What is nuclear waste?

Nuclear waste is a product usually generated as the result of human activity. Most nuclear waste requires special handling to avoid the health and environmental hazards associated with radiation. Nuclear waste is classified into four categories depending on its origin, level of radioactivity, and potential hazard. The categories are: high-level waste, low-level waste, transuranic waste, and tailings.

High-level waste

High-level waste, such as spent fuel from nuclear power plants, is the most highly radioactive waste. It decays (loses radioactivity) rapidly, although high-level waste may also contain quantities of the slowly decaying transuranic (heavier than uranium) elements. Some high-level waste must be handled by remote control from behind heavy protective shielding.

Spent fuel containing high-level waste is produced primarily by commercial nuclear reactors. This waste from the reactors is confined within the used fuel assemblies along with remaining uranium and plutonium, which have valuable energy content. Spent fuel is fuel that has been used in a nuclear power plant until it is so contaminated with waste that it no longer contributes efficiently to the nuclear chain reaction. High-level waste will eventually be placed in deep, geologic repositories to be operated by the U.S. Department of Energy.

Low-level waste

Low-level waste is less radioactive than high-level waste and is defined by law as waste that is not classified as high-level waste, transuranic waste, or spent nuclear fuel. Low-level waste does not require extensive shielding, although some protective shielding may be needed for handling certain low-level waste.

Low-level waste is produced by many commercial, medical, and industrial processes. It includes waste, such as rags, papers, filters, resins, and discarded protective clothing, from "housekeeping" functions of commercial and university nuclear facilities. Typically it has small amounts of radioactive material dispersed in large total volumes and poses little potential hazard. Commercial low-level waste is disposed of by shallow land burial.

Transuranic waste

Transuranic waste contains man-made elements that are heavier than uranium. It emits medium energy radiation and decays (loses radioactivity) slowly, although its total radioactivity may be no greater than certain low-level waste. Most transuranic waste results from reprocessing nuclear fuel as part of the nation's defense activities.

Some transuranic waste is now being stored in surface facilities, but eventually all of this waste will be placed in deep geologic repositories because, like high-level waste, it remains hazardous for long periods of time while decaying.

Tailings

Tailings are radioactive rock and soil—the by-products of uranium mining and milling. They contain small amounts of radium that decay to emit a radioactive gas (radon). Plans are being developed by the DOE for controlled disposal of tailings.

What is spent nuclear fuel?

Spent fuel is nuclear power plant fuel that has been burned (irradiated) in a nuclear reactor to the point where it no longer contributes efficiently to the nuclear chain reaction that produces heat to generate electricity. At that point it must be replaced.

Pellets containing uranium oxide are the fuel for nuclear plants generating electrical power in the United States and many other countries. These solid pellets are sealed in metal tubes approximately twice the diameter of a pencil and about 12 to 13 feet long. The tubes are bundled together into assemblies, each containing between 50 and 270 tubes, depending on the design of the reactor in which they are to be used.

When it leaves the reactor, spent fuel is thermally hot and highly radioactive. Most of this heat and radiation decays after about 5 years of storage, but spent fuel remains potentially dangerous for much longer periods of time. This danger exists because exposure to radiation over sufficiently long periods could cause harmful health effects. Also, some of the waste products could be chemically poisonous if ingested. However, spent fuel is not explosive.

After removal from a reactor, spent fuel is stored in a pool of water in the plant building. This was originally intended to be a temporary solution, but some spent fuel has been held in storage for nearly 30 years. The goal of the U.S. nuclear waste management program is to develop a permanent disposal method that poses no significant threat to people or the environment now or in the future. This program emphasizes the permanent disposal of waste in mined geologic repositories deep underground in stable rock formations.

Radiation and nuclear waste

How are they related?

Radiation, the emission of waves or particles, occurs in nature as well as in nuclear waste. Nuclear waste usually contains higher than natural concentrations of radioactive atoms. Three types of radiation are associated with using nuclear energy and creating nuclear waste; all three are also found in nature. These types are called "ionizing" radiation because they can produce charged particles (ions) in materials they strike. (Heat and sunlight are not ionizing radiation.)

When spent fuel is removed from a nuclear power plant, it contains the remains of split atoms, called "fission products," some of which are highly radioactive. These fission products decay (lose radioactivity) by emitting beta and gamma radiation. Beta and gamma radiation dominate for the first 500 to 1,000 years in high-level nuclear waste, and alpha radiation dominates thereafter. Spent fuel also contains radioactive forms of uranium and newly created elements that are heavier than uranium. These artifical elements form the basis of transuranic waste that emits alpha particles. Taken together, the transuranic elements and the fission products are handled with caution as high-level waste. Spent fuel can be reprocessed to remove a major portion of the transuranic elements.

Nuclear waste ultimately loses its radioactivity, decreasing to levels that occur naturally. Some fission products are extremely short lived; others require long periods to decay. Natural background radiation comes from cosmic rays and from the radioactivity of substances in the earth. Cosmic radiation increases as altitude above sea level increases. Other background radiation comes from X rays used in medicine and dentistry and from activities such as watching television, living in a brick house, and drinking water from deep wells.

Doses of radiation received by people are measured in units called "millirem". The average person receives 100 to 200 millirem of radiation a year from natural and artificial sources, depending on where and how the person lives. A single dose of 600,000 millirem received all at one time is considered lethal to 50 percent of those exposed.

Types of Radiation

Alpha radiation consists of positively charged particles. These particles can be stopped by a sheet of paper or even the outer layer of skin. So-called "transuranic" nuclear waste (heavier than uranium) emits alpha radiation.

Beta radiation consists of high-speed electrons. Beta radiation is more penetrating than alpha radiation and can pass through about an inch of water or human flesh. It can be stopped by a thin sheet of aluminum.

Gamma radiation consists of high-energy electromagnetic waves and can pass through the human body like high-energy X rays. (X rays and gamma rays have identical behaviors.) Dense materials such as concrete and lead can provide shielding against gamma radiation. For this reason, waste emitting gamma rays must be handled be remote-control mechanisms.