U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

BACKGROUNDER

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Radioactive Waste

Background

Radioactive (or nuclear) waste is a byproduct from nuclear reactors, fuel processing plants, and institutions such as hospitals and research facilities. It also results from the decommissioning of nuclear reactors and other nuclear facilities that are permanently shut down. The Nuclear Regulatory Commission separates wastes into two broad classifications: high-level or low-level waste. High-level radioactive waste results primarily from the fuel used by reactors to produce electricity. Low-level radioactive waste results from reactor operations and from medical, academic, industrial, and other commercial uses. These are described in more detail below.

The NRC has regulatory authority over storage and disposal of all commercially generated wastes in the United States and those high-level wastes generated by the Department of Energy that are subject to long-term storage and that are not used for, or part of, research and development activities. Regulations require conformance with minimum acceptable performance criteria for waste management activities, while providing for flexibility in technological approach. These criteria and guidelines are designed to ensure adequate protection of the public health and safety and the environment.

HIGH-LEVEL WASTE

High-level radioactive waste is uranium fuel that has been used in a nuclear power reactor and is "spent" or is no longer efficient in generating power to the reactor to produce electricity. Spent fuel is thermally hot as well as being highly radioactive, requiring remote handling and shielding. The basic fuel of a nuclear power reactor contains uranium 235, which is in ceramic pellets inside of metal rods. Before these fuel rods are used, they are only slightly radioactive and may be handled without special shielding. During the nuclear reaction, the fuel "fissions," which means that an atom of uranium is split, releasing two or three neutrons and a small amount of heat. The released neutrons then strike other atoms, causing them to split, and a chain reaction is formed, which releases large amounts of heat. This heat is used to generate electricity at nuclear power plants.

The splitting of relatively heavy uranium atoms during reactor operation creates radioactive isotopes of several lighter elements, such as cesium-137 and strontium-90, called "fission products," that account for most of the heat and penetrating radiation in high-level waste. Some uranium atoms also capture neutrons from fissioning uranium atoms nearby to form heavier elements like 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, also called "TRU," therefore account for most of the radioactive hazard remaining in high-level waste after a thousand years.

Radioactive isotopes will eventually decay, or disintegrate, to harmless materials. However, while they are decaying, they emit radiation. 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 (that means that half the radioactivity of a given quantity of strontium-90, for example, will decay in 30 years). Plutonium-239 has a half-life of 24,000 years.

High-level wastes are hazardous to humans and other life forms because of their high radiation levels that are capable of producing fatal doses during short periods of direct exposure. For example, ten years after removal from a reactor, the surface dose rate for a typical spent fuel assembly exceeds 10,000 rem/hour, whereas a fatal whole-body dose for humans is about 500 rem (if received all at one time). Furthermore, if constituents of these high-level wastes were to get into ground water or rivers, they could enter into food chains. Although the dose produced through this indirect exposure is much smaller than a direct exposure dose, there is a greater potential for a larger population to be exposed.

Reprocessing separates residual uranium and unfissioned 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 of 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 the reprocessing of commercial power reactor fuel in the 1960's and early 1970's. There is no commercial reprocessing of nuclear power fuel in the United States at present; almost all existing commercial high-level waste is in the form of unreprocessed spent fuel.

Storage and Disposal

At this time there are no facilities for permanent disposal of high-level radioactive waste. Since the only way radioactive wastes finally become harmless is through decay, which for some isotopes contained in high-level wastes can take hundreds of thousands of years, the wastes must be stored in a way that provides adequate protection for very long times.

The spent fuel rods from nuclear power plants must be handled and stored with the same care as separated high-level waste, since they contain the highly-radioactive fission products plus uranium and plutonium. Spent fuel is currently being stored in large water-cooled pools and dry storage casks at nuclear power plants. Some is also stored at facilities at West Valley, New York, Morris, Illinois, and Idaho National Engineering and Environmental Laboratory.

Existing high-level wastes from reprocessing are presently stored at West Valley, New York; Hanford, Washington; Idaho Falls, Idaho; and Savannah River, South Carolina. Liquid high-level wastes are stored in large underground tanks of either stainless steel or carbon steel, depending on whether they are acid or alkaline. Some of the liquid waste has been solidified into glass, ceramic slag, salt cake and sludge.

In 1982, the Congress enacted the Nuclear Waste Policy Act (NWPA) and on January 7, 1983, the President signed it into law. This legislation defined the Federal Government’s responsibility to provide permanent disposal in a deep geologic repository for spent fuel and high-level radioactive waste from commercial and defense activities. Under amended provisions (1987) of this Act, the Department of Energy (DOE) has the responsibility to locate, build, and operate a repository for such wastes. The NRC has the responsibility to establish regulations governing the construction, operation, and closure of the repository, consistent with environmental standards established by the U.S. Environmental Protection Agency.

The 1987 amendments required DOE to evaluate only the suitability of the site at Yucca Mountain, Nevada, for a geologic disposal facility. In addition, the amendments outlined a detailed approach for the disposal of high-level radioactive waste involving review by the President, Congress, State and Tribal governments, NRC and other Federal agencies.

In February 2002, after many years of studying the suitability of the site, DOE recommended to the President that the Yucca Mountain site be developed as a long-term geologic repository for high-level waste. In April 2002, the Governor of Nevada notified Congress of his State's objection to the proposed repository. Subsequently, Congress voted to override the objection of the state.

DOE is preparing a license application to submit to the NRC for construction authorization for a repository at Yucca Mountain. Although DOE's earlier plans were to submit the license application to the NRC in December 2004, it has been delayed. The Act specifies that the NRC will issue a decision on the license application within three years after receiving the DOE application. The NRC will issue a license only if DOE can demonstrate that it can construct and operate the repository safely and comply with NRC regulations.

NRC Responsibilities

The NRC is responsible for licensing and regulating the receipt and possession of high-level waste, including spent fuel as well as reprocessing waste, at privately-owned facilities and at certain facilities of the DOE. The DOE facilities which are or will be subject to NRC regulation are defined by law to include: (1) facilities used primarily for the receipt and storage of high-level waste resulting from activities licensed under the Atomic Energy Act and (2) facilities other than Research and Development facilities authorized for the express purpose of subsequent 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, Illinois, and Idaho National Engineering and Environmental Laboratory are licensed by NRC for temporary storage of spent fuel. Private Fuel Storage (PFS) has submitted an application to the NRC for a license to store spent fuel on the reservation of the Skull Valley Band of Goshute Indians about 60 miles from Salt Lake City.

By law, the Commission is not authorized to license:

- Receipt or possession of high-level waste (HLW) 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 (e.g., existing DOE HLW storage tanks);

- Operating DOE facilities for the storage or disposal of transuranic contaminated waste, foreign HLW 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 HLW storage facilities noted above, but also certain demonstration reactors);

- DOE HLW waste processing facilities, such as those for solidification, strontium and cesium extraction, and waste crystallization.

Responsibilities of Other Government Agencies

The responsibilities of other government agencies in the management of HLW include the following.

The Department of Energy (DOE) 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. The Nuclear Waste Policy Act of 1982 sets specific roles and schedules for the DOE to follow in developing HLW repositories. (The repositories will be licensed by the NRC.)

The Environmental Protection Agency (EPA) 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 to be followed when these wastes are disposed of. Under Section 121(a) of the Nuclear Waste Policy Act, the EPA is required to promulgate generally applicable standards for protection of the general environment from offsite releases from radioactive materials in repositories.

The Department of Transportation (DOT) regulates both the packaging and carriage of all hazardous materials including high-level nuclear waste. Packaging must meet NRC regulations, which are compatible with and generally derived from internationally developed standards, and the package design must be reviewed and certified by NRC. DOT prescribes 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 (DOI), 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, which are 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 that is required for high-level wastes. 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, equipments 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 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 containers approved by the Department of Transportation.

Part 61 of the NRC's regulations (Title 10 of the Code of Federal Regulations) sets forth the procedures, criteria, terms and conditions for licensing sites for land disposal of low-level waste. The requirements established under Part 61 also provide the basis for Agreement State regulations, since State rules must be compatible with NRC requirements. Additionally, 10 CFR 20.2002 is available for use by licensees for disposal of low-level wastes that typically are a small fraction of the Class A limits in Part 61, and for which the extensive controls in Part 61 are not needed to ensure protection of public health and safety and the environment.

There have been seven 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, Kentucky; (3) Sheffield, Illinois; (4) Beatty, Nevada; (5) Hanford, Washington; (6) Clive, Utah; and (7) Barnwell, South Carolina. At the present time, only the latter three sites are receiving waste for disposal; they are regulated by the states. The West Valley, Maxey Flats, Sheffield and Beatty sites have permanently stopped receiving wastes. 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.

In 2000, low-level waste disposal facilities received about 3.3 million cubic feet of commercially generated radioactive waste. Of this, 8.2% came from nuclear reactors, 83.8% from industrial users, 7.6% from government sources (other than nuclear weapons sites), 0.2% from academic users, and the rest was undefined.

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 that were not extracted during the milling process. Part 40, Appendix A of the NRC's regulations (10 CFR) sets forth procedures and criteria for the disposal of mill tailings and for the perpetual surveillance and maintenance of the disposal site.

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