U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

NRC–Independent Regulator of Nuclear Safety

Office of Public Affairs

NRC–Independent Regulator of Nuclear Safety

The U.S. Nuclear Regulatory Commission (NRC), created by Congress, began operating in 1975. Its mission is to regulate commercial and institutional uses of nuclear materials, including nuclear power plants. The agency succeeded the U.S. Atomic Energy Commission, which was responsible for both developing and regulating nuclear activities. Now, federal research and development, and nuclear weapons production are done by the U.S. Department of Energy.

The NRC's overall responsibility is to protect public health and safety. Its main regulatory functions are to:

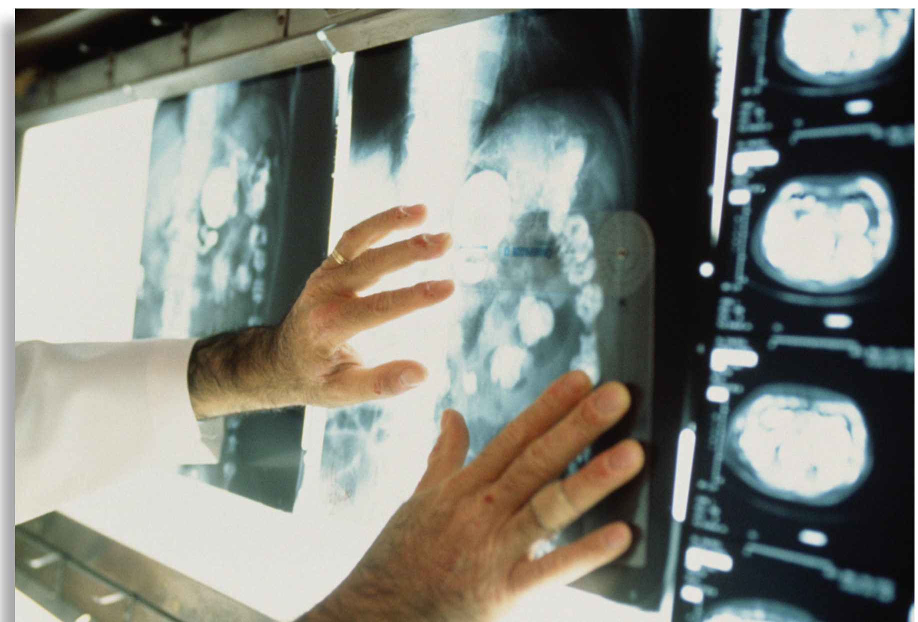
- establish standards and regulations;
- issue licenses for nuclear facilities and users of nuclear materials; and
- inspect facilities and users of nuclear materials to ensure compliance with the requirements.

These regulatory functions relate to both nuclear power plants and other uses of nuclear materials — such as nuclear medicine programs at hospitals, academic activities at educational institutions and research. They also relate to such industrial applications as gauges, irradiators and other devices that contain radioactive material.

The NRC places a high priority on keeping the public informed of its work. The agency maintains a Web site and has a Public Document Room at its headquarters in Rockville, Md. It also holds public meetings throughout the country.

WHY REGULATE?

The nuclear industry is strictly regulated because radioactive materials are potentially hazardous. Radioactive materials give off radiation, which can



Regulatory functions relate to both nuclear power plants and other uses of nuclear materials — such as nuclear medicine programs at hospitals.

be hazardous to people exposed to it in significant amounts. The amount of harm depends on the type and amount of radioactive material, the distance between the source of the radiation and a person, and the length of time a person is exposed to the radiation.

The risks can be reduced by certain actions. For example, the hazard is less if there is a "shielding" material like lead or concrete to block some of the radiation, if a person moves farther from the radiation source, or if the exposure time is reduced.

If radioactive materials are properly handled and regulated, they do not pose a significant risk to the public or to workers.

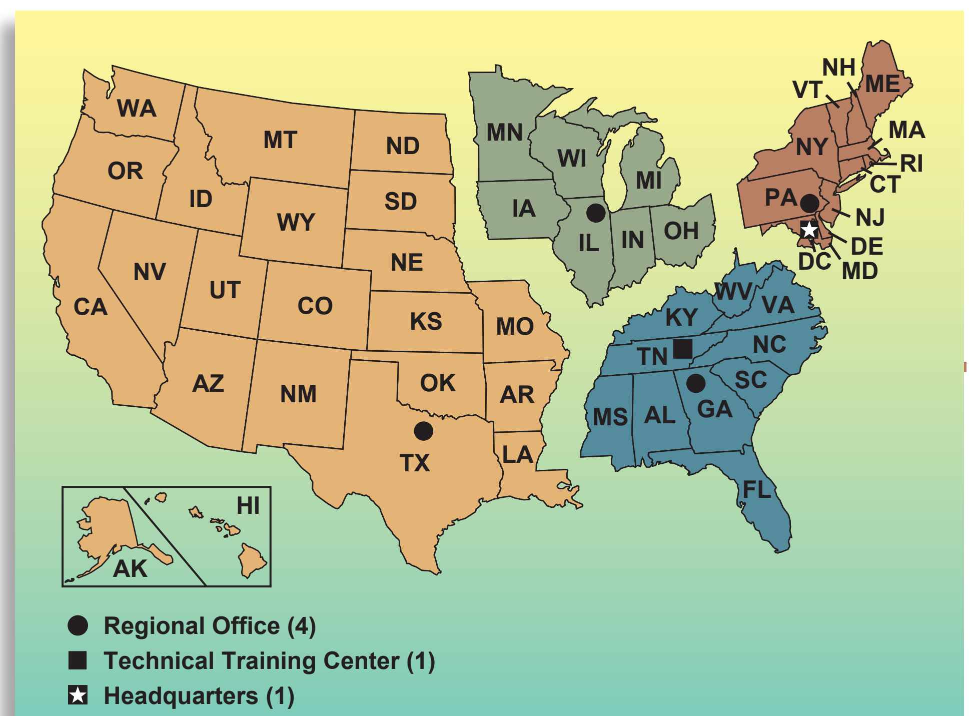
Radioactivity from natural sources is present throughout the world. People are continuously exposed to low-level radiation from certain materials in the earth and from cosmic rays from space. Exposure to natural radiation can be affected by geography and lifestyle. For example, flying in an airplane adds to overall exposure because of increased cosmic radiation at high altitudes. People also receive some radiation exposure from certain medical procedures, such as X-rays.

The NRC protects the public by setting limits on radiation exposure from the radioactive materials it licenses. It also requires those with licenses to use such material to take steps to keep exposures well below the limits.

NRC ORGANIZATION

The NRC is headed by a five-member Commission. The Commissioners are appointed to five-year terms by the President, with confirmation by the Senate. One of the Commissioners is designated as Chairman by the President.

The NRC has about 3,300 employees and an annual budget of about $800 million. About two-thirds of the NRC employees work in the agency's headquarters in Rockville, Md. The rest work primarily out of four regional offices or at resident inspector offices at



NRC Headquarters and Regional Office Locations each commercial nuclear power plant and some fuel cycle facilities.

NRC REGULATIONS

The NRC sets the rules that users of radioactive materials must follow. These rules are intended to protect workers using the radioactive materials and the general public from the potential hazards of radioactivity. NRC regulations are constantly reviewed and sometimes changed — or new regulations added — based on recommendations from the NRC staff. Members of the public and interested organizations can also request changes in regulations. The NRC wants to hear the views of the public, industry and other interested parties before new rules or changes are adopted.

REGULATORY RESEARCH

As part of its mission, the NRC has a research program that provides independent information and expertise to support the NRC's safety and security decisions and to study potential technical issues. Much of this research work is done by government laboratories, universities, and other research institutions under contracts with the NRC. Some examples of research subjects include: the long-term strength of various parts of a nuclear reactor; the impact of natural events, such as earthquakes on nuclear facilities; the transport of radioactive waste and its disposal; and the way workers react to instruments and systems in nuclear facilities.

LICENSES

The NRC licenses all commercial nuclear fuel facilities that process and fabricate uranium into reactor fuel. Licenses for more than 100 commercial nuclear power plants and their operators also are issued by the NRC. Licenses for other uses of radioactive materials are issued either by the NRC or by state governments under NRC-approved programs. About 4,500 licenses for radioactive materials are under the jurisdiction of the NRC, and about 17,000 are under the jurisdiction of those states known as Agreement States. Agreement States regulate certain radioactive materials under agreements with the NRC. The NRC and states also have regulatory oversight for certain radioactive materials that occur naturally or are produced by machines called particle accelerators.

In most cases, any organization or individual intending to have or use radioactive materials must obtain a license. There are some exceptions. Users of smoke detectors, which have a tiny radiation source inside them, do not need a license because the amount of material is so small that it does not pose a danger to public health. However, those companies that make these or similar items do need a license and are subject to NRC or Agreement States regulations.

A typical license identifies the type and amount of radioactive material that may be held and used. The license may also have certain restrictions. It would describe the location of use, the training and qualifications of workers, specific procedures for using the materials, and any special safety precautions required.

POWER PLANT LICENSES

The currently operating nuclear power plants had to obtain both a construction permit, which allowed the facility to be built, and an operating license, which allowed the facility to operate.

In 1989, the NRC adopted a streamlined licensing process. It allows for a single license, consisting of a combined construction permit and operating license, to be issued. This process also encourages the use of standard, pre-approved designs for future plant proposals. Another feature of the streamlined process is possible early approval of sites for nuclear plants. This new process allows for full public participation, and most issues to be resolved, before construction begins. Public hearings are held on certifying sites and issuing construction permits and operating licenses. Prior to its initial operation, a new nuclear plant must complete a series of tests and inspections.

Since 2000, several power companies have used the Department of Energy's "Nuclear Power 2010" initiative to "try out" parts of the NRC's new reactor licensing process. Following the passage of the Energy Policy Act of 2005, which included several sections on nuclear power, a number of utilities announced plans to build new plants using the streamlined licensing process. The NRC expects to be working on these applications for many years. These will be the first new licensing applications for nuclear power plants in about three decades.

Licenses for nuclear power plants are issued for 40 years. Some of the initial licenses expire by 2010. The NRC developed a process for issuing renewed licenses and ensuring the continued safe operation of those plants for an additional 20 years. License renewals have been approved for many plants and more requests are under review.

Licenses for nuclear power plants can be changed and updated to reflect experiences within the industry or new requirements. When necessary, the NRC can impose new regulations or require changes in operating procedures or equipment to improve nuclear power plant safety.

In addition to licensing the facility, the NRC also licenses the people who operate the controls of the reactor. Licenses fall into two categories — senior reactor operator, which requires a level of training necessary to act as a control room supervisor, and reactor operator. Before getting a license, individuals must complete an extensive training program and pass several tests. Once licensed, the operators continue their training to maintain their qualification.

INSPECTIONS

On a regular basis, the NRC inspects all facilities it licenses — including more than 100 nuclear power plants in 31 states — to make sure they are meeting NRC regulations, the terms of their licenses and orders issued by the NRC. The breadth of these inspections and how often they occur varies. For example, a nuclear power plant will be subject to many inspections each year, while a small medical or research facility using small amounts of radioactive materials might be inspected every few years. Normal inspections study a sample of the work being done by a licensee. If problems are found or suspected, the inspector will focus on that work area in more detail.

For nuclear power plants and certain fuel processing facilities, inspections are done by:

- NRC resident inspectors, who are stationed at the site on a full-time basis;
- NRC inspection specialists based in regional offices and headquarters; and
- special team inspectors looking at specific issues or potential problems.

The core of the NRC inspection program for nuclear power plants is carried out by the resident inspectors; at least two inspectors are assigned to each site.

The inspection specialists review plant security, emergency planning, radiation protection, environmental monitoring, plant equipment and systems, fire protection, construction activities, and other areas.

Each year, NRC specialists may conduct 10 to 25 routine inspections at each nuclear power plant and several inspections at fuel facilities. The special team inspections may focus on a specific activity, such as maintenance or security, or a team may be sent to the facility to look at a specific operating problem or incident.

The NRC uses these inspections as well as objective performance indicators to assess the performance of each operating nuclear power plant. The NRC reviews the material quarterly, with formal reviews conducted in the middle and the end of a 12-month assessment period. This Reactor Oversight Process is based on "cornerstones" of safe operation. The plant assessments, performance indicators, inspection reports, and other evaluation documents are posted on the NRC's Web site and available through the Public Document Room. Certain sensitive information — mostly related to nuclear facility security — may be excluded from the public version.

There is a range of actions the NRC can take if violations of NRC requirements are found during inspections. The basic enforcement action

On a regular basis, the NRC inspects all facilities it licenses.

is issuing a notice of violation, which requires the licensee to correct the problem and take steps to keep it from happening again. Serious and/or deliberate violations can result in fines. The largest fine the NRC has imposed to date was $5.45 million against the Davis-Besse nuclear power plant in 2005.

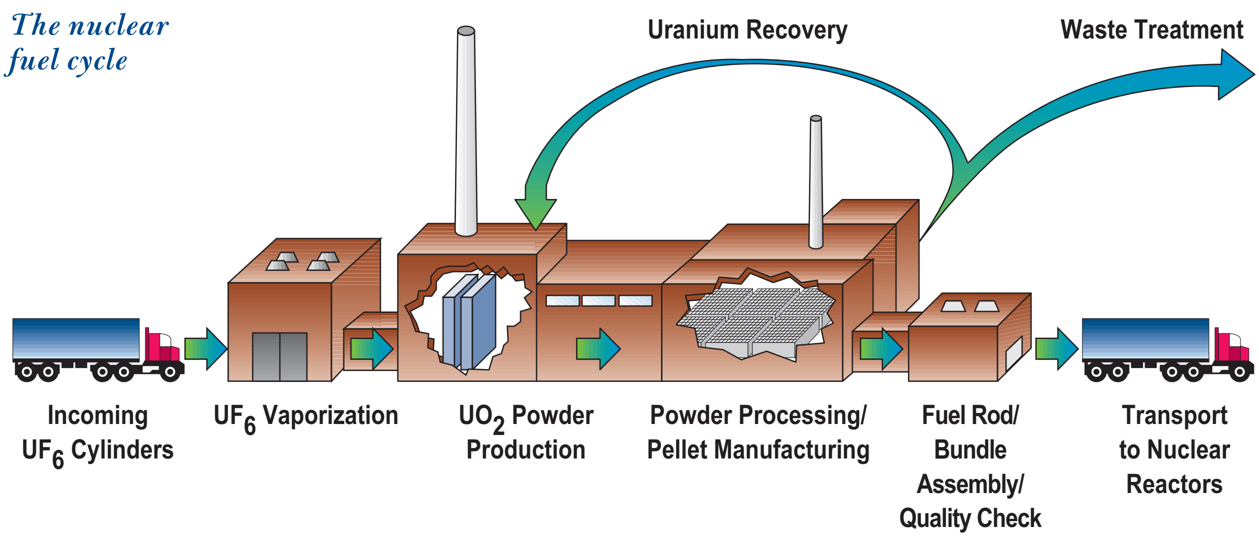
If there are serious questions about the safety of NRC-licensed activities, the NRC requires the activities be stopped or an individual removed from work involving NRC-licensed materials. The NRC may modify, suspend, or revoke a license at any time. If the NRC stops licensed activities, they cannot begin again until the problems are fixed. A licensee or individual subject to a fine or an order can ask for a hearing before the NRC.

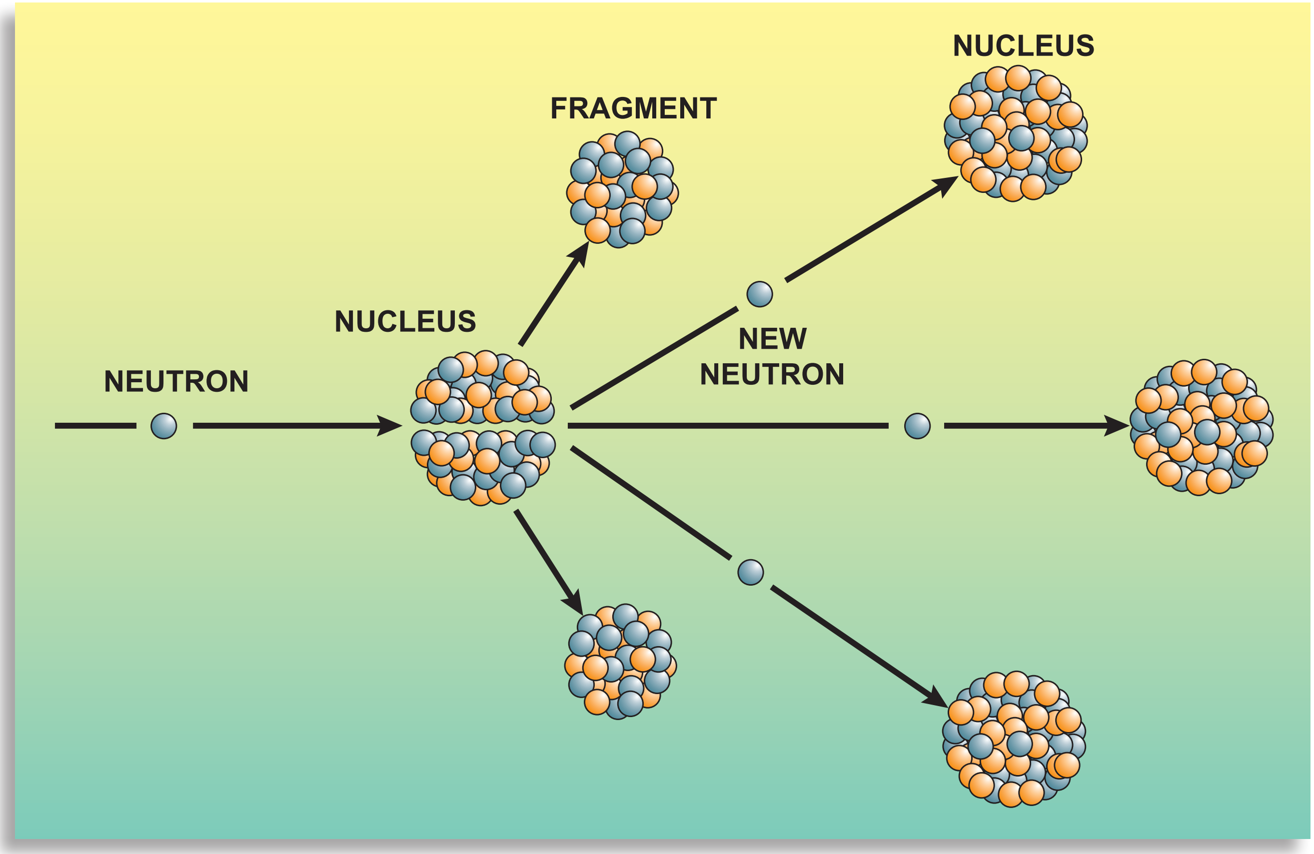
On occasion, the NRC receives allegations of safety problems or wrongdoing involving misconduct by licensees or their contractors. Allegations of possible criminal activities are handled by NRC professionals. These investigations may result in civil enforcement action or criminal prosecution. While the NRC is not dependent on allegations of safety problems to meet its responsibilities, the knowledge of thousands of employees working in NRC-regulated activities provides valuable insights into the day-to-day practices of licensees. The NRC encourages employees working in regulated activities to raise safety concerns.

THE NUCLEAR FUEL CYCLE

The nuclear fuel cycle (shown below) has several steps. It begins when uranium ore mined from the earth is milled or processed to produce uranium concentrate. This concentrate is called “yellowcake.” The yellowcake is converted into uranium hexafluoride gas at a special facility and loaded into cylinders. Next, the cylinders are sent to an enrichment plant, where uranium is enriched for use as reactor fuel. The enriched uranium is then converted into oxide powder and made into fuel pellets (each about the size of a fingertip). These are loaded into metal fuel rods about 12 feet long. Rods are bundled into reactor fuel assemblies at a fuel fabrication facility. The assemblies

The nuclear fuel cycle





Energy is released when an atom splits into smaller pieces. These smaller pieces strike other atoms, releasing more energy. This continuous splitting of atoms in a reactor is called a chain reaction.

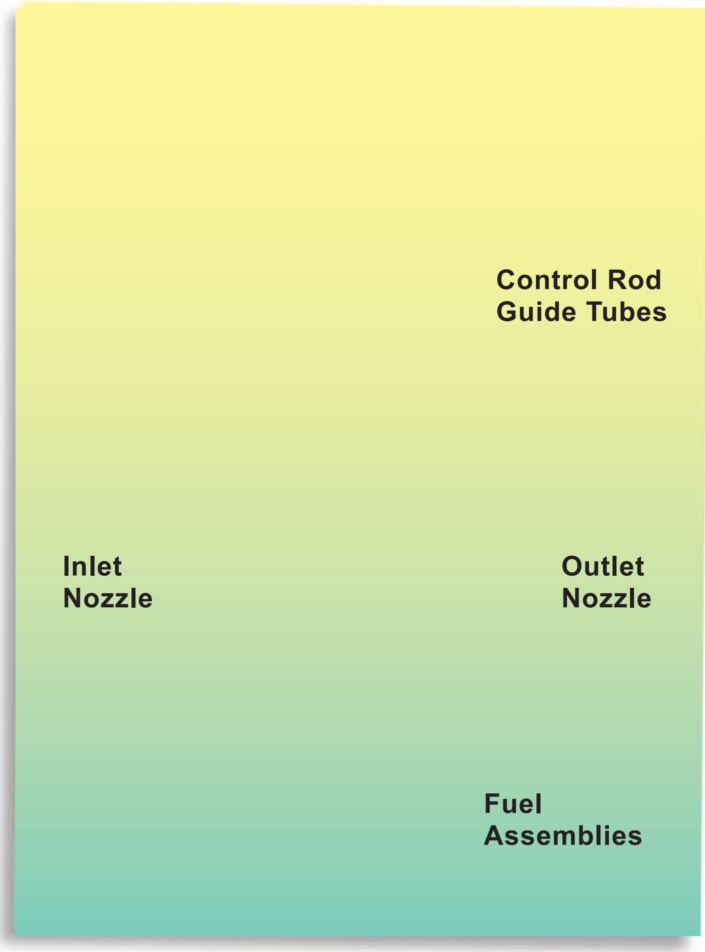
of various sizes are then transported to nuclear power plants or non-power research reactor facilities.

Seven major fuel fabrication and production facilities are licensed to operate in the United States and two enrichment facilities are regulated by the NRC. A third enrichment facility was licensed in June 2006 and is under construction and the licensing review for a fourth enrichment facility is nearly complete. Because they handle radioactive material, these facilities must take special precautions to protect the public and workers. The facilities also must prevent the material from being stolen or diverted for use by terrorists. The NRC licenses and regularly inspects these plants to ensure they operate safely.

HOW A NUCLEAR POWER PLANT WORKS

Power plants change one form of energy into another — that is, heat is turned into electricity. Some plants may use the energy from wind, falling water or the sun or burn coal, oil or gas to generate electricity. A nuclear power plant uses energy from uranium to produce electricity.

The heat — regardless how it's produced — is normally used to heat



water to the boiling point and produce steam. This steam is then carried by pipes to a turbine, which has a series of fan blades on a shaft. The force of the steam pushes against the blades and turns the turbine.

The turbine is connected to a generator. As the turbine shaft spins, the generator turns and produces electricity. This electricity is carried by wires to homes, businesses and institutions. Electricity is one of the few forms of energy that can easily be moved from one place to another. Electrical energy can be produced in large quantities at one location and transported by wires to many different places.

We can see coal, wood, or gas burning — and know from experience that it produces heat. Nuclear energy in a nuclear power plant cannot be seen, and there is no burning of fuel in the usual sense. Instead, energy is given off by the nuclear fuel as certain types of atoms inside the fuel split into pieces. This energy is in the form of fast-moving particles and invisible radiation. As the particles and radiation move through the fuel and surrounding water, the energy is converted into heat. The heat is the useful energy resulting from the splitting of atoms.

Water in the reactor is heated by the nuclear reaction and the steam is carried off to spin the turbine to produce electricity.

URANIUM FUEL

The fuel of a nuclear plant is uranium, but only a certain type of uranium atom can be easily split to produce energy. This type of uranium atom — called uranium-235 — is less than 1 percent of natural uranium ore. The uranium ore must be purified and then processed to make it usable as fuel for reactors. In U.S. reactors the concentration of uranium-235 must increase from 1 to about 3 or 4 percent. This percentage is enough to allow a continuous splitting of uranium atoms — but much less than the percentage necessary for a nuclear weapon, which requires almost 100 percent pure uranium-235. The low percentage of uranium-235 in reactor fuel is one of the reasons a plant can never explode like an atomic bomb.

To increase the percentage of uranium-235, a process called enrichment is used. One method of enrichment uses a process called gaseous diffusion. This process heats natural uranium to form a gas, and then separates the lighter molecules of uranium-235 from the heavier molecules of uranium-238 (another version of uranium). This separation is done by forcing the molecules through a membrane with tiny openings. Since the uranium-235 is lighter, it moves through the membrane more easily, and the two gases can then be partially separated. This process increases the concentration of uranium 235.

When a uranium-235 atom is hit by a particle called a neutron, it splits, or "fissions," and gives off energy in the form of radiation. It also gives off fast-moving pieces of the original atom, including neutrons, which can collide with another uranium-235 atom and cause it to split, too. A continuing series of these atomic splits, each triggering another one, is called a chain reaction.

Uranium-235 will split, or "fission," spontaneously, but these spontaneous atomic splits aren't frequent or reliable enough to use as an energy source. The neutrons fly away too fast and don't usually cause the fission of another atom. The neutrons need to be slowed down so that they can collide with another uranium-235 atom and continue the chain reaction.

Several types of materials can be used to slow down the neutrons. Most nuclear power plants (including all of those in the United States) use water as the material that slows down the particles and allows the chain reaction to continue.

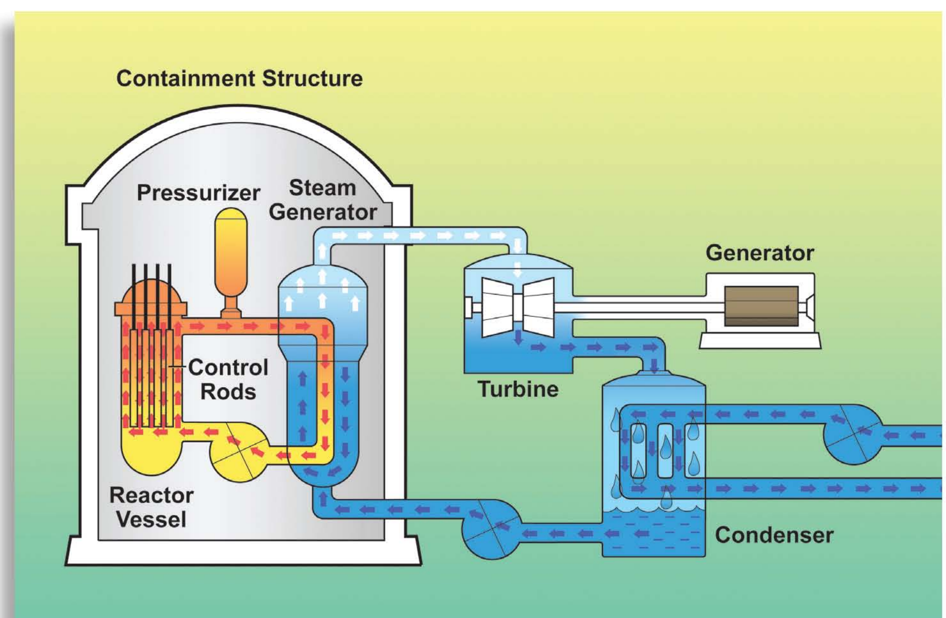
To control the chain reaction, reactors have control rods. These rods can be inserted into the reactor to absorb the neutrons, which slows or stops the chain reaction.

TWO REACTOR TYPES

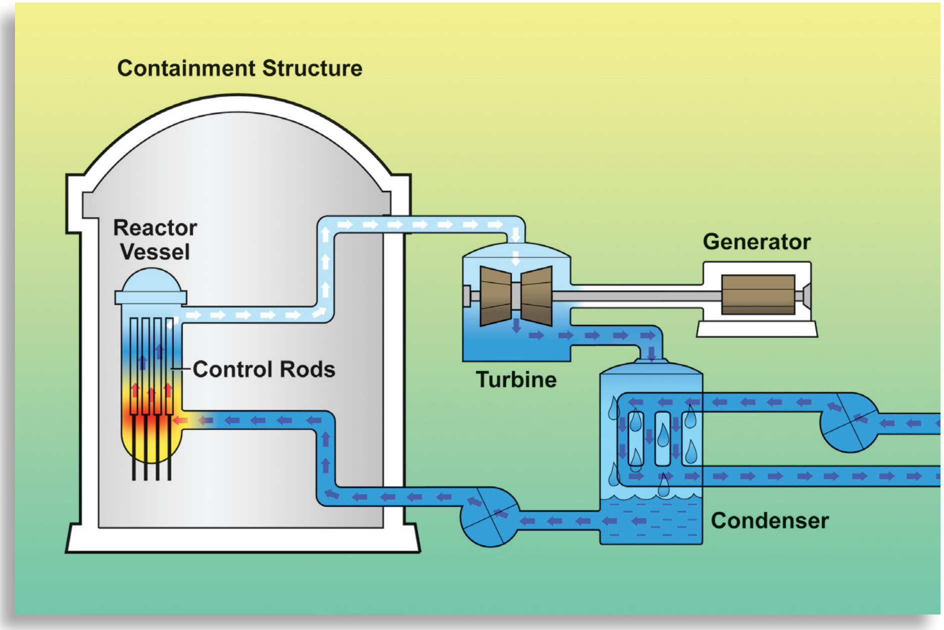
Two main types of reactors are in operation in the United States — the pressurized water reactor (PWR) and the boiling water reactor (BWR). About two-thirds of the reactors are PWRs, and the rest are BWRs.

The PWR is a two-stage system that keeps the water in the reactor under high pressure so that it does not boil.

Pressurized Water Reactor (PWR)



Piping carries this heated water to large components called steam generators. The heated reactor water flows through thousands of tubes in the steam generator. The tubes are surrounded by a secondary water supply. This secondary water supply, which is not radioactive, boils and produces steam, which is carried away by pipes to spin the turbine-generator.



Boiling Water Reactor (BWR)

The reactor cooling water then returns to the reactor to be reheated and recirculated to the steam generator, in a continuous loop.

The BWR is a single-stage system that allows the water in the reactor to boil and produce steam, which is then piped directly to the turbine generator.

In both types of reactors, once the steam loses its energy in spinning the turbine, it flows into a condenser. Because not all the heat energy in the steam can be converted into electricity, the leftover heat must be carried away by cooling water pumped through the condenser. The condenser contains thousands of tubes carrying cool water, which converts the steam back to water. The water is collected in the condenser and pumped back to be reheated, either in the reactor itself in a BWR or in a PWR's steam generator.

The condenser cooling water is drawn from a lake, river, or ocean. This water does not actually pass through the reactor, but only through the condenser tubes to cool the steam after it goes through the turbine. There is no contact between the condenser cooling water and the reactor cooling water or the reactor components themselves. The reactor cooling water is contained and kept isolated from the environment.

This outside cooling water, heated as it passes through the condenser, is returned to its source. Many nuclear plants — as well as other types of power plants or industrial facilities — use cooling towers, cooling lakes or ponds, or other techniques to reduce the effects of discharging heated water directly back into the river, lake, or ocean. With cooling towers, the water, once cooled, is usually pumped back into the condenser to be used again to carry off heat. Only a small portion of the water is returned to the natural water source. To preserve the environment, the water returned to its source must be no more than a few degrees warmer than the source water.

RADIOACTIVE BYPRODUCTS

Because the fission reaction produces radioactive materials, which can be hazardous, nuclear power plants have safety systems to protect workers, the public and the environment.

Radioactive materials must be used carefully because they produce radiation—a form of energy that can damage human cells and potentially cause cancer. The damage depends on how much radiation the cells were exposed to and for how long. Radiation can potentially cause cancer over long periods of time.

A person can be exposed to radiation in two ways — internally and externally. Internal exposures happen if a radioactive material enters the body. External exposures happen when a person is too close to radioactive material without adequate protection (called shielding).

In the reactor, most of these hazardous radioactive substances — called fission byproducts — are trapped in the fuel pellets themselves or in the sealed metal tubes holding the fuel. However, small amounts of these radioactive fission byproducts, mostly gases, become mixed with the water passing through the reactor. Other impurities in the water are also made radioactive as they pass through the reactor. The water is processed and filtered to remove these radioactive impurities and then returned to the reactor cooling system. During normal plant operations, very small amounts of radioactive gases and liquids that do not pose a significant risk to the public health are ultimately released to the environment under controlled and monitored conditions.

Radioactive materials lose their radioactive properties over time. This process is called radioactive decay. Some materials are short-lived and lose their radioactivity in seconds or minutes. Other radioactive elements take much longer — thousands of years in some cases — to lose their radioactivity.

The NRC has established limits for the release of radioactivity during routine plant operations. These limits are based on guidelines set by the U.S. Environmental Protection Agency, and by national and international standard-setting groups. The effects of very low levels of radiation are difficult to detect. But the NRC sets limits based on the conservative assumption that radiation exposures to the public should only be a small fraction of what is received from natural environmental radiation.

Nuclear plants typically release only traces of the amounts allowed during normal operations. A person spending a full year at a nuclear plant boundary would receive an additional radiation exposure of less than 1 percent of the radiation exposure everyone receives from naturally occurring radiation. (The average American receives 620 millirems a year from natural environmental radiation and manmade radiation exposures, such as from medical X-rays.) Year-round exposure at the plant boundary is an additional 1 to 2 millirems or less.

The NRC also sets limits for radiation exposure to people who work at nuclear plants and other facilities where radioactive materials are used. Radiation workers must wear devices that measure radiation to ensure their exposure is within the limits.

Routine operations at a nuclear power plant have only a very small environmental impact. But because of the radioactivity in the reactor fuel, the plant must have effective safety systems to prevent an accident that could release a large amount of radioactivity. Such an accident is not likely, but the possibility leads to special care in designing, building and operating nuclear power plants.

REACTOR SAFETY SYSTEMS

A nuclear power plant is equipped with several different safety systems to prevent accidents and reduce their effects if one should occur, including:

- A system to quickly shut down a reactor and stop the chain reaction.
- Systems that monitor reactor conditions, control reactor pressure and continue cooling the reactor fuel even if the reactor is shut down.
- A system of barriers to contain radioactivity if it escapes from the reactor fuel in an accident.

SHUTDOWN SYSTEMS

Each reactor has a system to insert the control rods into the reactor core within seconds to stop the fission reaction. This immediate shutdown — called a reactor "scram" or reactor "trip" — can be triggered by a reactor operator or by automatic controls that protect the reactor from any unusual conditions.

COOLING AND PRESSURE—SAFETY SYSTEMS

When a reactor is operating, the heat energy from the fission reaction is carried off in the cooling water. That energy is used as steam to spin the turbine-generator, making electricity. A reactor shutdown stops the fission reaction, but heat is still generated by the natural decay of the radioactive fission byproducts, which build up in the reactor fuel. Much less heat is created at this point, but the heat is still high enough to damage the fuel if it is not cooled. As time passes after the reactor shutdown, the amount of heat produced in the fuel in the reactor core drops. But continued cooling of the fuel is still necessary. Each plant has both normal cooling and emergency cooling systems to ensure that the fuel remains cooled at all times.

The emergency core cooling system has pumps, valves and pipes that are separate from the normal cooling system. This system contains equipment that can pump at high pressure to send water into the reactor when the pressure inside is at the high levels maintained during operation. In addition, low pressure systems pump water at lower pressures, such as those that might occur if a cooling water pipe broke and allowed pressure inside the reactor to drop.

The reactor systems also have valves that can be opened to reduce pressure by releasing steam. These relief valves open automatically if pressure gets too high in the reactor system. Some of the valves can be opened using controls in the reactor control room. These pressure-reduction systems can also be used to reduce reactor pressure so that the low pressure cooling systems can work.

SAFETY SYSTEM POWER

Most of the safety systems are powered by electricity, although some pumps use steam to drive them in order to have an alternative source of power. Because of this reliance on electrical power, nuclear plants are required to have multiple sources of electricity.

Some nuclear plants use a portion of the power they generate to run. Those plants also have a system that allows a shift to "offsite" power, if that is needed. Other plants run only on offsite power. In addition, all plants have emergency diesel generators in case offsite power is lost. The generators are large enough to supply electricity to the critical safety systems for days.

The control and instrument systems for maintaining plant conditions normally use direct current (DC) electricity, the kind of power found in batteries. For these systems, large banks of batteries provide DC power if there is an interruption in the normal sources of electricity.

CONTAINING RADIOACTIVITY

Nuclear power plants have three principal barriers to prevent the release of radioactivity — the sealed fuel rods, the reactor vessel and associated components, and the structure housing the reactor, called the reactor containment.

A serious reactor accident could damage the fuel rods, which form the first barrier, if there isn't enough cooling. Overheated fuel rods could leak or break apart and eventually melt. Possible damage to the reactor cooling system piping could cause the second barrier to fail.

Even if the first two barriers fail, the reactor containment is designed to hold radioactive material that might otherwise be released to the environment. One type of reactor containment is a domed structure made of reinforced concrete with a steel lining. It is designed to withstand the pressures that might build up inside as steam and gases escape from the reactor during an accident. Another type of containment, called a pressure suppression containment, has a large water-filled pool to cool the steam and reduce the pressure buildup in the containment.

The NRC requires that the reactor containment be periodically tested to show it meets requirements to prevent leaks to the environment.

Reactor containment buildings are designed to handle many types of serious accidents. But it's possible they may not be able to withstand the conditions that result from an extremely unlikely accident in which all cooling capability is lost in the reactor. Under these circumstances, the energy produced by the radioactivity remaining in the fuel could cause the fuel to melt. The melting fuel could eventually lead to a buildup of pressure that could cause radioactive gases to leak through seals and gaskets around the containment. The molten fuel could also damage the concrete base of the containment, possibly leading to a release of radioactivity. Even in these extremely unlikely cases, however, most of the long-term hazardous radioactive material would stay inside the containment structure.

In the only major commercial power reactor accident in the United States, the Three Mile Island accident in 1979, there was extensive fuel damage in the Pennsylvania reactor. Radioactive gases and contaminated cooling water filled the containment. Although some radioactivity was released to the atmosphere by an indirect route, the containment itself performed as designed and kept the radioactivity safely bottled up inside. The effectiveness of the containment was the major factor in preventing the release of large amounts of radioactive materials to the environment.

In 1986, a much more serious accident occurred at one of the Chernobyl reactors in the former Soviet Union. The reactor was very different from those used in the United States. The plant had no containment system like that of U.S. plants. The Chernobyl accident severely damaged the reactor core, releasing large quantities of radioactivity to the environment. Radioactive material was deposited in nearby countries, and radioactivity was detectable at very low levels in the United States.

EMERGENCY PREPAREDNESS

Although a major reactor accident is unlikely and each plant has safety systems to prevent or cope with an accident, there are additional measures in place to help protect public health and safety.

The first is special training given to the reactor operators in the handling of emergency situations. One of the lessons learned as a result of the Three Mile Island accident was that reactor operators needed to practice how they would handle emergencies. Detailed emergency operating procedures have been prepared and the operators have been trained to use them. In addition, most nuclear power plants use computer-based simulators for training in both routine and abnormal situations. These simulators are laid out just like the plant's control room with all of the same controls and instrumentation. Computers let the operators practice dealing with emergencies.

The Three Mile Island accident also pointed out the need for improved planning by federal, state, and local governments to deal with possible reactor accidents. The NRC now requires emergency plans for evacuation or other actions to protect residents in areas near nuclear plants. These plans usually cover about 10 miles in all directions around each nuclear plant. The company has its own plan to notify government officials of a possible emergency and to provide them with information and recommendations. State and local governments have detailed plans for sheltering and evacuating residents if necessary. Federal emergency plans include federal personnel, equipment, and resources needed to respond to a nuclear power plant accident. The NRC would closely follow the handling of an accident by a company and afterward investigate the causes of the accident. The NRC also would coordinate with appropriate federal and state officials.

These plans are tested through emergency exercises that simulate a serious reactor accident. Company workers and government officials follow their emergency plans in gathering information, consulting with each other, and issuing instructions to the public. These emergency exercises sometimes include small-scale evacuation drills for schools, nursing homes, and other institutions.

The NRC must determine that there is reasonable assurance that evacuation or other steps can be taken to protect residents in the event of a major reactor accident. To make this determination, the NRC reviews the company's plans, conducts inspections, and considers the assessment of state and local planning by the U.S. Department of Homeland Security (DHS).

SECURITY

Nuclear power plants have always been robust facilities with many security measures in place. After the terrorist attacks of Sept. 11, 2001, even more security measures were put in place. These measures are very strict in order to protect the plants from sabotage or attack.

The details of the added security measures are not available to the public because that might negatively affect the facility's security. But the measures generally include:

- increased guard patrols,
- additional security forces and capabilities,
- additional security posts,
- additional physical barriers,
- more restrictive controls on who can come into the site, and
- faster, more thorough checks of employee backgrounds.

The NRC is also working with the U.S. Department of Energy, FBI, DHS, and other organizations to protect radioactive material that terrorists might try to make into a “dirty bomb.” The NRC is requiring greater control and tracking of this material, among other requirements.

NUCLEAR INSURANCE

In 1957, Congress established a system of “no-fault” insurance to provide liability coverage in the event of a major reactor accident. This insurance program, also known as the Price-Anderson Act, combines commercial insurance and self-insurance by the nuclear industry. Large nuclear plants are required to have the maximum amount of liability insurance that is commercially available, currently $300 million. If there is an accident that causes damages higher than that, each licensed reactor will be assessed a share of the extra cost, up to $95.8 million, but no more than $15 million for any one reactor in a year.

With more than 100 commercial nuclear reactors in the United States, the combination of commercial insurance and industry self-insurance exceeds $10 billion. This is the total liability limit for an accident under the Price-Anderson Act. Congress, however, would consider the need for providing an additional source of funds should $10 billion not be enough.

The Price-Anderson Act provides for liability insurance coverage for actual damages incurred by anyone affected by a major reactor accident. Besides the coverage for offsite public liability claims, the NRC requires that utilities maintain $1 billion in onsite property damage insurance to provide funds to deal with cleanup of the reactor site after an accident.

RADIOACTIVE WASTE DISPOSAL

During normal operations, a nuclear power plant generates two types of radioactive waste — high level and low level. High-level waste is the used fuel, often called “spent” fuel. Low-level waste includes such items as contaminated equipment, filters, maintenance materials, and resins used in purifying water for the reactor cooling system. In addition to nuclear power plants, other users of radioactive materials — such as hospitals — also generate low-level waste. Each type of waste is handled differently.

HIGH-LEVEL WASTE

Typically, the spent fuel from nuclear power plants is stored in water-filled pools at each reactor site and at one storage facility in Illinois. In addition, some companies have begun using dry cask storage for older spent fuel pending final disposal. In this way, spent fuel that has cooled in the pool for at least five years is stored in large metal and concrete containers placed on concrete pads or in concrete bunkers adjacent to the reactor facility. About one-fourth to one-third of the reactor fuel is removed and replaced every 18 to 24 months.

When spent fuel is first removed from the reactor, it is highly radioactive because it contains the fission byproducts that were created within the reactor. Over time, these substances decay, leaving the longer-lived materials, which may be around for thousands of years, as the principal substances for disposal.

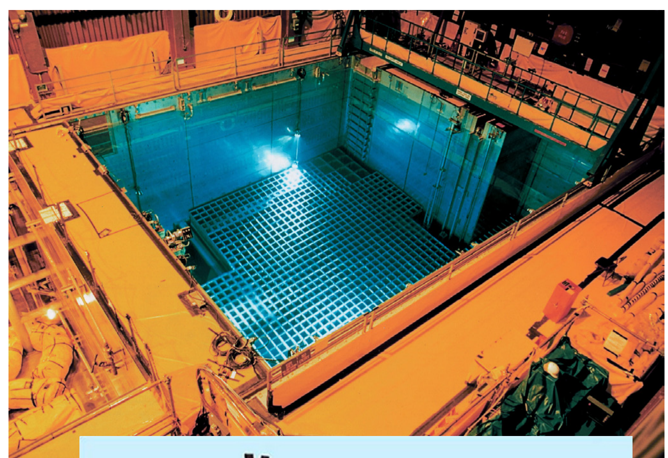
Special procedures are needed to handle spent fuel. The water in the spent fuel storage pool provides cooling and shielding from the radiation to protect workers in a nuclear plant. Concrete and steel in dry casks provide protection, too.

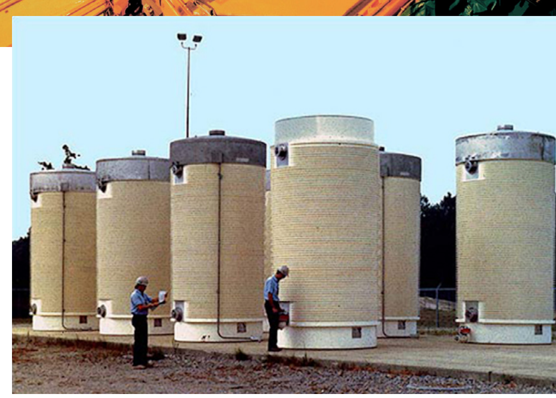
Although most of the spent fuel remains stored at individual plants, some spent fuel has been shipped to offsite interim storage facilities. These shipments have used heavily shielded shipping containers designed to withstand the conditions that might happen during a shipping accident. Spent fuel has been shipped by both rail and truck. The NRC certifies that each shipping container meets federal requirements, and the U.S. Department of Transportation sets the rules for actual transportation of the spent fuel.

Since some of the components in spent fuel remain hazardous for a long time, its permanent disposal requires a special disposal facility. The Department of Energy (DOE) had planned a permanent repository for spent fuel at Yucca Mountain, Nevada, but this effort was abandoned in 2010. The Secretary of Energy appointed a Blue Ribbon Commission on America's Nuclear Future to develop recommendations for alternative strategies for managing spent fuel. In a draft report issued in July 2011, the Blue Ribbon Commission recommended establishing one or more centralized sites for extended storage of spent fuel until other solutions, such as disposal or recycling the fuel, can be developed.

The NRC is preparing to support and regulate whatever direction DOE and Congress decide to pursue for spent fuel management.

Since no DOE disposal site has been developed, many nuclear power plants are running out of room to store spent fuel in their storage pools. Nearly 60 plants – including some that are permanently shut down – have transferred older spent fuel to safe interim storage in dry casks on site. This opens space in the spent fuel pool for cooling fuel that was removed from the reactor more recently.





Water-filled storage pool and dry cask storage a DOE site is available, other plants, particularly the older ones, may run out of storage space in their spent fuel pools. More than 30 plants — including some that are permanently shut down — have transferred older spent fuel to safe interim storage in dry casks on site. This opens space in the spent fuel pool for cooling fuel that was removed from the reactor more recently.

LOW-LEVEL WASTE

Low-level radioactive waste, whether from a nuclear power plant or from other users of radioactive material, is shipped to licensed commercial disposal facilities. There, it is packaged and placed in burial trenches and covered with soil. Less than half of the waste volume is from nuclear power plants. The rest is generated by hospitals, research institutes, and other users of radioactive materials. The NRC has a classification system for low-level waste based on its potential hazards. There are specific disposal requirements based on the classification.

TRANSPORTATION

About 3 million packages of radioactive materials are shipped each year in the United States — by highway, rail, air, and water. Regulating the safety of these shipments is the joint responsibility of the U.S. Department of Transportation (DOT) and the NRC.

The federal regulatory system protects transportation workers and the public by setting performance standards for the packages. The system also sets limits on the radioactive contents and radiation levels for packages and vehicles. Information on radioactive shipments is provided by package marking and labeling, vehicle identification, and shipping papers describing the materials.

DOT is responsible for radioactive shipments while the material is in transit. DOT also establishes shipping categories, sets the standards for labeling radioactive shipments, and establishes criteria for packages used for smaller quantities of radioactive materials. The NRC, which licenses the organizations shipping and receiving the radioactive

Site Decommissioning

Before

After

materials, assures that its licensees comply with DOT shipping requirements. The NRC also establishes the requirements for designing and manufacturing packages for larger amounts of radioactive materials.

Typical of small-quantity shipments — using packages meeting DOT requirements — are radioactive materials for medical diagnostic tests and therapy. These shipments make up the major portion of all shipments of radioactive materials each year. For these shipments, packaging (classified as "Type A") is used that is expected to withstand the rigors of normal transportation without being damaged.

The packages for larger quantities of radioactive materials are designed to withstand accident conditions without releasing their contents. These packages, designated as "Type B," are used for shipping industrial irradiators, medical radiation therapy devices, and some radioactive wastes. These packages must survive a series of tests involving impact, puncture, heat, and submersion in water.

The spent fuel shipping cask is a specialized Type B package. It is used to transport used fuel from nuclear reactors. These large shipping casks are carried on trucks or rail cars. Like all Type B packages, they are sealed to prevent leaks and heavily shielded to minimize radiation levels.

In addition to safety requirements, the NRC imposes security requirements on shipments of spent fuel and on shipments of larger quantities of radioactive materials. These security measures include evaluating the route and having escort personnel and vehicles. State governments are notified in advance of spent fuel shipments and those large-quantity shipments of radioactive waste requiring Type B packages.

The regulatory system for transporting radioactive materials has successfully minimized the safety impact from accidents involving the shipments. Few accidents have occurred involving shipments of radioactive materials (averaging less than 50 out of 3 million packages shipped annually). Only a small number of those accidents have involved any release of the radioactive contents. In these instances, radioactive contamination has been generally minor with no public safety consequences.

DECOMMISSIONING

Decommissioning is the term used for retiring a nuclear facility followed by cleanup to reduce radioactive contamination of the property. Nuclear power plants are licensed initially for a term of 40 years. Some plants may close before that time elapses.

Several nuclear power plants have been decommissioned, and some others are undergoing decommissioning. The NRC has adopted extensive regulations for dealing with the technical and financial issues associated with decommissioning.

During the operating life of a nuclear power plant, many plant components associated with the reactor become radioactive, either through contamination or as a result of the radiation from the fission reaction. For this reason, the decommissioning work must be done with care. Contaminated materials are shipped to a low-level radioactive waste disposal site for burial.

The NRC has identified two principal plans for decommissioning a nuclear power plant: immediate dismantling or safe storage for a period of 30 to 50 years followed by dismantling. A third option, called entombment, may also be available in some cases. This involves sealing off radioactive components with concrete and steel. Entombment requires less maintenance and fewer security provisions than the storage option.

The storage and entombment methods allow the radioactivity to reduce over time. NRC studies show that after 50 years radioactive decay would shrink the radioactively contaminated material to one-tenth of the original volume. Delay in dismantling a plant would also result in lower radiation exposures to the workers involved.

Cost estimates for decommissioning a large nuclear plant are $300 million or more, plus the cost of demolishing non-contaminated materials. The NRC decommissioning rules require companies to establish funds to pay for the future decommissioning of their plants.

Similar financial procedures are also required for other types of nuclear facilities, including plants that prepare fuel for nuclear power plants or process radioactive materials.

Some facilities that previously used nuclear materials in processing or manufacturing activities require special management attention. The NRC works to assure timely cleanup of certain unusual and difficult sites, particularly those with a lot of soil contamination or with old, contaminated buildings. The cleanup may take several years, but then the site can be used safely for any purpose.

More Information

The NRC's Web site has additional information and agency activities and programs. Here are some valuable links:

Governing Legislation: http://www.nrc.gov/about-nrc/governing-laws.html

Planning and Budget: http://www.nrc.gov/about-nrc/plans-performance.html

Rulemaking: http://www.nrc.gov/about-nrc/regulatory.html

Licensing: http://www.nrc.gov/about-nrc/regulatory/licensing.html

Emergency Preparedness: http://www.nrc.gov/about-nrc/emerg-preparedness.html

Nuclear Power Reactors: http://www.nrc.gov/reactors/power.html

New Reactor Licensing: http://www.nrc.gov/reactors/new-reactor-licensing.html

Nuclear Security: http://www.nrc.gov/security/domestic.html

Nuclear Materials: http://www.nrc.gov/materials.html

Radioactive Waste: http://www.nrc.gov/waste.html

Students' Corner: http://www.nrc.gov/reading-rm/basic-ref/students.html

For additional information, contact:

Office of Public Affairs
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001
301-415-8200
E-Mail: OPA@NRC.GOV
Internet Home Page: http://www.nrc.gov

Regional public affairs offices

Region I

2100 Renaissance Blvd.
Suite 100
King of Prussia, PA 19406-2713
610-337-5330 or
610-337-5331

Region II

245 Peachtree Center Ave., N.E.
Suite 1200,
Atlanta, GA 30303-1275
404-997-4000

Region III

2443 Warrenville Rd.
Suite 210
Lisle, IL 60532-4352
630-829-9663

Region IV

1600 East Lamar Blvd.
Arlington, TX 76011-4511
817-860-8100
effective 06/2012

NUREG/BR-0164, Rev. 9
June 2012