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## **Civilian Nuclear Waste Disposal**

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## Civilian Nuclear Waste Disposal

### SUMMARY

Management of civilian radioactive waste has posed difficult issues for Congress since the beginning of the nuclear power industry in the 1950s. Although federal policy is based on the premise that nuclear waste can be disposed of safely, new storage and disposal facilities have frequently been challenged on safety, health, and environmental grounds. Civilian radioactive waste ranges from the highly radioactive spent fuel from nuclear power plants to the far-less-radioactive uranium mill tailings that result from the processing of uranium ore. Most of the debate over civilian waste disposal focuses on spent fuel and on “low level” waste from nuclear power plants, medical institutions, civilian research facilities, and industry.

The Nuclear Waste Policy Act of 1982 (NWPA) calls for disposal of spent nuclear fuel in a repository in a deep geologic formation that is unlikely to be disturbed for thousands of years. NWPA established an office in the Department of Energy (DOE) to develop such a repository and required the program’s civilian costs to be covered by a fee on nuclear-generated electricity, paid into the Nuclear Waste Fund. Amendments to NWPA in 1987 restricted DOE’s repository site studies to Yucca Mountain in Nevada. DOE is studying numerous scientific issues in determining the suitability of Yucca Mountain for a nuclear waste repository, which must be licensed by the Nuclear Regulatory Commission (NRC). Questions about the site include the likelihood of earthquakes, volcanoes, groundwater contamination, and human intrusion.

NWPA’s goal for loading waste into the repository was 1998, but DOE does not expect to open the facility until 2010 at the earliest.

President Bush recommended the site to Congress February 15, 2002, and Nevada Governor Guinn exercised his right to “veto” the site April 8, 2002. The veto would have blocked further development of the site if the President had not signed a congressional approval resolution within 90 days of continuous session. The House passed a Yucca Mountain approval resolution (H.J.Res. 87) May 8, 2002, by a vote of 306-117. The Senate passed H.J.Res. 87 by voice vote July 9, 2002, and the President signed it July 23, 2002 (P.L. 107-200).

DOE plans to submit a construction permit application to NRC in late 2004 for a Yucca Mountain repository. DOE received \$457 million for the waste program in FY2003, and the Administration is requesting \$591 million for the program for FY2004, a 30% boost. Between FY2005 and FY2010, funding will have to further increase to an average of \$1.3 billion per year, according to the DOE budget justification. The Administration is proposing that discretionary spending caps be adjusted to accommodate the program’s higher future funding.

Low-level waste sites are a state responsibility under the Low-Level Radioactive Waste Policy Act of 1980. Pursuant to that act, 10 regional compacts for disposal of low-level waste have been approved by Congress. Only three commercial low-level waste sites are currently operating, in the states of South Carolina, Utah, and Washington. The Washington facility is accepting waste just from within the Northwest and Rocky Mountain regional compacts, and the Utah site accepts only the least-concentrated class of low-level waste.



## **MOST RECENT DEVELOPMENTS**

The Bush Administration's FY2004 budget request, released February 3, includes \$591 million for the DOE civilian nuclear waste disposal program, a 30% boost over FY2003. The FY2003 appropriation, signed by the President on February 20 (P.L. 108-7), boosted the waste program by more than 20% over the previous year. The program's rapidly rising budget is intended primarily to pay for preparing a construction permit application for a national nuclear waste repository at Yucca Mountain, Nevada. DOE expects to submit the 10,000-page application to the Nuclear Regulatory Commission (NRC) in December 2004. The additional funds are also needed for detailed repository design work, repository performance studies, and transportation planning, according to DOE.

DOE contends that it cannot meet its 2010 target date for shipping nuclear waste to Yucca Mountain without receiving its entire FY2004 budget request for the program. Between FY2005 and FY2010, funding will have to further increase to an average of \$1.3 billion per year, according to the budget justification. The Administration is proposing that discretionary spending caps be adjusted to accommodate the program's higher future funding.

A private-sector plan to build a spent nuclear fuel storage facility in Utah, where commercial reactor waste could be held pending disposal at Yucca Mountain, was blocked by a panel of NRC administrative law judges March 10. The NRC panel refused to license the facility without sufficient evidence that it could withstand a crash from fighter jets based nearby. Developers of the proposed facility appealed to the NRC commissioners March 31.

## **BACKGROUND AND ANALYSIS**

### **Introduction**

Nuclear waste has sometimes been called the Achilles' heel of the nuclear power industry; much of the controversy over nuclear power centers on the lack of a disposal system for the highly radioactive spent fuel that must be regularly removed from operating reactors. As a result, progress on nuclear waste disposal is widely considered a prerequisite for any future growth of nuclear power.

Under the Nuclear Waste Policy Act of 1982 (NWPA) and 1987 amendments, the Department of Energy (DOE) is focusing on Yucca Mountain, Nevada, to house a deep underground repository for spent nuclear fuel and other highly radioactive waste. The State of Nevada has strongly opposed DOE's efforts on the grounds that the site is unsafe, pointing to potential volcanic activity, earthquakes, water infiltration, underground flooding, nuclear chain reactions, and fossil fuel and mineral deposits that might encourage future human intrusion.

However, DOE contends that the evidence so far indicates that Yucca Mountain is likely to prove suitable and that licensing of the site by the Nuclear Regulatory Commission (NRC)

should proceed. A Draft Environmental Impact Statement (EIS) completed by DOE in July 1999 and finalized in February 2002 recommended that the project proceed as planned. The planned Yucca Mountain repository is not scheduled to open until 2010 at the earliest, more than a decade later than the 1998 goal specified by NWPA.

The safety of geologic disposal of highly radioactive waste, as planned in the United States, depends largely on the characteristics of the rock formations from which a repository would be excavated. Because many geologic formations are believed to have remained undisturbed for millions of years, it appeared technically feasible to isolate radioactive materials from the environment until they decayed to safe levels. "There is no scientific or technical reason to think that a satisfactory geological repository cannot be built," according to the National Research Council.

But, as the Yucca Mountain controversy indicates, scientific confidence about the concept of deep geologic disposal has turned out to be difficult to apply to specific sites. Every high-level waste site that has been proposed by DOE and its predecessor agencies has faced allegations or discovery of unacceptable flaws, such as water intrusion or earthquake vulnerability, that could release radioactivity into the environment. Much of the problem results from the inherent uncertainty involved in predicting waste site performance for the 10,000-year period that nuclear waste is to be isolated. Opponents of geologic disposal have urged greater emphasis on new or alternative technologies that might allow entirely different approaches to high-level radioactive waste management.

**Other Programs.** Other types of civilian radioactive waste have also generated public controversy, particularly low-level radioactive waste, which is produced by nuclear power plants, medical institutions, industrial operations, and research activities. Civilian low-level waste currently is disposed of in large trenches at sites in South Carolina and Washington state, and the Washington facility does not accept waste from outside its region. The lowest-concentration class of low-level radioactive waste is also accepted by a commercial disposal facility in Utah, which is applying for a license to receive all major classes of low-level waste. Threats by states to close their disposal facilities led to congressional authorization of regional compacts for low-level waste disposal in 1985, although no new sites have been opened by any of the 10 authorized disposal compacts. Texas Governor Perry signed a law June 20, 2003, to authorize disposal facilities for commercial low-level waste and federal radioactive waste.

## Nuclear Utility Lawsuits

Nuclear utilities, which pay for most of the high-level waste disposal program through a fee on nuclear power, have sued DOE for failing to begin the removal of spent nuclear fuel from storage at commercial reactors by January 31, 1998, the deadline established by the Nuclear Waste Policy Act.

In response to a utility lawsuit, the U.S. Court of Appeals for the District of Columbia Circuit ruled November 14, 1997, that DOE would be liable for unspecified damages to nuclear utilities if it missed the 1998 deadline. DOE was ordered to work out a remedy with the utilities under the procedures of the standard disposal contract signed by all nuclear utilities pursuant to NWPA.

In the first set of rulings on breach-of-contract suits filed by several utilities, the U.S. Court of Federal Claims decreed on October 29, 1998, that DOE must pay fuel storage costs for three closed commercial reactors. Those costs are to be determined by future trials; the three utilities are claiming damages of \$2.4 billion. Damage claims were denied to Northern States Power by another Court of Federal Claims judge on April 6, 1999, but that ruling was reversed by the U.S. Court of Appeals for the Federal Circuit on August 31, 2000. The Appeals court decision cleared the way for nuclear power companies to proceed with lawsuits in the Court of Federal Claims against DOE. Industry officials contend that total damages for missing the 1998 disposal deadline could eventually reach tens of billions of dollars, assuming that no disposal ever takes place. Claims from more than 20 nuclear utilities are pending, and more are expected this year.<sup>1</sup>

DOE has been negotiating with various reactor owners since 1999 on the missed nuclear waste deadline and reached its first settlement agreement with a nuclear utility, PECO Energy Co. (now part of Exelon), on July 19, 2000. The agreement allowed PECO to keep up to \$80 million in nuclear waste fee revenues during the subsequent 10 years and may result in DOE's taking title to waste and storage facilities at PECO's Peach Bottom plant in Pennsylvania. In return, PECO agreed not to sue DOE over the missed disposal deadline. However, other utilities sued DOE to block the settlement, contending that nuclear waste fees may be used only for the DOE waste program and not as compensation for missing the disposal deadline. The U.S. Court of Appeals for the 11<sup>th</sup> Circuit agreed, ruling September 24, 2002, that any compensation would have to come from general revenues or other sources than the waste fund.

Although some of the delays have been blamed on poor program management, DOE contends that tight funding has been a major barrier. DOE cannot spend the nuclear industry's mandatory waste fees without congressional approval, and only about half the total fees collected have been appropriated to the program so far. However, some surplus in the fund may be necessary to pay future nuclear waste disposal costs after today's nuclear plants have ceased operation. The nuclear industry and others have long urged changes in the waste program's funding mechanism but have consistently been stymied by budget scoring issues.

## Nuclear Spent Fuel Legislation

President Bush recommended the Yucca Mountain site to Congress on February 15, 2002, and Nevada Governor Guinn submitted a notice of disapproval, or "state veto," April 8, 2002, as allowed by NWPA. The state veto would have blocked further repository development at Yucca Mountain if a resolution approving the site had not been passed by Congress and signed into law within 90 days of continuous session.

Senator Bingaman introduced the approval resolution in the Senate April 9, 2002 (S.J.Res. 34), and Representative Barton introduced it in the House April 11, 2002 (H.J.Res. 87). The Subcommittee on Energy and Air Quality of the House Committee on Energy and Commerce approved H.J.Res. 87 on April 23 by a 24-2 vote, and the full Committee approved the measure two days later, 41-6 (H.Rept. 107-425). The resolution was passed

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<sup>1</sup> "More Utility Damage Claims Expected," *NuclearFuel*, January 20, 2003, p. 8.

by the House May 8, 2002, by a vote of 306-117. The Senate Committee on Energy and Natural Resources approved S.J.Res. 34 by a 13-10 vote June 5, 2002 (S.Rept. 107-159). Following a 60-39 vote to consider S.J. Res 34, the Senate passed H.J.Res. 87 by voice vote July 9, 2002. President Bush signed the resolution July 23, 2002 (P.L. 107-200).

President Bush's FY2004 budget request recommends that discretionary spending caps be adjusted to accommodate the Administration's proposed nuclear waste budget increases, but specific language to implement the idea has not been transmitted to Congress. The nuclear industry and other program supporters have long contended that funding constraints have slowed the program's progress. Opponents of the program, particularly the State of Nevada, contend that increased spending should not be directed to the Yucca Mountain site, which they view as fundamentally flawed.

Omnibus energy legislation (H.R. 6) passed by the House on April 11, 2003, and a related energy bill (S. 14), which began Senate floor debate May 6, 2003, would authorize funding for a spent nuclear fuel "recycling" research and development program. H.J.Res. 2 as passed by the Senate includes \$77.9 million in FY2003 for spent fuel recycling. Supporters of such research contend that new technologies could reduce the volume and long-term toxicity of nuclear waste, particularly by destroying plutonium in the waste through nuclear fission. Opponents note that such treatment requires reprocessing of spent fuel to at least partially separate its major constituents, such as uranium and plutonium, and that separated plutonium could be used for nuclear explosives. Such a program, opponents contend, could undermine U.S. nuclear nonproliferation efforts aimed at discouraging other nations from separating plutonium from spent nuclear fuel.

The nuclear industry and its supporters have urged Congress to require DOE to build an interim storage facility that could begin receiving spent fuel from nuclear power plants as soon after the missed 1998 deadline as possible. Such a facility, consisting of storage casks on concrete pads or in surface-based bunkers, could reduce spent fuel storage costs, increase safety, and fulfill the federal government's legal obligations, supporters contend (see NEI perspective at [<http://www.nei.org>]).

But environmental, anti-nuclear power, and other groups warn that interim storage would result in earlier transportation of unprecedented quantities of nuclear waste; they contend it would be safer to leave the waste in place until a permanent solution can be found (see Nuclear Information and Resource Service perspective at [<http://www.nirs.org>]). (For more on the controversy over nuclear waste transportation, see CRS Report 97-403, *Transportation of Spent Nuclear Fuel*.)

## Characteristics of Nuclear Waste

Radioactive waste is a term that encompasses a broad range of material with widely varying characteristics. Some is relatively slightly radioactive and safe to handle, while other types are intensely hot in both temperature and radioactivity. Some decays to safe levels of radioactivity in a matter of days or weeks, while other types will remain dangerous for thousands of years. Major types of radioactive waste are generally defined by DOE and the Nuclear Regulatory Commission (NRC) as follows:

*Spent nuclear fuel.* Fuel rods that have been permanently withdrawn from a nuclear reactor because they can no longer efficiently sustain a nuclear chain reaction (although they contain uranium and plutonium that could be extracted through reprocessing to make new fuel). By far the most radioactive type of civilian nuclear waste, spent fuel contains extremely hot but relatively short-lived fission products (fragments of uranium and other fissile elements) as well as long-lived radionuclides such as plutonium, which remains dangerously radioactive for tens of thousands of years.

*High-level waste.* Highly radioactive residue created by spent fuel reprocessing (almost entirely for defense purposes in the United States). High-level waste contains most of the radioactive fission products of spent fuel, but most of the uranium and plutonium usually has been removed for re-use. Enough long-lived radioactive elements remain, however, to require isolation for 10,000 years or more.

*Transuranic (TRU) waste.* Relatively low-activity waste that contains more than a certain level of long-lived elements heavier than uranium (primarily plutonium). Shielding may be required for handling of some types of TRU waste. In the United States, transuranic waste is generated almost entirely by nuclear weapons production processes. Because of the plutonium, long-term isolation is required.

*Low-level waste.* Radioactive waste not classified as spent fuel, high-level waste, TRU waste, or byproduct material such as uranium mill tailings (below). Four classes of low-level waste have been established by NRC, ranging from least radioactive and shortest-lived to the longest-lived and most radioactive. Although some types of low-level waste can be more radioactive than some types of high-level waste, in general low-level waste contains relatively low amounts of radioactivity that decays relatively quickly. Low-level waste disposal facilities cannot accept material that exceeds NRC concentration limits.

*Uranium mill tailings.* Sand-like residues remaining from the processing of uranium ore. Such tailings have very low radioactivity but extremely large volumes that can pose a hazard, particularly from radon emissions or groundwater contamination.

*Mixed waste.* High-level, low-level or TRU waste that contains hazardous non-radioactive waste. Such waste poses serious institutional problems, because the radioactive portion is regulated by DOE or NRC under the Atomic Energy Act, while EPA regulates the non-radioactive elements under the Resource Conservation and Recovery Act (RCRA).

## **Spent Nuclear Fuel**

When spent nuclear fuel is removed from a reactor, usually after several years of power production, it is thermally hot and highly radioactive. The spent fuel is in the form of fuel assemblies, which consist of arrays of metal-clad fuel rods 12-15 feet long.

A fresh fuel rod, which emits relatively little radioactivity, contains uranium that has been enriched in the isotope U-235 (usually 3-5%). But after nuclear fission has taken place in the reactor, many of the uranium atoms in the fuel rods have been split into a variety of highly radioactive fission products; others have absorbed neutrons to become radioactive plutonium, some of which has also split into fission products. Radioactive gases are also contained in the spent fuel rods. Newly withdrawn spent fuel assemblies are stored in large



pools of water adjacent to the reactors to keep them from overheating and to protect workers from radiation.

The approximately 47,000 metric tons of spent fuel discharged from U.S. commercial nuclear reactors through 2002 is currently stored at about 70 power plant sites around the nation. (Some is also held at two small central storage facilities.) As long as nuclear power continues to be generated, the amounts stored at plant sites will continue to grow until an interim storage facility or a permanent repository can be opened — or until alternative treatment and disposal technology is developed.

A typical large commercial nuclear reactor discharges an average of 20-30 metric tons of spent fuel per year — about 2,000 metric tons annually for the entire U.S. nuclear power industry. As a result, the total amount of spent fuel is expected to reach 60,000 metric tons by 2010, the earliest feasible date for opening the Yucca Mountain repository, and almost 80,000 metric tons by 2020.

New storage capacity at operating nuclear plant sites will be required if DOE is unable to begin accepting waste into its disposal system for another 8 years. Most utilities are expected to construct new dry storage capacity for their older fuel. On-site dry storage facilities currently in operation or planned typically consist of metal casks or concrete modules. NRC has determined that spent fuel could be stored safely at reactor sites for up to 100 years.

The terrorist attacks of September 11, 2001, have heightened concerns about the vulnerability of stored spent fuel. Concerns have been raised that an aircraft crash into a reactor's pool area could drain the pool and cause the spent fuel inside to overheat. A report released by NRC January 17, 2001, found that overheating could cause the zirconium alloy cladding of spent fuel to catch fire and release hazardous amounts of radioactivity, although it characterized the probability of such a fire as low. Nuclear industry representatives contend that the several hours required for uncovered spent fuel to heat up enough to catch fire would allow ample time for alternative measures to cool the fuel.

## **Commercial Low-level Waste**

Low-level waste disposed of in commercial sites makes up about a third of all accumulated low-level waste in the United States; the remaining two-thirds has been generated by DOE activities and sent to DOE-owned disposal sites. About 1.4 million cubic feet of commercial low-level waste was shipped to disposal sites in 1998 (the most recent year reported), according to NRC. Commercial nuclear reactors accounted for 210,000 cubic feet, or about 15%. The volume of commercial low-level radioactive waste peaked in 1980 and fell steadily in the 1990s, primarily because of escalating disposal fees. However, the statistics for many years excluded the large volumes of low-activity waste sent to the Envirocare site in Utah.

## Current Policy and Regulation

Spent fuel and high-level waste are a federal responsibility, while states are authorized to develop disposal facilities for commercial low-level waste. In general, disposal requirements have grown more stringent over the years, in line with overall national environmental policy and heightened concerns about the hazards of radioactivity.

### Spent Nuclear Fuel

**Current Program.** The Nuclear Waste Policy Act of 1982 (NWPAA, P.L. 97-425) established a system for selecting a geologic repository for the permanent disposal of up to 70,000 metric tons (77,000 tons) of spent nuclear fuel and high-level waste. DOE's Office of Civilian Radioactive Waste Management (OCRWM) was created to carry out the program. The Nuclear Waste Fund, consisting of a fee on commercial nuclear power and federal contributions for emplacement of high-level defense waste, was established to pay for the program. DOE was required to select three candidate sites for the first national high-level waste repository.

After much controversy over DOE's implementation of NWPAA, the Act was substantially modified by the Nuclear Waste Policy Amendments Act of 1987 (Title IV, Subtitle A of P.L. 100-203, the Omnibus Budget Reconciliation Act of 1987). Under the amendments, the only candidate site DOE may consider for a permanent high-level waste repository is at Yucca Mountain, Nevada. If that site cannot be licensed, DOE must return to Congress for further instructions.

The 1987 amendments also authorized construction of a monitored retrievable storage (MRS) facility to store spent fuel and prepare it for delivery to the repository. But because of fears that the MRS would reduce the need to open the permanent repository and become a de facto repository itself, the law forbids DOE from selecting an MRS site until recommending to the President that a permanent repository be constructed. The repository recommendation occurred in February 2002, but DOE has not announced any plans for an MRS.

**Waste Facility Schedules.** DOE's most recent nuclear waste program schedule calls for the repository to begin operating by 2010 — 12 years later than the law's target date.

The major activity at the Yucca Mountain site so far has been the construction of an "exploratory studies facility" (ESF) with a 25-foot-diameter tunnel boring machine. The ESF consists primarily of a five-mile tunnel with ramps leading to the surface at its north and south ends. The tunnel boring machine began excavating the north ramp in October 1994 and broke through to the surface at the south entrance April 25, 1997. Underground studies are being conducted at several side alcoves that have been excavated off the main tunnel.

DOE completed a "viability assessment" of Yucca Mountain in December 1998, which was followed by a draft environmental impact statement (EIS) for the project in July 1999. DOE issued a preliminary site suitability evaluation August 21, 2001, that found Yucca Mountain could meet EPA and NRC requirements.

Energy Secretary Abraham on February 14, 2002, recommended to the President that the Yucca Mountain project go forward. At the same time, the Secretary submitted the final EIS and other supporting materials (for details, see the Yucca Mountain Project home page at [<http://www.ymp.gov>]). As noted previously, President Bush recommended the Yucca Mountain site to Congress the day after the Secretary's recommendation, and Nevada Governor Guinn subsequently submitted a notice of disapproval, or "state veto," as allowed by NWPA. An approval resolution passed by the House and Senate to overturn the state veto was signed by the President July 23, 2002 (P.L. 107-200).

DOE plans to submit a license application to NRC in December 2004. In the meantime, during 2003, DOE plans to decide what mode of waste transportation to use, which is expected to be mostly rail. DOE hopes to receive an NRC construction permit by 2006 and a license to begin receiving waste at the repository by 2010. The repository is to be permanently closed in 2116, according to the DOE viability assessment.

The State of Nevada plans to vigorously oppose the Yucca Mountain license application when it is submitted to NRC and is also fighting DOE in court, with six lawsuits currently pending. A suit filed in June 2002 charges DOE with violating NWPA by relying too strongly on casks and other engineered barriers to prevent radioactive releases, rather than on Yucca Mountain's natural site characteristics. The most recent, filed January 9, 2003, contends that Congress violated the Constitution in eliminating all candidate waste sites except Yucca Mountain.

The DOE Total System Life Cycle Cost Report, issued in May 2001, estimates that the entire program will cost \$49.3 billion (in constant 2000 dollars) from 2001-2119. The report says the program spent \$6.7 billion in year-of-expenditure dollars through FY2000.

**Private Interim Storage.** Delays in the federal nuclear waste program have prompted interest in a private interim storage facility. A utility consortium signed an agreement with a Utah Indian tribe on December 27, 1996, to develop a private spent fuel storage facility on tribal land. The Private Fuel Storage (PFS) consortium submitted a license application to NRC June 25, 1997. Project officials told NRC in March 1997 that the dry-cask storage facility would be located on 98 acres of the sparsely populated reservation of the Skull Valley Band of Goshute Indians, about 70 miles southwest of Salt Lake City. The initial lease for the site would run for 25 years, with possible renewal for another 25 years. The facility's capacity would be 40,000 metric tons, available to any U.S. nuclear utility in addition to the eight consortium members.

The PFS facility, strongly opposed by the State of Utah, would not require DOE assistance or congressional or state approval. Six of the eight partners in the PFS consortium have told the State of Utah that they would continue to fund the project only through the NRC licensing phase, which is still ongoing, and not move into the construction phase unless progress on Yucca Mountain were to bog down.

However, the future of the PFS proposal was thrown into doubt March 10, 2003, by a licensing panel of NRC administrative law judges. The NRC panel refused to license the facility without sufficient evidence that it could withstand a crash from fighter jets based nearby. Developers of the proposed facility appealed to the NRC commissioners March 31, 2003.

**Regulatory Requirements.** NWPA requires that high-level waste facilities be licensed by the NRC in accordance with general standards issued by EPA. Under the Energy Policy Act of 1992 (P.L. 102-486), EPA was required to write new standards specifically for Yucca Mountain. NWPA also requires the repository to meet general siting guidelines prepared by DOE and approved by NRC. Transportation of waste to storage and disposal sites is regulated by NRC and the Department of Transportation.

NRC's licensing requirements for Yucca Mountain, at 10 CFR 63, require compliance with EPA's standards (described below) and establish procedures that DOE must follow in seeking a repository license. For example, DOE must conduct a repository performance confirmation program that would indicate whether natural and man-made systems were functioning as intended and assure that other assumptions about repository conditions were accurate.

DOE's repository siting guidelines, at 10 CFR 960, developed with NRC concurrence, established the criteria that the Secretary of Energy used in determining the suitability of the Yucca Mountain site. DOE issued new siting guidelines November 14, 2001, that prompted the State of Nevada to file a court challenge on December 17, 2001. The new guidelines replaced numerous individual disqualifying conditions, such as a high rate of water movement through the repository, with an analysis of "total system performance," in which previously unacceptable conditions could be mitigated by other factors. The Nevada lawsuit contends that the new guidelines allow too much reliance on waste packages and other engineered barriers, rather than natural geologic features, to prevent radioactive releases from the repository.

The Energy Policy Act of 1992 (P.L. 102-486) made a number of changes in the nuclear waste regulatory system, particularly that EPA must issue new environmental standards specifically for the Yucca Mountain repository site. General EPA repository standards previously issued and subsequently revised no longer apply to Yucca Mountain. DOE and NRC had complained that some of EPA's general standards might be impossible or impractical to meet.

The new standards, which limit the radiation dose that the repository could impose on individual members of the public, were required to be consistent with the findings of a study by the National Academy of Sciences (NAS), which was issued August 1, 1995. The NAS study recommended that the Yucca Mountain environmental standards establish a limit on risk to individuals near the repository, rather than setting specific limits for the releases of radioactive material or on radioactive doses, as under previous EPA standards. The NAS study also examined the potential for human intrusion into the repository and found no scientific basis for predicting human behavior thousands of years into the future.

Pursuant to the Energy Policy Act, EPA published its proposed Yucca Mountain radiation protection standards on August 27, 1999. The proposal would have limited annual radiation doses to 15 millirems for the "reasonably maximally exposed individual," and to 4 millirems from groundwater exposure, for the first 10,000 years of repository operation. EPA calculated that its standard would result in an annual risk of fatal cancer for the maximally exposed individual of seven chances in a million. The nuclear industry criticized the EPA proposal as being unnecessarily stringent, particularly the groundwater standard. On the other hand, environmental groups contended that the 10,000-year standard proposed

by EPA was too short, because DOE had projected that radioactive releases from the repository would peak well after that period.

EPA issued its final Yucca Mountain standards on June 6, 2001. The final standards include most of the major provisions of the proposed version, including the 15 millirem overall exposure limit and the 4 millirem groundwater limit. The most significant changes in the final rules were to require that compliance be demonstrated about one mile closer to the repository and to double the amount of groundwater that would be analyzed. Despite the Department's opposition to the EPA standards, DOE's site suitability evaluation determined that the Yucca Mountain site would be able to meet them. NRC revised its repository regulations September 7, 2001, to conform to the EPA standards.

**Alternative Technologies.** Several alternatives to the geologic disposal of spent fuel have been studied by DOE and its predecessor agencies, as well as technologies that might make waste disposal easier. However, most of these technologies involve large technical obstacles, uncertain costs, and potential public opposition.

Among the primary long-term disposal alternatives to geologic repositories are disposal in deep ocean trenches and transport into space, neither of which is currently being studied by DOE. Other technologies have been studied that, while probably not replacing geologic disposal, might make geologic disposal safer and more predictable. Chief among these is the concept of "burning" long-lived plutonium and other radionuclides in a special nuclear reactor or particle accelerator, converting them to faster-decaying fission products. However, as noted above, such "recycling" technologies are strongly opposed by nuclear weapons nonproliferation groups.

**Funding.** The Bush Administration's FY2004 budget request, released February 3, 2003, includes \$591 million for the DOE civilian nuclear waste disposal program, a 30% boost over FY2003. The FY2003 appropriation, signed by the President on February 20, 2003 (P.L. 108-7), boosted the waste program by more than 20% over the previous year. DOE contends that it cannot meet its 2010 target date for shipping nuclear waste to Yucca Mountain without receiving its entire FY2004 budget request for the program. Between FY2005 and FY2010, funding will have to further increase to an average of \$1.3 billion per year, according to the budget justification. The Administration is proposing that discretionary spending caps be adjusted to accommodate the program's higher future funding.

Continuation of site studies and preparation of the 10,000-page construction permit application are budgeted for most of the requested increase. A more than 200% boost in funding for transportation and waste acceptance will be required to help prepare for shipments in 2010, according to the DOE budget justification. One of the FY2004 goals of the waste transportation program is to develop final policies and procedures for providing technical assistance and grants to states through which nuclear waste will be shipped.

**Table 1. DOE Civilian Spent Fuel Management Funding**  
(in millions of current dollars)

<b>Program</b>	<b>FY2002 Approp.</b>	<b>FY2003 Approp.</b>	<b>FY2004 Request</b>	
Yucca Mountain	296.9	– *	419.0	
Waste acceptance, storage, transportation	4.1	–	73.1	
Program integration	18.0	–	23.7	
Program direction	58.3	–	75.2	
<b>Total</b>	<b>375.0</b>	<b>457.0</b>	<b>591.0</b>	
<b>Source of Funding</b>				
Nuclear Waste Fund approp.	95.0	144.1	161.0	
Defense waste appropriations	280.0	313.0	430.0	

**Sources:** House and Senate Appropriations Committees, DOE FY2003 Congressional Budget Request, Congressional Record. Subcategories do not add exactly to the total because of adjustments made after submission of the Administration budget request.

\*subcategories not yet available

As Table 1 indicates, about 25% of the FY2003 funding request for the program would come from the Nuclear Waste Fund, with the rest coming from the defense waste account. Although nuclear utilities pay fees to the Nuclear Waste Fund to cover the disposal costs of civilian nuclear spent fuel, DOE cannot spend the money in the fund until it is appropriated by Congress. Through the end of August 2002, utility nuclear waste fees and interest totaled \$18.04 billion, of which about \$5.87 billion had been disbursed to the waste disposal program, according to DOE, leaving a balance of \$12.17 billion in the Nuclear Waste Fund. Another \$2.3 billion was owed by utilities for spent fuel generated before 1983. The nuclear waste program's appropriations for FY1983-FY2002 total about \$7.2 billion, according to DOE, including \$1.7 billion for defense waste disposal.

## Low-level Radioactive Waste

**Current Policy.** Selecting disposal sites for low-level radioactive waste, which generally consists of low concentrations of relatively short-lived radionuclides, is a state responsibility under the 1980 Low-level Radioactive Waste Policy Act and 1985 amendments. Most states have joined congressionally approved interstate compacts to handle low-level waste disposal, while others are developing single-state disposal sites. Under the 1985 amendments, the nation's three (at that time) operating commercial low-level waste disposal facilities could start refusing to accept waste from outside their regional interstate compacts after the end of 1992. One site is currently using that authority and another closed, leaving only one open to nationwide disposal of all major types of low-level waste. A third site, in Utah, has since become available nationwide for most Class A low-

level waste. The Utah site's operator, Envirocare, applied to the State on November 1, 1999, for a license amendment to accept Class B and C waste as well. Utah regulators announced preliminary approval of the request January 2, 2001, but Envirocare has deferred seeking final state approval.

Despite the 1992 deadline, no new disposal sites have been opened. A facility in California's Ward Valley to serve California, Arizona, North Dakota, and South Dakota received a state operating permit in 1993. However, the site is on federal land, which the Department of the Interior would not transfer to the state as had originally been expected.

Legislation providing congressional consent to a compact among Texas, Maine, and Vermont was signed by President Clinton September 20, 1998 (P.L. 105-236). However, on October 22, 1998, a proposed disposal site near Sierra Blanca, Texas, was rejected by the Texas Natural Resource Conservation Commission. Texas Governor Perry signed legislation June 20, 2003, authorizing the Texas Commission on Environment Quality to license adjacent disposal facilities for commercial and federally generated low-level waste.

The Midwestern Compact voted June 26, 1997, to halt development of a disposal facility in Ohio. Nebraska regulators rejected a proposed waste site for the Central Compact December 21, 1998, drawing a lawsuit from five utilities in the region. A U.S. district court judge ruled September 30, 2002, that Nebraska had exercised bad faith in disapproving the site and ordered the state to pay \$151 million to the Compact. Most other regional disposal compacts and individual states that have not joined compacts are making little progress toward finding disposal sites, largely because of public opposition and the continued availability of the disposal facilities in South Carolina and, for most Class A waste, Utah.

Only one disposal facility, at Barnwell, S.C., is currently accepting all Class A, B and C low-level waste from most states. The Barnwell facility had stopped accepting waste from outside the Southeast Compact at the end of June 1994. The Southeast Compact Commission in May 1995 twice rejected a South Carolina proposal to open the Barnwell site to waste generators outside the Southeast and to bar access to North Carolina until that state opened a new regional disposal facility, as required by the Compact. The rejection of those proposals led the South Carolina General Assembly to vote in 1995 to withdraw from the Southeast Compact and begin accepting waste at Barnwell from all states but North Carolina. North Carolina withdrew from the Southeast Compact July 26, 1999, a move that prompted a lawsuit from the Compact on July 10, 2000.

South Carolina joined the Atlantic Compact (formerly the Northeast Compact) with Connecticut and New Jersey on July 1, 2000. Under the compact, South Carolina can limit the use of the Barnwell facility to the three compact members. A state law enacted in June 2000 phases out acceptance of non-compact waste through 2008.

The only other existing disposal facility for all three major classes of low-level waste is at Hanford, Washington. Controlled by the Northwest Compact, the Hanford site will continue taking waste from the neighboring Rocky Mountain Compact under a contract. States barred from access to existing disposal facilities are likely to require low-level waste generators to store their waste on site until new disposal sites are available, particularly for Class B and C waste. However, the Envirocare site in Utah could provide nationwide disposal if its Class B and C license is approved.

**Regulatory Requirements.** Licensing of commercial low-level waste facilities is carried out under the Atomic Energy Act by NRC or by “agreement states” with regulatory programs approved by NRC. NRC regulations governing low-level waste licenses must conform to general environmental protection standards and radiation protection guidelines issued by EPA. Transportation of low-level waste is jointly regulated by NRC and the Department of Transportation.

Most states considering new or expanded low-level waste disposal facilities, including Texas, California, and Utah, are agreement states. Most states, both agreement and non-agreement, have established substantially stricter technical requirements for low-level waste disposal than NRC’s, such as banning shallow land burial and requiring concrete bunkers and other engineered barriers. NRC would issue the licenses in non-agreement states.

## LEGISLATION

### H.R. 6 (Tauzin)

Omnibus energy legislation that includes authorization of DOE nuclear waste “recycling” research. Introduced April 7, 2003; passed House April 11, 2003, by vote of 247-145.

### H.R. 238 (Boehlert)

Energy Research, Development, Demonstration, and Commercial Application Act of 2003. Includes provisions to establish a nuclear waste “recycling” research program. Introduced January 8, 2003; referred to Committee on Science.

### S. 14 (Domenici)

Energy Policy Act of 2003. Omnibus energy legislation that includes authorization of DOE nuclear waste “recycling” research. Based on Chairman’s Mark ordered reported by Committee on Energy and Natural Resources April 30, 2003. Introduced April 30, 2003; placed directly on Senate Calendar.

## CONGRESSIONAL HEARINGS, REPORTS, AND DOCUMENTS

U.S. Congress. House. Committee on Energy and Commerce. Subcommittee on Energy and Air Quality. *A Review of the President’s Recommendation to Develop a Nuclear Waste Repository at Yucca Mountain, Nevada*. Hearing, 107<sup>th</sup> Congress, 2<sup>nd</sup> session. April 18, 2002. Washington, U.S. Govt. Print. Off., 2002. 294 p.  
“Serial no. 107-99”

U.S. Congress. House. Committee on Commerce. Subcommittee on Energy and Power. *Status of the Department of Energy Program to Develop a Permanent Geologic Repository at Yucca Mountain, Nevada*. Hearing, 106<sup>th</sup> Congress, 2<sup>nd</sup> session. June 23, 2000. Washington, U.S. Govt. Print. Off., 2000. 165 p.  
“Serial no. 106-151”



U.S. Congress. Senate. Committee on Energy and Natural Resources. *Yucca Mountain Repository Development*. Hearings, 107<sup>th</sup> Congress, 1<sup>st</sup> session. May 16, 22, and 23, 2002. Washington, U.S. Govt. Print. Off., 2002. 240 p.  
S. Hrg. 107-483.

---- *Nuclear Waste Litigation*. Hearing, 106<sup>th</sup> Congress, 2<sup>nd</sup> session. September 28, 2000. Washington, U.S. Govt. Print. Off., 2001. 58 p.  
S. Hrg. 106-918

---- *Nuclear Waste Storage and Disposal Policy*. Hearing, 106<sup>th</sup> Congress, 1<sup>st</sup> session. March 24, 1999. Washington, U.S. Govt. Print. Off., 1999. 99 p.  
S. Hrg. 106-105

U.S. Congress. Senate. Committee on Environment and Public Works. *Disposal of Low-Level Radioactive Waste*. Hearing, 106<sup>th</sup> Congress, 2<sup>nd</sup> session. July 25, 2000. Washington, U.S. Govt. Print. Off., 2001. 166 p.

## **FOR ADDITIONAL READING**

League of Women Voters Education Fund. *The Nuclear Waste Primer*. Washington, D.C., 1993. 170 p.

Nuclear Waste Technical Review Board. *Report to the U.S. Congress and the U.S. Secretary of Energy*. April 2003. 162 p.

U.S. Department of Energy. *Office of Civilian Radioactive Waste Management home page*; covers DOE activities for disposal, transportation, and other management of civilian nuclear waste. [<http://www.rw.doe.gov>]

U.S. General Accounting Office. *Nuclear Waste: Impediments to Completing the Yucca Mountain Repository Project*. GAO/RCED-97-30. January 1997. 56 p.

U.S. Geological Survey. *Yucca Mountain as a Radioactive-Waste Repository*. Circular 1184. 1999. 19 p.