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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. Federal policy is based on the premise that nuclear waste can be disposed of safely, but new storage and disposal facilities have frequently been challenged on safety, health, and environmental grounds. Although civilian radioactive waste encompasses a wide range of materials, most of the current debate focuses on the highly radioactive spent fuel from nuclear power plants.

The Nuclear Waste Policy Act of 1982 (NWPA) calls for disposal of spent nuclear fuel in a deep geologic repository 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 at Yucca Mountain in preparing an application to the Nuclear Regulatory Commission (NRC) for the planned repository. 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. A resolution to allow Yucca Mountain licensing to proceed despite the state veto was passed by the House

(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 2005 for the Yucca Mountain repository. The Administration requested \$880 million for the program for FY2005, a 50% increase. The Administration also proposed that \$749 million of the FY2005 request be offset by the existing fee on nuclear power, so that the net appropriation would be \$131 million. Because legislation to enact the proposed offset did not pass, the House voted to provide only the requested \$131 million net appropriation for FY2005. After substantial controversy, Congress provided \$577 million for the program, about the same as in FY2004.

Delays in the Yucca Mountain project could be exacerbated by a July 2004 federal circuit court decision that the Environmental Protection Agency's (EPA's) 10,000-year regulatory compliance period for the repository was too short. However, the court rejected several other challenges to EPA's Yucca Mountain regulations.

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. 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

After considerable controversy, the Department of Energy (DOE) civilian nuclear waste program received \$577 million in the Consolidated Appropriations Act for FY2005 (P.L. 108-447), signed by President Bush on December 8. The Administration's proposed budget for the program totaled \$880 million — a 50% boost over FY2004 — but \$749 million was to be offset by revenue from the long-established nuclear waste fee, so that the net appropriation would be \$131 million. The House, noting that Congress had not enacted the Administration's waste-fee offset proposal, voted to provide only the \$131 million net appropriation request rather than cut other programs to make up the difference. The controversy contributed to a decision by the Senate Appropriations Committee's Energy and Water Development Subcommittee against holding a markup on the FY2005 funding bill.

A key aspect of the Environmental Protection Agency's (EPA's) regulations for DOE's planned Yucca Mountain, Nevada, nuclear waste repository was overturned July 9 by the U.S. Court of Appeals for the District of Columbia Circuit. The three-judge panel ruled that EPA's 10,000-year compliance period was too short, but it rejected several other challenges to the standards.

DOE had planned to submit a construction permit application for the Yucca Mountain repository to the Nuclear Regulatory Commission (NRC) by late 2004, but program officials announced on November 22 that the application would be delayed until 2005.

Further delays in the nuclear waste program could prove costly under a settlement announced August 10 between the Department of Justice and Exelon Corporation, which had filed a breach-of-contract suit over DOE's failure to begin accepting spent fuel by 1998 as required by the Nuclear Waste Policy Act. Under the settlement, Exelon is to be reimbursed from the federal Judgment Fund for its spent fuel storage costs caused by the waste program delays. Exelon estimates that it will receive \$300 million if DOE begins accepting waste by 2010 as currently scheduled, and up to \$600 million if waste acceptance does not begin until 2015.

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 years or longer 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 Utah commercial disposal facility, which is seeking approval 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 approved disposal compacts. Pursuant to a 2003 Texas statute, an application to build a disposal facility for commercial and federal low-level waste in Andrews County, Texas, was filed August 2, 2004, by Waste Control Specialists LLC.

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.¹ The Court of Claims on May 21, 2004, denied a claim of \$100 million in damages from Indiana Michigan Power Company, ruling that the company had not demonstrated any costs resulting from DOE's breach of contract.²

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. 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 11th Circuit agreed, ruling September 24, 2002, that any compensation would have to come from general revenues or other sources than the waste fund.

Exelon announced a settlement with the Department of Justice August 10, 2004, in which compensation for the company's nuclear waste storage costs would be paid from the federal Judgment Fund. Exelon, which operates 17 reactors, calculates that it would be reimbursed \$300 million if DOE began taking waste by the current goal of 2010, and up to \$600 million if the schedule slipped to 2015.

Although some of the program's delays have been blamed on poor management, DOE contends that tight funding has been a major barrier. DOE cannot spend the nuclear industry's mandatory waste fees without congressional appropriations, 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

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

² Hiruo, Elaine. "Indiana Michigan Mulls Appeal in Spent Fuel Default Case," *Nucleonics Week*, June 3, 2004, p. 5.

the waste program's funding mechanism but have consistently been stymied by budget scoring and policy 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 NWPAs. 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 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 recommended 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.

The conference agreement on an omnibus energy bill (H.R. 6), passed by the House on November 18, 2003, would have authorized funding for DOE's ongoing spent nuclear fuel "recycling" research and development program and required DOE to prepare a feasibility study on deep borehole disposal. Supporters of spent fuel 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>]).

Characteristics of Nuclear Waste

Radioactive waste is a term that encompasses a broad range of material with widely varying characteristics. Some has relatively slight radioactivity and is 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.

Spent fuel discharged from U.S. commercial nuclear reactors is currently stored at 72 power plant sites around the nation, plus two small central storage facilities. At the end of 2002 (the most recent DOE survey), commercial spent fuel totaled 46,927 metric tons. A typical large commercial nuclear reactor discharges an average of 20-30 metric tons of spent fuel per year — an average of about 2,150 metric tons annually for the entire U.S. nuclear power industry. As a result, the total amount of commercial spent fuel is expected to exceed 53,000 metric tons by the end of 2005 and 62,000 metric tons by 2010, when the Yucca Mountain repository is planned to open. Including 7,000 metric tons of DOE spent fuel and high-level waste that is also planned for disposal at Yucca Mountain, the total amount would nearly reach NWPAs' 70,000-metric-ton limit by the time the repository is scheduled to open. (For details on current spent fuel storage, see CRS Report RS22001, *Spent Nuclear Fuel Storage Locations and Inventory*, by Anthony Andrews.)

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. DOE estimates that the amount of commercial spent fuel and other highly radioactive waste may grow to 105,000 metric tons by 2035.³

New storage capacity at operating nuclear plant sites or other locations will be required if DOE is unable to begin accepting waste into its disposal system for another five years or longer. 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.

³ DOE Office of Civilian Radioactive Waste Management. *OCRWM Annual Report to Congress, Fiscal Year 2002*. DOE/RW-0560. October 2003. Appendix C.

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. Several million cubic feet of commercial low-level waste is shipped to disposal sites each year, according to NRC. Volumes can vary widely from year to year, based on the status of nuclear decommissioning projects and cleanup activities that can generate especially large quantities.

For more background on radioactive waste characteristics, see CRS Report RL32163, *Radioactive Waste Streams: An Overview of Waste Classification for Disposal*, by Anthony Andrews.

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 (NWPA, 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 NWPA, 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 (see [http://www.ymp.gov/documents/feis_a/index.htm]) and other supporting materials (for details, see the Yucca Mountain Project home page at [<http://www.ocrwm.doe.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 had planned to submit a license application to NRC in December 2004, but program officials announced on November 22, 2004, that the application would be delayed until 2005. DOE hopes to receive an NRC construction permit by 2006 and a license to begin receiving waste at the repository by 2010. However, NRC Commissioner Edward McGaffigan was quoted October 24, 2003, as calling the 2010 goal "just about impossible."⁴ The repository is to be permanently closed in 2116, according to the DOE viability assessment.

DOE announced April 8, 2004, that it planned to transport nuclear waste mostly by rail to the planned Yucca Mountain repository. The Record of Decision on the waste transportation mode was published in the *Federal Register* along with the selection of a corridor in Nevada for a 300-mile rail spur to the Yucca Mountain site. DOE estimated that

⁴ "Nuclear Regulator Says Nevada Nuke Dump May Not Open Before 2015," Associated Press, October 24, 2003.

Yucca Mountain would receive 9,000-10,000 rail shipments and 3,000-3,300 truck shipments over a 24-year period after the repository opened.

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 U.S. Court of Appeals for the District of Columbia Circuit rejected those challenges July 9, 2004, but it struck down EPA's 10,000-year regulatory compliance period as too short.

Nevada also successfully challenged DOE's June 30, 2004, certification that it had made all licensing background materials available. NRC requires that such material be available on its web-based Licensing Support Network at least six months before a repository application is docketed, so the DOE certification was on the last day that would still allow docketing before the end of 2004. An NRC licensing board ruled August 31, 2004, that DOE had not yet placed all relevant information onto the system; however, the board estimated that completing the task would not "take DOE a significant amount of time."

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 on 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. The U.S. Circuit Court of Appeals for the 10th Circuit on August 4, 2004, struck down several statutes that Utah had enacted to block the PFS project, but the state is appealing the decision.

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 (DOT). Under NWPA, DOE shipments to Yucca Mountain must use NRC-certified casks and comply with NRC requirements for notifying state and local governments. Yucca Mountain shipments must also follow DOT regulations on routing, placarding, and safety.

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. However, as noted above, the Court of Appeals rejected that contention on July 9, 2004.

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 after about 480,000 years.

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.

In a ruling that could delay the nuclear waste program, a three-judge panel of the U.S. Court of Appeals for the District of Columbia Circuit on July 9, 2004, struck down the 10,000-year regulatory compliance period in the EPA and NRC Yucca Mountain standards. The court ruled that the 10,000-year period was inconsistent with the NAS study on which the Energy Policy Act required the Yucca Mountain regulations to be based. In fact, the court found, the NAS study had specifically rejected a 10,000-year compliance period because of analysis that showed peak radioactive exposures from the repository would take place several hundred thousand years in the future.

EPA had limited the regulatory period to 10,000 years because of the difficulty in addressing the inherent uncertainties in demonstrating compliance for longer time frames. The Administration is not appealing the decision but instead is moving to revise the Yucca Mountain regulations to accommodate the long-term uncertainties. It remains unclear whether NRC could begin considering a Yucca Mountain license application from DOE before revised regulations were in place.

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. As noted above, the conference agreement on omnibus energy legislation (H.R. 6) would have authorized funding for DOE's ongoing spent nuclear fuel "recycling" research and development program and required DOE to prepare a feasibility study on deep borehole disposal.

Funding. The Bush Administration's FY2005 budget request, released February 2, 2004, included \$880 million for the DOE civilian nuclear waste disposal program, a 50% boost over FY2004. The Administration also proposed that \$749 million of the FY2005 request be offset by the existing nuclear waste fee, so that the net appropriation would be \$131 million. The House Energy and Commerce Committee approved a bill (H.R. 3981, H.Rept. 108-594) on June 24, 2004, to provide most of the proposed offset. A bill introduced November 4, 2003, by Representative Shimkus (H.R. 3429) would also change the budget treatment of payments to the Nuclear Waste Fund so that they would offset appropriations to the waste program. However, neither measure was enacted.

Only the requested \$131 million net appropriation was included in the FY2005 Energy and Water Development Appropriations bill approved by the House on June 25, 2004 (H.R. 4614, H.Rept. 108-554). According to a May 24, 2004, letter from DOE to the House Appropriations Committee, a funding level of \$131 million would have forced layoffs of 70% of the program's 2,400-person workforce and caused "an indefinite delay" in opening the Yucca Mountain repository. DOE contends that funding for the waste program must average \$1.3 billion per year between FY2005 and FY2010 to meet the current 2010 target date for shipping nuclear waste to Yucca Mountain.

The Administration had proposed that OCRWM take over management of DOE defense and research waste that is currently under another program, bringing the waste office's total FY2005 funding request to \$907.5 million. However, the transfers were not approved.

As **Table 1** indicates, about 15% of the FY2005 request for the program came 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 FY2003, utility nuclear waste fees and interest totaled \$20.457 billion, of which \$5.997 billion had been disbursed to the waste disposal program, according to DOE's program summary report (see [http://www.ocrwm.doe.gov/pm/budget/monsum_aug2004.pdf]), leaving a balance of \$14.460 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-FY2003 total about \$7.906 billion, according to DOE, including \$1.975 billion for defense waste disposal.

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

Program	FY2003 Approp.	FY2004 Approp.	FY2005 Request	FY2005 House	FY2005 P.L. 108- 447
Yucca Mountain	368.3	403.6	558.9	— *	— *
Transportation	7.9	63.6	186.0	—	—
Program integration	21.2	29.7	47.6	—	—
Program direction	59.6	79.8	87.5	—	—
Total	457.0	576.6	880.0	0	577.0

Source of Funding					
Nuclear Waste Fund approp.	144.1	188.9	749.0	0	346.0
Defense waste appropriations	313.0	387.7	131.0	131.0	231.0

Sources: House and Senate Appropriations Committees, DOE FY2005 Congressional Budget Request, Congressional Record.

*Subcategories not specified. FY2005 request would be offset by \$749 million, for a net appropriations of \$131 million. Figures for P.L. 108-577 do not reflect an 0.8% across-the-board reduction.

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 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, and Maine has since withdrawn. 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. Pursuant to that statute, an application to build a disposal facility for commercial and federal low-level waste in Andrews County, Texas, was filed August 2, 2004, by Waste Control Specialists LLC.

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. A settlement was reached August 9, 2004, in which Nebraska will pay the compact \$140.4 million, and the compact will seek access to the planned Texas disposal facility. 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.

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 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

(108th Congress)

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. Passed Senate July 31, 2003, with provisions from Senate-passed version of H.R. 4 from the 107th Congress. Conference report (108-375) passed by House November 18, 2003, by vote of 246-180. Senate rejected motion to invoke cloture November 21, 2003, by vote of 57-40.

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.

H.R. 3429 (Shimkus)

Nuclear Waste Financing Act of 2003. Changes the budget treatment of payments to the Nuclear Waste Fund so that they would offset appropriations to the DOE nuclear waste program. Introduced November 4, 2003; referred to Committee on Energy and Commerce. Subcommittee on Energy and Air Quality held hearing March 25, 2004.

H.R. 3981 (Barton)

Reclassifies fees paid into the Nuclear Waste Fund as offsetting collections. Introduced March 17, 2004; referred to Committee on Energy and Commerce. Approved by committee June 24, 2004, by vote of 29-19 (H.Rept. 108-594).

H.R. 4614 (Hobson)

Energy and Water Development Appropriations for FY2005. Includes funding for DOE civilian nuclear waste program. Ordered reported as an original measure by House Committee on Appropriations June 18, 2004 (H.Rept. 108-554). Passed House June 25, 2004, by vote of 370-16. Superseded by Consolidated Appropriations Act, 1995 (P.L. 108-447), signed December 8, 2004.

H.R. 4818 (Kolbe)

Consolidated Appropriations Act, 2005. Division C includes funding for DOE civilian nuclear waste program. Conference report approved November 20, 2004 (H.Rept. 108-792). Signed into law December 8, 2004 (P.L. 108-447).

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

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“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, 106th Congress, 2nd 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, 107th Congress, 1st session. May 16, 22, and 23, 2002. Washington, U.S. Govt. Print. Off., 2002. 240 p.
S. Hrg. 107-483.

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

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

FOR ADDITIONAL READING

Harvard University. John F. Kennedy School of Government. Belfer Center for Science and International Affairs. *The Economics of Reprocessing vs. Direct Disposal of Spent Nuclear Fuel*. DE-FG26-99FT4028. December 2003.

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*. May 2004. 152 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.ocrwm.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.

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