BACKGROUNDER
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Radioactive Waste

Radioactive (or nuclear) waste is a byproduct from nuclear reactors, fuel processing plants, hospitals and research facilities. Radioactive waste is also generated while decommissioning and dismantling nuclear reactors and other nuclear facilities. There are two broad classifications: high-level or low-level waste. High-level waste is primarily spent fuel removed from reactors after producing electricity. Low-level waste comes from reactor operations and from medical, academic, industrial and other commercial uses of radioactive materials.

The NRC regulates the storage and disposal of all commercially generated radioactive wastes in the United States. The NRC also regulates high-level wastes generated by the Department of Energy that are subject to long-term storage and not used for, or part of, research and development activities. Regulations establish minimum acceptable performance criteria for licensees managing wastes, while providing for flexibility in technological approach.

High-Level Waste

High-level radioactive waste primarily is uranium fuel that has been used in a nuclear power reactor and is "spent," or no longer efficient in producing electricity. Spent fuel is thermally hot as well as highly radioactive and requires remote handling and shielding. Nuclear reactor fuel contains ceramic pellets of uranium-235 inside of metal rods. Before these fuel rods are used, they are only slightly radioactive and may be handled without special shielding.

During the fission process, two things happen to the uranium in the fuel. First, uranium atoms split, creating energy that is used to produce electricity. The fission creates radioactive isotopes of lighter elements such as cesium-137 and strontium-90. These isotopes, called "fission products," account for most of the heat and penetrating radiation in high-level waste. Second, some uranium atoms capture neutrons produced during fission. These atoms form heavier elements such as plutonium. These heavier-than-uranium, or "transuranic," elements do not produce nearly the amount of heat or penetrating radiation that fission products do, but they take much longer to decay. Transuranic wastes, sometimes called TRU, account for most of the radioactive hazard remaining in high-level waste after 1,000 years.

Radioactive isotopes eventually decay, or disintegrate, to harmless materials. Some isotopes decay in hours or even minutes, but others decay very slowly. Strontium-90 and cesium-137 have half-lives of about 30 years (half the radioactivity will decay in 30 years). Plutonium-239 has a half-life of 24,000 years.

High-level wastes are hazardous because they produce fatal radiation doses during short periods of direct exposure. For example, 10 years after removal from a reactor, the surface dose rate for a typical

spent fuel assembly exceeds 10,000 rem/hour – far greater than the fatal whole-body dose for humans of about 500 rem received all at once. If isotopes from these high-level wastes get into groundwater or rivers, they may enter food chains. The dose produced through this indirect exposure would be much smaller than a direct-exposure dose, but a much larger population could be exposed.

Reprocessing separates residual uranium and plutonium from the fission products. The uranium and plutonium can be used again as fuel. Most of the high-level waste (other than spent fuel) generated over the last 35 years has come from reprocessing fuel from government-owned plutonium production reactors and from naval, research and test reactors. A small amount of liquid high-level waste was generated from reprocessing commercial power reactor fuel in the 1960s and early 1970s. There is no commercial reprocessing of nuclear power fuel in the United States at present; almost all existing commercial high-level waste is unreprocessed spent fuel.

Storage and Disposal

All U.S. nuclear power plants store spent nuclear fuel in "spent fuel pools." These pools are made of reinforced concrete several feet thick, with steel liners. The water is typically about 40 feet deep and serves both to shield the radiation and cool the rods.

Dry Cask Storage of Spent Fuel

As the pools near capacity, utilities move some of the older spent fuel into "dry cask" storage. These casks are stainless steel canisters surrounded by concrete. Fuel is typically cooled at least five years in the pool before transfer to cask. NRC has authorized transfer as early as three years; the industry norm is about 10 years. The NRC certifies cask designs and licenses dry cask storage facilities for up to 40 years. The certifications and licenses can be renewed.

The NRC believes spent fuel pools and dry casks both provide adequate protection for public health and safety and the environment. Therefore there is no pressing safety or security reason to mandate earlier transfer of fuel from pool to cask.

Spent fuel storage at power plant sites is considered temporary, with the ultimate goal being permanent disposal. The NRC is currently reviewing two applications for "Consolidated Interim Storage Facilities," in Texas and New Mexico. These facilities would store spent fuel from commercial nuclear power plants until a permanent disposal facility is available.

At this time there are no facilities for permanent disposal of high-level waste. In the Nuclear Waste Policy Act of 1982, amended in 1987, Congress directed the Department of Energy to design and construct an underground geologic repository at Yucca Mountain, Nevada. DOE applied to the NRC for a construction authorization in 2008; however, DOE canceled the project in 2010 before the NRC completed its review. The NRC closed out its review and the associated adjudicatory hearing in 2011. The NRC completed its technical review in 2015 and published a supplement to the Yucca Mountain Environmental Impact Statement in 2016, in compliance with an appeals court ruling. For more information on this process, see the backgrounder on Licensing Yucca Mountain.

NRC Responsibilities

The NRC licenses and regulates the receipt and possession of high-level waste at privately owned facilities and at certain DOE facilities. The DOE facilities subject to NRC regulation are defined by law to include: (1) facilities used primarily for receiving and storing high-level waste from activities licensed under the Atomic Energy Act and (2) facilities other than research and development facilities authorized for the express purpose of long-term storage of DOE-generated waste. Facilities for permanent disposal will require a license from NRC under these provisions.

Currently, facilities at reactor sites and at Morris, Ill., and the Idaho National Engineering and Environmental Laboratory are licensed by NRC for temporary storage of spent fuel.

By law, the Commission is not authorized to license:

- Receipt or possession of high-level waste used for or part of DOE activities in a DOE research and development facility;
- DOE facilities for the short-term storage of high-level waste from DOE activities (such as existing DOE high-level waste storage tanks);
- Operating DOE facilities for the storage or disposal of transuranic contaminated waste, foreign high-level waste not resulting from a licensed activity, and low-level wastes;
- Decommissioned DOE facilities, except those covered under Section 202 of the Energy Reorganization Act. (Section 202 authorizes NRC to license certain DOE facilities, including not only the high-level waste storage facilities noted above, but also certain demonstration reactors);
- DOE high-level waste processing facilities, such as those for solidification, strontium and cesium extraction, and waste crystallization.

Responsibilities of Other Government Agencies

Other government agencies play a role in managing high-level waste.

The Department of Energy plans and carries out programs for safe handling of DOE-generated radioactive wastes, develops waste disposal technologies, and will design, construct and operate disposal facilities for DOE-generated and commercial high-level wastes. DOE has completed solidifying the liquid wastes that are currently in storage at West Valley in New York. The Nuclear Waste Policy Act of 1982 sets specific roles and schedules for the DOE to follow in developing high-level waste repositories. (The repositories will be licensed by the NRC.)

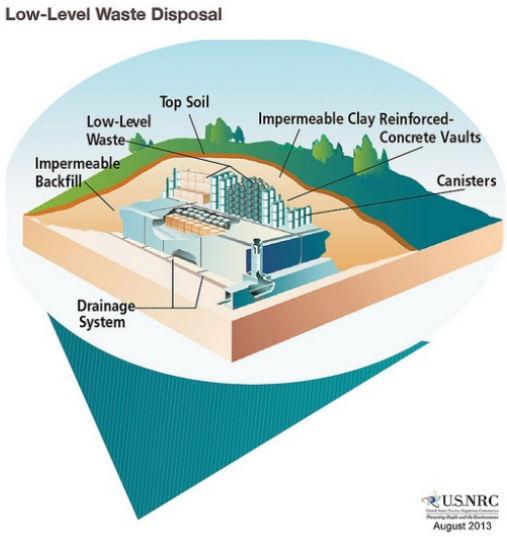
The Environmental Protection Agency develops environmental standards and federal radiation protection guidance for offsite radiation due to the disposal of spent nuclear fuel and high-level and transuranic radioactive wastes. The standards limit the amount of radioactivity entering the biosphere outside the boundaries of the facility, and also limit the radiation exposure to the public from management of spent fuel and waste prior to disposal. The guidance establishes criteria for disposing of waste.

The Department of Transportation regulates both the packaging and carriage of all hazardous materials including radioactive waste. Packaging must meet NRC regulations, which are compatible with internationally developed standards, and the package design must be reviewed and certified by the NRC. DOT sets limits for external radiation levels and contamination, and controls the mechanical condition of carrier equipment and qualifications of carrier personnel.

The Department of the Interior, through the U.S. Geological Survey, conducts laboratory and field geologic investigations in support of DOE's waste disposal programs and collaborates with DOE on the earth science technical activities. The Bureau of Land Management, within DOI, manages certain public lands. DOI may withdraw such public lands for the limited exclusive use of DOE in support of radioactive waste disposal actions.

Low-Level Waste

Low-level wastes, generally defined as radioactive wastes other than high-level and wastes from uranium recovery operations, are commonly disposed of in near-surface facilities rather than in a geologic repository. There is no intent to recover the wastes once they are disposed of.



Low-level waste includes items that have become contaminated with radioactive material or have become radioactive through exposure to neutron radiation. This waste typically consists of contaminated protective shoe covers and clothing, wiping rags, mops, filters, reactor water treatment residues, equipment and tools, luminous dials, medical tubes, swabs, injection needles, syringes, and laboratory animal carcasses and tissues. The radioactivity can range from just above background levels found in nature to much higher levels in certain cases, such as from parts from inside the reactor vessel in a nuclear power plant.

Low-level waste is typically stored on-site by licensees, either until it has decayed away and can be disposed of as ordinary trash, or until amounts are large enough for shipment to a low-level waste disposal site in approved containers.

The NRC's regulations (10 CFR Part 61) establish procedures, criteria, terms and conditions for licensing low-level waste disposal sites. Part 61 also provides the basis for Agreement State regulations, since state rules must be compatible with NRC requirements. Additionally, licensees may use 10 CFR 20.2002 to dispose of low-level wastes that typically are a small fraction of the Class A limits in Part 61. The extensive controls in Part 61 are not needed to ensure protection of public health and safety and the environment from such wastes.

There have been eight operating commercial facilities in the United States licensed to dispose of low-level radioactive wastes. They are located at (1) West Valley, New York; (2) Maxey Flats near

Morehead, Ky.; (3) Sheffield, Ill.; (4) Beatty, Nev.; (5) Hanford, Wash.; (6) Clive, Utah; (7) Barnwell, S.C.; and (8) Andrews, Texas. At the present time, only the latter four sites are receiving waste for disposal; they are regulated by the states. Burial of transuranic waste is limited at all of the sites. Transuranic waste includes material contaminated with radioactive elements (e.g., neptunium, americium, plutonium) that are artificially made and is produced primarily from reprocessing spent fuel and from use of plutonium in fabrication of nuclear weapons.

Mill Tailings

Another type of radioactive waste consists of tailings generated during the milling of certain ores to extract uranium or thorium. These wastes have relatively low concentrations of radioactive materials with long half-lives. Tailings contain radium (which, through radioactive decay, becomes radon), thorium, and small residual amounts of uranium left over from the milling process. Part 40 Appendix A of the NRC's regulations sets procedures and criteria for disposing of mill tailings and maintaining the disposal site.

June 2019