



Civilian Nuclear Waste Disposal

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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 proposed 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 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. NWPA established the Office of Civilian Radioactive Waste Management (OCRWM) in the Department of Energy (DOE) to develop such a repository, which would be licensed by the Nuclear Regulatory Commission (NRC). The program's civilian costs were required 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 submitted a license application for the proposed Yucca Mountain repository to NRC on June 3, 2008. The NRC license must be based on radiation exposure standards set by the Environmental Protection Agency (EPA), which issued revised standards September 30, 2008. The state of Nevada strongly opposes the Yucca Mountain project, disputing DOE's analysis that the repository would meet EPA's standards. Risks cited by repository opponents include excessive water infiltration, earthquakes, volcanoes, and human intrusion.

The Obama Administration "has determined that developing the Yucca Mountain repository is not a workable option and the Nation needs a different solution for nuclear waste disposal," according to the DOE FY2011 budget justification. As a result, no funding for Yucca Mountain or OCRWM was requested or provided for FY2011. DOE filed a motion with NRC to withdraw the Yucca Mountain license application on March 3, 2010. DOE's withdrawal motion has prompted legal challenges from states that have defense-related and civilian waste awaiting permanent disposal. An NRC licensing board denied DOE's withdrawal motion on June 29, 2010, a decision that is under review by the NRC commissioners.

Alternatives to Yucca Mountain are being evaluated by the Blue Ribbon Commission on America's Nuclear Future. The commission's draft report, released July 29, 2011, called for a new, "single-purpose organization" to be established to "expeditiously" develop one or more nuclear waste repositories with an "assured" source of funding. The draft recommendations also urged that the roles of various levels of government in siting and regulating nuclear waste facilities be established through negotiations, that one or more "consolidated interim storage facilities" be developed, and that long-term research, development, and demonstration be conducted on technologies that could provide waste disposal benefits.

For FY2012, the Administration again requested no funding for the Yucca Mountain project, but the House provided \$25 million to DOE and \$20 million to NRC to continue the Yucca Mountain licensing process in the FY2012 energy and water development appropriations bill (H.R. 2354). The House bill specifies that the funds may not be used for closing out licensing activities unless the NRC commissioners accept DOE's license withdrawal motion, "or for actions that irrevocably remove the possibility that Yucca Mountain may be a repository option in the future."

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Most Recent Developments

The Obama Administration's nuclear waste policy calls for termination of the Yucca Mountain repository project and the development of alternative approaches to waste management. Under the Nuclear Waste Policy Act (NWPA), the Yucca Mountain site in Nevada has been the only location under consideration by the Department of Energy (DOE) for construction of a national high-level radioactive waste repository. DOE had submitted a license application for the Yucca Mountain repository to the Nuclear Regulatory Commission (NRC) on June 3, 2008.

The Administration's FY2011 budget request called for a complete halt in funding for the Yucca Mountain project and elimination of the Office of Civilian Radioactive Waste Management (OCRWM), the DOE office that had run the program. In line with the request, the FY2011 Continuing Appropriations Act (P.L. 112-10) provided no DOE funding for the program. DOE shut down the Yucca Mountain project at the end of FY2010 and transferred OCRWM's remaining functions to the Office of Nuclear Energy.

DOE filed a motion to withdraw the Yucca Mountain license application on March 3, 2010, "with prejudice," meaning the application could not be resubmitted to NRC in the future.¹ DOE's motion to withdraw the license application, filed with NRC's Atomic Safety and Licensing Board (ASLB), received strong support from the state of Nevada but drew opposition from states with defense-related and civilian radioactive waste that had been expected to go to Yucca Mountain. State utility regulators also filed a motion to intervene on March 15, 2010, contending that "dismissal of the Yucca Mountain application will significantly undermine the government's ability to fulfill its outstanding obligation to take possession and dispose of the nation's spent nuclear fuel and high level nuclear waste."²

The ASLB denied DOE's license withdrawal motion June 29, 2010, ruling that the NWPA prohibits DOE from withdrawing the license application until NRC determines whether the repository is acceptable.³ The NRC commissioners are reviewing the ASLB decision but have not released their final vote on the matter. Lawsuits to overturn the Yucca Mountain license withdrawal on statutory grounds were filed with the U.S. Court of Appeals for the District of Columbia Circuit, which on July 1, 2011, declined to issue a ruling before NRC takes final action.⁴

For FY2012, the Administration again requested no funding for the Yucca Mountain project. However, the House voted July 15, 2011, to provide \$25 million to DOE and \$20 million to NRC to continue the Yucca Mountain licensing process in the FY2012 energy and water development appropriations bill (H.R. 2354). The House voted to increase NRC's Yucca Mountain licensing funding from \$10 million to \$20 million in an amendment approved July 14, 2011, by a 297-130 vote. The House bill specifies that the funds may not be used for closing out licensing activities

¹ U.S. Department of Energy's Motion to Withdraw, NRC Atomic Safety and Licensing Board, Docket No. 63-0001, March 3, 2010, http://www.energy.gov/news/documents/DOE_Motion_to_Withdraw.pdf.

² National Association of Regulatory Utility Commissioners, "NARUC Seeks Party Status at NRC, Says Yucca Review Must Continue," press release, March 16, 2010, <http://www.naruc.org/News/default.cfm?pr=191&pdf=>.

³ U.S. Nuclear Regulatory Commission, Atomic Safety and Licensing Board, Docket No. 63-001-HLW, Memorandum and Order, June 29, 2010.

⁴ *In Re: Aiken County, Petitioner*, U.S. Court of Appeals for the District of Columbia Circuit, USCA Case No. 10-1050, decided July 1, 2011.

unless the NRC commissioners accept DOE's license withdrawal motion, "or for actions that irrevocably remove the possibility that Yucca Mountain may be a repository option in the future."

The Administration established the Blue Ribbon Commission on America's Nuclear Future to develop alternatives to the Yucca Mountain program. The commission's draft report, released July 29, 2011, called for a new, "single-purpose organization" to be established to "expeditiously" develop one or more nuclear waste repositories with an "assured" source of funding. The draft recommendations also urged that the roles of various levels of government in siting and regulating nuclear waste facilities be established through negotiations, that one or more "consolidated interim storage facilities" be developed, and that long-term research, development, and demonstration be conducted on technologies that could provide waste disposal benefits.⁵

The March 11, 2011, accident at Japan's Fukushima Daiichi nuclear power plant increased concern about spent fuel stored in pools of water at nuclear plant sites. The loss of power at the site, caused by a huge earthquake and tsunami, disabled cooling systems at the plant's spent fuel pools. Water in the pools may have boiled or leaked and dropped below the level of the stored spent fuel, potentially leading to fuel damage and radioactive releases into the atmosphere.

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. Low-level radioactive waste generated by nuclear power plants, industry, hospitals, and other activities is also a long-standing issue.

Spent Nuclear Fuel Program

The Nuclear Waste Policy Act of 1982 (NWPA), as amended in 1987, required the Department of Energy (DOE) to focus on Yucca Mountain, Nevada, as the site of 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.

Under the George W. Bush Administration, DOE determined that Yucca Mountain was suitable for a repository and that licensing of the site by the Nuclear Regulatory Commission (NRC) should proceed, as specified by NWPA. DOE submitted a license application for the repository to NRC on June 3, 2008, and projected that the repository could begin receiving waste in 2020, about 22 years later than the 1998 goal established by NWPA.⁶

⁵ Blue Ribbon Commission on America's Nuclear Future, Draft Report to the Secretary of Energy, July 29, 2011, <http://brc.gov/index.php?q=announcement/brc-releases-their-draft-full-commission-report>.

⁶ Nuclear Energy Institute, Key Issues, Yucca Mountain, <http://www.nei.org/keyissues/nuclearwastedisposal/yuccamountain/>, viewed April 11, 2008.

However, the Obama Administration decided that the Yucca Mountain repository should not be opened, largely because of Nevada's continuing opposition, although it requested FY2010 funding to continue the NRC licensing process. But the Administration's FY2011 budget request reversed the previous year's plan to continue licensing the repository and called for a complete halt in funding and elimination of the Office of Civilian Radioactive Waste Policy (OCRWM), which had run the program.

In line with that policy, DOE filed a motion to withdraw the Yucca Mountain license application on March 3, 2010, "with prejudice," meaning the application could not be resubmitted to NRC in the future. To develop alternative waste disposal strategies, the Administration established the Blue Ribbon Commission on America's Nuclear Future (BRC), which released draft recommendations on May 13, 2011. The BRC commissioned a series of reports on various aspects of nuclear waste policy to assist in its deliberations.⁷ (For a discussion of policy options, see CRS Report R40202, *Nuclear Waste Disposal: Alternatives to Yucca Mountain*, by Mark Holt.)

For FY2012, the Administration again requested no funding for the Yucca Mountain project. However, the House voted July 15, 2011, to provide \$25 million to DOE and \$20 million to NRC to continue the Yucca Mountain licensing process in the FY2012 energy and water development appropriations bill (H.R. 2354). The House bill specifies that the funds may not be used for closing out licensing activities unless the NRC commissioners accept DOE's license withdrawal motion, "or for actions that irrevocably remove the possibility that Yucca Mountain may be a repository option in the future." The House Committee on Science, Space, and Technology issued a majority staff report in June 2011 that criticized the Administration for not providing a technical justification for abandoning Yucca Mountain as a repository site.⁸

The safety of geologic disposal of spent nuclear fuel and high-level waste (HLW), 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 strong worldwide consensus that the best, safest long-term option for dealing with HLW is geologic isolation," according to the National Research Council.⁹

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

⁷ Blue Ribbon Commission on America's Nuclear Future, Commissioned Papers, <http://brc.gov/index.php?q=library/documents/commissioned-papers>.

⁸ Report by the Majority Staff of the House Committee on Science, Space, and Technology, *Yucca Mountain: The Administration's Impact on U.S. Nuclear Waste Management Policy*, June 2011, <http://science.house.gov/sites/republicans.science.house.gov/files/documents/Letters/Yucca%20Mountain%20-%20The%20Administration%27s%20Impact%20on%20U.S.%20Nuclear%20Waste%20Management%20Policy%20FULL.pdf>.

⁹ National Research Council, Board on Radioactive Waste Management, *Rethinking High-Level Radioactive Waste Disposal: A Position Statement of the Board on Radioactive Waste Management* (1990), p. 2.

uncertainty involved in predicting waste site performance for the 1 million years that nuclear waste is to be isolated under current regulations.

President Obama's FY2012 budget calls for long-term research on a wide variety of technologies that could reduce the volume and toxicity of nuclear waste. The Bush Administration had proposed to demonstrate large-scale facilities to reprocess and recycle spent nuclear fuel by separating long-lived elements, such as plutonium, that could be made into new fuel and "transmuted" into shorter-lived radioactive isotopes. Spent fuel reprocessing, however, has long been controversial because of the potential weapons use of separated plutonium and cost concerns. The Obama Administration has refocused DOE's nuclear waste research toward fundamental science and away from the near-term design and development of reprocessing facilities.

President Bush had 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. An approval resolution was signed by President Bush July 23, 2002 (P.L. 107-200).¹⁰

Other Programs

Other types of civilian radioactive waste have also generated public controversy, particularly low-level 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 the states of South Carolina and Washington. However, the Washington facility does not accept waste from outside its region, and the South Carolina site is available only to the three members of the Atlantic disposal compact (Connecticut, New Jersey, and South Carolina) as of June 30, 2008. The lowest-concentration class of low-level radioactive waste (class A) is accepted from any waste generator by a Utah commercial disposal facility.

Threats by states to close their disposal facilities led to congressional authorization of regional compacts for low-level waste disposal in 1985. No new sites have been opened by any of the 10 approved disposal compacts, although a site in Texas received construction approval on January 7, 2011.¹¹ The Texas Legislature approved legislation in May 2011 to allow up to 30% of the facility's capacity to be used by states outside the Texas Compact, which consists of Texas and Vermont.¹²

¹⁰ 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.

¹¹ Low Level Waste Forum, "TCEQ Authorizes Commencement of Construction at WCS," January 12, 2011, <http://www.texassolution.com/documents/press.LLW%20Forum.TCEQ%20Authorizes%20Construction.1.12.11.pdf>.

¹² Waste Control Specialists LLC, "Waste Control Specialists Commends Passage of Legislation," press release, May 31, 2011, http://www.wcstexas.com/PDF_downloads/WCSAnnounceslegislation.pdf?nxd_id=98546.

Nuclear Waste Litigation

NWPA section 302 authorized DOE to enter into contracts with U.S. generators of spent nuclear fuel and other highly radioactive waste; under the contracts, DOE was to dispose of the waste in return for a fee on nuclear power generation. The act prohibited nuclear reactors from being licensed to operate without a nuclear waste disposal contract with DOE, and all reactor operators subsequently signed them.¹³ As required by NWPA, the contracts specified that DOE would begin disposing of nuclear waste no later than January 31, 1998.

After DOE missed the contractual deadline, nuclear utilities began filing lawsuits to recover their additional storage costs—costs they would not have incurred had DOE begun accepting waste in 1998 as scheduled. DOE reached its first settlement with a nuclear utility, PECO Energy Company (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.

Through January 2011, the Department of Justice had negotiated 12 settlements of the 74 lawsuits filed against DOE for missing the waste disposal deadline. Under the settlements, utilities submit annual reimbursement claims to DOE for any delay-related nuclear waste storage costs they incurred during that year. Any disagreements over reimbursable claims between DOE and a utility would go to arbitration. Through January 2011, the federal government had paid about \$956 million under the settlements and for two court judgments.¹⁴ The payments are made from the U.S. Treasury's Judgment Fund, a permanent account that is used to cover damage claims against the U.S. government.¹⁵

Other nuclear utilities have not reached settlements, but have continued pursuing their damage claims through the U.S. Court of Federal Claims. Unlike the settlements, which cover all past and future damages resulting from DOE's nuclear waste delays, awards by the Court of Claims can cover only damages that have already been incurred; therefore, utilities must continue filing claims as they accrue additional delay-related costs. About 30 cases involving initial damage claims have been decided in the Court of Claims so far, and about 30 more are pending.¹⁶ According to the Congressional Budget Office (CBO), the federal government's current liability for settlements, final judgments, and entered judgments under appeal stood at \$1.8 billion in July 2010.¹⁷

¹³ The Standard Contract for Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Waste can be found at 10 CFR 961.11.

¹⁴ Statement of Michael F. Hertz, Deputy Assistant Attorney General, Civil Division, before the Blue Ribbon Commission on America's Nuclear Future, February 2, 2011, p. 6.

¹⁵ Telephone conversation with David K. Zabransky, Nuclear Utility Specialist, Office of Civilian Radioactive Waste Management, U.S. Department of Energy, March 25, 2009.

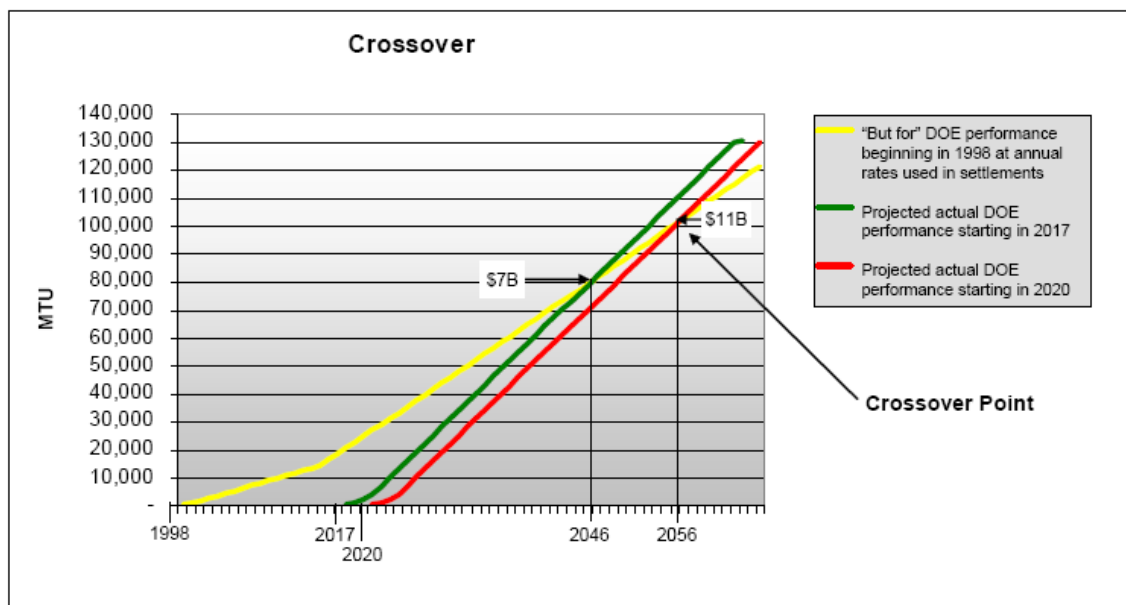
¹⁶ Hertz, *op. cit.*

¹⁷ Statement of Kim Cawley, Chief, Natural and Physical Resources Costs Estimates Unit, Congressional Budget Office, before the House Committee on the Budget, July 27, 2010, p. 5, http://www.cbo.gov/ftpdocs/117xx/doc11728/07-27-NuclearWaste_Testimony.pdf.

Future Liability Estimates

DOE estimated in July 2008 that its potential liabilities for waste program delays would total \$11 billion through 2056 (in current dollars) if the department were able to begin taking spent nuclear fuel from plant sites by 2020, which had been the most recent goal under the previous Administration. (That estimate has since been raised to at least \$13 billion.¹⁸) DOE's methodology for this estimate is shown in **Figure 1**. The yellow line shows DOE's estimate of how much spent fuel would have been removed from nuclear plant sites had shipments begun on the NWA deadline of January 1998. The rate of waste acceptance under that scenario is 900 metric tons per year from 1998 through 2015 and 2,100 tons/year thereafter. That assumed acceptance rate was negotiated by DOE as part of the settlements discussed above. The annual costs reimbursed by DOE under the settlements cover utilities' expenses for storing waste that would have already been taken away under the assumed acceptance rate (the yellow line).

Figure 1. DOE Estimate of Future Liabilities for Nuclear Waste Delays



Source: Christopher A. Kouts, Principal Deputy Director, Office of Civilian Radioactive Waste Management, U.S. Department of Energy, "Yucca Mountain Program Status Update," July 22, 2008, p. 18.

The green and red lines in **Figure 1** show DOE's planned waste acceptance rate if waste shipments begin by 2017 or 2020. Under those scenarios, DOE would take away 400 metric tons the first year, 600 the second year, 1,200 the third year, 2,000 the fourth year, and 3,000 per year thereafter. This is the rate assumed by DOE's Total System Life Cycle Cost Report.¹⁹ At that higher acceptance rate, DOE would be able to eventually catch up with the amount of waste that it was assumed to take under the settlements (the yellow line). If waste acceptance began by 2017

¹⁸ Ibid.

¹⁹ U.S. Department of Energy, Office of Civilian Radioactive Waste Management, *Analysis of the Total System Life Cycle Cost of the Civilian Radioactive Waste Management Program, Fiscal Year 2007*, DOE/RW-0591, Washington, DC, July 2008, p. 20, http://ocrwm.doe.gov/about/budget/pdf/TSLCC_2007_8_05_08.pdf.

(the green line), the backlog would be eliminated by 2046, and if acceptance began by 2020 (the red line) the backlog would be gone by 2056. Under the settlements, therefore, there would be no further annual damage payments after those years, if DOE were able to achieve the 2017 or 2020 acceptance scenario.

DOE bases its estimate of the total damage payments that would be paid through 2046 or 2056 on the amounts paid to date under the settlement claims. As noted above, estimates of future payments have already risen substantially since the 2008 estimates shown in **Figure 1**. If damage awards by the Court of Claims (currently involving about two-thirds of U.S. reactors) exceed the rates paid under the settlements, then future payments could further exceed those estimates.

Further delays in the start of waste acceptance would delay the point at which DOE would catch up to the cumulative waste shipments assumed under the settlement scenario (yellow line) and would no longer have to make annual damage payments. DOE estimates that each year's delay in the startup date would increase the total eventual damage payments by as much as \$500 million.

DOE filed a license application with the Nuclear Regulatory Commission (NRC) for the proposed Yucca Mountain repository in June 2008, and has estimated that annual program spending would have to increase to nearly \$2 billion (from around \$300 million in FY2009) to allow waste shipments to begin by 2020 if the license were approved.²⁰ However, President Obama's FY2011 budget request eliminated Yucca Mountain funding, as noted above. As a result, it appears unlikely that spent nuclear fuel shipments to Yucca Mountain could begin by 2020, even if full funding for the project were to be restored in the future. Waste acceptance by 2020 might be possible if Congress were to authorize one or more temporary storage sites within the next few years, although previous efforts to develop such facilities have been blocked by state and local opposition.

Delays in the federal waste disposal program could also lead to future environmental enforcement action over DOE's own high-level waste and spent fuel, mostly resulting from defense and research activities. Some of the DOE-owned waste is currently being stored in non-compliance with state and federal environmental laws, making DOE potentially subject to fines and penalties if the waste is not removed according to previously negotiated compliance schedules.

The National Association of Regulatory Utility Commissioners (NARUC), representing state utility regulators, and the Nuclear Energy Institute, representing the nuclear industry, filed petitions with the U.S. Court of Appeals on April 2 and April 5, 2010, to halt the federal government's collection of fees on nuclear power under the NWPA contracts. The suits argue that the fees, totaling about \$800 million per year, should not be collected while the federal government's nuclear waste disposal program has been halted.²¹ DOE responded that the federal government still intends to dispose of the nation's nuclear waste and that the fees must continue to be collected to cover future disposal costs.²²

²⁰ *Ibid.*, p. B-2.

²¹ NARUC, "State Regulators Go to Court with DOE over Nuclear Waste Fees, news release, April 2, 2010, <http://www.naruc.org/News/default.cfm?pr=193>; *Nuclear Energy Institute et al. v. U.S. DOE*, Joint Petition for Review, U.S. Court of Appeals for the District of Columbia Circuit, April 5, 2010.

²² Jeff Beattie, "NARUC, Utilities Sue DOE Over Nuke Waste Fee," *Energy Daily*, April 6, 2010, p. 1.

License Withdrawal

DOE's motion to withdraw the Yucca Mountain license application "with prejudice," meaning that it could not be resubmitted in the future, was filed with NRC's Atomic Safety and Licensing Board (ASLB) on March 3, 2010. DOE's motion argued that the licensing process should be terminated because "the Secretary of Energy has decided that a geologic repository at Yucca Mountain is not a workable option" for long-term nuclear waste disposal. Subsequent DOE statements have reiterated that the license withdrawal motion was not based on scientific or technical findings. Instead, the policy change was prompted by the perceived difficulty in overcoming continued opposition from the state of Nevada and a desire to find a waste solution with greater public acceptance, according to DOE.²³ DOE contended that the license application should be withdrawn "with prejudice" because of the need to "provide finality in ending the Yucca Mountain project."²⁴

The state of Nevada strongly endorsed DOE's motion to withdraw the license application with prejudice²⁵ and has moved to intervene in a court challenge to the license withdrawal.²⁶ Nevada has long contended that the geology of the site is unsuitable for long-term nuclear waste disposal.

However, DOE's withdrawal motion has drawn opposition from states and localities with defense-related and civilian nuclear waste that had been expected to go to Yucca Mountain. The state of South Carolina, which has large amounts of high-level radioactive waste at DOE's Savannah River Site, and the state of Washington, which hosts extensive nuclear waste storage facilities at DOE's Hanford Site, filed motions to intervene in the Yucca Mountain licensing proceeding to oppose the license application withdrawal.

NARUC also filed a motion to intervene in the Yucca Mountain licensing proceedings, contending that "dismissal of the Yucca Mountain application will significantly undermine the government's ability to fulfill its outstanding obligation to take possession and dispose of the nation's spent nuclear fuel and high level nuclear waste." NARUC's motion also contends that \$17 billion collected from utility ratepayers for the nuclear waste program will be wasted if the Yucca Mountain license application is withdrawn.²⁷ Also seeking to intervene were Aiken County, SC, and the Prairie Island Indian Community in Minnesota.

The ASLB denied DOE's license withdrawal motion June 29, 2010, ruling that NWA prohibits DOE from withdrawing the license application until NRC determines whether the repository is acceptable. According to the board, "Surely Congress did not contemplate that, by withdrawing the Application, DOE might unilaterally terminate the Yucca Mountain review process in favor of DOE's independent policy determination that 'alternatives will better serve the public interest.'"²⁸

²³ Statement of Peter B. Lyons, Assistant Secretary for Nuclear Energy, U.S. Department of Energy, before the Committee on Energy and Commerce, Subcommittee on Environment and the Economy, June 1, 2011.

²⁴ DOE Motion to Withdraw, *op. cit.*

²⁵ Nicole E. Matthews, "DOE Withdraws Application for Yucca Nuke Dump," *Fox5Vegas.com*, March 3, 2010, <http://www.fox5vegas.com/news/22734591/detail.html>.

²⁶ *Motion for the State of Nevada for Leave to Intervene as Intervenor-Respondent*, U.S. Court of Appeals for the Fourth Circuit, Case No. 10-1229, March 19, 2010, <http://www.state.nv.us/nucwaste/licensing/nv100319motion3.pdf>.

²⁷ National Association of Regulatory Utility Commissioners, "NARUC Seeks Party Status at NRC, Says Yucca Review Must Continue," press release, March 16, 2010, <http://www.naruc.org/News/default.cfm?pr=191&pdf=>.

²⁸ U.S. Nuclear Regulatory Commission, Atomic Safety and Licensing Board, Docket No. 63-001-HLW, Memorandum (continued...)

The next day, the NRC commissioners invited briefs on whether it should review the ASLB decision, and DOE filed a brief on July 9, 2010, urging that the ruling be reversed. DOE argued in its brief that the Secretary of Energy has broad authority under the Atomic Energy Act and Department of Energy Organization Act “to make policy decisions regarding disposal of nuclear waste and spent nuclear fuel.” DOE contended that such authority includes “the authority to discontinue the Yucca Mountain project” and that NRC rules provide “that applicants in NRC licensing proceedings may withdraw their applications.”²⁹ The NRC commissioners have not released a decision on the matter.

South Carolina and Aiken County filed challenges to the Yucca Mountain license withdrawal in the U.S. Court of Appeals for the District of Columbia Circuit, contending that NWPA requires the licensing process to proceed. The Court on July 1, 2011, declined to rule on the issue before NRC has taken final action. However, the Court noted that NWPA’s three-year deadline for NRC to issue a final decision on the Yucca Mountain license application occurs during 2011 (either in June or September, depending on whether the clock started when the application was filed or when it was docketed) and that further NRC delay might draw Court intervention on those grounds.³⁰

(For more details about nuclear waste legal proceedings, see CRS Report R40996, *Contract Liability Arising from the Nuclear Waste Policy Act (NWPA) of 1982*, by Todd Garvey.)

Congressional Action

President Obama’s proposal to terminate the Yucca Mountain project and search for disposal alternatives has prompted substantial congressional debate and a number of legislative proposals. Debate over nuclear waste policy has also been affected by the March 11 Fukushima Daiichi nuclear accident in Japan. The loss of power at the Fukushima site, caused by a huge earthquake and tsunami, disabled cooling systems at the plant’s spent fuel pools. Water in the pools may have boiled or leaked and dropped below the level of the stored spent fuel, potentially leading to fuel damage and radioactive releases into the atmosphere. Concerns have been raised in Congress about the risk posed by stored spent fuel, particularly that cancellation of the Yucca Mountain repository would leave growing amounts of spent fuel indefinitely stored at nuclear plant sites throughout the country.

Representative Markey introduced legislation March 29, 2011, that would require spent fuel to be transferred from pools to dry casks, which are cooled by natural air circulation, within one year after it has sufficiently cooled (H.R. 1242). A bill by Representative Engel includes the same dry cask storage requirement but allows costs to be offset by lower payments into the Nuclear Waste Fund (H.R. 2075). Senator Feinstein, chairman of the Senate Appropriations Subcommittee on Energy and Water, urged in an April 8, 2011, letter to NRC that spent fuel be moved more rapidly

(...continued)

and Order, June 29, 2010.

²⁹ *U.S. Department of Energy’s Brief in Support of Review and Reversal of the Board’s Ruling on the Motion to Withdraw*, Docket No. 63-001-HLW, July 9, 2010.

³⁰ *In Re: Aiken County, Petitioner*, U.S. Court of Appeals for the District of Columbia Circuit, USCA Case No. 10-1050, decided July 1, 2011.

from spent fuel pools to dry casks than under current policy.³¹ Other bills would encourage recycling of spent nuclear fuel, develop nuclear waste disposal capacity, provide incentives for local governments to host privately owned nuclear waste storage facilities, and remove statutory limits on waste disposal at the proposed Yucca Mountain repository (see “Legislation” at the end of this report).

Nuclear waste policy has been the subject of numerous hearings in the 112th Congress, in both appropriations and authorizing committees. In a hearing June 1, 2011, Representative Shimkus, chairman of the Subcommittee on Environment and the Economy of the House Committee on Energy and Commerce, criticized DOE for halting the Yucca Mountain project without citing a technical basis for the decision. “Politics, not science, is driving the debate,” he said in his opening statement.³² At a June 14, 2011, hearing, the subcommittee questioned NRC Chairman Gregory Jaczko’s decision to terminate the Yucca Mountain license review during FY2011, including a nearly completed safety review of the repository.³³ After examining NRC’s unreleased draft safety review, the majority staff of the House Committee on Science, Space, and Technology reported in June 2011 that NRC staff had “made over 1500 findings related to the scientific and technical research efforts of the Department of Energy” and that 98.5% of those findings had been in agreement with DOE’s conclusions.³⁴

Characteristics and Handling of Nuclear Waste

Radioactive waste is a term that encompasses a broad range of material with widely varying characteristics. Some waste has relatively slight radioactivity and is safe to handle in unshielded containers, 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 described below:³⁵

Spent nuclear fuel. Fuel rods that have been withdrawn from a nuclear reactor after irradiation, usually because they can no longer efficiently sustain a nuclear chain reaction. (The term “spent nuclear fuel” is defined in NWPA. The nuclear industry typically refers to spent fuel as “used nuclear fuel,” because it contains uranium and plutonium that could be extracted through

³¹ Senator Dianne Feinstein, “Feinstein Urges Reform of U.S. Spent Nuclear Fuel Storage,” press release, April 11, 2011, http://feinstein.senate.gov/public/index.cfm?FuseAction=NewsRoom.PressReleases&ContentRecord_id=46244216-5056-8059-76e0-3d5a15d5d570.

³² Opening Statement, Chairman John Shimkus, Environment Subcommittee Hearing, “DOE’s Role in Managing Civilian Radioactive Waste,” June 1, 2011, <http://republicans.energycommerce.house.gov/Media/file/Hearings/Environment/060111/Shimkus.pdf>.

³³ House Energy and Commerce Subcommittee on Environment and the Economy, “Bipartisan Concern Over Administration’s Haste to Terminate Permanent Nuclear Repository,” press release, June 15, 2011, <http://energycommerce.house.gov/news/PRArticle.aspx?NewsID=8710>.

³⁴ Yucca Mountain: The Administration’s Impact on U.S. Nuclear Waste Management Policy, Report by the Majority Staff of the House Science, Space, and Technology Committee, June 2011, p. 34, <http://science.house.gov/press-release/committee-releases-report-outlining-administration%E2%80%99s-actions-undermine-us-nuclear>.

³⁵ Statutory definitions for “spent nuclear fuel,” “high-level radioactive waste,” and “low-level radioactive waste” can be found in Section 2 of the Nuclear Waste Policy Act of 1982 (42 U.S.C. 10101). “Transuranic waste” is defined in Section 11ee. of the Atomic Energy Act (42 U.S.C. 2014e); Section 11e.(2) of the Act includes uranium mill tailings in the definition of “byproduct material.” “Mixed waste” consists of chemically hazardous waste as defined by EPA regulations (40 CFR Part 261, Subparts C and D) that contains radioactive materials as defined by the Atomic Energy Act.

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 the nuclei of uranium and other fissile elements) as well as long-lived radionuclides (radioactive atoms) such as plutonium, which remains dangerously radioactive for tens of thousands of years or more.

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 typically 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. TRU waste is being sent to a deep underground repository, the Waste Isolation Pilot Plant (WIPP), near Carlsbad, NM.

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. Chemically hazardous waste that includes radioactive material. High-level, low-level, and TRU waste, and radioactive byproduct material, often falls under the designation of mixed waste. Such waste poses complicated institutional problems, because the radioactive portion is regulated by DOE or NRC under the Atomic Energy Act, while the Environmental Protection Agency (EPA) and states regulate 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, most of the U-235 nuclei in the fuel rods have been split into a variety of highly radioactive fission products. Some of the nuclei of the dominant isotope U-238 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 deep pools of water adjacent to the reactors to keep them from

overheating and to protect workers from radiation. To prevent the pools from filling up, older, cooler spent fuel often is sealed in dry canisters and transferred to radiation-shielded storage facilities elsewhere at reactor sites.

Spent fuel discharged from U.S. commercial nuclear reactors is currently stored at 64 operating nuclear plant sites, 10 shutdown plant sites, and the Idaho National Laboratory.³⁶ 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. The nuclear industry estimated that the total amount of commercial spent fuel was 65,193 metric tons at the end of 2010, including 16,113 metric tons in dry storage and other separate storage facilities.³⁷ Counting 7,000 metric tons of DOE spent fuel and high-level waste that had also been planned for disposal at Yucca Mountain, the total amount of existing waste would exceed NWPA's 70,000-metric-ton limit for the repository.

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's most recent estimates of the total amount of U.S. commercial spent fuel that may eventually require disposal range from 105,000 metric tons³⁸ to 130,000 metric tons.³⁹

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 an indefinite period. Most utilities are expected to construct new dry storage capacity at reactor sites. Fifty-three licensed dry storage facilities are currently operating in the United States.⁴⁰ NRC has determined that spent fuel could be stored safely at reactor sites for at least 60 years after a site's reactors cease operation (for a total of 120 years, assuming reactors are licensed for 60 years).⁴¹

The terrorist attacks of September 11, 2001, heightened concerns about the vulnerability of stored spent fuel. Concerns have been raised that an aircraft crash into a reactor's pool area or acts of sabotage 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.

In a report released April 6, 2005, the National Academy of Sciences (NAS) found that "successful terrorist attacks on spent fuel pools, though difficult, are possible." To reduce the likelihood of spent fuel cladding fires, the NAS study recommended that hotter and cooler spent

³⁶ Gutherman Technical Services, *2010 Used Fuel Data*, January 18, 2011. This includes General Electric's spent fuel storage facility at Morris, IL, located adjacent to the Dresden nuclear plant. Also, the Hope Creek and Salem nuclear plants in New Jersey are counted as a single site.

³⁷ Gutherman Technical Services, *op. cit.*

³⁸ DOE Office of Civilian Radioactive Waste Management, *OCRWM Annual Report to Congress, Fiscal Year 2002*, DOE/RW-0560, October 2003, Appendix C.

³⁹ DOE Office of Civilian Radioactive Waste Management, *Draft Supplemental Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada*, Summary, DOE/EIS-0250F-S1D, October 2007, p. S-47.

⁴⁰ Gutherman Technical Services, *op. cit.* In addition, GE operates an independent pool storage facility near Morris, IL.

⁴¹ Nuclear Regulatory Commission, *Waste Confidence Decision Update*, 75 *Federal Register* 81037, December 23, 2010, <http://www.federalregister.gov/articles/2010/12/23/2010-31637/waste-confidence-decision-update#p-372>.

fuel assemblies be interspersed throughout spent fuel pools, that spray systems be installed above the pools, and that more fuel be transferred from pools to dry cask storage.⁴² NRC has agreed to consider some of the recommendations, although it contends that current security measures would prevent successful attacks. The nuclear industry contends 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.

As noted above, the Fukushima accident demonstrated that spent fuel pools could be vulnerable to accidental damage resulting from the loss of cooling systems. The safety of spent fuel pools is one of the areas examined by an NRC task force that identified near-term lessons that the Fukushima accident may hold for U.S. nuclear power plant regulation. The task force recommended that assured sources of electrical power as well as water spray systems be available for spent fuel pools.⁴³

Commercial Low-Level Waste

More than 2.1 million cubic feet of low-level waste with about 60,000 curies of radioactivity was shipped to commercial disposal sites in 2010, according to DOE.⁴⁴ Volumes and radioactivity can vary widely from year to year, based on the status of nuclear decommissioning projects and cleanup activities that can generate especially large quantities.

Low-level radioactive waste is divided into three major categories for handling and disposal: Class A, B, and C. Classes B and C have constituted less than 1% of the volume of U.S. low-level waste disposal during the past five years but contain most of its radioactivity. As discussed below, most of the nation's Class B and C waste has been stored where it has been generated since June 2008 for lack of a permanent disposal site. For more background on radioactive waste characteristics, see CRS Report RL32163, *Radioactive Waste Streams: Waste Classification for Disposal*, by Anthony Andrews.

Current Policy and Regulation

Disposal of spent fuel and high-level waste is 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.

⁴² National Academy of Sciences, *Safety and Security of Commercial Spent Nuclear Fuel Storage: Public Report*, released April 6, 2005, p. 2.

⁴³ U.S. Nuclear Regulatory Commission, Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident, *Recommendations for Enhancing Reactor Safety in the 21st Century*, p. 46, <http://pbadupws.nrc.gov/docs/ML1118/ML111861807.pdf>.

⁴⁴ U.S. Department of Energy, Management Information Manifest System, <http://mims.apps.em.doe.gov/mims.asp#>.

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, holding receipts from 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.

Along with halting all funding for the Yucca Mountain project, the Obama Administration terminated OCRWM at the end of FY2010 and transferred its remaining functions to DOE's Office of Nuclear Energy. The Blue Ribbon Commission on America's Nuclear Future issued its draft report on a new nuclear waste strategy July 29, 2011.

Private Interim Storage

In response to delays in the federal nuclear waste program, a utility consortium signed an agreement with the Skull Valley Band of the Goshute Indians in Utah 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, and an NRC licensing board recommended approval on February 24, 2005. On September 9, 2005, NRC denied the state of Utah's final appeals and authorized the NRC staff to issue the license. The 20-year license for storing up to 44,000 tons of spent fuel in dry casks was issued on February 21, 2006, although NRC noted that Interior Department approval would also be required.

On September 7, 2006, the Department of the Interior issued two decisions against the PFS project. The Bureau of Indian Affairs disapproved a proposed lease of tribal trust lands to PFS, concluding there was too much risk that the waste could remain at the site indefinitely.⁴⁵ The

⁴⁵ Bureau of Indian Affairs, *Record of Decision for the Construction and Operation of an Independent Spent Fuel Storage Installation (ISFSI) on the Reservation of the Skull Valley Band of Goshute Indians (Band) in Tooele County, Utah*, September 7, 2006.

Bureau of Land Management rejected the necessary rights-of-way to transport waste to the facility, concluding that a proposed rail line would be incompatible with the Cedar Mountain Wilderness Area and that existing roads would be inadequate.⁴⁶

In reaction to the Interior Department decisions, Senator Hatch, a staunch opponent of the PFS proposal, declared the project “stone cold dead.”⁴⁷ However, the Skull Valley Band of Goshutes and PFS filed a federal lawsuit July 17, 2007, to overturn the Interior decisions on the grounds that they were politically motivated.⁴⁸ A federal district court judge on July 26, 2010, ordered the Department of the Interior to reconsider its decisions on the PFS permits.⁴⁹

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 would have to use NRC-certified casks and comply with NRC requirements for notifying state and local governments. Yucca Mountain shipments would also have to follow DOT regulations on routing, placarding, and safety.

NRC’s licensing requirements for Yucca Mountain, at 10 C.F.R. 63, require compliance with EPA’s standards (described below) and establish procedures that DOE must follow in seeking a repository license. For example, DOE is required to 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.

The Energy Policy Act of 1992 (P.L. 102-486) made a number of changes in the nuclear waste regulatory system, particularly that EPA was required to 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 raised concern that some of EPA’s general standards might be impossible or impractical to meet at Yucca Mountain.⁵⁰

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

⁴⁶ Bureau of Land Management, *Record of Decision Addressing Right-of-Way Applications U 76985 and U 76986 to Transport Spent Nuclear Fuel to the Reservation of the Skull Valley Band of Goshute Indians*, September 7, 2006.

⁴⁷ Senator Orrin Hatch, *Utahns Deliver Killing Blow to Skull Valley Nuke Waste Plan*, News Release, September 7, 2006.

⁴⁸ Winslow, Ben, “Goshutes, PFS Sue Interior,” *Deseret Morning News*, July 18, 2007.

⁴⁹ U.S. District Court for the District of Utah, *Skull Valley Band of Goshute Indians and Private Fuel Storage v. United States Department of the Interior*, Civil Action No. 07-cv-0526-DME-DON, July 26, 2010, <http://64.38.12.138/docs/court/goshute/order072610.pdf>.

⁵⁰ See, for example: NRC, “Analysis of Energy Policy Act of 1992 Issues Related to High-Level Waste Disposal Standards, SECY-93-013, January 25, 1993, attachment p. 4.

Academy of Sciences (NAS), which was issued August 1, 1995.⁵¹ 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 of 1992, 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 400,000 years.

EPA issued its final Yucca Mountain standards on June 6, 2001. The final standards included most of the major provisions of the proposed version, including the 15 millirem overall exposure limit and the 4 millirem groundwater limit. 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.

A three-judge U.S. Court of Appeals panel on July 9, 2004, struck down the 10,000-year regulatory compliance period in the EPA and NRC Yucca Mountain standards.⁵² 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.

In response to the court decision, EPA proposed a new version of the Yucca Mountain standards on August 9, 2005. The proposal would have retained the dose limits of the previous standard for the first 10,000 years but allowed a higher annual dose of 350 millirems for the period of 10,000 years through 1 million years. EPA also proposed to base the post-10,000-year Yucca Mountain standard on the median dose, rather than the mean, potentially making it easier to meet.⁵³ Nevada state officials called EPA’s proposed standard far too lenient and charged that it was “unlawful and arbitrary.”⁵⁴

⁵¹ National Research Council. *Technical Bases for Yucca Mountain Standards*. National Academy Press. 1995.

⁵² *Nuclear Energy Institute v. Environmental Protection Agency*, U.S. Court of Appeals for the District of Columbia Circuit, No. 01-1258, July 9, 2004.

⁵³ Especially high doses at the upper end of the exposure range would raise the mean, or average, more than the median, or the halfway point in the data set.

⁵⁴ Office of the Governor, Agency for Nuclear Projects. *Comments by the State of Nevada on EPA’s Proposed New Radiation Protection Rule for the Yucca Mountain Nuclear Waste Repository*. November 2005.

EPA issued its final rule to amend the Yucca Mountain standards on September 30, 2008. The final rule reduced the annual dose limit during the period of 10,000 through 1 million years from the proposed 350 millirems to 100 millirems, which the agency contended was consistent with international standards. Under the final rule, compliance with the post-10,000-year standard will be based on the arithmetic mean of projected doses, rather than the median as proposed. The 4 millirem groundwater standard will continue to apply only to the first 10,000 years.⁵⁵ NRC revised its repository licensing regulations to conform to the new EPA standards on April 13, 2009.⁵⁶ (For more information, see CRS Report RL34698, *EPA's Final Health and Safety Standard for Yucca Mountain*, by Bonnie C. Gitlin.)

DOE estimated in its June 2008 Final Supplemental Environmental Impact Statement (FSEIS) for the Yucca Mountain repository that the maximum mean annual individual dose after 10,000 years would be 2 millirems. That is substantially below the level estimated by the 2002 Final Environmental Impact Statement, which calculated that the peak doses—occurring after 400,000 years—would be about 150 millirems (Volume 1, Chapter 5). The FSEIS attributed the reduction to changes in DOE's computer model and in the assumptions used, noting that "various elements of DOE's modeling approach may be challenged as part of the NRC licensing process."⁵⁷

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 reduce waste disposal risks. 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 below the seabed 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 reprocessing or "recycling" of spent fuel so that plutonium, uranium, and other long-lived radionuclides could be converted to faster-decaying fission products in special nuclear reactors or particle accelerators. Emplacing waste in deep boreholes, at much greater depths than most proposed repositories, has also been suggested.

DOE's Fuel Cycle Research and Development Program conducts "long-term, science-based" research on a wide variety of technologies for improving the management of spent nuclear fuel, according to the DOE budget justification. The total FY2012 funding request for this program is \$155 million.

Under the Obama Administration, the program has been redirected toward development of technology options for a wide range of nuclear fuel cycle approaches, including direct disposal of spent fuel (the "once through" cycle) and partial and full recycling, according to the justification. "Specifically, the program will research and develop a suite of technology options that will enable

⁵⁵ Posted on the EPA website at <http://www.epa.gov/radiation/yucca>.

⁵⁶ Nuclear Regulatory Commission, "Implementation of a Dose Standard After 10,000 Years," 74 *Federal Register* 10811, March 13, 2009.

⁵⁷ FSEIS, p. S-42. Posted on the DOE website at http://www.rw.doe.gov/ym_repository/seis/docs/002_Summary.pdf.

future decision-makers to make informed decisions about how best to manage nuclear waste and used fuel from reactors,” the justification says.

Funding

The Obama Administration’s FY2011 budget request called for a complete halt in funding for the Yucca Mountain project and elimination of OCRWM. In line with the request, the FY2011 Continuing Appropriations Act (P.L. 112-10) provided no DOE funding for the program. DOE shut down the Yucca Mountain project at the end of FY2010 and transferred OCRWM’s remaining functions to the Office of Nuclear Energy.

NRC requested \$10 million from the Nuclear Waste Fund in FY2011 for the Yucca Mountain licensing process. In light of DOE’s motion to withdraw the Yucca Mountain license application, the NRC funding request would cover the costs of adjudicating the license withdrawal motion as well as “work related to an orderly closure of the agency’s Yucca Mountain licensing support activities such as archiving material, knowledge capture and management, and maintenance of certain electronic systems,” according to NRC’s budget presentation. The NRC funding request was approved by P.L. 112-10.

For FY2012, the Administration again requested no funding for the Yucca Mountain project, but the House voted July 15, 2011, to provide \$25 million to DOE and \$20 million to NRC to continue the Yucca Mountain licensing process. The House-passed bill specifies that the funds may not be used for closing out licensing activities unless the NRC commissioners accept DOE’s license withdrawal motion, “or for actions that irrevocably remove the possibility that Yucca Mountain may be a repository option in the future.”

During consideration of the FY2010 budget request, the House Appropriations Committee had stipulated that the Blue Ribbon Commission consider the continuation of the Yucca Mountain project under current law as one of the future waste management alternatives, and the Senate Appropriations Committee had called for the Secretary of Energy to suspend the Nuclear Waste Fee on nuclear power generation, which pays for the waste program. However, both provisions were dropped in conference.

Funding for the nuclear waste program has historically been provided under two appropriations accounts, as shown in **Table 1**. These accounts are, first, appropriations from the Nuclear Waste Fund, which holds fees paid by nuclear utilities, and, second, the Defense Nuclear Waste Disposal account, which pays for disposal of high-level waste from the nuclear weapons program.

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 January 31, 2010, utility nuclear waste fees and interest totaled \$31.69 billion, of which \$7.41 billion had been disbursed to the waste disposal program, according to DOE’s program summary report, leaving a balance of \$24.276 billion in the Nuclear Waste Fund. In addition to the disbursements from the Nuclear Waste Fund, the waste disposal program received defense waste disposal appropriations totaling \$3.974 billion through FY2010, according to DOE.⁵⁸

⁵⁸ DOE, Office of Civilian Radioactive Waste Management, Office of Program Management, *Monthly Summary of Program Financial and Budget Information*, as of July 1, 2009, available at <http://www.rw.doe.gov/about/> (continued...)

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

Program	FY2009 Approp.	FY2010 Approp.	FY2011 Approp.	FY2012 Request	FY2012 House.
Yucca Mountain	183.3	116.1	0	0	20.0
Transportation	2.1	0	0	0	0
Management and Integration	26.2	10.7	0	0	0
Program Direction and Other	76.8	70.0	0	0	5.0
Total	288.4	196.8	0	0	25.0
Source of Funding					
Nuclear Waste Fund appropriations	145.4	98.4	0	0	25.0
Defense waste appropriations	143.0	98.4	0	0	0

Sources: DOE congressional budget requests, H.Rept. 111-203, S.Rept. 111-45.

DOE's most recent update of its Analysis of the Total System Life Cycle Cost of the Civilian Radioactive Waste Management Program was released on August 5, 2008.⁵⁹ According to that estimate, the Yucca Mountain program as then planned would cost \$96.2 billion in 2007 dollars from the beginning of the program in 1983 to repository closure in 2133. DOE's previous estimate, issued in 2001, was \$57.5 billion in 2000 dollars. Major factors in the increase are inflation and a higher estimate of spent fuel to be generated by existing reactors. Spent fuel from proposed new reactors is not included in the cost estimate.

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 authorized to be conducted by states 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. 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 of the three sites, near Beatty, NV, closed. The remaining

(...continued)

Monthly_Financial_and_Budget_Summary.shtml. The report notes that some figures may not add due to independent rounding.

⁵⁹ Available on the OCRWM website at http://www.rw.doe.gov/about/budget/pdf/TSLCC_2007_8_05_08.pdf.

two—at Barnwell, SC, and Hanford, WA—are using their congressionally granted authority to prohibit waste from outside their regional compacts. Another site, in Utah, has since become available nationwide for most Class A low-level waste, but no site is currently open to nationwide disposal of all major types of low-level waste. As a result, most of the nation’s class B and C waste is currently being stored at the sites where it is generated.

A commercial low-level waste disposal site planned by the Texas Compact may address the class B and C storage problem. The Texas legislature voted in May 2011 to allow up to 30% of the Texas disposal site’s capacity to be used by states outside of the compact, which consists of Texas and Vermont. The disposal site, in Andrews County, TX, is licensed to handle class A, B, and C waste. The facility is currently under construction and scheduled to begin receiving waste by the end of 2011.⁶⁰

Legislation providing congressional consent to the Texas compact, which originally also included Maine as well as 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, TX, was rejected by the Texas Natural Resource Conservation Commission, and Maine subsequently withdrew. Texas Governor Perry signed legislation June 20, 2003, authorizing the Texas Commission on Environmental Quality (TCEQ) to license adjoining disposal facilities for commercial and federally generated low-level waste. Pursuant to that statute, an application to build the Andrews County disposal facility was filed August 2, 2004, by Waste Control Specialists LLC. TCEQ voted January 14, 2009, to issue the license after the necessary land and mineral rights had been acquired and approved construction of the facility January 7, 2011.⁶¹

The disposal facility at Barnwell, SC, is currently accepting all Class A, B, and C low-level waste from the Atlantic Compact (formerly the Northeast Compact), in which South Carolina joined original members 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, and a state law enacted in June 2000 phased out acceptance of non-compact waste through June 30, 2008. The Barnwell facility previously 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. The U.S. Supreme Court ruled on June 1, 2010, that the withdrawal did not subject North Carolina to sanctions under the compact.⁶²

The only other existing disposal facility for all three major classes of low-level waste is at Hanford, WA. Controlled by the Northwest Compact, the Hanford site will continue taking waste from the neighboring Rocky Mountain Compact under a contract. Since the South Carolina facility closed to out-of-region waste, the 36 states and the District of Columbia that are outside the Northwest, Rocky Mountain, and Atlantic compacts have had no disposal site for Class B and C low-level waste.

⁶⁰ Waste Control Specialists website, <http://www.wcstexas.com>.

⁶¹ TCEQ website: http://www.tceq.state.tx.us/permitting/radmat/licensing/wcs_license_app.html#wcs_status.

⁶² *Alabama et al. v. North Carolina*, S. Ct. (2010), <http://www.supremecourt.gov/opinions/09pdf/132Orig.pdf>.

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.

Concluding Discussion

Disposal of radioactive waste will be a key issue in the continuing nuclear power debate. Without a national disposal system, spent fuel from nuclear power plants must be stored on-site indefinitely. This situation may raise public concern near proposed reactor sites, particularly at sites without existing reactors where spent nuclear fuel is already stored. Concern about spent fuel storage safety has been heightened by the March 2011 accident at Japan’s Fukushima Daiichi nuclear plant.

Under current law, the federal government’s nuclear waste disposal policy is focused on the Yucca Mountain site. However, President Obama’s plan to terminate the Yucca Mountain project and develop a new waste strategy through the Blue Ribbon Commission on America’s Nuclear Future has brought most activities in the DOE waste program to a halt. Congress is continuing to debate the project’s termination, particularly through the appropriations process.

Because of their waste-disposal contracts with DOE, owners of existing reactors are likely to continue seeking damages from the federal government if disposal delays continue. DOE’s 2004 settlement with the nation’s largest nuclear operator, Exelon, could require payments of up to \$600 million from the federal judgment fund, for example. DOE estimates that payments could rise above \$13 billion if the federal government cannot begin taking waste from reactor sites before 2020, as previously planned. The nuclear industry has predicted that future damages could reach tens of billions of dollars if the federal disposal program fails altogether.

Lack of a nuclear waste disposal system could also affect the licensing of proposed new nuclear plants, both because of NRC licensing guidelines and various state laws.⁶³ In addition, further repository delays could force DOE to miss compliance deadlines for defense waste disposal.

Problems being created by nuclear waste disposal delays are being addressed by the Blue Ribbon Commission. Major options include centralized interim storage, continued storage at existing nuclear sites, reprocessing and waste treatment technology, development of alternative repository sites, or a combination. Given the delays resulting from the ongoing shutdown of the nuclear waste program, longer on-site storage is almost a certainty under any option. Any of the options would also face intense controversy, especially among states and regions that might be potential hosts for future waste facilities. As a result, substantial debate would be expected over any proposals to change the Nuclear Waste Policy Act.

⁶³ Lovell, David L., Wisconsin Legislative Council Staff, *State Statutes Limiting the Construction of Nuclear Power Plants*, October 5, 2006.

Legislation

H.R. 301 (Forbes)

New Manhattan Project for Energy Independence. Establishes program to develop new energy-related technologies, including treatment of nuclear waste. Introduced January 18, 2011; referred to Committee on Science, Space, and Technology.

H.R. 617 (Matheson)

Radioactive Import Deterrence Act. Restricts imports of radioactive waste. Introduced February 10, 2011; referred to Committee on Energy and Commerce.

H.R. 909 (Nunes)

Roadmap for America's Energy Future. Includes provisions to triple the number of U.S. nuclear power plants, encourage recycling of spent nuclear fuel, develop nuclear waste disposal capacity, remove statutory limits on waste disposal at the proposed Yucca Mountain repository, establish a nuclear fuel supply reserve, and require NRC to establish expedited procedures for issuing new reactor combined construction and operating licenses. Introduced March 3, 2011; referred to multiple committees.

H.R. 1023 (Thornberry)

No More Excuses Energy Act of 2011. Includes provisions to prohibit NRC from considering nuclear waste storage when licensing new nuclear facilities, and to establish a tax credit for obtaining nuclear component manufacturing certification. Introduced March 10, 2011; referred to multiple committees.

H.R. 1242 (Markey)

Nuclear Power Plant Safety Act of 2011. Requires NRC to revise its regulation within 18 months to ensure that nuclear plants could handle major disruptive events, a loss of off-site power for 14 days, and the loss of diesel generators for 72 hours. Spent fuel would have to be moved from pool to dry-cask storage within a year after it had cooled sufficiently, and emergency planning would have to include multiple concurrent disasters. NRC could not issue new licenses or permits until the revised regulations were in place. Introduced March 29, 2011; referred to Committee on Energy and Commerce.

H.R. 1710 (Burgess)

Nuclear Used Fuel Prize Act of 2011. Authorizes the Secretary of Energy to establish monetary prizes for advancements in used nuclear fuel management technology. Introduced May 4, 2011; referred to Committees on Science, Space, and Technology and Ways and Means.

H.R. 2075 (Engel)

Dry Cask Storage Act. Requires spent nuclear fuel to be moved from storage pools to dry casks within one year after it has sufficiently cooled. Owners of spent fuel could reduce their payments to the Nuclear Waste Fund to offset extra dry cask storage costs resulting from the act. Introduced June 1, 2011; referred to Committee on Energy and Commerce.

H.R. 2133 (Matheson)/S. 1220 (Conrad)

Fulfilling U.S. Energy Leadership (FUEL) Act. Among other provisions, authorizes nuclear fuel cycle research and development, including waste treatment processes and advanced waste forms. Requires the Secretary of Energy to consider recommendations of the Blue Ribbon Commission on America's Nuclear Future in implementing the authorized program and to submit a report to Congress comparing the Secretary's proposed long-term nuclear waste management solutions with the proposed Yucca Mountain repository. House bill introduced June 3, 2011; referred to multiple committees. Senate bill introduced June 16, 2011; referred to Committee on Finance.

S. 1320 (Murkowski)

Nuclear Fuel Storage Improvement Act of 2011. Authorizes the Secretary of Energy to provide payments to units of local government that, with the approval of the state governor, volunteer to host a "privately owned and operated temporary used fuel storage facility." Introduced June 30, 2011; referred to Committee on Environment and Public Works.

For Additional Reading

Blue Ribbon Commission on America's Nuclear Future.

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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.

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University of Illinois. Program in Arms Control, Disarmament, and International Security. *'Plan D' for Spent Nuclear Fuel*. 2009. <http://acdis.illinois.edu/publications/207/publication-PlanDforSpentNuclearFuel.html>.

U.S. Department of Energy. *Office of Civilian Radioactive Waste Management home page*; provides archived documents from the Yucca Mountain project, which the Obama Administration is working to terminate. <http://www.ocrwm.doe.gov>.

U.S. General Accounting Office. *Low-Level Radioactive Waste: Disposal Availability Adequate in the Short Term, but Oversight Needed to Identify Any Future Shortfalls*. GAO-04-604. June 2004. 53 p.

Walker, J. Samuel. *The Road to Yucca Mountain: The Development of Radioactive Waste Policy in the United States*. University of California Press. 2009. 228 p.

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