reactor core. Advanced reactors can also consider fuel materials and designs that differ radically from today's enriched-uranium dioxide pellets within zirconium cladding.

### Agreement State

A U.S. State that has signed an agreement with the U.S. Nuclear Regulatory Commission (NRC) authorizing the State to regulate certain uses of radioactive materials within the State.

### Atomic energy

The energy that is released through a nuclear reaction or radioactive decay process. One kind of nuclear reaction is fission, which occurs in a nuclear reactor and releases energy, usually in the form of heat and radiation. In a nuclear power plant, this heat is used to boil water to produce steam that can be used to drive large turbines. The turbines drive generators to produce electrical power.

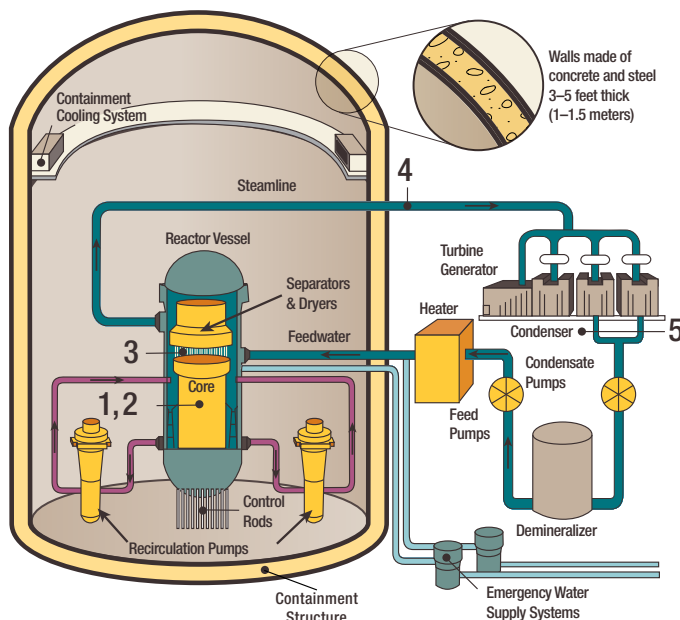


### Background radiation

The natural radiation that is always present in the environment. It includes cosmic radiation that comes from the sun and stars, terrestrial radiation that comes from the Earth, and internal radiation that exists in all living things and enters organisms by ingestion or inhalation. The typical average individual exposure in the United States from natural background sources is about 310 millirem per year.

## Boiling-water reactor (BWR)

A nuclear reactor in which water is boiled using heat released from fission. The steam released by boiling then drives turbines and generators to produce electrical power. BWRs operate similarly to electrical plants using fossil fuel, except that the BWRs are heated by nuclear fission in the reactor core.



### How Nuclear Reactors Work

In a typical design concept of a commercial BWR, the following process occurs:

1. The nuclear fuel core inside the reactor vessel creates heat from nuclear fission.
2. A steam-water mixture is produced when very pure water (reactor coolant) moves upward through the core, absorbing heat.
3. The steam-water mixture leaves the top of the core and enters the two stages of moisture separation where water droplets are removed before the steam is allowed to enter the steamline.
4. The steam is piped to the main turbine, causing it to turn the turbine generator, which produces electricity.
5. The steam is exhausted to the condenser, where it is condensed into water. The resulting water is pumped out of the condenser with a series of pumps and pumped back to the reactor vessel.

The reactor's core contains fuel assemblies that are cooled by water circulated using electrically powered pumps. These pumps and other operating systems in the plant receive their power from the electrical grid. If offsite power is lost, cooling water is supplied by other pumps, which can be powered by onsite diesel generators or steam generated by the core. Other safety systems, such as the containment cooling system, also need electric power. BWRs contain between 370–800 fuel assemblies.

## Brachytherapy

A medical procedure during which a sealed radioactive source (or sources) is implanted directly into a person being treated for cancer (usually of the mouth, breast, lung, prostate, ovaries, or uterus). The radioactive implant may be temporary or permanent, and the radiation kills cells in the tumor as long as the device remains in place and emits radiation. Brachytherapy uses radioisotopes, such as iridium-192 or iodine-125, which are regulated by the NRC and Agreement States.

## Byproduct material

As defined by NRC regulations, byproduct material includes any radioactive material (except enriched uranium or plutonium) produced by a nuclear reactor, through the use of a particle accelerator, or any discrete source of radium-226 used for a commercial, medical, or research activity. It also includes the tailings or wastes produced by the extraction or concentration of uranium or thorium or the fabrication of fuel for nuclear reactors. In addition, the NRC, in consultation with the U.S. Environmental Protection Agency, U.S. Department of Energy, U.S. Department of Homeland Security, and others, can designate as byproduct material any source of naturally occurring radioactive material, other than source material, that it determines would pose a threat to public health and safety or the common defense and security of the United States.

## Canister

See *Dry cask storage*.

## Capability

The maximum load that a generating unit, generating station, or other electrical apparatus can carry under specified conditions for a given period of time without exceeding approved limits of temperature and stress.

## Capacity

The amount of electric power that a generator, turbine transformer, transmission, circuit, or system is able to produce, as rated by the manufacturer.

## Capacity factor

The ratio of the available capacity (the amount of electrical power actually produced by a generating unit) to the theoretical capacity (the amount of electrical power that could theoretically have been produced if the generating unit had operated continuously at full power) during a given time period.

## Capacity utilization

A percentage that a generating unit fulfilled its capacity in generating electric power over a given time period. This percentage is defined as the margin between the unit's available capacity (the amount of electrical power the unit actually produced) and its theoretical capacity (the amount of electrical power that could have been produced if the unit had operated continuously at full power) during a certain time period. Capacity utilization is computed by dividing the amount of power actually produced by the theoretical capacity and multiplying by 100.

## Cask

A heavily shielded container used for the dry storage or shipment (or both) of radioactive materials such as spent nuclear fuel or other high-level radioactive waste (HLW). Casks are often made from lead, concrete, and/or steel. Casks must meet regulatory requirements.

## Categories of radiation sources

The categories for radiation sources are defined by the International Atomic Energy Agency's Code of Conduct on the Safety and Security of Radioactive Sources. This helps ensure that sufficient controls are being used to achieve safety and security. Only Categories 1 and 2 for radiation sources are defined by NRC requirements. The five categories are as follows:

- Category 1 sources, if not safely or securely managed, would be likely to cause permanent injury to a person who handled them or was otherwise in contact with them for more than a few minutes. It would probably be fatal to be close to this amount of unshielded material for a period of a few minutes to an hour. These sources are typically used in radiothermal generators, irradiators, and radiation teletherapy.
- Category 2 sources, if not safely or securely managed, could cause permanent injury to a person who handled them or was otherwise in contact with them for a short time (minutes to hours). It could possibly be fatal to be close to this amount of unshielded radioactive material for a period of hours to days. These sources are typically used in industrial gamma radiography, high- and medium-dose rate brachytherapy, and radiography.
- Category 3 sources, if not safely or securely managed, could cause permanent injury to a person who handled them or was otherwise in contact with them for hours. It could possibly—although it is unlikely—be fatal to be close to this amount of unshielded radioactive material for a period of days to weeks. These sources are typically used in fixed industrial gauges such as level gauges, dredger gauges, conveyor gauges, spinning pipe gauges, and well logging gauges.
- Category 4 sources, if not safely managed or securely protected, could possibly cause temporary injury to someone who handled them or was otherwise in contact with or close to them for a period of many weeks, though this is unlikely. It is very unlikely anyone would be permanently injured by this amount of radioactive material. These sources are typically used in fixed or portable gauges, static eliminators, or low dose brachytherapy.
- Category 5 sources cannot cause permanent injury. They are used in X-ray fluorescence devices and electron capture devices.

## Categories of special nuclear material

The NRC categorizes special nuclear materials and the facilities that possess them into three categories based upon the materials' potential for use in nuclear weapons or their "strategic significance." The three categories are as follows:

- Category I, high strategic significance
- Category II, moderate strategic significance
- Category III, low strategic significance

The NRC's physical security and safeguards requirements differ by category, with Category I facilities subject to more stringent requirements because they pose greater security and safeguards risks.

## Classified information

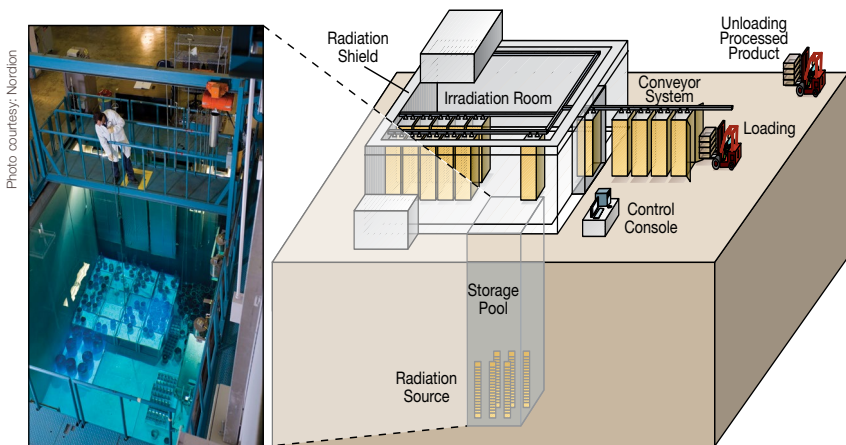
Information that has been determined pursuant to an executive order to require protection against unauthorized disclosure and is marked to indicate its classified status when in documentary form. The NRC has two types of classified information. The first type, known as national security information, is information that is classified by an executive order. Its release would damage national security. The second type, known as restricted data, would assist individuals or organizations in designing, manufacturing, or using nuclear weapons. Access to both types of information is restricted to authorized persons who have been properly cleared and have a “need to know” the information to accomplish their official duties.

## Combined license (COL)

An NRC-issued license that authorizes a licensee to construct and (with certain specified conditions) operate a nuclear power facility, such as a nuclear plant at a specific site.

## Commercial irradiator

A facility that uses high doses of radiation to sterilize or treat products, such as food and spices, medical supplies, and wood flooring. Irradiation can be used to eliminate harmful bacteria, germs, and insects or for hardening or other purposes. The radiation does not leave radioactive residue or make the treated products radioactive. Radiation sources include radioactive materials (e.g., cobalt-60), an x-ray machine, or an electron beam.



## Compact

A group of two or more U.S. States that have formed alliances to dispose of low-level radioactive waste (LLW).

## Construction recapture

The maximum number of years that could be added to a nuclear power plant's license expiration date to recapture the period between the date the NRC issued the plant's construction permit and the date it granted an operating license. A licensee must submit an application to request this extension.

### **Containment structure**

A resilient gas-tight shell or other enclosure around a nuclear reactor to confine fission products that otherwise might be released to the atmosphere in the event of a severe reactor accident. Such enclosures are usually dome-shaped and made of steel-reinforced concrete.

### **Contamination**

Undesirable radiological or chemical material (with a potentially harmful effect) that is either airborne or deposited in (or on the surface of) structures, objects, soil, water, or living organisms.

### **Criticality**

The condition involving fission of nuclear materials when the number of neutrons produced equals or exceeds the nuclear containment. During normal reactor operations, nuclear fuel sustains a fission chain reaction or criticality. A reactor achieves criticality (and is said to be critical) when each fission event releases a sufficient number of neutrons to sustain an ongoing series of reactions.

### **Decommissioning**

The process of safely closing a nuclear power plant (or other facility where nuclear materials are handled) to retire it from service after its useful life has ended. This process primarily involves decontaminating the facility to reduce residual radioactivity and then releasing the property for unrestricted or (under certain conditions) restricted use. This often includes dismantling the facility or dedicating it to other purposes. *See ENTOMB and SAFSTOR.*

### **DECON**

A phase of reactor decommissioning in which structures, systems, and components that contain radioactive contamination are removed from a site and safely disposed of at a commercially operated low-level waste disposal facility or decontaminated to a level that permits the site to be released for unrestricted use.

### **Decontamination**

A process used to reduce, remove, or neutralize radiological or chemical contamination to reduce the risk of exposure. Decontamination may be accomplished by cleaning or treating surfaces to reduce or remove the contamination, filtering contaminated air or water, or subjecting contamination to evaporation and precipitation. The process can also simply allow adequate time for radioactive decay to decrease the radioactivity.

### **Defense in depth**

An approach to designing and operating nuclear facilities that prevents and mitigates accidents that release radiation or hazardous materials. The key is creating multiple independent and redundant layers of controls or design features to compensate for potential human and mechanical failures so that no single control, no matter how robust, is exclusively relied upon to achieve safety or security. Defense in depth includes the use of access controls, physical barriers, redundant and diverse key safety functions, and emergency response measures.



## Depleted uranium

Uranium with a percentage of uranium-235 lower than the 0.7 percent (by mass) contained in natural uranium. Depleted uranium is the byproduct of the uranium enrichment process. Depleted uranium can be blended with highly enriched uranium, such as that from weapons, to make reactor fuel.

## Design-basis threat (DBT)

A description of the type, composition, and capabilities of an adversary that a security system is designed to protect against. The NRC uses the DBT as a basis for designing safeguards systems to protect against acts of radiological sabotage and to prevent the theft of special nuclear material. Certain nuclear facility licensees are required to defend against the DBT.

## Design certification

Certification and approval by the NRC of a standard nuclear power plant design independent of a specific site or an application to construct or operate a plant. A design certification is valid for 15 years from the date of issuance but can be renewed for an additional 10 to 15 years.

## Dose (radiation)

The National Council on Radiation Protection and Measurements estimates that an average person in the United States receives a total annual dose of about 0.62 rem (620 millirem) from all radiation sources, a level that has not been shown to cause humans any harm. Of this total, natural background sources of radiation—including radon and thoron gas, natural radiation from soil and rocks, radiation from space, and radiation sources that are found naturally within the human body—account for about 50 percent. Medical procedures such as computed tomography (CT) scans and nuclear medicine account for about another 48 percent. Other small contributors of exposure to the U.S. population include consumer products and activities, industrial and research uses, and occupational tasks. The maximum permissible yearly dose for a person working with or around nuclear material is 5 rem.

## Dry cask storage

A method for storing spent nuclear fuel in special containers known as dry casks. After fuel has been cooled in a spent fuel pool, dry cask storage allows spent fuel assemblies to be sealed in casks and surrounded by inert gas. They are welded or bolted closed, and each cask includes steel, concrete, lead, or other material to provide leak-tight containment and radiation shielding. The casks may store fuel horizontally or vertically.



### **Early site permit (ESP)**

A permit granted by the NRC to approve one or more proposed sites for a nuclear power facility, independent of a specific nuclear plant design or an application for a construction permit or combined license. An ESP is valid for 10 to 20 years but can be renewed for an additional 10 to 20 years.

### **Economic Simplified Boiling-Water Reactor (ESBWR)**

A 4,500-megawatt thermal nuclear reactor design, which has passive safety features and uses natural circulation (with no recirculation pumps or associated piping) for normal operation. The NRC certified the ESBWR standard design submitted by GE-Hitachi Nuclear Energy on October 15, 2014.

### **Efficiency, plant**

The percentage of the total energy content of a power plant's thermal energy that is converted into electricity. The remaining energy is lost to the environment as heat.

### **Electric power grid**

A system of synchronized power providers and consumers, connected by transmission and distribution lines and operated by one or more control centers. In the continental United States, the electric power grid consists of three systems—the Eastern Interconnect, the Western Interconnect, and the Texas Interconnect. In Alaska and Hawaii, several systems encompass areas smaller than the State.

### **Electric utility**

A corporation, agency, authority, person, or other legal entity that owns or operates facilities within the United States, its territories, or Puerto Rico for the generation, transmission, distribution, or sale of electric power (primarily for use by the public). Facilities that qualify as cogenerators or small power producers under the Public Utility Regulatory Policies Act are not considered electric utilities.

### **Emergency classifications**

Sets of plant conditions that indicate various levels of risk to the public and that might require response by an offsite emergency response organization to protect citizens near the site.

### **Emergency preparedness (EP)**

The programs, plans, training, exercises, and resources used to prepare for and rapidly identify, evaluate, and respond to emergencies, including those arising from terrorism or natural events such as hurricanes. EP strives to ensure that operators of nuclear power plants and certain fuel cycle facilities can implement measures to protect public health and safety in the event of a radiological emergency. Licensees who operate certain nuclear facilities, such as nuclear power plants, must develop and maintain EP plans that meet NRC requirements.

### **Energy Information Administration (EIA)**

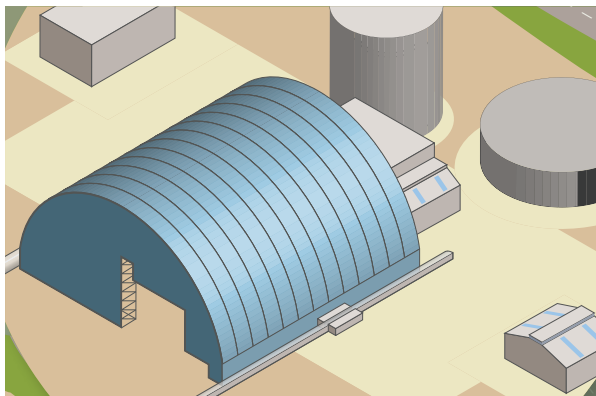
The agency within the U.S. Department of Energy that provides policy-neutral statistical data, forecasts, and analyses to promote sound policymaking, efficient markets, and public understanding regarding energy and its interaction with the economy and the environment.

## Enrichment

See *Uranium enrichment*.

## ENTOMB

A method of decommissioning a nuclear power plant in which radioactive contaminants are encased in a structurally long-lived material, such as concrete. The entombed structure is maintained and surveillance is continued until the radioactive waste decays to a level that permits termination of the license and unrestricted release of the property.



## Event Notification System

An automated system used by the NRC to document incoming notifications of significant nuclear events with an actual or potential effect on the health and safety of the public and the environment. Significant events are reported to the NRC by licensees, Agreement States, other Federal agencies, the public, and other countries.

## Exposure (radiation)

Absorption of ionizing radiation or the amount of a hazardous substance that has been ingested, inhaled, or contacted the skin. Acute exposure occurs over a short period of time. Chronic exposure is exposure received over a long period of time, such as during a lifetime. See *Occupational dose*.

## Federal Emergency Management Agency (FEMA)

A component of the U.S. Department of Homeland Security responsible for protecting the Nation and reducing the loss of life and property from all hazards such as natural disasters and acts of terrorism. FEMA leads and supports a risk-based, comprehensive emergency management system of preparedness, protection, response, recovery, and mitigation.

## Federal Energy Regulatory Commission (FERC)

An independent agency that regulates the interstate transmission of electricity, natural gas, and oil. FERC also regulates and oversees hydropower projects and the construction of liquefied natural gas terminals and interstate natural gas pipelines. FERC protects the economic, environmental, and safety interests of the American public, while working to ensure abundant, reliable energy in a fair, competitive market.

### **Fiscal year (FY)**

The 12-month period from October 1 through September 30 used by the Federal Government for budget formulation and execution. The FY is designated by the calendar year in which it ends; for example, FY 2017 runs from October 1, 2016, through September 30, 2017.

### **Fissile material**

A nuclide that is capable of undergoing fission after capturing neutrons. Although sometimes used as a synonym for fissionable material, this term has acquired its more restrictive interpretation with the limitation that the nuclide must be fissionable by thermal neutrons. With that interpretation, the three primary fissile materials are uranium-233, uranium-235, and plutonium-239. This definition excludes natural uranium and depleted uranium that have not been irradiated or have only been irradiated in thermal reactors.

### **Fission**

The splitting of an atom, which releases a considerable amount of energy (usually in the form of heat). Fission may be spontaneous but is usually caused by the nucleus of an atom becoming unstable (or "heavy") after capturing or absorbing a neutron. During fission, the nucleus splits into roughly equal parts, producing the nuclei of at least two lighter elements. In addition to energy, this reaction usually releases gamma radiation and two or more daughter neutrons.

### **Force on force**

A type of security exercise designed to evaluate and improve the effectiveness of a security system. For the NRC, force-on-force exercises are used to assess the ability of the licensee to defend a nuclear power plant and other nuclear facilities against a design-basis threat.

### **Foreign Assignee Program**

An on-the-job training program sponsored by the NRC for assignees from other countries, usually under bilateral information exchange arrangements with their respective regulatory organizations. The assignees' regulatory authorities generally identify the individuals participating and pay their salaries.

### **Freedom of Information Act (FOIA)**

A Federal law that requires Federal agencies to provide, upon written request, access to records or information. Some material is exempt from FOIA, and FOIA does not apply to records that are maintained by State and local governments, Federal contractors, grantees, or private organizations or businesses.

### **Fuel assembly (fuel bundle, fuel element)**

A structured group of fuel rods (long, slender, metal tubes containing pellets of fissionable material, which provide fuel for nuclear reactors). Depending on the design, each reactor core may have dozens of fuel assemblies (also known as fuel bundles), each of which contains dozens of fuel rods.

**Fuel cycle**

The series of steps involved in supplying fuel for nuclear power reactors. The uranium fuel cycle includes the following:

- uranium recovery to extract and concentrate the uranium to produce yellowcake
- conversion of yellowcake into uranium hexafluoride ( $\text{UF}_6$ )
- enrichment to increase the concentration of uranium in  $\text{UF}_6$
- fuel fabrication to convert enriched  $\text{UF}_6$  into fuel for nuclear reactors
- use of the fuel in reactors (nuclear power research or naval propulsion)
- interim storage of spent nuclear fuel
- reprocessing of spent fuel to recover the fissionable material remaining in the spent fuel (currently not done in the United States)
- final disposition/disposal of high-level radioactive waste
- transportation of the uranium in all forms, including spent fuel

The NRC regulates these processes, as well as the fabrication of mixed-oxide (MOX) nuclear fuel, which is a combination of uranium and plutonium oxides.

**Fuel reprocessing (recycling)**

The processing of reactor fuel to separate the unused fissionable material from waste material. Reprocessing extracts uranium and plutonium from spent nuclear fuel so they can be used again as reactor fuel. Commercial reprocessing is not practiced in the United States, although it has been in the past. However, the U.S. Department of Energy operates reprocessing facilities at Hanford, WA, and Savannah River, SC, for national defense purposes.

**Fuel rod**

A long, slender, zirconium metal tube containing pellets of fissionable material, which provide fuel for nuclear reactors. Fuel rods are assembled into bundles called fuel assemblies, which are loaded individually into the reactor core.

**Full-time equivalent (FTE)**

A human resources measurement equal to one person working full time for 1 year.

**Gas centrifuge**

Uranium enrichment technology that uses many rotating cylinders that are connected in long lines to increase the concentration of uranium-235. Gas is placed in the cylinder, which spins at a high speed, creating a strong centrifugal force. Heavier gas molecules move to the cylinder wall, while lighter molecules collect near the center. The stream, slightly enriched, is fed into the next cylinder. The depleted stream is recycled back into the previous cylinder.

**Gas chromatography**

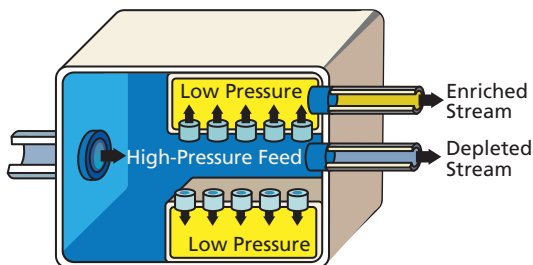
An analytical technique for separating chemical substances from a mixed sample by passing the sample, carried by a moving stream of gas, through a tube packed with a finely divided solid that may be coated with a liquid film. Gas chromatography devices are used to analyze air pollutants, blood alcohol content, essential oils, and food products.

### Gaseous diffusion

A uranium enrichment process used to increase the concentration of uranium-235 in uranium for use in fuel for nuclear reactors by separating its isotopes (as gases) based on their slight difference in mass. (Lighter isotopes diffuse faster through a porous membrane or vessel than do heavier isotopes.)

This process involves filtering  $UF_6$  gas to separate uranium-234 and uranium-235 from uranium-238, increasing the percentage of uranium-235.

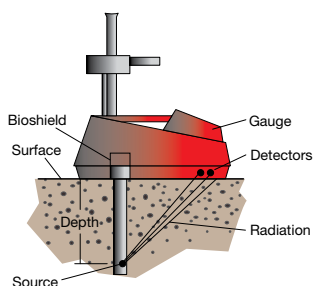
In May 2013, the last remaining gaseous diffusion plant in operation in the United States in Paducah, KY, shut down. A similar plant near Piketon, OH, was closed in March 2001. Another plant in Oak Ridge, TN, closed years ago and was not regulated by the NRC.



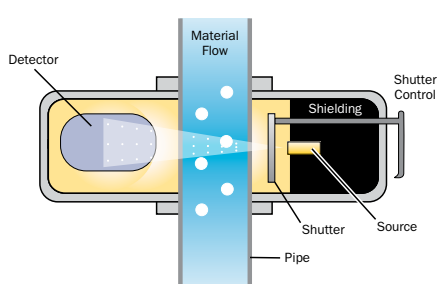
### Gauging devices

Devices used to measure, monitor, and control the thickness of sheet metal, textiles, paper napkins, newspaper, plastics, photographic film, and other products as they are manufactured. Gauges mounted in fixed locations are designed for measuring or controlling material density, flow, level, thickness, or weight. The gauges contain sealed sources that radiate through the substance being measured to a readout or controlling device. Portable gauging devices, such as moisture density gauges, are used at field locations. These gauges contain a gamma-emitting sealed source, usually cesium-137, or a sealed neutron source, usually americium-241 and beryllium.

#### Moisture Density Gauge



#### Fixed Fluid Gauge



### Generation (gross)

The total amount of electric energy produced by a power generating station, as measured at the generator terminals.

## Generation (net)

The gross amount of electric energy produced by a generating station, minus the amount used to operate the station. Net generation is usually measured in watt-hours.

## Generator capacity

The maximum amount of electric energy that a generator can produce (from the mechanical energy of the turbine), adjusted for ambient conditions. Generator capacity is commonly expressed in megawatts.

## Geological repository

An excavated, underground facility that is designed, constructed, and operated for safe and secure permanent disposal of high-level radioactive waste (HLW). A geological repository uses an engineered barrier system and a portion of the site's natural geology, hydrology, and geochemical systems to isolate the radioactivity of the waste.

## Gigawatt (GW)

A unit of power equivalent to one billion (1,000,000,000) watts.

## Gigawatthour (GWh)

One billion (1,000,000,000) watt-hours.

## Grid

See *Electric power grid*.

## Half-life (radiological)

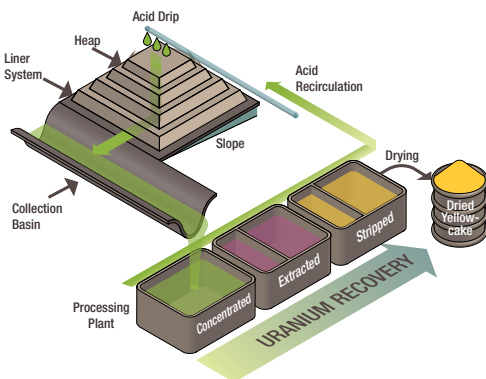
The time required for half the atoms of a particular radioactive material to decay. A specific half-life is a characteristic property of each radioisotope. Measured half-lives range from millionths of a second to billions of years, depending on the stability of the nucleus. Radiological half-life is related to, but different from, biological half-life and effective half-life.

## Health physics

The science concerned with recognizing and evaluating the effects of ionizing radiation on the health and safety of people and the environment, monitoring radiation exposure, and controlling the associated health risks and environmental hazards to permit the safe use of technologies that produce ionizing radiation.

## Heap leach recovery process

A method for extracting uranium from ore. The ore is placed in piles or heaps on top of liners. The liners prevent uranium and other chemicals from moving into the ground. Sulfuric acid is dripped onto the heap and dissolves uranium as it moves through the ore. Uranium solution drains into collection basins, where it is piped to a processing plant. At the plant, uranium is extracted, concentrated, and dried to form yellowcake.



### High-level radioactive waste (HLW)

The highly radioactive materials produced as byproducts of fuel reprocessing or of the reactions that occur inside nuclear reactors. HLW includes the following:

- irradiated spent nuclear fuel discharged from commercial nuclear power reactors
- highly radioactive liquid and solid materials resulting from the reprocessing of spent nuclear fuel, which contains fission products in concentration, including some reprocessed HLW from defense activities and a small quantity of reprocessed commercial HLW
- other highly radioactive materials that the Commission may determine require permanent isolation

### Highly (or high-) enriched uranium

Uranium enriched to at least 20 percent uranium-235 (a higher concentration than exists in natural uranium ore).

### In situ recovery (ISR)

A common method currently used to extract uranium from ore bodies without physical excavation of the ore. ISR is also known as “solution mining” or in situ leaching.

### Incident response

Activities that address the short-term, direct effects of a natural or human-caused event and require an emergency response to protect life or property.

### Independent spent fuel storage installation (ISFSI)

A complex designed and constructed for the interim storage of spent nuclear fuel; solid, reactor-related, greater-than-Class-C waste; and other associated radioactive materials. A spent fuel storage facility may be considered independent, even if it is located on the site of another NRC-licensed facility.

### International Atomic Energy Agency (IAEA)

A United Nations agency established in 1957 to serve as a world center of cooperation in the nuclear field. The agency works with nearly 170 member States and multiple partners worldwide to promote safe, secure, and peaceful nuclear technology.

### International Nuclear Regulators Association

An association established in January 1997 to give national nuclear regulators with mature civilian nuclear reactor and materials programs a forum to discuss nuclear safety and security issues of mutual interest. Canada, France, Japan, the Republic of South Korea, Spain, Sweden, the United Kingdom, and the United States are members.

### Irradiation

Exposure to ionizing radiation. Irradiation may be intentional, such as in cancer treatments or in sterilizing medical instruments. Irradiation may also be accidental, such as from exposure to an unshielded source. Irradiation does not usually result in radioactive contamination, but damage can occur, depending on the dose received.



## **Isotope**

Two or more forms (or atomic configurations) of a given element that have identical atomic numbers (the same number of protons in their nuclei) and the same or very similar chemical properties but different atomic masses (different numbers of neutrons in their nuclei) and distinct physical properties. Thus, carbon-12, carbon-13, and carbon-14 are isotopes of the element carbon, and the numbers denote the approximate atomic masses. Among their distinct physical properties, some isotopes (known as radioisotopes) are radioactive, because their nuclei are unstable and emit radiation as they decay spontaneously toward a more stable nuclear configuration. For example, carbon-12 and carbon-13 are stable, but carbon-14 is unstable and radioactive.

## **Kilowatt (kW)**

A unit of power equivalent to 1,000 watts.

## **Licensed material**

Source material, byproduct material, or special nuclear material that is received, possessed, used, transferred, or disposed of under a general or specific license issued by the NRC or Agreement States and is not otherwise exempt from regulation.

## **Licensee**

A company, organization, institution, or other entity to which the NRC or an Agreement State has granted a general or specific license to construct or operate a nuclear facility, or to receive, possess, use, transfer, or dispose of source, byproduct, or special nuclear material.

## **Licensing basis**

The collection of documents or technical criteria that provides the basis upon which the NRC issues a license to construct or operate a nuclear facility; to conduct operations involving the emission of radiation; or to receive, possess, use, transfer, or dispose of source, byproduct, or special nuclear material.

## **Light-water reactor**

A term used to describe reactors using ordinary water as a moderated coolant, including boiling-water reactors and pressurized-water reactors (PWRs), the most common types used in the United States.

## **Low-level radioactive waste (LLW)**

A general term for a wide range of waste that is contaminated with radioactive material or has become radioactive through exposure to neutron radiation. A variety of industries, hospitals and medical institutions, educational and research institutions, private or government laboratories, and nuclear fuel cycle facilities generate LLW. Some examples include radioactively contaminated protective shoe covers and clothing; cleaning rags, mops, filters, and reactor water treatment residues; equipment and tools; medical tubes, swabs, and hypodermic syringes; and carcasses and tissues from laboratory animals.

### **Loss-of-coolant accident (LOCA)**

A potential accident in which a breach in a reactor's pressure boundary causes the coolant water to rush out of the reactor faster than makeup water can be added back in. Without sufficient coolant, the reactor core could heat up and potentially melt the zirconium fuel cladding, causing a major release of radioactivity.

### **Megawatt (MW)**

A unit of power equivalent to 1,000,000 watts.

### **Megawatt-hour (MWh)**

A unit equals 1,000 kilowatts of electricity used continuously for 1 hour.

### **Metric ton**

About 2,200 pounds.

### **Mill tailings**

Primarily, the solid residue from a conventional uranium recovery facility in which uranium or thorium ore is crushed and processed mechanically or chemically to recover the uranium, thorium, or other valuable materials. This naturally radioactive ore residue contains the radioactive decay products from the uranium chains (mainly the uranium-238 chain). Although the milling process recovers about 93 percent of the uranium, the "tailings" contain several naturally occurring radioactive elements, including uranium, thorium, radium, polonium, and radon, as well as heavy metals and other constituents.

### **Mixed-oxide (MOX) fuel**

A type of nuclear reactor fuel that contains plutonium oxide mixed with either natural or depleted uranium oxide, in ceramic pellet form. This differs from conventional nuclear fuel, which is made of uranium oxide before it is irradiated in a reactor. Using plutonium reduces the amount of enriched uranium needed to produce a controlled reaction in commercial light-water reactors. However, plutonium exists only in trace amounts in nature and, therefore, must be produced by neutron irradiation of uranium-238 or obtained from other manufactured sources. As directed by Congress, the NRC regulates the fabrication of MOX fuel by DOE, a program that is intended to dispose of plutonium from excess nuclear weapons.

### **Monitoring of radiation**

Periodic or continuous determination of the amount of ionizing radiation or radioactive contamination in a region. Radiation monitoring is a safety measure to protect the health and safety of the public and the environment through the use of bioassay, alpha scans, and other radiological survey methods to monitor air, surface water and ground water, soil and sediment, equipment surfaces, and personnel.

### **National Response Framework**

The guiding principles, roles, and structures that enable all domestic incident response partners to prepare for and provide a unified national response to disasters and emergencies. It describes how the Federal Government, States, Tribes, communities, and the private sector work together to coordinate a national response. The framework, which became effective March 22, 2008, builds upon the National Incident Management System, which provides a template for managing incidents.

**National Source Tracking System (NSTS)**

A secure, Web-based data system that helps the NRC and its Agreement States track and regulate the medical, industrial, and academic uses of certain nuclear materials, from the time they are manufactured or imported to the time of their disposal or exportation. This information enhances the ability of the NRC and Agreement States to conduct inspections and investigations, communicate information to other government agencies, and verify the ownership and use of nationally tracked sources.

**Natural uranium**

Uranium containing the relative concentrations of isotopes found in nature: 0.7 percent uranium-235, 99.3 percent uranium-238, and a trace amount of uranium-234 by mass. In terms of radioactivity, however, natural uranium contains about 2.2 percent uranium-235, 48.6 percent uranium-238, and 49.2 percent uranium-234. Natural uranium can be used as fuel in nuclear reactors or as feedstock for uranium enrichment facilities.

**Net electric generation**

The gross amount of electric energy produced by a generating station, minus the amount used to operate the station. Note: Electricity required for pumping at pumped-storage plants is regarded as electricity for station operation and is deducted from gross generation. Net electric generation is measured in watt-hours, except as otherwise noted.

**Nonpower reactor (research and test reactor)**

A nuclear reactor that is used for research, training, or development purposes (which may include producing radioisotopes for medical and industrial uses) but has no role in producing electrical power. These reactors, which are also known as research and test reactors, contribute to almost every field of science, including physics, chemistry, biology, medicine, geology, archeology, and ecology.

**NRC Headquarters Operations Center**

The primary center of communication and coordination among the NRC, its licensees, State and Tribal agencies, and other Federal agencies regarding operating events involving nuclear reactors or materials. Located in Rockville, MD, the Headquarters Operations Center is staffed 24 hours a day by employees trained to receive and evaluate event reports and coordinate incident response activities.

**Nuclear energy**

*See Atomic energy.*

**Nuclear Energy Agency (NEA)**

A specialized agency within the Organisation for Economic Co-operation and Development (OECD), which was created to assist its member countries in maintaining and further developing the scientific, technological, and legal bases for safe, environmentally friendly, and economical use of nuclear energy for peaceful purposes. The NEA's current membership consists of 31 countries in Europe, North America, and the Asia-Pacific region, which account for about 86 percent of the world's installed nuclear capacity.

## **Nuclear fuel**

Fissionable material that has been enriched to a composition that will support a self-sustaining fission chain reaction when used to fuel a nuclear reactor, thereby releasing energy (usually in the form of heat or useful radiation) for use in other processes.

## **Nuclear materials**

*See Special nuclear material, Source material, and Byproduct material.*

## **Nuclear Material Management and Safeguards System (NMMSS)**

A centralized U.S. Government database used to track and account for source and special nuclear material. The system contains current and historical data on the possession, use, and shipment of source and special nuclear material within the United States, as well as all exports and imports of such material. The database is jointly funded by the NRC and DOE and is operated under a DOE contract.

## **Nuclear poison (or neutron poison)**

In reactor physics, a substance (other than fissionable material) that has a large capacity for absorbing neutrons in the vicinity of the reactor core. This effect may be undesirable in some reactor applications, because it may prevent or disrupt the fission chain reaction, thereby affecting normal operation. However, neutron-absorbing materials (commonly known as “poisons”) are intentionally inserted into some types of reactors to decrease the reactivity of their initial fresh fuel load for fuel intended to achieve higher burnup levels during the fuel cycle. Adding poisons, such as control rods or boron, is described as adding “negative reactivity” to the reactor.

## **Nuclear power plant**

A thermal power plant, in which the energy (heat) released by the fissioning of nuclear fuel is used to boil water to produce steam. The steam spins the propeller-like blades of a turbine that turns the shaft of a generator to produce electricity. Of the various nuclear power plant designs, pressurized-water reactors and boiling-water reactors are in commercial operation in the United States. These facilities generate about 20 percent of U.S. electrical power.

## **Nuclear and Radiological Incident Annex**

An annex to the National Response Framework, which provides for a timely, coordinated response by Federal agencies to nuclear or radiological accidents or incidents within the United States. This annex covers radiological dispersal devices and improvised nuclear devices, as well as accidents involving commercial reactors or weapons production facilities, lost radioactive sources, transportation accidents involving radioactive material, and foreign accidents involving nuclear or radioactive material.

**Nuclear reactor**

The heart of a nuclear power plant or nonpower reactor, in which nuclear fission may be initiated and controlled in a self-sustaining chain reaction to generate energy or produce useful radiation. Although there are many types of nuclear reactors, they all incorporate certain essential features, including the use of fissionable material as fuel, a moderator (such as water) to increase the likelihood of fission (unless reactor operation relies on fast neutrons), a reflector to conserve escaping neutrons, coolant provisions for heat removal, instruments for monitoring and controlling reactor operation, and protective devices (such as control rods and shielding).

**Nuclear waste**

A subset of radioactive waste that includes unusable byproducts produced during the various stages of the nuclear fuel cycle, including extraction, conversion, and enrichment of uranium; fuel fabrication; and use of the fuel in nuclear reactors. Specifically, these stages produce a variety of nuclear waste materials, including uranium mill tailings, depleted uranium, and spent (depleted) fuel, all of which are regulated by the NRC. (By contrast, “radioactive waste” is a broader term, which includes all wastes that contain radioactivity, regardless of how they are produced. It is not considered “nuclear waste” because it is not produced through the nuclear fuel cycle and is generally not regulated by the NRC.)

**Occupational dose**

The internal and external dose of ionizing radiation received by workers in the course of employment in such areas as fuel cycle facilities, industrial radiography, nuclear medicine, and nuclear power plants. These workers are exposed to varying amounts of radiation, depending on their jobs and the sources with which they work. The NRC requires its licensees to limit occupational exposure to 5,000 millirem (50 millisieverts) per year. Occupational dose does not include the dose received from natural background sources, doses received as a medical patient or participant in medical research programs, or “second-hand doses” to members of the public received through exposure to patients treated with radioactive materials.

**Organisation for Economic Co-operation and Development (OECD)**

An intergovernmental organization (based in Paris, France) that provides a forum for discussion and cooperation among the governments of industrialized countries committed to democracy and the market economy. The primary goal of OECD and its member countries is to support sustainable economic growth, boost employment, raise living standards, maintain financial stability, assist other countries' economic development, and contribute to growth in world trade. In addition, OECD is a reliable source of comparable statistics and economic and social data. OECD also monitors trends, analyzes and forecasts economic developments, and researches social changes and evolving patterns in trade, environment, agriculture, technology, taxation, and other areas.

### **Orphan sources (unwanted radioactive material)**

Sealed sources of radioactive material contained in a small volume (but not radioactively contaminated soils and bulk metals) in any one or more of the following conditions:

- an uncontrolled condition that requires removal to protect public health and safety from a radiological threat
- a controlled or uncontrolled condition for which a responsible party cannot be readily identified
- a controlled condition compromised by an inability to ensure the continued safety of the material (e.g., the licensee may have few or no options to provide for safe disposition of the material)
- an uncontrolled condition in which the material is in the possession of a person who did not seek, and is not licensed, to possess it
- an uncontrolled condition in which the material is in the possession of a State radiological protection program solely to mitigate a radiological threat resulting from one of the above conditions and for which the State does not have the necessary means to provide for the appropriate disposition of the material

### **Outage**

The period during which a generating unit, transmission line, or other facility is out of service. Outages may be forced or scheduled and full or partial.

#### **Outage (forced)**

The shutdown of a generating unit, transmission line, or other facility for emergency reasons, or a condition in which the equipment is unavailable as a result of an unanticipated breakdown. An outage (whether full, partial, or attributable to a failed start) is considered “forced” if it could not reasonably be delayed beyond 48 hours from identification of the problem, if there had been a strong commercial desire to do so. In particular, the following problems may result in forced outages:

- any failure of mechanical, fuel handling, or electrical equipment or controls within the generator’s ownership or direct responsibility (i.e., from the point the generator is responsible for the fuel through to the electrical connection point)
- a failure of a mine or fuel transport system dedicated to that power station with a resulting fuel shortage that cannot be economically managed
- inadvertent or operator error
- limitations caused by fuel quality

Forced outages do not include scheduled outages for inspection, maintenance, or refueling.

#### **Outage (full forced)**

A forced outage that causes a generating unit to be removed from the committed state (when the unit is electrically connected and generating or pumping) or the available state (when the unit is available for dispatch as a generator or pump but is not electrically connected and not generating or pumping). Full-forced outages do not include failed starts.

### **Outage (scheduled)**

The shutdown of a generating unit, transmission line, or other facility for inspection, maintenance, or refueling, which is scheduled well in advance (even if the schedule changes). Scheduled outages do not include forced outages and could be deferred if there were a strong commercial reason to do so.

### **Pellet, fuel**

A thimble-sized ceramic cylinder (about 3/8-inch in diameter and 5/8-inch in length), consisting of uranium (typically uranium oxide), which has been enriched to increase the concentration of uranium-235 (U-235) to fuel a nuclear reactor. Modern reactor cores in PWRs and BWRs may contain up to 10 million pellets stacked in the fuel rods that form fuel assemblies.



### **Performance-based regulation**

A regulatory approach that focuses on desired, measurable outcomes, rather than prescriptive processes, techniques, or procedures. Performance-based regulation leads to defined results without specific direction regarding how those results are to be obtained. At the NRC, performance-based regulatory actions focus on identifying performance measures that ensure an adequate safety margin and offer incentives for licensees to improve safety without formal regulatory intervention by the agency.

### **Performance indicator**

A quantitative measure of a particular attribute of licensee performance that shows how well a plant is performing when measured against established thresholds. Licensees submit their data quarterly; the NRC regularly conducts inspections to verify the submittals and then uses its own inspection data plus the licensees' submittals to assess each plant's performance.

### **Possession-only license**

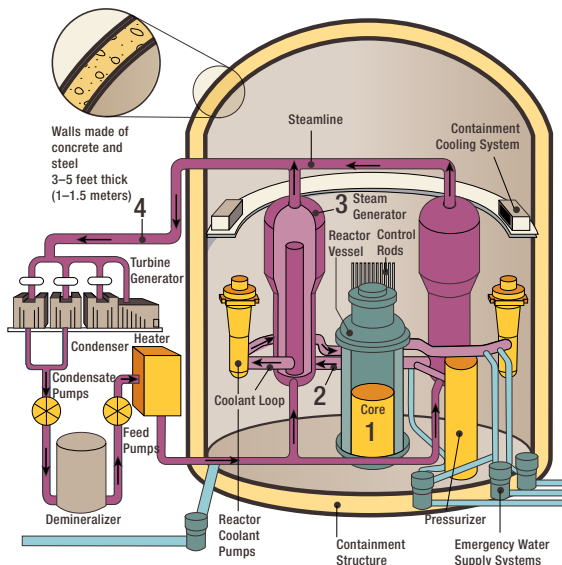
A license, issued by the NRC, that authorizes the licensee to possess specific nuclear material but does not authorize its use or the operation of a nuclear facility.

### **Power uprate**

The process of increasing the maximum power level at which a commercial nuclear power plant may operate. This power level, regulated by the NRC, is included in the plant's operating license and technical specifications. A licensee may only change its maximum power output after the NRC approves an uprate application. The NRC analyses must demonstrate that the plant could continue to operate safely with its proposed new configuration. When all requisite conditions are fulfilled, the NRC may grant the power uprate by amending the plant's operating license and technical specifications.

## Pressurized-water reactor (PWR)

A common nuclear reactor design in which very pure water is heated to a very high temperature by fission, kept under high pressure (to prevent it from boiling), and converted to steam by a steam generator (rather than by boiling, as in a BWR). The resulting steam is used to drive turbines, which activate generators to produce electrical power. A PWR essentially operates like a pressure cooker, where a lid is tightly placed over a pot of heated water, causing the pressure inside to increase as the temperature increases (because the steam cannot escape) but keeping the water from boiling at the usual 212 degrees Fahrenheit (100 degrees Celsius). About two-thirds of the operating nuclear reactor power plants in the United States are PWRs.



### How Nuclear Reactors Work

In a typical design concept of a commercial PWR, the following process occurs:

1. The core inside the reactor vessel creates heat.
2. Pressurized water in the primary coolant loop carries the heat to the steam generators.
3. Inside the steam generators, heat from the primary coolant loop vaporizes the water in a secondary loop, producing steam.
4. The steamline directs the steam to the main turbine, causing it to turn the turbine generators, which produces electricity.

The steam is exhausted to the condenser, where it is condensed into water. The resulting water is pumped out of the condenser with a series of pumps, reheated, and pumped back to the steam generators. The reactor's core contains fuel assemblies that are cooled by water circulated using electrically powered pumps. These pumps and other systems in the plant receive their power from the electrical grid. If offsite power is lost, cooling water is supplied by other pumps, which can be powered by onsite diesel generators. Other safety systems, such as the containment cooling system, also need electric power. PWRs contain between 120–200 fuel assemblies.



## Probabilistic risk assessment (PRA)

A systematic method for assessing three questions that the NRC uses to define “risk.” These questions consider (1) what can go wrong, (2) how likely it is to happen, and (3) what the consequences might be. These questions allow the NRC to understand likely outcomes, sensitivities, areas of importance, system interactions, and areas of uncertainty, which the staff can use to identify risk-significant scenarios. The NRC uses PRA to determine a numeric estimate of risk to provide insights into the strengths and weaknesses of the design and operation of a nuclear power plant.

## Production expense

Production expense is one component of the cost of generating electric power, which includes costs associated with fuel, as well as plant operation and maintenance.

## Rad (radiation-absorbed dose)

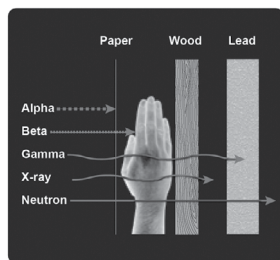
One of the two units used to measure the amount of radiation absorbed by an object or person, known as the “absorbed dose,” which reflects the amount of energy that radioactive sources deposit in materials through which they pass. The radiation-absorbed dose (rad) is the amount of energy (from any type of ionizing radiation) deposited in any medium (e.g., water, tissue, air). An absorbed dose of 1 rad means that 1 gram of material absorbed 100 ergs of energy (a small but measurable amount) as a result of exposure to radiation. The related international system unit is the gray (Gy), where 1 Gy is equivalent to 100 rad.

## Radiation, ionizing

A form of radiation, which includes alpha particles, beta particles, gamma rays, x-rays, neutrons, high-speed electrons, and high-speed protons. Compared to nonionizing radiation, such as found in ultraviolet light or microwaves, ionizing radiation is considerably more energetic. When ionizing radiation passes through material such as air, water, or living tissue, it deposits enough energy to break molecular bonds and displace (or remove) electrons. This electron displacement may lead to changes in living cells. Given this ability, ionizing radiation has a number of beneficial uses, including treating cancer or sterilizing medical equipment. However, ionizing radiation is potentially harmful if not used correctly, and high doses may result in severe skin or tissue damage. It is for this reason that the NRC strictly regulates commercial and institutional uses of the various types of ionizing radiation.

## Radiation, nuclear

Energy given off by matter in the form of tiny, fast-moving particles (alpha particles, beta particles, and neutrons) or pulsating electromagnetic rays or waves (gamma rays) emitted from the nuclei of unstable radioactive atoms. All matter is composed of atoms, which are made up of various parts; the nucleus contains minute particles called protons and neutrons, and the atom’s outer shell contains other particles called electrons. The nucleus carries a positive electrical charge, while the electrons carry a negative electrical charge. These forces work toward a strong, stable balance by getting rid of excess atomic energy (radioactivity). In that process, unstable radioactive nuclei may emit energy, and this spontaneous emission is called nuclear radiation.



All types of nuclear radiation are also ionizing radiation, but the reverse is not necessarily true; for example, x-rays are a type of ionizing radiation, but they are not nuclear radiation because they do not originate from atomic nuclei. In addition, some elements are naturally radioactive, as their nuclei emit nuclear radiation as a result of radioactive decay, but others become radioactive by being irradiated in a reactor. Naturally occurring nuclear radiation is indistinguishable from induced radiation.

### **Radiation source**

A radioactive material or byproduct that is specifically manufactured or obtained for the purpose of using the emitted radiation. Such sources are commonly used in teletherapy or industrial radiography; in various types of industrial gauges, irradiators, and gamma knives; and as power sources for batteries (such as those used in spacecraft). These sources usually consist of a known quantity of radioactive material, which is encased in a manmade capsule, sealed between layers of nonradioactive material, or firmly bonded to a nonradioactive substrate to prevent radiation leakage. Other radiation sources include devices such as accelerators and x-ray generators.

### **Radiation standards**

Exposure limits; permissible concentrations; rules for safe handling; and regulations regarding receipt, possession, use, transportation, storage, disposal, and industrial control of radioactive material.

### **Radiation therapy (radiotherapy)**

The therapeutic use of ionizing radiation to treat disease in patients. Although most radiotherapy procedures are intended to kill cancerous tissue or reduce the size of a tumor, therapeutic doses may also be used to reduce pain or treat benign conditions. For example, intervascular brachytherapy uses radiation to treat clogged blood vessels. Other common radiotherapy procedures include gamma stereotactic radiosurgery (gamma knife), teletherapy, and iodine treatment to correct an overactive thyroid gland. These procedures use radiation sources, regulated by the NRC and its Agreement States, that may be applied either inside or outside the body. In either case, the goal of radiotherapy is to deliver the required therapeutic or pain-relieving dose of radiation with high precision and for the required length of time, while preserving the surrounding healthy tissue.

### **Radiation warning symbol**

An officially prescribed magenta or black trefoil on a yellow background, which must be displayed where certain quantities of radioactive materials are present or where certain doses of radiation could be received.



### **Radioactive contamination**

Undesirable radioactive material (with a potentially harmful effect) that is either airborne or deposited in (or on the surface of) structures, objects, soil, water, or living organisms (people, animals, or plants) in a concentration that may harm people, equipment, or the environment.

**Radioactive decay**

The spontaneous transformation of one radionuclide into one or more decay products (also known as “daughters”). This transformation is commonly characterized by the emission of an alpha particle, a beta particle, or gamma ray photon(s) from the nucleus of the radionuclide. The rate at which these transformations take place, when a sufficient quantity of the same radionuclide is present, depends on the half-life of the radionuclide. Some radionuclides (e.g., hydrogen-3, also known as “tritium”) decay to stable daughters that are not radioactive. However, other radionuclides (e.g., uranium-238) decay to radioactive daughters (e.g., thorium-234) and may be part of a radioactive decay chain consisting of two or more radionuclides linked in a cascading series of radioactive decay.

**Radioactivity**

The property possessed by some elements (such as uranium) of spontaneously emitting energy in the form of radiation as a result of the decay (or disintegration) of an unstable atom. Radioactivity is also the term used to describe the rate at which radioactive material emits radiation. Radioactivity is measured in units of becquerels or disintegrations per second.

**Radiography**

The use of sealed sources of ionizing radiation for nondestructive examination of the structure of materials. When the radiation penetrates the material, it produces a shadow image by blackening a sheet of photographic film that has been placed behind the material, and the differences in blackening suggest flaws and unevenness in the material.

**Radioisotope (radionuclide)**

An unstable isotope of an element that decays or disintegrates spontaneously, thereby emitting radiation. About 5,000 natural and artificial radioisotopes have been identified.

**Radiopharmaceutical**

A pharmaceutical drug that emits radiation and is used in diagnostic or therapeutic medical procedures. Radioisotopes that have short half-lives are generally preferred to minimize the radiation dose to the patient and the risk of prolonged exposure. In most cases, these short-lived radioisotopes decay to stable elements within minutes, hours, or days, allowing patients to be released from the hospital in a relatively short time.

**Reactor core**

The central portion of a nuclear reactor, which contains the fuel assemblies, water, and control mechanisms, as well as the supporting structure. The reactor core is where fission takes place.

**Reactor Oversight Process (ROP)**

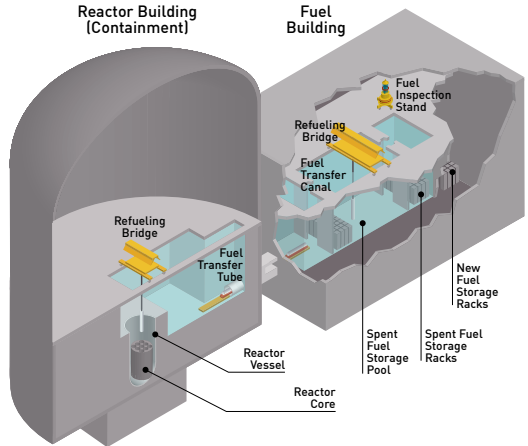
The process by which the NRC monitors and evaluates the performance of commercial nuclear power plants. Designed to focus on those plant activities that are most important to safety, the ROP uses inspection findings and performance indicators to assess each plant's safety performance.

## Refueling

The process of removing older fuel and loading new fuel. These actions are all performed underwater in order to provide continuous cooling for the fuel and provide shielding from the radioactive spent fuel.

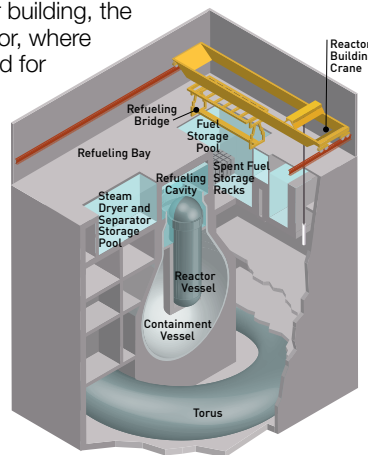
### PWR refueling

As new fuel shipping canisters arrive in the fuel building, the reactor building crane (not shown) lifts them to the fuel inspection stand, where the fuel is removed from the canister and inspected for defects. Fuel in the new fuel storage area is moved into the fuel pool before refueling begins. To refuel the reactor, the vessel head is removed, the fuel transfer canals and transfer tube areas are flooded, and removable gates are opened in order to connect the refueling canal to the fuel pool. The reactor building refueling bridge is used to remove a fuel assembly from the reactor vessel and transfer it to the “up-ender” basket, which is then tilted until it is horizontal, sent through the transfer tube into the fuel building, and returned upright. The refueling bridge then moves the fuel assembly into the spent fuel storage racks. This process is reversed when fuel is loaded into the reactor.



### BWR refueling

As new fuel shipping canisters arrive in the reactor building, the reactor building crane lifts them to the refueling floor, where the fuel is removed from the canister and inspected for defects. The fuel can then be stored in either the new fuel storage area (which is dry) or in the refueling pool, depending upon the needs of the site. Fuel in the new fuel storage area is moved into the fuel pool before refueling begins. To refuel the reactor, the containment vessel lid and the reactor vessel head are removed, the refueling cavity above the reactor vessel is flooded, and the gates between the reactor cavity and fuel pool are removed. The refueling bridge removes one fuel bundle at a time from the reactor and transfers it to the spent fuel storage racks until about a third of the fuel is removed. The process is reversed when fuel is removed from the fuel pool and placed in the reactor. In BWRs, the fuel remains in a vertical position throughout the process.



**Regulation**

The governmental function of controlling or directing economic entities through the process of rulemaking and adjudication.

**Regulatory Information Conference**

An annual NRC conference that brings together NRC staff, regulated utilities, materials users, and other interested stakeholders to discuss nuclear safety topics and significant and timely regulatory activities through informal dialogue to ensure an open regulatory process.

**Rem (roentgen equivalent man)**

One of the two standard units used to measure the dose equivalent (or effective dose), which combines the amount of energy (from any type of ionizing radiation) that is deposited in human tissue with the biological effects of the given type of radiation. For beta and gamma radiation, the dose equivalent is the same as the absorbed dose. By contrast, the dose equivalent is larger than the absorbed dose for alpha and neutron radiation because these types of radiation are more damaging to the human body. Thus, the dose equivalent (in rem) is equal to the absorbed dose (in rads) multiplied by the quality factor of the type of radiation (Title 10 of the *Code of Federal Regulations* (10 CFR) 20.1004, "Units of Radiation Dose"). The related international system unit is the sievert (Sv), where 100 rem is equivalent to 1 Sv.

**Renewable resources**

Natural, but limited, energy resources that can be replenished, including biomass, hydro, geothermal, solar, and wind. These resources are virtually inexhaustible but limited in the amount of energy that is available per unit of time. In the future, renewable resources could also include the use of ocean thermal, wave, and tidal action technologies. Utility renewable resource applications include bulk electricity generation, onsite electricity generation, distributed electricity generation, nongrid-connected generation, and demand-reduction (energy efficiency) technologies.

**Risk**

The combined answer to three questions that consider (1) what can go wrong, (2) how likely it is to occur, and (3) what the consequences might be. These three questions allow the NRC to understand likely outcomes, sensitivities, areas of importance, system interactions, and areas of uncertainty, which can be used to identify risk-significant scenarios.

**Risk-based decisionmaking**

An approach to regulatory decisionmaking that considers only the results of a probabilistic risk assessment.

**Risk-informed decisionmaking**

An approach to regulatory decisionmaking in which insights from probabilistic risk assessment are considered with other engineering insights.

### **Risk-informed regulation**

An approach to regulation taken by the NRC that incorporates an assessment of safety significance or relative risk. This approach ensures that the regulatory burden imposed by an individual regulation or process is appropriate to its importance in protecting the health and safety of the public and the environment.

### **Risk significant**

The term referring to a facility's system, structure, component, or accident sequence that exceeds a predetermined limit for contributing to the risk associated with the facility. The term also describes a level of risk exceeding a predetermined significance level.

### **Safeguards**

The use of material control and accounting programs to verify that all special nuclear material is properly controlled and accounted for, as well as the physical protection (or physical security) equipment and security forces. As used by the IAEA, this term also means verifying that the peaceful use commitments made in binding nonproliferation agreements, both bilateral and multilateral, are honored.

### **Safeguards Information**

A special category of sensitive unclassified information that must be protected. Safeguards Information concerns the physical protection of operating power reactors, spent fuel shipments, strategic special nuclear material, or other radioactive material.

### **Safety related**

In the regulatory arena, this term applies to systems, structures, components, procedures, and controls (of a facility or process) that are relied upon to remain functional during and following design-basis events. Their functionality ensures that key regulatory criteria, such as levels of radioactivity released, are met. Examples of safety-related functions include shutting down a nuclear reactor and maintaining it in a safe-shutdown condition.

### **Safety significant**

When used to qualify an object, such as a system, structure, component, or accident sequence, a term identifying that object as having an impact on safety, whether determined through risk analysis or other means, that exceeds a predetermined significance criterion.

### **SAFSTOR**

A long-term storage condition for a permanently shutdown nuclear power plant. During SAFSTOR, radioactive contamination decreases substantially, making subsequent decontamination and demolition easier and reducing the amount of low-level waste requiring disposal.

### **Scram**

The sudden shutting down of a nuclear reactor, usually by rapid insertion of control rods, either automatically or manually by the reactor operator (also known as a "reactor trip").

## **Sensitive unclassified nonsafeguards information**

Information that is generally not publicly available and that encompasses a wide variety of categories, such as proprietary information, personal and private information, or information subject to attorney-client privilege.

## **Shutdown**

A decrease in the rate of fission (and heat or energy production) in a reactor (usually by the insertion of control rods into the core).

## **Small Modular Reactor (SMR)**

Small reactors that use water to cool the reactor core in the same way as today's large light-water reactors. SMR designs also use the same enriched-uranium fuel as current U.S. reactors. However, SMR designs are considerably smaller and can bundle together several reactors in a single containment. Each SMR module generates 300 megawatts electric (MWe) or less, compared to today's large designs that can generate 1,000 MWe or more per reactor. The NRC's discussions to date with SMR designers involve modules generating less than 200 MWe.

## **Source material**

Uranium or thorium, or any combination thereof, in any physical or chemical form, or ores that contain, by weight, 1/20 of 1 percent (0.05 percent) or more of (1) uranium, (2) thorium, or (3) any combination thereof. Source material does not include special nuclear material.

## **Special nuclear material**

Plutonium, uranium-233, or uranium enriched in the isotopes uranium-233 or uranium-235.

## **Spent fuel pool**

An underwater storage and cooling facility for spent (depleted) fuel assemblies that have been removed from a reactor.

## **Spent (depleted or used) nuclear fuel**

Nuclear reactor fuel that has been used to the extent that it can no longer effectively sustain a chain reaction.

## **Subcriticality**

The condition of a nuclear reactor system in which nuclear fuel no longer sustains a fission chain reaction (i.e., the reaction fails to initiate its own repetition, as it would in a reactor's normal operating condition). A reactor becomes subcritical when its fission events fail to release a sufficient number of neutrons to sustain an ongoing series of reactions, possibly as a result of increased neutron leakage or poisons.

## **Teletherapy**

Treatment in which the source of the therapeutic radiation is at a distance from the body. Because teletherapy is often used to treat malignant tumors deep within the body by bombarding them with a high-energy beam of gamma rays (from a radioisotope such as cobalt-60) projected from outside the body, it is often called "external beam radiotherapy."

## Title 10 of the *Code of Federal Regulations* (10 CFR)

The *Code of Federal Regulations* (CFR) addresses energy-related topics. Chapter I, Parts 1 to 199, contain the regulations (or rules) established by the NRC. These regulations govern the transportation and storage of nuclear materials; use of radioactive materials at nuclear power plants, research and test reactors, uranium recovery facilities, fuel cycle facilities, waste repositories, and other nuclear facilities; and use of nuclear materials for medical, industrial, and academic purposes.

### Transient

A change in the reactor coolant system temperature, pressure, or both, attributed to a change in the reactor's power output. Transients can be caused by (1) adding or removing neutron poisons, (2) increasing or decreasing electrical load on the turbine generator, or (3) accident conditions.

### Transuranic waste

Material contaminated with transuranic elements—artificially made radioactive elements, such as neptunium, plutonium, americium, and others—that have atomic numbers higher than uranium in the periodic table of elements. Transuranic waste is primarily produced from recycling spent fuel or using plutonium to fabricate nuclear weapons.

### Tritium

A radioactive isotope of hydrogen. Because it is chemically identical to natural hydrogen, tritium can easily be taken into the body by any ingestion path. It decays by emitting beta particles and has a half-life of about 12.5 years.

### Uprate

*See Power uprate.*


### Uranium

A radioactive element with the atomic number 92 and, as found in natural ores, an atomic weight of about 238.

The two principal natural isotopes are uranium-235 and uranium-238. Uranium-235 is composed of 0.7 percent natural uranium and is fissile. Uranium-238 is composed of 99.3 percent natural uranium, is fissionable by fast neutrons, and is fertile. This means that it becomes fissile after absorbing one neutron. Natural uranium also includes a minute amount of uranium-234.



A piece of natural uranium ore

92	2 8 18 32 21 9 2
	U
	Uranium
	238.02891

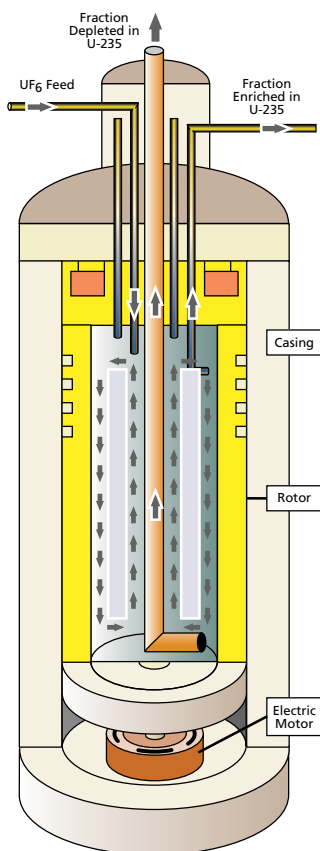


## Uranium enrichment process

The process of increasing the percentage of uranium-235 (U-235) from 0.7 percent in natural uranium to about 3 to 5 percent for use in fuel for nuclear reactors. Enrichment can be done through gaseous diffusion, gas centrifuges, or laser isotope separation.

### Gas Centrifuge Process

The gas centrifuge process uses many rotating cylinders that are connected in long lines. Gas is placed in the cylinder, which spins at a high speed, creating a strong centrifugal force. Heavier gas molecules move to the cylinder wall, while lighter molecules collect near the center. The stream, now slightly enriched, is fed into the next cylinder. The depleted stream is recycled back into the previous cylinder.



## Uranium fuel fabrication facility

A facility that converts enriched  $\text{UF}_6$  into fuel for commercial light-water power reactors, research and test reactors, and other nuclear reactors. The  $\text{UF}_6$ , in solid form in containers, is heated to a gaseous form and then chemically processed to form uranium dioxide ( $\text{UO}_2$ ) powder. This powder is then processed into ceramic pellets and loaded into metal tubes, which are subsequently bundled into fuel assemblies. Fabrication can also involve MOX fuel, which contains plutonium oxide mixed with either natural or depleted uranium oxide in ceramic pellet form.

## Uranium hexafluoride production facility (or uranium conversion facility)

A facility that receives natural uranium in the form of ore concentrate (known as yellowcake) and converts it into  $\text{UF}_6$ , in preparation for fabricating fuel for nuclear reactors.

### **U.S. Department of Energy (DOE)**

The Federal agency established by Congress to advance the national, economic, and energy security of the United States, among other missions.

### **U.S. Department of Homeland Security (DHS)**

The Federal agency responsible for leading the unified national effort to secure the United States against those who seek to disrupt the American way of life. DHS is also responsible for preparing for and responding to all hazards and disasters and includes the formerly separate FEMA, the Coast Guard, and the Secret Service.

### **U.S. Environmental Protection Agency (EPA)**

The Federal agency responsible for protecting human health and safeguarding the environment. EPA leads the Nation's environmental science, research, education, and assessment efforts to ensure that attempts to reduce environmental risk are based on the best available scientific information. EPA also ensures that environmental protection is an integral consideration in U.S. policies.

### **Viability assessment**

A decisionmaking process used by DOE to assess the prospects for safe and secure permanent disposal of high-level waste in an excavated, underground facility known as a geologic repository. This decisionmaking process is based on (1) specific design work on the critical elements of the repository and waste package, (2) a total system performance assessment that will describe the probable behavior of the repository, (3) a plan and cost estimate for the work required to complete the license application, and (4) an estimate of the costs to construct and operate the repository.

### **Waste, radioactive**

Radioactive materials at the end of their useful life or in a product that is no longer useful and requires proper disposal. *See High-level waste, Low-level waste, and Spent nuclear fuel.*

### **Waste classification (classes of waste)**

Classification of low-level waste (LLW) according to its radiological hazard. The classes include Class A, B, and C, with Class A being the least hazardous and accounting for 96 percent of LLW in the U.S. As the waste class and hazard increase, the regulations established by the NRC require progressively greater controls to protect the health and safety of the public and the environment.

### **Watt**

A unit of power (in the International System of Units) defined as the consumption or conversion of 1 joule of energy per second. In electricity, a watt is equal to current (in amperes) multiplied by voltage (in volts).