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Environmental Protection
Agency

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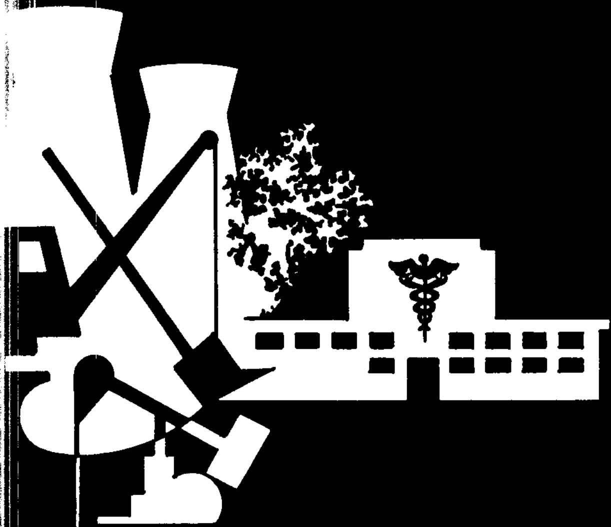
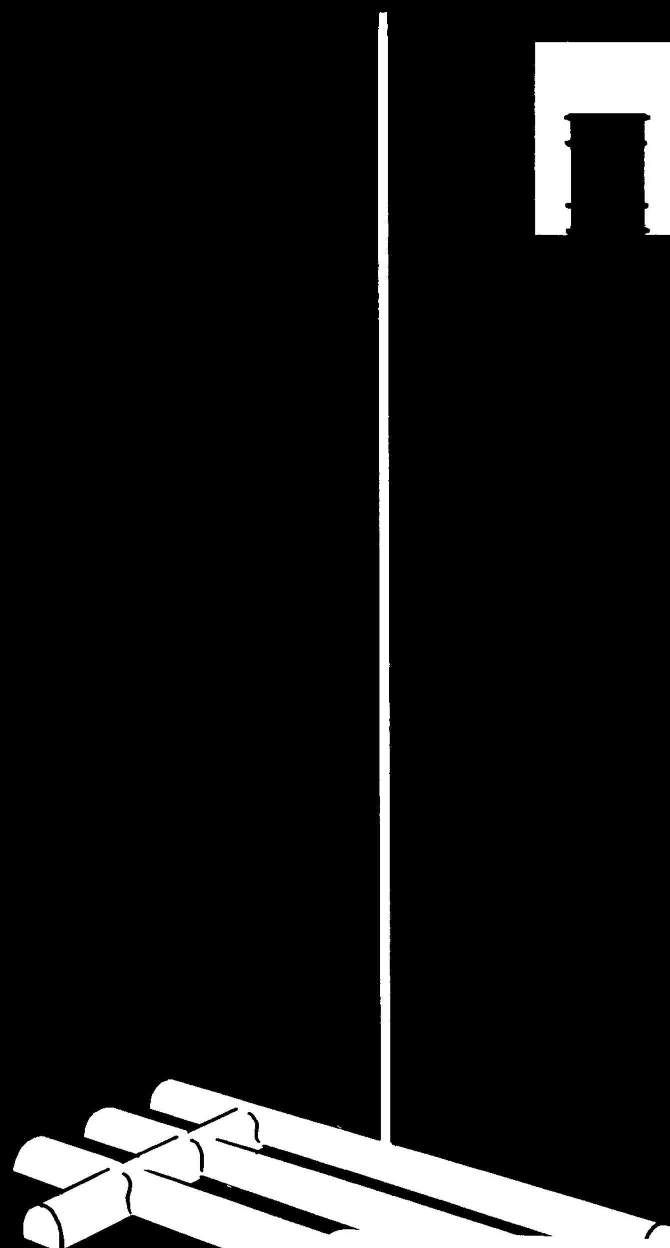
EPA

Radioactive Waste Disposal

An Environmental Perspective





Introduction

Any activity that produces or uses radioactive materials generates radioactive waste. Mining, nuclear power generation, and various processes in industry, defense, medicine, and scientific research produce byproducts that include radioactive waste. Radioactive waste can be in gas, liquid, or solid form, and its level of radioactivity can vary. The waste can remain radioactive for a few hours or several months or even hundreds of thousands of years. Because it can be so hazardous and can remain radioactive for so long, finding suitable disposal facilities for radioactive waste is difficult. Depending on the type of waste disposed, the disposal facility may need to contain radiation for a very long time. Proper disposal is essential to ensure protection of the health and safety of the public and quality of the environment including air, soil, and water supplies.

Radioactive waste disposal practices have changed substantially over the last twenty years. Evolving environmental protection considerations have provided the impetus to improve disposal technologies, and, in some cases, clean up facilities that are no longer in use. Designs for new disposal facilities and disposal methods must meet environmental protection and pollution prevention standards that are more strict than were foreseen at the beginning of the atomic age.

Disposal of radioactive waste is a complex issue, not only because of the nature of the waste, but also because of the complicated regulatory structure for dealing with radioactive waste. There are a variety of stakeholders affected, and there are a number of regulatory entities involved. Federal government agencies involved in radioactive waste management include: the Environmental Protection Agency (EPA), the Nuclear Regulatory Commission (NRC), the Department of Energy (DOE), and the Department of Transportation. In addition, the states and affected Indian Tribes play a prominent role in protecting the public against the hazards of radioactive waste.

Types Of Radioactive Waste

There are five general categories of radioactive waste: (1) *spent nuclear fuel* from nuclear reactors and *high-level waste* from the reprocessing of spent nuclear fuel, (2) *transuranic waste* mainly from defense programs, (3) *uranium mill tailings* from the mining and milling of uranium ore, (4) *low-level waste*, and (5) *naturally occurring and accelerator-produced radioactive materials*. Radioactive waste is categorized according to its origin and not necessarily according to its level of radioactivity. For example, some low-level waste has the same level of radioactivity as some high-level waste.

This booklet describes the different categories of waste, discusses disposal practices for each type, and describes the way they are regulated.

Spent Nuclear Fuel and High-level Radioactive Waste

Sources and Volume

In addition to being used to generate commercial electricity, nuclear reactors are used in government-sponsored research and development programs, universities and industry; in science and engineering experimental programs; at nuclear weapons production facilities; and by the U.S. Navy and military services. The operation of nuclear reactors results in spent reactor fuel. The reprocessing of that spent fuel produces high-level radioactive waste (HLW).

The fuel for most nuclear reactors consists of pellets of ceramic uranium dioxide that are sealed in hundreds of metal rods. These rods are bundled together to form what is known as a "fuel assembly." Depending upon the type and size of the reactor, a fuel assembly can weigh up to 1,500 pounds. As the nuclear reactor operates, uranium atoms fission (split apart) and release energy. When most of the usable uranium has fissioned, the "spent" fuel assembly is removed from the reactor.

Until a disposal or long-term storage facility is operational, most spent fuel is stored in water pools at the reactor site where it was produced. The water removes leftover heat generated by the spent fuel and serves as a radiation shield to protect workers at the site.

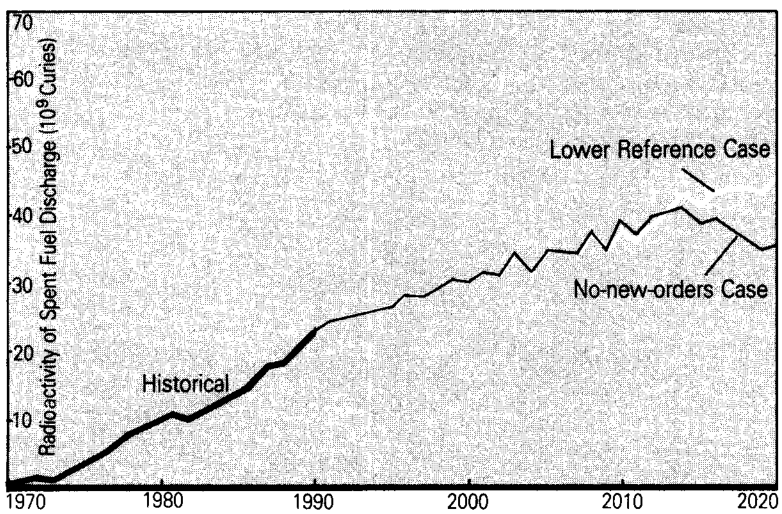
The operation of nuclear reactors over the last twenty years has substantially added to the amount of radioactive waste in this country. As shown in the following graph, by the year 2020, the total amount of spent fuel is expected to increase significantly.

HLW is the liquid waste that results when spent fuel is reprocessed to recover unfissioned uranium and plutonium. During this process, the fuel is dissolved by strong chemicals, and this results in liquid HLW. Plans are to solidify these liquids into a form that is suitable for disposal. Solidification is still in the planning stages. While currently there are no commercial facilities in this country that reprocess spent fuel, spent fuel from defense program reactors has been routinely reprocessed for use in producing nuclear weapons or for reuse in new fuel.

Compared to the total inventory of HLW, the volume of commercial HLW from the reprocessing of commercial spent fuel is almost insignificant, less than one percent. Defense-related HLW comprises greater than ninety-nine percent of the volume of HLW. The following graph shows the historical and projected volume of defense-related HLW through the year 2020. The effect of the end of the "Cold War" on these projections is uncertain.

Figure 1

Projected Accumulated Radioactivity of Commercial Spent Fuel Discharges for the DOE/EIA No-New-Orders and Lower Reference Cases



Note: Reference for figure is the *Integrated Data Base for 1991: U.S. Spent Fuel and Radioactive Waste Inventory Projections and Characteristics, DOE, Oak Ridge National Laboratory, Oct. 1991.* (DOE/RW-0006, Rev. 7)

HLW is now stored in underground tanks or stainless steel silos on federal reservations in South Carolina, Idaho, and Washington and at the Nuclear Fuel Services Plant in West Valley, NY. These facilities have begun programs to solidify and structurally stabilize the waste in preparation for disposal at a national repository.

Regulation of Disposal

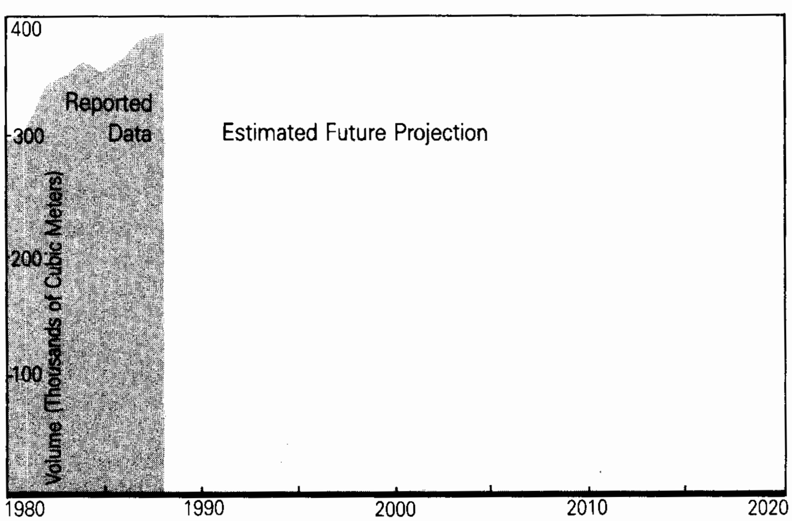
Some elements, such as plutonium, in HLW and spent fuel are highly radioactive and remain so for thousands of years. Therefore, the safe disposal of this waste is one of the most controversial environmental subjects facing the federal government and affected states.

The federal government (the EPA, the DOE, and the NRC) has overall responsibility for the safe disposal of HLW and spent fuel. The EPA is responsible for developing environmental standards that apply to both DOE-operated and NRC-licensed facilities. Currently, the NRC is responsible for licensing such facilities and ensuring their compliance with the EPA standards. DOE is responsible for developing the deep geologic repository which has been authorized by Congress for disposing of spent fuel and high level waste. Both the NRC and the Department of Transportation are responsible for regulating the transportation of these wastes to storage and disposal sites.

Site Selection for Storage and Disposal

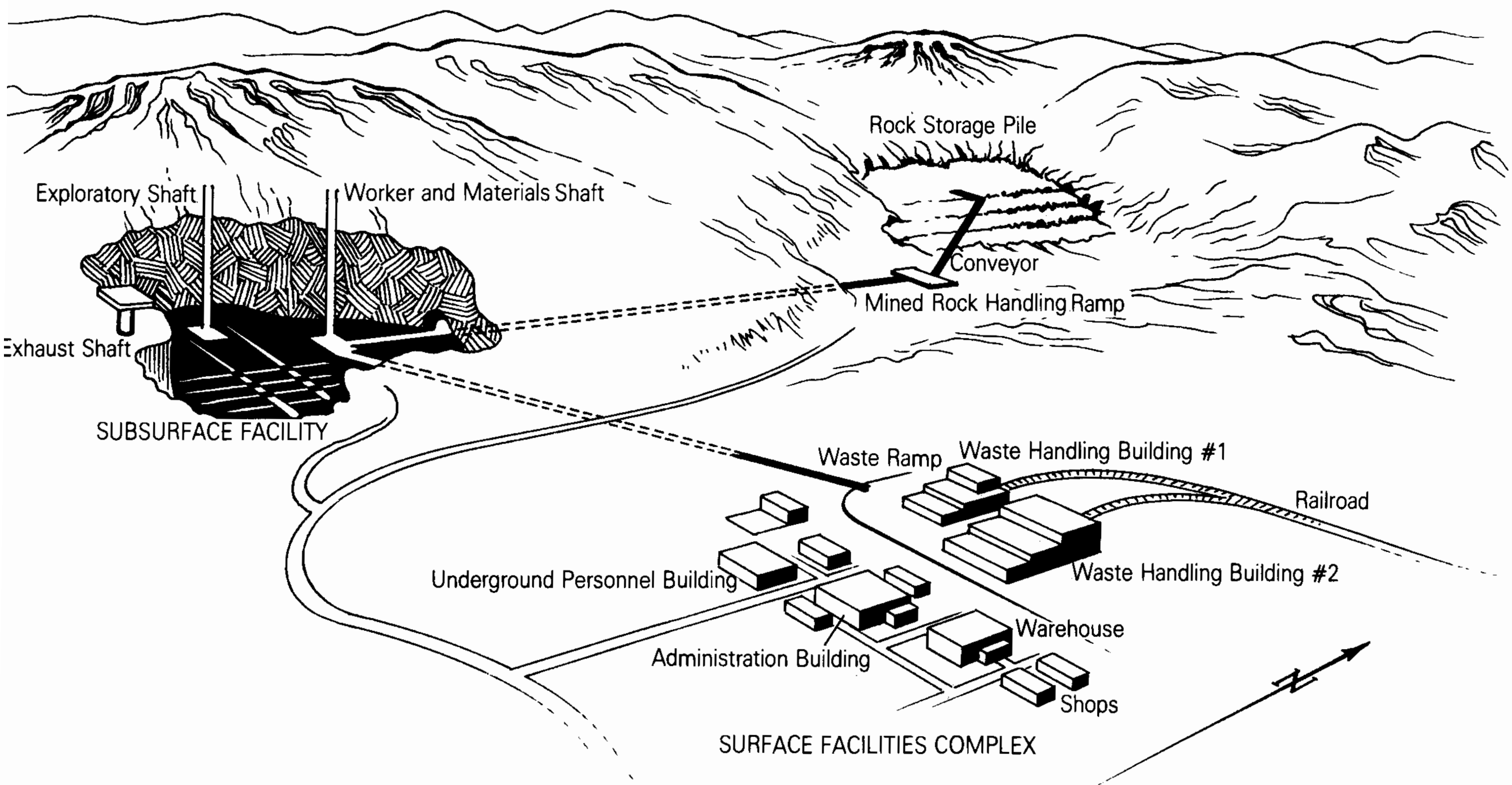
In the early 1980's, the DOE formally adopted a national strategy to develop mined geologic repositories as disposal facilities for spent fuel and high-level radioactive waste. In 1983, the DOE identified nine potentially acceptable sites and, in 1984, selected three sites as candidates for further characterization. In 1987, Congress directed the DOE to pursue the investigation of only the Yucca Mountain, NV site in order to determine whether the site is suitable for development as a repository. The DOE has designed a comprehensive "site characterization" program to evaluate the suitability of the Yucca Mountain site. The objectives of this program are to: (1) determine the geologic, hydrologic, and geochemical conditions at Yucca Mountain; (2) provide information needed to design a package for the disposal of radioactive waste; (3) provide information for the design of the repository facility; and (4) evaluate whether Yucca Mountain can meet NRC and EPA protection and safety requirements. Figure 3 is

Figure 2
Historical and Projected Inventories of Defense High-Level Radioactive Waste



DOE/RW-0006, Rev. 7

Figure 3
Artist's Rendition of the Proposed Yucca Mountain Repository



an artist's rendition of the proposed Yucca Mountain repository.

The DOE is also developing plans for the siting and development of a potential Monitored Retrievable Storage (MRS) facility. The MRS facility could be used to receive and store spent fuel from commercial power reactors for subsequent shipment to a repository when such a facility becomes operational.

Setting Environmental Protection Standards

In 1985, the EPA published final regulations that established generally applicable environmental standards for the management and disposal of spent nuclear fuel, HLW, and transuranic (TRU) wastes. (TRU wastes are discussed in the next section.) The disposal portion of these standards was successfully challenged in the courts and returned to the Agency for revision. The court was primarily concerned that the regulations might not adequately protect ground water and individuals from radioactive contamination. Following the court's ruling in 1987, the EPA worked to repromulgate the disposal portion of these standards.

In October 1992, two laws were enacted, the Waste Isolation Pilot Plant (WIPP) Land Withdrawal Act and the Energy Policy Act, that affected EPA's development of standards for the management and disposal of spent nuclear fuel, HLW and TRU wastes. As explained more fully in the next section on TRU waste, EPA's Administrator issued the revised disposal standards as mandated by the WIPP Land Withdrawal Act in December 1993. These standards apply to all HLW, spent fuel, and TRU waste disposal except for disposal at the Yucca Mountain site. The Energy Policy Act directs the EPA to issue environmental standards, which protect public health and safety and are specific to the Yucca Mountain site. The Act also requires that the National Academy of Sciences (NAS) conduct a study to provide findings and recommendations related to the form and content of environmental radiation protection standards for Yucca Mountain, Nevada. The EPA's standards for Yucca Mountain must be developed based upon the findings and recommendations of the NAS and must be issued within one year from the time the EPA receives the NAS recommendations. NRC, as the licensing authority for this site, must incorporate the EPA's environmental standards in their overall licensing regulations for HLW disposal (10 CFR 60).

Transuranic Radioactive Waste

Sources and Volume

Transuranic (TRU) waste materials have been generated in the U.S. since the 1940's. Most of this waste originates from nuclear weapons production facilities for defense programs. "Transuranic" refers to atoms of man-made elements that are heavier (higher in atomic number) than uranium. The most prominent element in most TRU waste is plutonium. Some TRU waste consists of items such as rags, tools, and laboratory equipment contaminated with radioactive materials. Other forms of TRU waste include organic and inorganic residues or even entire enclosed contaminated cases in which radioactive materials were handled.

Some TRU waste emits high levels of penetrating radiation; this type requires protective shielding. However, most TRU waste does not emit high levels of penetrating radiation but poses a danger when small particles of it are inhaled or ingested. The radiation from the particles is damaging to lung tissue and internal organs. As long as this type of TRU waste remains enclosed and contained, it can be handled safely.

Another problem with TRU waste is that most of its radioactive elements are long-lived. That is, they stay radioactive for a long time. For example, half of the original amount of plutonium-239 in the waste will remain harmful after 24,000 years. Disposal must be carefully planned so that the waste poses no undue threat to public health or the environment for years to come.

The total volume of TRU waste and TRU-contaminated soil is estimated at around one million cubic meters. The following figure provides the historical and projected amounts of TRU wastes to the year 2015.

Site Selection for Storage and Disposal

In the past, much of the TRU waste was disposed of similarly to low-level radioactive waste, i.e., in pits and trenches covered with soil. In 1970, the Atomic Energy Commission (predecessor to the DOE) decided that TRU waste should be stored for easy retrieval to await disposal at a repository. Federal facilities in Washington, Idaho, California, Colorado, New Mexico, Nevada, Tennessee, South Carolina, Ohio, and Illinois are currently storing TRU waste.

The DOE has evaluated several alternatives for managing buried waste and contaminated soil including: (1) leaving it in place and monitoring it; (2) leaving it in place and improving the containment; and (3) removing, processing, and disposing of the waste in a repository.

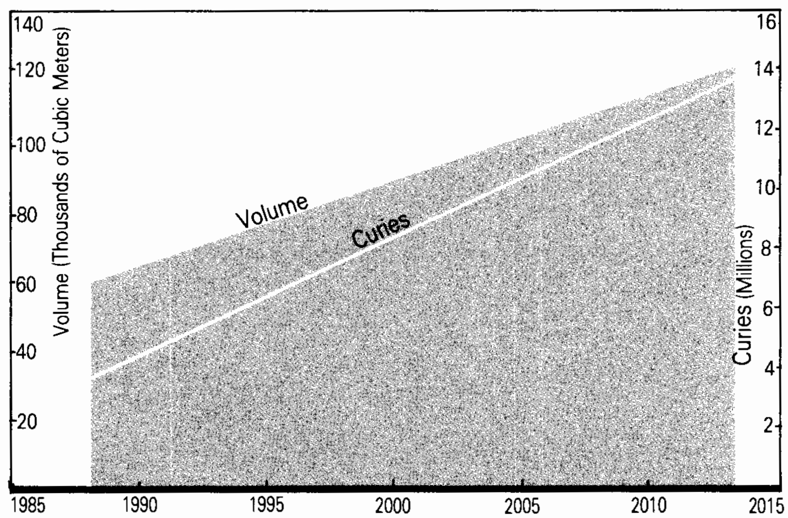
As a first step in developing a permanent disposal site for TRU waste, the DOE is developing an underground, geologic repository called the Waste Isolation Pilot Plant (WIPP), near Carlsbad, NM. This site has been excavated in a salt bed about 2,100 feet underground. The WIPP will have to meet environmental standards established by the EPA before it can be used as a permanent disposal site.

If the WIPP site is eventually determined to be suitable for the disposal of TRU waste, the underground disposal area is planned to cover 100 acres. It will have a design capacity of over 2 million cubic meters, or about 850,000 barrels, of TRU waste. The following is a schematic drawing of the WIPP.

Setting Environmental Protection Standards

As stated earlier, the EPA established environmental standards applicable to spent fuel, HLW and TRU waste, but they were returned to the Agency by the courts for revision. While the Energy Policy Act specifies procedures for developing standards for a repository at Yucca Mountain, NV, the Waste Isolation Pilot Plant (WIPP) Land Withdrawal Act requires the EPA to promulgate final standards applicable to WIPP and all other spent nuclear fuel, HLW, and TRU waste disposal facilities other than those developed under the Nuclear Waste Policy Act of 1982.

Figure 4
DOE Accumulated TRU Waste



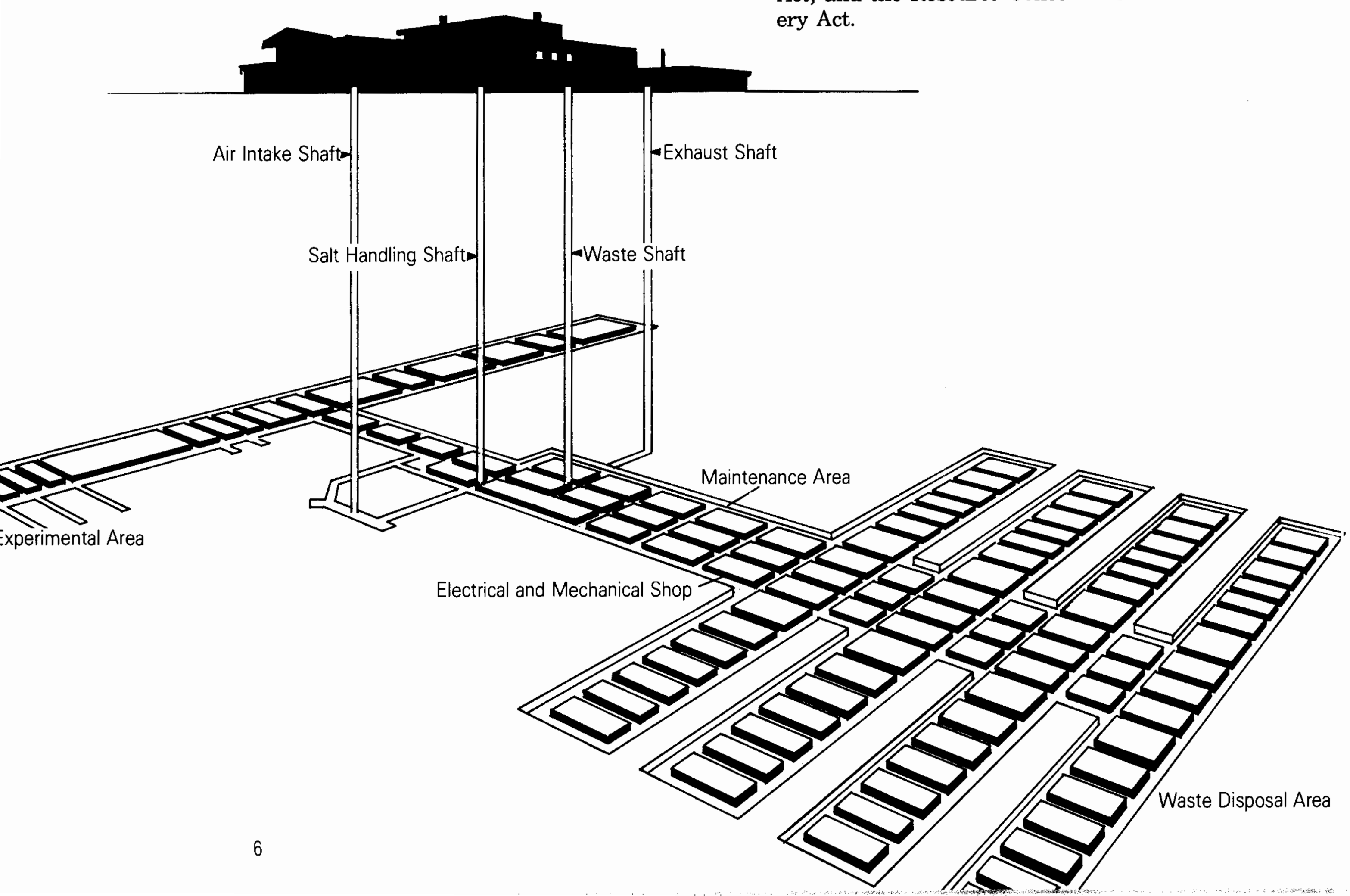
The WIPP Land Withdrawal Act reinstated all of the EPA's 1985 radioactive waste disposal standards except for the sections that the court found problematic, i.e., the Individual and Ground-Water Protection Requirements of the disposal standards. The reinstated sections consist primarily of containment requirements and assurance requirements. These requirements are designed to help ensure that the wastes will be disposed of in a manner that limits the release of radioactive materials.

In 1993, EPA finalized amendments to the standards to address the court's concerns. Individual radiation protection standards will limit a person's total annual radiation exposure, considering the sum of all possible exposures. Ground-water protection standards protect present and future sources of drinking water.

New Regulatory Responsibilities for EPA

Under the WIPP Land Withdrawal Act, Congress gave EPA the responsibility for implementing its radioactive waste disposal standards at the WIPP. The Act also requires the EPA to review and approve of the DOE's plans for testing and retrieving waste at the WIPP. EPA must also ensure compliance with all federal environmental laws and regulations. In order for the WIPP to become a permanent disposal facility, the EPA must certify that the facility complies with its disposal standards. If the EPA does not certify the WIPP, the DOE must decommission the facility. Even if the EPA certifies the WIPP, the Agency will have to determine, on an ongoing basis, whether it continues to comply with the disposal standards as well as all other federal environmental laws, regulations, and permit requirements that apply. In particular, DOE must demonstrate that the WIPP complies with the Clean Air Act; the Comprehensive Environmental Response, Compensation, and Liability Act; the Solid Waste Disposal Act; the Safe Drinking Water Act; and the Resource Conservation and Recovery Act.

Figure 5
Schematic of the WIPP Repository



Uranium Mill Tailings

Sources and Volume

Uranium mill tailings are the radioactive sand-like materials that remain after uranium is extracted by milling ore mined from the earth. Tailings are placed in huge mounds called tailings piles which are located close to the mills where the ore is processed.

The most important radioactive component of uranium mill tailings is radium, which decays to produce radon. Other potentially hazardous substances in the tailings are selenium, molybdenum, uranium, and thorium.

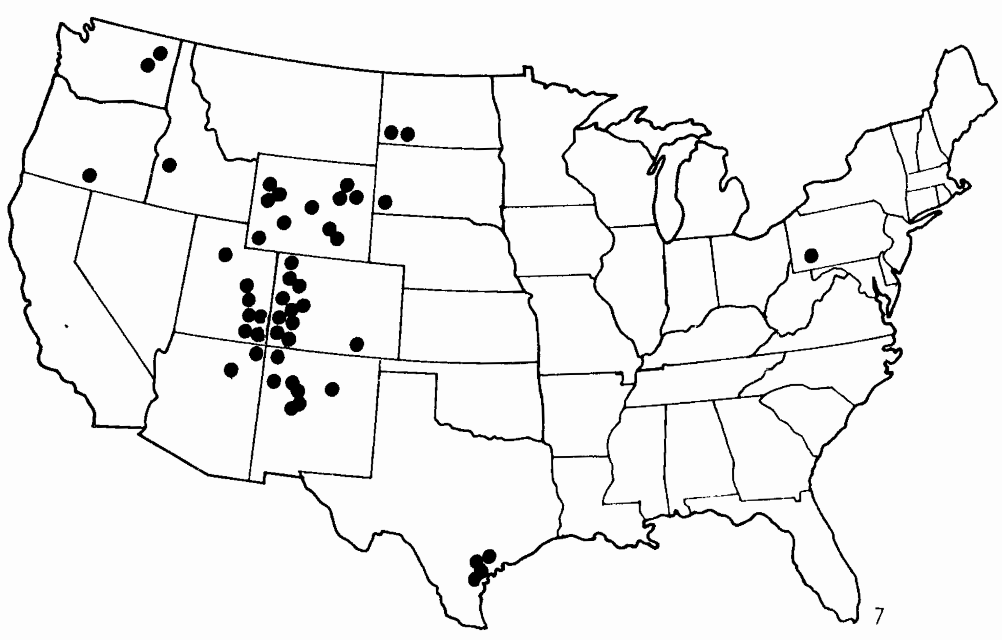
Uranium mill tailings can adversely affect public health. There are four principal ways (or exposure pathways) that the public can be exposed to the hazards from this waste. The first is the diffusion of radon gas directly into indoor air if tailings are misused as a construction material or for backfill around buildings. When people breathe air containing radon, it increases their risk of developing lung cancer. Second, radon gas can diffuse from the piles into the atmosphere where it can be inhaled and small particles can be blown from the piles where they can be inhaled or ingested. Third, many of the radioactive decay products in tailings produce gamma radiation, which poses a health hazard to people in the immediate vicinity of tailings. Finally, the dispersal of tailings by wind or water, or by leaching, can carry radioactive and other toxic materials to surface or ground water that may be used for drinking water.

The NRC and some individual states that have regulatory agreements with the NRC have licensed 26 sites for milling uranium ore. However, most of the mills at these sites are no longer processing ore. Another 24 sites have been abandoned and are currently the responsibility of DOE.

All the tailings piles except for one abandoned site located in Canonsburg, PA, are located in the West, predominantly in arid areas (Figure 6). The licensed tailings piles contain a combined total of approximately 200 million metric tons (MT), with individual piles ranging from about 2 million MT to about 30 million MT. (A metric ton is 2,200 pounds.) The 24 abandoned sites contain a total of about 26 million MT and range in size from about 50 thousand MT to about 3 million MT.

It is unlikely that there will be much additional accumulation of mill tailings in the U.S., because foreign countries now produce uranium much more cheaply than can domestic producers.

Figure 6
Uranium Mill Tailings Piles



Setting Environmental Protection Standards

The EPA issued two sets of standards controlling hazards from uranium mill tailings in 1983, under the authority of the Uranium Mill Tailings Radiation Control Act of 1978. These standards provide for the cleanup and disposal of mill tailings at abandoned sites and the disposal of tailings at licensed sites after cessation of operations. They are implemented by DOE, NRC, and some states through agreements with NRC, and require a combination of active and passive controls to clean up contaminated ground water as well as tailings that have been misused at off-site locations, and to dispose of tailings in a manner that will prevent misuse, limit radon emissions, and protect ground water.

Active controls include building fences, putting up warning signs, and establishing land use restrictions. Passive controls include constructing thick earthen covers, protected by rock and designed to prevent seepage into ground water, over the waste. Earthen covers also effectively limit radon emissions and gamma radiation and, in conjunction with the rock covers, serve to stabilize the piles to prevent dispersion of the tailings through erosion or intrusion. In some cases, piles may be moved to safer locations.

The standards were amended in 1993 to require that all licensed sites that have ceased operation undergo remedial action as soon as possible. The EPA is in the process of enacting revised ground-water protection standards that will require the same treatment of ground water at the abandoned sites as is now required at the licensed sites.

In addition, EPA enacted Clean Air Act standards in 1989 limiting radon emissions and restricting the length of time that abandoned piles may remain uncovered with no controls on radon emissions. EPA also requires that any piles that may be constructed in the future meet requirements that limit radon emissions and inhibit ground-water contamination during their operational phase. Licensed mills also are subject to the Uranium Fuel Cycle standard which regulates radionuclide emissions other than radon.

Low-level Radioactive Waste

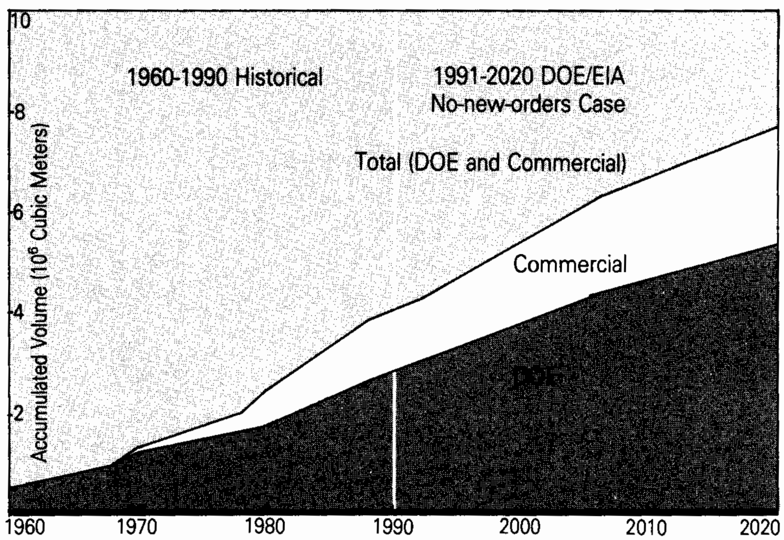
Sources and Volume

Low-level radioactive waste (LLW) is radioactively contaminated industrial or research waste such as paper, rags, plastic bags, protective clothing, cardboard, packaging material, organic fluids, and water-treatment residues. It is waste that does not fall into any of the three categories previously discussed. Its classification does not directly depend on the level of radioactivity it contains.

LLW is generated by government facilities, utilities, industries, and institutional facilities. In addition to 35 major DOE facilities, over 20,000 commercial users of radioactive materials generate some amount of LLW. LLW generators include approximately 100 operating nuclear power reactors, associated fuel fabrication facilities, and uranium fuel conversion plants, which together are known as nuclear fuel-cycle facilities. Hospitals, medical schools, universities, radiochemical and radiopharmaceutical manufacturers and research laboratories are other users of radioactive materials which produce LLW. The clean-up of contaminated buildings and sites will generate more LLW in the future.

Figure 7

Historical and Projected Accumulated Volume of LLW



Note: Reference for figure is the *Integrated Data Base for 1991: U.S. Spent Fuel and Radioactive Waste Inventory Projections and Characteristics, DOE Oak Ridge National Laboratory, Oct. 1991.*

Figure 7 provides a historical look at the overall volume of LLW produced through 1990. It also projects that the volume will double by 2020. Figure 8 below shows the volume of low-level radioactive waste disposed of by major sources in the United States.

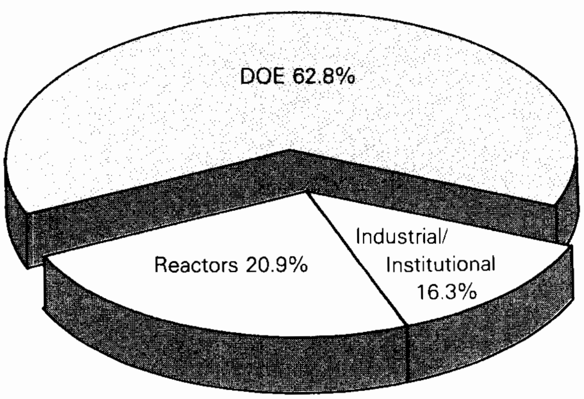
Both commercial and defense-related LLW have been disposed of using shallow land disposal methods. There are currently 23 DOE and commercial LLW disposal sites in the U.S. The major sites are depicted in Figure 9. Although some LLW facilities are closed, they are continuously monitored to detect releases of radioactivity into the environment.

Disposal Management

The EPA has the authority to set generally applicable environmental standards for LLW disposal; such standards would be implemented by the NRC and the DOE. DOE is planning the clean-up of radioactively contaminated sites which will result in considerable volumes of LLW. Because of this, EPA is developing clean-up regulations as well as general environmental standards for LLW disposal. EPA plans to propose the disposal standards at the end of 1994. The standards will facilitate planning and reduce costs for clean-up and disposal.

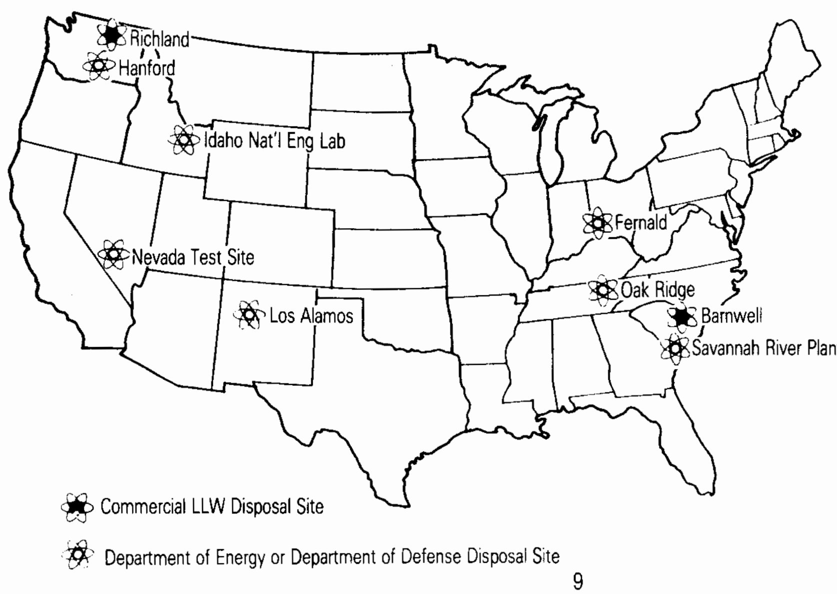
The NRC and some individual states that have regulatory agreements with NRC regulate all disposal of commercial LLW. In 1982, the NRC improved its regulatory requirements. That year, the NRC established disposal site performance objectives for land disposal of LLW; technical requirements for the siting, design, operation, and closure for near-surface disposal facilities; technical requirements concerning waste packaging for land disposal; classification of waste; institutional requirements; and administrative and procedural requirements for licensing a disposal facility. Though the 1982 NRC regulations exempted existing NRC dis-

Figure 8
Volume of LLW Disposed in 1990



Total volume of LLW disposed in 1990: **86,900** cubic meters

Figure 9
Major LLW Disposal Sites



posal site licensees, the NRC and the states are working to incorporate such requirements into those licenses.

In 1988, the DOE, which is self-regulating, issued its own orders governing the DOE disposal sites.

The general regulatory framework for the disposal of LLW has changed to account for new technology, what we have learned from past disposal practices, and current wisdom about environmental protection. As a result of increasing costs of LLW disposal at existing sites, predisposal waste processing (e.g., volume reduction) is a more common practice. The waste is processed by separating radioactive from nonradioactive components and by compacting bulk waste before packaging for disposal. Consequently, while the volume of waste to be disposed of is reduced, the concentration of radioactivity is greater. This waste requires more stringent safeguards for its disposal.

Site Selection for Disposal

The first of six regional, commercial LLW disposal sites was licensed in 1962. Since then, four of the commercial sites have closed, mainly because of problems with site instability. These problems included the collapse of the earth covering the waste and difficulties in managing surface- and ground-water contamination. Since then the technology and requirements governing disposal sites have been upgraded. New disposal facilities must be designed to avoid two kinds of failures: those caused by long-term processes such as subsidence and those caused by more unpredictable events such as human intrusion (either intentional or unintentional) and natural disaster.

The Low-Level Radioactive Waste Policy Act of 1980 and subsequent amendments direct states to take care of their own LLW either individually or through regional groupings, referred to as compacts. The states are now in the process of selecting new LLW disposal sites to take care of their own waste. The selection process for these new sites is complex and varies because of many factors including the regulations for site selection. This selection process will be affected by EPA's new LLW standard.

Disposal of Naturally Occurring and Accelerator-Produced Radioactive Materials (NARM)

Sources and Volume

Accelerator-Produced Materials

Accelerator-produced radioactive waste is produced during the operation of atomic particle accelerators for medical, research, or industrial purposes. The accelerators use magnetic fields to move atomic particles at higher and higher speeds before crashing into a preselected target. This reaction produces desired radioactive materials in metallic targets or kills cancer cells where a cancer tumor is the target. The radioactivity contained in the waste from accelerators is generally short-lived, less than one year. The waste may be stored at laboratories or production facilities until it is no longer radioactive. An extremely small fraction of the waste may retain some longer-lived radioactivity with half lives greater than one year. There are no firm estimates of the amount of this type of radioactive waste; however, it is generally accepted that the volume is extremely small compared to the other wastes discussed.

Naturally Occurring Radioactive Materials (NORM)

Naturally occurring radioactive materials (NORM) generally contain radionuclides found in nature. Once NORM becomes concentrated through human activity, such as mineral extraction, it can become a radioactive waste. There are two types of naturally occurring radioactive waste: discrete and diffuse. The first, discrete NORM, has a relatively high radioactivity concentration in a very small volume, such as a radium source used in medical procedures. Estimates of the volumes of discrete NORM waste are imprecise, and the EPA is conducting studies to provide a more accurate assessment of how much of this waste requires attention. Because of its relatively high concentration of radioactivity, this type of waste poses a direct radiation exposure hazard.

The second type, diffuse NORM, has a much lower concentration of radioactivity, but a high volume of waste. This type of waste poses a different type of disposal problem because of its high volume. The following are six sources of such naturally occurring radioactive materials. Included for each category is an estimate of the volume that would accumulate over a 20-year period based on today's technology and production levels. It should be noted, however, that the level of radioactivity varies widely among these wastes.

Metal Mining & Processing Waste—20 billion metric tons*

Coal Ash—1.7 billion metric tons

Phosphate Waste—800 million metric tons*

Uranium Mining Overburden—740 million metric tons

Oil and Gas Production Wastes—13 million metric tons*

Water Treatment Residues—6 million metric tons*

*(These categories may contain high-concentration radioactive components.)

Diffuse NORM may pose a health hazard because of its many uses. For example, though most metal-mining waste is stored near where it is generated, small amounts have been used as construction backfill and road building materials. It is also used in concrete and wallboard.

- Coal ash is primarily used as an additive in concrete and as backfill.
- Phosphate waste (slag) from the processing of elemental phosphorous has been used in construction and in paving.
- Uranium mining waste is the soil and rock that is removed during surface or underground uranium mining. This waste is sometimes used to backfill mined-out areas and to construct roads around the mining site.
- Oil and gas production may produce radioactive pipe scale (a residue left in pipes from drilling oil wells) and sludge that leave sites and equipment contaminated. Some radiation-contaminated piping has been used by schools and other organizations for playground equipment, welding material, and fencing.

• Radiation-contaminated water treatment residue accumulates when radioactive material is filtered out of drinking water during the purifying process. This waste may be disposed of in landfills or lagoons. It may also be used in agriculture as a soil conditioner.

There is increasing evidence that improper use or disposal of such naturally-occurring radioactive materials can result in significant contamination of the environment and radiation exposure. This can adversely affect the health of those occupationally exposed, as well as the public in general.

Disposal Issues

There are currently no federal regulations covering disposal of NARM with high radioactivity concentrations. Few states have regulations, and those regulations are inconsistent. The EPA has initiated studies to more accurately characterize the radiological hazards posed by NARM.

For More Information

The safe disposal of radioactive waste is a very important issue today. Radioactive waste disposal standards have changed substantially with improved technology and evolving environmental protection considerations. Regulatory programs and standards continue to change, so if you would like more information on the disposal of radioactive waste, write to:

Office of Radiation and Indoor Air
Criteria and Standards Division (6602J)
U.S. Environmental Protection Agency
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