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Waist-Deep in Nuclear Waste: How the NRC Can Rebuild Confidence in a Stalled Waste Management Program

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By Emily Casey*

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I. INTRODUCTION

The United States is in a particularly uncertain situation as to how to dispose of spent nuclear fuel, which is highly radioactive waste that is now being held at various facilities across the country. For over two decades, U.S. nuclear waste policy rested on the development of a long-term geologic burial site in Yucca Mountain, Nevada. However, the Yucca Mountain waste management program was suspended indefinitely in 2010. The United States is now "back to the drawing board" in the sense that it lacks a long-term solution for the safe disposal of nuclear waste.

The agency responsible for licensing nuclear facilities, the Nuclear Regulatory Commission (NRC), is now in a difficult position. Recently, in *New York v. Nuclear Regulatory Commission*,[1] the D.C. Circuit Court of Appeals vacated two NRC rulings that enabled the agency to issue operating licenses to nuclear facilities. The court held that the NRC's rulings improperly conclude that permanent storage of nuclear waste will become available "when necessary," which is an insufficient evaluation under the National Environmental Policy Act (NEPA).[2] In response, the NRC announced a freeze on all licensing and renewals of licenses until it addresses the court's ruling.

This comment will explain why the federal nuclear waste management program is at a standstill and will suggest a course of action for the NRC to help revive the program. Part II describes the environmental hazards of spent nuclear fuel and the federal government's effort to site and build a geologic repository for this nuclear waste. Part III explains the role of the NRC in the nuclear regulatory scheme and how safety and environmental regulations are promulgated and enforced. Part IV narrows in on the NRC rulemakings called the "Waste Confidence Decision" and

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[1] New York v. Nuclear Regulatory Comm'n, 681 F.3d 471 (D.C. Cir. 2012).

[2] *Id.* at 478.

"Temporary Storage Rule," and the reasons why they were defeated in *New York v. Nuclear Regulatory Commission*. In Part V, I propose that the NRC make significant changes to these "waste confidence" rulings to ensure compliance with NEPA.

Political failures have demonstrated that the NRC can no longer presume the opening of a permanent geologic repository within a reasonable time frame. In the absence of a repository, the NRC should amend the rulings to consider other interim options, namely consolidation of above-ground storage sites. By incorporating these changes, the NRC will acknowledge the current reality of nuclear waste policy, promote practical strategies that are likely to be pursued given this reality, and thus offer a better environmental evaluation under NEPA.

II. THE PROBLEM OF SPENT NUCLEAR FUEL

It may come as a surprise to learn that roughly twenty percent of the nation's electricity is generated by nuclear energy.[3] Nuclear power production has increased over the last decade,[4] surpassing electricity generation from all other sources but coal, which produces roughly half of the electricity in the United States.[5] Nuclear energy is a leading option for the future, namely because it is produced domestically, reduces national fossil fuel dependency, and is one of the least expensive forms of energy.[6] Relative to other sources of

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[3] BLUE RIBBON COMMISSION ON AMERICA'S NUCLEAR FUTURE, REPORT TO THE SECRETARY OF ENERGY 14 (Jan. 2012) [hereinafter BRC REPORT], *available at* http://cybercemetery.unt.edu/archive/brc/20120620220235/http://brc.gov/sites/default/files/documents/brc_finalreport_jan2012.pdf.

[4] *See* U.S. ENERGY INFORMATION ADMINISTRATION, ANNUAL ENERGY REVIEW 2011 273, Table 9.2 (Sept. 2012), *available at* http://www.eia.gov/totalenergy/data/annual/pdf/aer.pdf. Although no new nuclear power plants have begun construction since 1978, existing nuclear plants have increased capacity. *Id.* Nuclear plants are now operating at an average of ninety percent capacity, whereas in the 1990s they were averaging seventy-five percent and in the 1980s they were averaging sixty percent. *Id.*

[5] Roger H. Bezdek, *Nuclear Power Prospects in the USA: The Continuing Problem of the Waste Issue*, 20 ENERGY & ENV'T 375, 375 (2009).

[6] Aaron Szabo, *Reprocessing: The Future of Nuclear Waste*, 29 TEMP. J. SCI. TECH. & ENVTL. L. 231, 233 (2010). Nuclear energy is the lowest cost producer of baseload electricity per kilowatt-hour, costing an average of 2 cents per

electricity, nuclear energy generates drastically lower carbon emissions and other criteria pollutants.[7] Regardless of the debates as to whether the commercial nuclear energy sector will or even should expand, the reality is that there are 104 nuclear reactors currently operating in the United States, and these reactors produce an aggregate total of 2,000 to 2,400 metric tons of spent nuclear fuel per year.[8] Accumulation of nuclear waste remains a glaring concern. Safe disposal of spent nuclear fuel has proven to be both a scientific and political challenge. The public must feel uneasy, if not seriously disturbed, at the status of nuclear waste policy in the United States, given that it currently has no long-term solution whatsoever for the disposal of highly radioactive nuclear waste.

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kilowatt-hour. *Nuclear Energy: Just the Facts*, NUCLEAR ENERGY INST., 17 (2010), http://www.nei.org/resourcesandstats/documentlibrary/reliableandaffordableenergy/brochures/justthefacts. Because only a quarter of its production costs are attributed to fuel costs, nuclear power is relatively unaffected by the price fluctuations that drive the costs of fossil-fuel energy, and thus nuclear power has remarkable forward price stability. *Id.*

[7] Justin Gundlach, *What's the Cost of a New Nuclear Power Plant? The Answer's Gonna Cost You: A Risk-Based Approach to Estimating the Cost of New Power Plants*, 18 N.Y.U. ENVTL. L.J. 600, 605 (2010). The nuclear lifecycle yields a small volume of greenhouse gases, close to that of wind power. *Id.* (citing M.V. Ramana, *Nuclear Power: Economic, Safety, Health, and Environmental Issues of Near-Term Technologies*, 34 ANN. REV. ENV'T & RESOURCES, 127, 144 (2009)). In the year 2011, nuclear-generated electricity diverted 613 million metric tons of carbon dioxide. This is roughly equivalent to the amount of carbon dioxide "released from 110 million cars, which is nearly all U.S. passenger cars." *See Environment: Emissions Prevented*, NUCLEAR ENERGY INST., http://www.nei.org/resourcesandstats/nuclear_statistics/environmentemissionsprevented/ (last visited Mar. 10, 2013).

[8] BRC REPORT, *supra* note 3, at 14. Most nuclear power plants are fueled by enriched uranium oxide. Charles de Saillan, *Disposal of Spent Nuclear Fuel in the United States and Europe: A Persistent Environmental Problem*, 34 HARV. ENVTL. L. REV. 461, 472 (2010). The enriched uranium oxide is suspended in zirconium alloy tubes about three or four meters in length called fuel rods. *Id.* Several hundred fuel rods are bundled together to form assemblies within one reactor. *Id.* As the reactor operates, the uranium-235 atoms are split into lighter elements. *Id.* After three or four years, the concentration of uranium-235 decreases such that the nuclear reactor must be shut down and replaced with new fuel. *Id.* These depleted fuel rod assemblies are referred to as "spent nuclear fuel." *Id.*

Spent nuclear fuel (SNF) is composed of highly radioactive nuclear byproducts, some of which have half-lives spanning thousands of years.[9] It also emits thermal heat, making it very dangerous to handle when it comes out of the reactor.[10] Consequently, SNF is first kept in temporary storage to cool before it is moved to another site.[11] Shortly after it is removed from the reactor, SNF is stored in on-site containment pools of circulating water.[12] The water cools the SNF and defrays some of the radiation.[13] After an average of five years in the pool, the SNF can be moved to another facility for further processing, temporary storage, or permanent disposal.[14]

In the absence of a permanent storage facility, nuclear facilities are compensating by keeping SNF at on-site storage units even after they have completed the cooling process. Some plants have adopted dry cask storage, whereby SNF is inserted into a container made of concrete and steel, filled with inert gas, and bolted and welded shut.[15] Dry cask storage is the safest and most preferred storage option, but also more expensive.[16] In studies, the casks have persisted against airplane crashes, explosives, and rounds fired at the

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[9] *See* de Saillan, *supra* note 8, at 472–73. A "half-life" is the amount of time it takes for fifty percent of the atoms in a radioactive isotope to decay. *Id.* at 472 n.74.

[10] *Id.* at 472.

[11] *Id.* at 473.

[12] *Id.* at 474.

[13] *Id.*

[14] "Disposal" and "storage" have different meanings in the context of nuclear waste. Disposal is the final, long-term stage of waste management that relies "only on the passive operation of natural environmental and man-made barriers." BRC REPORT, *supra* note 3, at xi. Disposal refers to geologic burial with the purpose of isolating the nuclear waste from human contact for tens of thousands of years. *See* NEA Issue Brief: No. 3, *The Disposal of High-Level Radioactive Waste*, NEA (Jan. 1989), http://www.oecd-nea.org/brief/brief-03.html. In contrast, "storage" is an interim period in waste management. BRC REPORT, *supra* note 3, at xi. Storage involves managed access to the waste with "active human control and maintenance" so that the waste is still retrievable. *Id.* Nuclear waste in storage is subject to later disposal. *Id.*

[15] de Saillan, *supra* note 8, at 474.

[16] BRC REPORT, *supra* note 3, at 34.

exterior armor.[17] The casks are designed for dual purposes of interim storage and transport, although only a small percentage of SNF has been relocated to off-site facilities. About 15,000 metric tons of commercial SNF have been converted to the dry cask storage form.[18]

The aggregate amount of SNF and high-level waste (HLW) in the United States is over 70,000 metric tons.[19] Nearly all of the existing SNF is stored at the reactor sites where it was generated, including sites that have been shut down.[20] About three-quarters of the SNF remains in its original cooling containment pools.[21] Some nuclear reactors are now storing up to five times as much SNF in their containment pools as was initially subscribed by their operating licenses.[22] Packing more SNF assemblies into these pools impairs the circulation of water and increases the risk of fire.[23]

A. Federal Administrative Responsibility of Nuclear Disposal

As a result of these pronounced dangers, nuclear development is highly regulated by the federal government. The Energy Reorganization Act (ERA) of 1974 established the regulatory system that closest resembles the structure in place today.[24] The ERA of 1974 eliminated the Atomic Energy Commission, which was once the sole, centralized agency for all nuclear development, and divided its functions into two new agencies.[25] First, it designated the responsibility of licensing and regulation of commercial nuclear facilities to the NRC.[26] The second agency, which ultimately evolved into the Department of Energy (DOE), was charged with

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[17] Richard B. Stewart, *U.S. Nuclear Waste Law and Policy: Fixing a Bankrupt System*, 17 N.Y.U. ENVTL. L.J. 783, 805 (2010).

[18] BRC REPORT, *supra* note 3, at 11.

[19] Stewart, *supra* note 17, at 787. High-level waste is spent nuclear fuel that has been reprocessed, but is still highly radioactive. *Id.* at 786. To put this in context, 70,000 metric tons of SNF and HLW would fill one football field to a height of over than 20 feet. *See* BRC REPORT, *supra* note 3, at 14.

[20] BRC REPORT, *supra* note 3, at 14.

[21] *Id.*

[22] de Saillan, *supra* note 8, at 478.

[23] *Id.*

[24] Stewart, *supra* note 17, at 789.

[25] *Id.*

[26] *Id.*

development of nuclear weapons and promotion of nuclear energy.[27] In short, the NRC holds regulatory power over civilian nuclear facilities, while the DOE operates defense nuclear facilities.[28]

In the Nuclear Waste Policy Act (NWPA) of 1982, Congress assumed responsibility for permanent disposal of SNF and HLW, and chose geologic burial as the method of disposal.[29] The NWPA charged the DOE with the overall task of developing a permanent federal repository for commercial waste.[30] To pay for the repository, the NWPA established the Nuclear Waste Fund, which collects fees calculated by the amount of kilowatts of electricity produced from commercial nuclear facilities.[31] The NWPA created a Standard

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[27] *Id.*

[28] *Id.*

[29] Geologic burial was not always the clear choice for nuclear waste disposal. In the initial stages, scientists suggested waste storage in remote and desolate areas, such as Antarctica or space. Karen Breslin, *Radio-Free America: What to Do with the Waste*, 102 ENVTL. HEALTH PERSPECTIVES 832 (1994). These options were abandoned due to exorbitant costs and the risk of catastrophic failure. *Id.* Another suggestion was burial deep within sediments in the seabed. This, too, would be expensive, difficult to retrieve, and potentially violate international ocean dumping laws. *Id.* Another alternative is long-term storage in above-ground units, allowing for more flexibility and easier retrieval. Above-ground storage would rely on human institutions to control and monitor the waste for an indefinite period of time. *Id.* at 833. The United States is not considering this as a long-term strategy, although NGOs have proposed it. *Id.* Geologic burial is the option currently in the lead in the United States and most nuclear countries. *See also* Jane C.S. Long & Rodney C. Ewing, *Yucca Mountain: Earth-Science Issues at a Geologic Repository for High-Level Nuclear Waste*, 32 ANN. REV. OF EARTH & PLANETARY SCI. 363, 368 (2004).

[30] 42 U.S.C. § 10132(a) (2012). The DOE currently operates a geologic repository for *defense*-generated transuranic radioactive waste called the Waste Isolation Pilot Project (WIPP). D.D. TRENT, ET. AL., GEOLOGY AND THE ENVIRONMENT 539 (6th ed. 2010). WIPP is the nation's first underground nuclear waste repository, located in Carlsbad, New Mexico, and has been operating successfully since 1999. *Id.* WIPP is unrelated to the NWPA and its federal repository program for commercial nuclear waste.

[31] 42 U.S.C. § 10222 (2012). The fees yield approximately $750 million per year, and the total unspent balance of the Fund is $27 billion. BRC REPORT, *supra* note 3, at 72. The Fund was created for the "sole purpose" of ensuring that the repository program would not have to compete with other federal programs for funding. *Id.* at xi. However, subsequent congressional and executive actions have defeated this purpose and effectively rendered the Nuclear Waste Fund unavailable. *Id.* at 72–73. Now, nuclear waste programs are paid through yearly appropriations

Contract that obligates the DOE to dispose of SNF and HLW in return for payment by nuclear utilities companies. The Contract's terms specified that the DOE shall take title to all commercial SNF and open a permanent repository by 1998.[32] In addition to outlining a permanent repository program, the NWPA also authorized the DOE to research and design a site for "monitored retrievable storage" (MRS) where SNF could be stored for a longer term prior to burial.[33] The NWPA sought to establish a fair process for selecting a repository location to prevent the perception that a particular state would have to bear the burden of the nation's total nuclear waste.[34] To further this purpose, Congress expressly limited the capacity of the first repository to hold only 70,000 metric tons of waste until a second repository opened.[35]

B. Political and Technical Obstacles in Finding a Permanent Repository

Pursuant to the NWPA, the DOE published a set of guidelines, or site-suitability criteria, to be used to objectively evaluate potential sites.[36] The site suitability factors included consideration of "hydrology, geophysics, seismic activity, . . . proximity to water supplies, proximity to populations, . . . proximity to sites where high-level radioactive waste and spent nuclear fuel is

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from the Treasury and "therefore subject to exactly the budget constraints and uncertainties that the Fund was created to avoid." *Id.* at xi. Thus, the U.S. government has incurred a significant liability to the nuclear utilities companies, while the appropriations process has "clearly proven to be a poor mechanism for financing a very long-term and complex effort." *Id.* at 74; *see also* Stewart, *supra* note 17, at 799.

[32] Gundlach, *supra* note 7, at 646. The 1998 deadline was not met. As a result, seventy-eight lawsuits have commenced, some of which have settled, and others have resulted in judgments that found the DOE in "partial breach" of the Standard Contract. BRC REPORT, *supra* note 3, at 79. The DOE predicts that the total damage awards to nuclear utilities companies could reach $20 billion even if the federal government were to begin accepting nuclear waste in 2020. *Id.*

[33] BRC REPORT, *supra* note 3, at 22.

[34] *Id.* at 20. The Act originally called for the selection of two repository sites, with the assumption that one would be located in the east and the other in the west. *Id.* at 20–21.

[35] Stewart, *supra* note 17, at 794.

[36] BRC REPORT, *supra* note 3, at 23.

generated or temporarily stored and the transportation and safety factors involved in moving such waste to a repository."[37] Despite its primarily scientific objective, the DOE faced social and political hurdles in attempting to nominate sites for nuclear waste storage.[38] The DOE identified three potential sites for an MRS facility, all located in Tennessee, but met with harsh political opposition in the state.[39] The DOE suggested nine sites for a permanent geologic repository, including sites in Texas, Utah, Louisiana, Mississippi, Washington, and Nevada.[40] Subsequently, in 1982 the DOE narrowed the list and submitted three sites to President Reagan as candidates for site characterization, ranking Yucca Mountain in Nye County, Nevada, first among them.[41] In 1986, the Secretary of Energy announced that the DOE had suspended its efforts to look for a second geologic repository.[42] Due to the NWPA's climbing costs and unmet deadlines, Congress amended the Act in 1987 to cancel all ongoing research for a second repository program or MRS site, and instead specifically directed the licensing and development of a single repository at Yucca Mountain.[43]

Yucca Mountain is one of the most extensively studied cases for nuclear waste disposal, with federal investment totaling approximately fifteen billion dollars.[44] The DOE performed

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[37] 42 U.S.C. § 10132(a) (2012). The DOE's final site sustainability rules required that "engineered barriers shall not be used to compensate for an inadequate site; mask the innate deficiencies of a site; disguise the strengths and weaknesses of a site . . . and mask differences between sites when they are compared." 10 C.F.R. § 960.3-1-5 (1984). Thus, the goal of this process was to locate a site with sound natural geologic barriers rather than creating one artificially through a massive engineering feat.

[38] Stewart, *supra* note 17, at 795.

[39] *Id.* at 798.

[40] *Id.* at 795.

[41] *Id.* The DOE also recommended the Hanford site in Washington and a site in Deaf Smith County, Texas. *Id.* at 795.

[42] *Id.* at 796 n.35.

[43] *Id.* at 795. The decision was criticized for its political implications. It produced strong opposition in Nevada, a state with no commercial nuclear facilities, and came to be known as the "Screw Nevada" bill. BRC REPORT, *supra* note 3, at 22.

[44] U.S. GOV'T ACCOUNTABILITY OFFICE, G.A.O. 11-229, COMMERCIAL NUCLEAR WASTE: EFFECTS OF A TERMINATION OF THE YUCCA MOUNTAIN

thorough site characterization studies throughout the 1990s and published an official finding of the site's suitability in 2002.[45] Yucca Mountain has several ideal characteristics: a very arid climate, layers of volcanic tuff that further reduce moisture, and rock beds that contain minerals called zeolites that slowly absorb radionuclides.[46] The DOE intensively studied the groundwater paths in Yucca Mountain, and estimated that any flow of radioactive material would be minimal and at a very slow rate.[47] However, local opposition to the project remained high, especially as other technical problems with the site were pointed out.[48] The state of Nevada submitted a "Notice of Disapproval," essentially a veto, provided under the NWPA.[49] However, in 2002, Congress issued a resolution to

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REPOSITORY PROGRAM AND LESSONS LEARNED 27 (2011) [hereinafter G.A.O. 11-229].

[45] BRC REPORT, *supra* note 3, at 23.

[46] David Applegate, *The Mountain Matters*, *in* UNCERTAINTY UNDERGROUND: YUCCA MOUNTAIN AND THE NATION'S HIGH-LEVEL NUCLEAR WASTE, 105, 105 (Alison Macfarlane & Rodney Ewing eds., 2006).

[47] U.S. SENATE COMM. ON ENV'T & PUB. WORKS, YUCCA MOUNTAIN: THE MOST STUDIED REAL ESTATE ON THE PLANET 16–17 (2006), *available at* http://www.epw.senate.gov/repwhitepapers/YuccaMountainEPWReport.pdf. Geology is a complex field that applies multiple disciplines over vast time frames, often introducing more questions than answers. For a comprehensive summary of the geoscience issues related to the suitability of Yucca Mountain as a nuclear waste repository, see Long & Ewing, *supra* note 29. *See also* DEP'T OF ENERGY, FINAL 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, DOE/EIS-0250 (2002).

[48] *See* Marta Adams, *Yucca Mountain—Nevada's Perspective*, 46 IDAHO L. REV. 423, 423-29 (2010). Scientists advanced three primary reasons why Yucca Mountain would never be suitable for a permanent repository. First, they contend that porous volcanic tuff is not ideal for nuclear waste storage, as it may release carbon-14, a radioactive gas, from the spent fuel into the air. *See generally* Ning Lu & Benjamin Ross, *Simulation of Gas Phase Transport of Carbon-14 at Yucca Mountain, Nevada, USA*, 14 WASTE MANAGEMENT, 409 (1994). Second, they express concern that moisture will corrode the containers because the repository is positioned above a water table, relatively shallow, and subject to high temperatures. *See* Adams, *supra* note 48, at 425. Third, the Yucca Mountain site is seismically active and prone to earthquakes. *Id; see also* State of Nevada Petition to Intervene, In the Matter of U.S. Dep't of Energy, U. S. Nuclear Regulatory Commission, No. 63-001-HLW, *available at* http://www.state.nv.us/nucwaste/licensing/Contentions_NV.pdf.

[49] BRC REPORT, *supra* note 3, at 23.

override the state's veto, which President George W. Bush signed, allowing the DOE to proceed with the license application.[50] In 2008, the DOE submitted the first license application to the NRC to construct the Yucca Mountain repository.[51]

Despite over twenty years of effort dedicated exclusively to this site, the Yucca Mountain Repository Program was suspended indefinitely in 2010.[52] Under instructions from President Obama, the Secretary of Energy filed a motion to withdraw its license application in March 2010.[53] While Yucca Mountain notably endured local opposition over several decades, crucially, the project was subject to yearly congressional appropriations.[54] Facing a projected final cost of $76 billion,[55] the DOE announced in the fiscal year of 2010 that "all funding for development of the Yucca Mountain facility has been eliminated, such as further land acquisition, transportation access, and additional engineering."[56] The administration stated that its decision to terminate the program was for policy reasons, and did not cite any safety or technical reasons.[57] The 2012 Blue Ribbon

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[50] *Id.* However, the battle did not end there. With no authority in the "political decision making process," Nevada has effectively delayed the project through legal means. Stewart, *supra* note 17, at 797. The State of Nevada and various environmental groups have legally challenged the regulatory standards issued by the DOE, NRC, and EPA for the Yucca facility, resulting in some partial victories. *Id.*

[51] BRC REPORT, *supra* note 3, at 23.

[52] Lisa Mascaro, *Feds File Request for Suspension of Yucca Mountain License*, LAS VEGAS SUN (Feb. 1, 2010), http://www.lasvegassun.com/news/2010/feb/01/feds-move-withdraw-yucca-mountain-license-applicat/.

[53] *See* U.S. DEP'T OF ENERGY, MOTION TO WITHDRAW, ASLBP No. 09-892-HLW-CAB04 (Mar. 3, 2010).

[54] *See* OFFICE OF MGMT. & BUDGET, TERMINATIONS, REDUCTIONS, AND SAVINGS: BUDGET OF THE U.S. FOR FISCAL YEAR 2010, at 68 (2009), *available at* http://www.gpo.gov/fdsys/pkg/BUDGET-2010-TRS/pdf/BUDGET-2010-TRS.pdf; *see also supra* note 31 and accompanying text regarding the Nuclear Waste Fund.

[55] DEPT. OF ENERGY, ANALYSIS OF THE TOTAL SYSTEM LIFE CYCLE COST OF THE CIVILIAN RADIOACTIVE WASTE MANAGEMENT PROGRAM, Fiscal Year 2007, No. RW-0591 (2008).

[56] Richard M. Jones, *FY 2010 Energy & Water Development Appropriations Bill: Nuclear Waste, Number 119*, FYI: The AIP Bulletin of Science Policy News, AM. INST. OF PHYSICS. Oct. 6, 2009, http://www.aip.org/fyi/2009/119.html.

[57] G.A.O. 11-229, *supra* note 44, at 11.

Commission Report to the Secretary of Energy concluded that the failure of Yucca Mountain was rooted in political inadequacies—namely the NWPA's rigid "prescriptiveness" and non-consensual site selection process.[58]

Much ink has been spilled regarding Yucca Mountain's suitability as a nuclear waste repository and whether the project should be revived.[59] Nonetheless, the Yucca Mountain repository will not be completed for years to come,[60] if ever, and the nuclear waste on hand already exceeds Yucca Mountain's authorized capacity.[61] The failure of the Yucca Mountain repository program demonstrates that the United States is at an impasse with regard to nuclear waste disposal. Absent renewed financial support and major revisions to the NWPA, over 70,000 metric tons of nuclear waste will continue to reside in thirty-five states and seventy-five different reactor sites, ten of which are shut down.[62] Concerns about long-

[58] BRC REPORT, *supra* note 3, at 23 ("The State of Nevada was not asked for, and did not provide, consent for the site to be selected for investigation. On the contrary, the state and a majority of its citizens strongly opposed the selection of Yucca Mountain as a repository site . . . .").

[59] *See generally* Applegate, *supra* note 46, at 105; Adams, *supra* note 48; Karoun Demirjian, *Yucca Mountain Debate Returns to Capitol Hill*, LAS VEGAS SUN (Aug. 2, 2013), http://www.lasvegassun.com/news/2013/aug/02/yucca-mountain-debate-returns-capitol-hill/; Brian Wingfield, *Yucca Nuclear Debate Seen Revived as Court Rebuffs NRC*, BLOOMBERG NEWS (Aug. 13, 2013), http://www.bloomberg.com/news/2013-08-14/yucca-nuclear-debate-seen-revived-as-court-rebuffs-nrc.html.

[60] Under the NWPA, the NRC is obligated to issue a decision regarding Yucca Mountain within three years of the DOE's license submission. 42 U.S.C. § 10134(d) (2006). Thus, the NRC's licensing decision was due in June 2011. In August 2013, the D.C. Circuit Court of Appeals granted a Petition for Writ of Mandamus against the NRC for violating the NWPA's statutory mandate for its failure to continue the Yucca Mountain licensing process. *In re* Aiken Cty., 725 F.3d 255 (D.C. Cir. 2013). Although the NRC argued that the licensing proceeding should not continue because the project lacked Congressional appropriations, the Court held that the NRC is currently "flouting the law" and the agency is legally obligated to resume licensing proceedings with the funds that are currently available to it. *Id*. at 5–7.

[61] *See supra* Part IIA–B.

[62] Rodney Ewing & Frank von Hippel, *Nuclear Waste Management in the United States—Starting Over*, 325 SCIENCE 151, 151 (2009).

term security, health, and safety are at an all-time high, while trust and confidence in U.S. nuclear waste policy is at an all-time low.[63]

III. THE NUCLEAR LICENSING PROCESS AND JUDICIAL REVIEW OF LICENSING DECISIONS

Despite the close of the Yucca Mountain Repository Program, commercial nuclear power plants have continued their daily operations. The DOE will eventually need to address the status of the federal repository program as part of its obligations under the NWPA. In the meantime, though, the NRC continues to regulate commercial nuclear operations in the United States. A key task of the NRC is to review applications and issue or renew operating licenses to nuclear power plants.[64]

The majority of today's nuclear power plants were licensed during the 1960s and 1970s, and thus subject to a different licensing process.[65] Under the old licensing procedure, nuclear power plants were granted a construction permit based on an initial design or blueprint.[66] Safety and environmental concerns were addressed after the permit was issued and usually were not resolved until close to the completion of the site.[67] The public would not have access to the details of the design until the plant was almost fully constructed.[68] In 1989, the NRC updated the licensing procedure to ensure that safety and regulatory concerns were addressed at an earlier stage and to open up the process for public involvement.[69] Under the new rules, the complete process is estimated to take ten years, including siting, approval, construction, and development.[70] No nuclear developer has

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[63] *See generally* BRC Report, *supra* note 3.

[64] *About NRC*, U.S. NUCLEAR REG. COMM'N (July 18, 2013), http://www.nrc.gov/about-nrc.html.

[65] *Licensing New Nuclear Power Plants*, NUCLEAR ENERGY INST. (Oct. 2010), http://www.nei.org/corporatesite/media/filefolder/Licensing_New_Nuclear_Power_Plants_October_2010.pdf?ext=.pdf.

[66] *Id*.

[67] *Id*.

[68] *Id*.

[69] *Id*; *see also* 10 C.F.R. §§ 52.15–.27 (2012).

[70] Gundlach, *supra* note 7, at 626.

yet completed the entire licensing process under the post-1989 rules.[71]

A. Current Licensing Procedure for Commercial Nuclear Reactors

Under 10 C.F.R. § 52, the nuclear licensing process is divided into three overarching phases. First, the developer submits an application for an Early Site Permit (ESP), which is normally drafted and approved within thirty months.[72] The ESP is valid for twenty years, during which time the developer may take foundational steps for construction of a nuclear reactor on the property.[73] The NRC has issued four ESPs thus far, with the process ranging from thirty-six to sixty months.[74] This could include surveys and investigation to determine the best way "to link a massive new source of electricity to the transmission grid" as well as making physical modifications to the site.[75] In the second phase, the developer submits a proposed nuclear reactor design to obtain a Standard Design Certificate (SDC) from the NRC.[76] The NRC invites public participation to determine whether the reactor design is safe by utilizing a notice-and-comment process.[77] Ultimately, the NRC issues a rule that outlines the

[71] *Id.*

[72] *Id.* at 627.

[73] *Id.*

[74] *Early Site Permit Applications for New Reactors*, U.S. NUCLEAR REG. COMM'N (Aug. 12, 2013), http://www.nrc.gov/reactors/new-reactors/esp.html.

[75] Gundlach, *supra* note 7, at 627.

[76] *Id.* at 627–28.

[77] 10 C.F.R. §§ 52.51–.63 (2012). All proposed design certificate rulemakings are published in the Federal Register to give the public an opportunity to submit comments to the NRC. *Id.* At its discretion, the NRC may call legislative hearings during this time. *Id.* After public comments have been collected, the Advisory Committee on Reactor Safeguards issues a report to the NRC, and the NRC may render a final decision on the design certification. *Id.* The total process, from the submission of an application to the promulgation of a rule that describes the safety parameters of the reactor design, spans three years at minimum. Gundlach, *supra* note 7, at 628. Notice and comment procedures are used throughout the NRC. Any member of the public may petition the NRC to develop a rulemaking or even modify an existing one. *See, e.g.*, *The Rulemaking Petition Process*, U.S. NUCLEAR REG. COMM'N, http://www.nrc.gov/about-nrc/regulatory/rulemaking/petition-rule.html (last visited Mar. 10, 2013).

requirements of the approved reactor design.[78] The SDC is valid for ten to fifteen years, with the ability to renew for a second term.[79] The NRC has certified four designs under this procedure.[80] In the third and final phase, the developer applies for a Combined Construction & Operating License (COL) from the NRC.[81] The COL authorizes the developer to actually construct the proposed reactor.[82] Developers must overcome extreme financial obstacles in the private sector—to the tune of $10 billion—in order to begin construction of a nuclear facility.[83] Therefore, the NRC reviews each COL application for the developer's qualifications and operational programs, and verifies construction under inspections, tests, analyses, and acceptance criteria before issuing a COL.[84] Although eighteen power plants have submitted applications for twenty-eight new reactors, no COL has been issued to date.[85] A complete COL approval is predicted to take twenty-four to forty months for approval.[86] The COL is valid for forty years from the date of issuance, and can be renewed for another twenty years.[87]

In addition to regulating the construction of a nuclear reactor, the NRC also regulates the storage of SNF through its licensing process. Storage of SNF at the same active reactor site is covered by

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[78] Gundlach, *supra* note 7, at 628.

[79] 10 C.F.R. § 52.55.

[80] Gundlach, *supra* note 7, at 628.

[81] *Combined License Applications for New Reactors*, U.S. NUCLEAR REG. COMM'N, http://www.nrc.gov/reactors/new-reactors/col.html (last visited Mar. 10, 2013).

[82] *Id.*

[83] *See* Gundlach, *supra* note 7 (explaining that nuclear energy developers face uncertainties in the form of technological designs, licensing, engineering and fuel costs, severe construction delays, high insurance rates, and reactor lifespan and decommissioning costs). "In addition to developing the reactor itself, a developer must also plan for: (1) how to integrate that new reactor into the electricity transmission grid; (2) who will staff the plant and operate the reactor; and (3) how much it will cost to acquire fuel and manage the radioactive waste left behind . . . ." *Id.* at 629–30.

[84] *Combined License Applications for New Reactors*, U.S. NUCLEAR REG. COMM'N, *supra* note 81.

[85] *Id.*

[86] Gundlach, *supra* note 7, at 629.

[87] 10 C.F.R. § 52.103(g) (2012).

its general operating license.[88] Therefore, a facility does not have to apply for a separate license to store SNF in its containment pools. However, if the facility decides to rearrange the assemblies within the pool to increase its capacity, the license must be amended to reflect this change.[89] Likewise, dry cask storage located on an active reactor site is covered by the plant's general operating license.[90] The facility must notify the NRC and obtain certification for the design of the cask.[91] General licenses authorizing storage of SNF are valid for forty years from the date issued, but can be renewed for another twenty years.[92] Storage of SNF at an *off-site* location requires a site-specific license obtained under a different process.[93] A site-specific license for an independent spent fuel storage installation is valid for twenty years with an option for renewal.[94]

B. NEPA: Addressing Safety and Environmental Concerns in the Licensing Process

Nuclear development and waste storage raise a host of safety and environmental concerns that play a major role in the NRC's regulatory function. The U.S. Environmental Protection Agency (EPA) was formed in 1970 as the agency charged with enforcing environmental regulations under an array of federal laws.[95] For instance, the Nuclear Waste Policy Act specifically authorizes the EPA to establish standards that apply to both DOE-operated and NRC-licensed facilities to protect the public from radioactive material.[96] In addition to EPA standards, NEPA established

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[88] *See* 10 C.F.R. § 72.212 (2012).

[89] de Saillan, *supra* note 8, at 475 (citing Lower Alloways Creek Twp. v. Pub. Serv. Elec. & Gas Co., 687 F.2d 732 (3d Cir. 1982)).

[90] 10 C.F.R. § 72.210.

[91] *See* 10 C.F.R. § 72.212(b).

[92] *See Combined License Applications for New Reactors*, U.S. NUCLEAR REG. COMM'N, *supra* note 81; *see also* 10 C.F.R. § 72.42.

[93] *Spent Fuel Storage Licensing*, U.S. NUCLEAR REG. COMM'N, http://www.nrc.gov/waste/spent-fuel-storage/licensing.html (last visited Mar. 10, 2013).

[94] *Id.*

[95] *See* Reorganization Plan No. 3 of 1970, 35 Fed. Reg. 15, 623 (Dec. 2, 1970).

[96] 42 U.S.C. § 10141(a) (2012).

procedural requirements for all federal government agencies to evaluate possible environmental effects of future federal agency actions.[97] Thus, the NRC has a dual responsibility to ensure compliance with EPA standards and to conduct environmental evaluations pursuant to NEPA.

NEPA is implicated when a federal agency proposes a "major Federal action significantly affecting the quality of the human environment."[98] Under NEPA, the agency must prepare an Environmental Impact Statement (EIS) or, alternatively, conduct an environmental assessment (EA) and make a Finding of No Significant Environmental Impact (FONSI).[99] An EIS or FONSI can be challenged in court on procedural or substantive grounds. However, NEPA is an "essentially procedural" statute because it requires the agency to research and report on the full range of environmental consequences with the intent of producing "fully informed and well-considered" decisions, but it does not mandate that an agency choose the most environmentally protective decision.[100]

It is well established that the granting of a nuclear reactor license is a major federal action affecting the quality of the human environment.[101] Specifically, the issuance of an ESP implicates NEPA and requires the submission of an EIS to detail "the siting's effects on the human environment."[102] Likewise, the issuance of a COL implicates NEPA and requires the submission of an EIS. The NRC estimates that the entire environmental review process—including scoping, issuance of the draft EIS, the notice and comment period, revisions, and issuance of the final EIS—spans two years.[103] NEPA documents are subject to judicial review and often stimulate

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[97] *See generally* 42 U.S.C. § 4331 (2012).

[98] 42 U.S.C. § 4332(c).

[99] *Id.*

[100] Vt. Yankee Nuclear Power Corp. v. Natural Res. Def. Council Inc., 435 U.S. 519, 558 (1978).

[101] 10 C.F.R. § 51.20 (2012); *see also* New York v. Nuclear Reg. Comm'n, 589 F.3d 551, 553 (2d Cir. 2009).

[102] Gundlach, *supra* note 7, at 627.

[103] *See Regulations, Guidance, and Communications for New Reactors*, U.S. NUCLEAR REG. COMM'N, http://www.nrc.gov/reactors/new-reactors/regs-guides-comm.html (last visited Mar. 10, 2013).

litigation, particularly when the stakes involve burial of nuclear waste.

C. How Courts Enforce NEPA in Nuclear Licensing Decisions

The legal significance of NEPA and its future impact on the NRC was first set forth in *Calvert Cliffs' Coordinating Committee v. U.S. Atomic Energy Commission*,[104] shortly after enactment of the new statute. NEPA was enacted prior to the formation of the NRC, so the Atomic Energy Commission (AEC) was the first agency to promulgate rules to conform its licensing proceedings to NEPA.[105] The suit arose when local residents challenged the licensing of the Calvert Cliffs nuclear power plant in Chesapeake Bay, Maryland, and appealed the AEC's new rule statements.[106] Although it was initially uncertain whether NEPA would actually affect federal decisions, the court held that NEPA was to be "rigorously enforced by reviewing courts."[107] The court rejected the AEC rule that limited the agency's consideration of environmental issues to those that were affirmatively raised at a hearing.[108] Rather, the court held that an agency must conduct an independent review, even where no party challenges a conclusion, in order to create a "detailed statement" that evaluates all environmental concerns.[109] Judge Wright explained,

> NEPA establishes environmental protection as an integral part of the [Nuclear Regulatory Commission's] basic mandate. The primary responsibility for fulfilling that mandate lies with the Commission. Its responsibility is not simply to sit back, like an umpire, and resolve adversary contentions at the hearing stage. Rather, it must itself

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[104] 449 F.2d 1109 (D.C. Cir. 1971).

[105] David Repka & Tyson Smith, *A Dose of History: Nuclear Energy Cases that Shaped Environmental Law*, 25 NAT. RESOURCES & ENV'T 28, 28 (2010).

[106] *Id.*

[107] *Id.* (quoting *Calvert Cliffs*, 449 F.2d at 1114). Skelly Wright, the D.C. Circuit judge who wrote the opinion, was widely known as one of the more liberal judges from the civil rights era. Repka & Smith, s*upra* note 105, at 28.

[108] *See Calvert Cliffs*, 449 F.2d at 1118–19.

[109] *Id.*

> take the initiative of considering environmental values at every distinctive and comprehensive stage of the process . . . .[110]

While *Calvert Cliffs* issued a clear mandate for federal agencies to initiate comprehensive environmental reviews under NEPA, agencies differed in their procedural approaches to carrying out this mandate. All agencies were required to assess the impacts and risks of major federal actions under NEPA, but precisely *how* they conducted these assessments and arrived at their conclusions was open to court scrutiny.[111] This was largely true until 1978, when the Supreme Court delivered the *Vermont Yankee Nuclear Power Corp. v. Natural Resources Defense Council* decision, and severely limited the ability of the courts to proscribe agency procedure.[112]

Although *Vermont Yankee* had a broad application on administrative law as a whole, the case coincidentally arose from a nuclear licensing dispute.[113] Because the AEC faced several challenges of the licensing of individual power plants, it opted to issue one rule to "generically address[]" the recurring environmental issues associated with the uranium fuel cycle.[114] The AEC promulgated the so-called "fuel cycle rule" using an informal notice-and-comment procedure that complied with the basic requirements of the Administrative Procedure Act (APA).[115] On appeal, the D.C. Circuit struck down the fuel cycle rule because of "perceived inadequacies" of the AEC's rulemaking procedure.[116] The Supreme Court reversed the D.C. Circuit's decision in a powerful "rebuke to

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[110] *Id.* at 1119.

[111] *See* Repka & Smith, *supra* note 105, at 29.

[112] 435 U.S. 519, 558 (1978).

[113] *Id.* at 527. The dispute concerned the NRC's decision to grant a construction license to a Vermont power plant. *Id.* The NRDC and local residents challenged the procedural rights afforded to individuals in the AEC's licensing process. *Id.* at 527–28.

[114] Repka & Smith, *supra* note 105, at 29.

[115] *Id.*

[116] *Vt. Yankee*, 435 U.S. at 541. Specifically, the D.C. Circuit found that the AEC's decision not to allow discovery or cross-examination of agency personnel rendered the procedure inadequate because it deprived the challengers of a meaningful opportunity to participate in the proceedings as a matter of due process. *Id.*

what it considered judicial activism of the day,"[117] holding that courts must exercise deference to agency procedures. So long as the AEC rulemaking procedure did not violate the "*statutory minima*" (the requirements of the APA and NEPA), there was no other basis for the court to invalidate the AEC's procedure.[118] Absent constitutional restraints or extremely rare circumstances, administrative agencies "should be free to fashion their own rules of procedure and to pursue methods of inquiry capable of permitting them to discharge their multitudinous duties."[119] Thus, *Vermont Yankee* severely curtailed judicial review of agency rulemaking procedures and engendered a certain deference to the unique duties and expertise of administrative agencies.

The practical effect of *Vermont Yankee*, then, makes it almost impossible for reviewing courts to impose additional procedural requirements upon the NRC. However, the NRC may grant, and has granted, additional procedural rights at its own discretion. The scoping and comment process under NEPA does not normally call for an administrative hearing.[120] The NRC takes an exceptional step beyond the requirements of NEPA by offering a full hearing opportunity.[121] Following the NEPA review, the NRC provides an opportunity for all "interested persons" to participate in hearings to consider any environmental issues related to a proposed project.[122] The high degree of public participation in the licensing process, combined with the technical sophistication of the NRC as a whole, usually results in very detailed and comprehensive environmental impact statements.[123]

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[117] Repka & Smith, *supra* note 105, at 29.

[118] *Vt. Yankee*, 435 U.S. at 548.

[119] *Id*. at 543 (quoting FCC v. Schreiber, 381 U.S. 279, 290 (1965)).

[120] Repka & Smith, *supra* note 105, at 29.

[121] *Id.*

[122] *Id.* "Importantly, the standard of review for NRC hearings on environmental issues is not skewed in favor of the agency . . . . [F]or an applicant to prevail on a factual issue in the NRC hearing process, its position must be supported by the preponderance of the evidence." *Id.*

[123] *Id.* "The NRC has an enviable record in defending its NEPA documents on judicial review." *Id.*

D. Highly Deferential Review of Agency Scientific Determinations

The Supreme Court reinforced its deferential position toward agency expertise in *Baltimore Gas & Electric v. National Resources Defense Council, Inc.*[124] In this case, the Court considered whether an NRC generic rule, the "permanent storage rule," complied with NEPA.[125] Generic rules, like the "fuel cycle rule" in *Vermont Yankee*, are settled regulations that an agency relies upon as a base assumption in future agency decisions.[126] The NRC developed the permanent storage rule to allow future licensing boards to assume, for the purposes of NEPA, that the permanent storage of certain nuclear wastes would have no significant environmental impact (called the "zero release assumption").[127] The NRC came to this conclusion based on "tentative but favorable" evidence that an appropriate repository site would be found to support the zero-release assumption.[128] The D.C. Circuit Court of Appeals rejected the rule, finding that it violated NEPA because it prevented future licensing boards from considering uncertainties regarding emissions of HLW in long-term storage.[129] The Supreme Court unanimously reversed,

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[124] 462 U.S. 87 (1983).

[125] *Id.* at 87.

[126] *Id.* at 95.

[127] Repka & Smith, *supra* note 105, at 29.

[128] *Balt. Gas*, 462 U.S. at 94. The Court summarized the NRC's conclusion:

> [The NRC] acknowledged that this assumption was uncertain because of the remote possibility that water might enter the repository, dissolve the radioactive materials, and transport them into the biosphere. Nevertheless, the Commission predicted that a bedded-salt repository would maintain its integrity, and found the evidence 'tentative but favorable' that an appropriate site would be found.

Id. The Court acknowledged that the NRC carefully considered and disclosed all relevant uncertainties as required by NEPA and properly concluded that these uncertainties were "not sufficient to affect the outcome of any individual licensing decision." *Id.* at 97–98.

[129] *Id.* at 96. The heart of the dispute was the values within Table S-3, a numerical table adopted in the NRC regulations that estimated the emissions generated by one year of fuel cycle activities from the average commercial reactor. *Id.* at 91.

upholding the NRC's permanent storage rule as the result of a proper evaluation under NEPA and the APA.[130]

From the outset, the Court maintained that generic rules are necessary and "clearly appropriate" under NEPA because they further administrative efficiency, consistency of decision, and prevent "needless repetition of litigation."[131] The importance of *Baltimore Gas & Electric*, however, is the degree of deference that the Court extends to agency decisions. Justice O'Connor reminded reviewing courts:

> The [NRC] is making predictions, within its area of special expertise, at the frontiers of science. . . . It is not our task to determine what decision we, as Commissioners, would have reached. Our only task is to determine whether the Commission has considered the relevant factors and articulated a rational connection between the facts found and the choice made."[132]

The Court stressed that judicial inquiry into scientific or technical determinations requires the *highest* level of deference.[133] The NRC's permanent storage rule could only be rejected upon a finding that the NRC "acted arbitrarily or capriciously" in forming its decision, a violation of section 10(e) of the APA.[134] Thus, *Baltimore Gas & Electric* limited judicial inquiry of agency decisions to whether the agency complied with the procedural requirements of the controlling statutes, NEPA and the APA.[135] The extreme judicial deference to expert agencies advanced in *Baltimore Gas & Electric* is a basic foundation of administrative law.[136]

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[130] *Id.* at 108.
[131] *Id.* at 101.
[132] *Id.* at 103–05.
[133] *Id.* at 103.
[134] *Id.* at 87.
[135] Repka & Smith, *supra* note 105, at 30.
[136] *Balt. Gas*, 462 U.S. at 87; *see, e.g.*, Chevron U.S.A., Inc. v. Natural Res. Def. Council Inc., 467 U.S. 837 (1984) (holding courts must defer to an administrative agency's interpretation of statutory authority where the intent of Congress is ambiguous and the interpretation is reasonable or permissible); N.J. Envtl. Fed'n v. U.S. Nuclear Reg. Comm'n, 645 F.3d 220 (3d Cir. 2011) (holding

IV. THE D.C. CIRCUIT COURT OF APPEALS VACATES THE NRC WASTE CONFIDENCE DECISION

Although the Supreme Court yielded to the expertise of the NRC in *Baltimore Gas & Electric*, states and private interest groups continue to call on the courts to review certain NRC decisions.[137] One NRC rule in particular, called the Waste Confidence Decision (WCD), has been the center of litigation and scientific controversy for nearly three decades.[138] The WCD is a generic rule published in 1984 and amended several times, recently culminating in a lawsuit in which the U.S. Court of Appeals for the District of Columbia held that the WCD stood in violation of NEPA.[139] In August of 2012, shortly after this judgment, the NRC issued an indefinite freeze on all licensing proceedings.[140]

A. The Development of the Waste Confidence Decision

The NRC originally issued the WCD in response to the judgment in *Minnesota v. Nuclear Regulatory Commission.*[141] In this case, the D.C. Circuit remanded two licensing actions that allowed

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NRC did not abuse its discretion by rejecting challenge of ultrasonic testing monitoring frequency at nuclear plant); Ariz. Cattle Growers Ass'n v. Salazar, 606 F.3d 1160 (9th Cir. 2010) (holding U.S. Fish and Wildlife Service did not arbitrarily designate critical habitat for Mexican spotted owl under Endangered Species Act); BCCA Appeal Group v. U.S. EPA, 355 F.3d 817 (5th Cir. 2003) (holding EPA's approval of state plan for zone attainment was not arbitrary or capricious); Bark v. U.S. Bureau of Land Mgmt., 643 F. Supp. 2d 1214 (D. Or. 2009) (holding Bureau's environmental assessment of logging project satisfied requirements of NEPA and was not arbitrary or capricious); Nat'l Home Equity Mortg. Ass'n v. Office of Thrift Supervision, 271 F. Supp. 2d 264 (D.D.C. 2003) (holding OTS permissibly construed statute as allowing it to identify which regulations apply to state creditors).

[137] *See* Repka & Smith, *supra* note 105, at 32.

[138] CTR. FOR NUCLEAR WASTE REG. ANALYSES, SUMMARY REPORT: THE STATE OF KNOWLEDGE OF WASTE CONFIDENCE, 1–5 (1988), *available at* http://pbadupws.nrc.gov/docs/ML0333/ML033371006.pdf.

[139] New York v. Nuclear Reg. Comm'n, 681 F.3d 471 (D.C. Cir. 2012).

[140] NUCLEAR REG. COMM'N, MEMORANDUM & ORDER TO SUSPEND FINAL DECISIONS IN ALL PENDING REACTOR LICENSING PROCEEDINGS PENDING COMPLETION OF REMANDED WASTE CONFIDENCE PROCEEDINGS, CLI-12-16 (2012) [hereinafter NRC ORDER].

[141] 602 F.2d 412 (D.C. Cir. 1979).

the expansion of SNF pools, demanding that the NRC answer particular questions that should have been addressed in the administrative record under NEPA.[142] The court asked the NRC to consider whether there was "reasonable assurance" that (1) an off-site storage solution will be available by the expiration of the plant's operating licenses and (2) if not, the fuel could be stored safely at the sites beyond those dates.[143] The court also acknowledged that the NRC could properly address these waste disposal issues in a generic rule because they were "essentially common to all nuclear facilities."[144]

In response, the NRC published the original WCD in 1984.[145] The original WCD included five "Waste Confidence Findings," briefly summarized as follows: the NRC found "reasonable assurance" that (1) safe disposal of HLW and SNF in a mined geologic repository is technically feasible; (2) one or more geologic repositories will be available by 2007 to 2009; (3) waste will be managed safely until a repository is available; (4) if necessary, SNF can be stored safely at nuclear plants at least thirty years beyond the licensed life of each plant; and (5) safe, independent storage will be made available when needed.[146] In 1990, the NRC amended Finding 2 to predict the creation of a permanent geologic repository by 2025.[147] The NRC relied on the WCD as a generic rule to comply with NEPA in subsequent license issuances and renewals.

Over the years, the NRC has periodically reviewed the WCD to address the changing status of the DOE geologic repository program. In 2008, the NRC proposed substantial revisions to the WCD. After receiving public comments, the NRC reaffirmed three of its findings and amended two of its findings in 2010.[148] The NRC amended Finding 2 to state that a permanent repository will become

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[142] *Id.* at 417.

[143] *Id.* at 418.

[144] *Id.* at 417.

[145] Waste Confidence Decision, 49 Fed. Reg. 34,658 (Aug. 31, 1984).

[146] *Id.* at 34,659–60.

[147] Waste Confidence Decision Review, 55 Fed. Reg. 38,474, 38,505 (Sept. 18, 1990).

[148] Waste Confidence Decision Update, 75 Fed. Reg. 81,037 (Dec. 23, 2010) [hereinafter *WCD Update*].

available "when necessary" rather than by a specific year.[149] The NRC arrived at this conclusion after considering the "the political and technical obstacles" in creating a permanent repository, and determined that one will be available "when the safety of temporary on-site storage can no longer be assured."[150]

The NRC also amended Finding 4, known as the "Temporary Storage Rule" (TSR).[151] The original TSR stated that SNF could be stored safely on-site for thirty years beyond the licensed life of the nuclear power plant, including the license renewal period.[152] The updated version of Finding 4 now states that SNF can be safely stored on-site for sixty years beyond the licensed life of the plant, including the license renewal period.[153] In developing this finding, the NRC assessed the environmental risks of temporary storage, specifically the risk of leakage from containment pools and the risk of fire caused by SNF exposure to air.[154] With regard to potential leaks, the NRC studied previous leaks at facilities and found that the near-term health effects were negligible.[155] The NRC predicted a further reduction in leaks as a result of recent regulations, and concluded that leaks do not pose a threat of a significant environmental impact.[156] Similarly, the NRC determined that the likelihood of pool fires was low enough to present no threat of a significant environmental impact.[157]

B. New York v. NRC *Renders Waste Confidence Decision Invalid*

On June 8, 2012, the D.C. Circuit Court of Appeals vacated the NRC's Waste Confidence Decision for lacking a sufficient environmental evaluation under NEPA in *New York v. Nuclear*

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[149] *Id.*

[150] New York v. Nuclear Reg. Comm'n, 681 F.3d 471, 475 (D.C. Cir. 2012).

[151] *WCD Update*, *supra* note 148, at 81,038.

[152] *Id.*

[153] *Id.* at 81,037. The sixty-year period applies to various types of temporary storage—"a combination of storage in its spent fuel storage basin and either onsite or offsite independent spent fuel storage installations." *Id.*

[154] *New York v. NRC*, 681 F.3d at 475.

[155] *Id.* at 481.

[156] *WCD Update*, *supra* note 148, at 81,069–71.

[157] *New York v. NRC*, 681 F.3d at 475.

Regulatory Commission.[158] The states of New York, New Jersey, Vermont, and Connecticut, along with an Indian community and multiple environmental groups, petitioned for judicial review of the 2010 amendments to the WCD relating to permanent disposal and temporary storage of nuclear waste.[159] The judgment was founded on two main holdings. First, the court held that the WCD constitutes a "major federal action" under NEPA, requiring either an EIS or a FONSI.[160] Second, the court held that the NRC's evaluation of risks was a "deficient" environmental assessment under NEPA.[161]

The court first assessed whether the WCD itself constituted a "major federal action" implicating NEPA. The NRC contended that the WCD was simply a response to the court's mandate in *Minnesota v. Nuclear Regulatory Commission*, to provide general public assurance that permanent disposal of nuclear waste will be accomplished safely in the future.[162] The NRC maintained that the WCD is not a major federal action because the WCD itself "does not authorize the licensing of any nuclear reactor or storage facility," but rather, the agency conducts a site-specific EIS for each individual licensing action.[163] In rejecting this argument, the court explained that it failed to align with controlling precedent.[164] Under *Calvert Cliffs*, NEPA requires environmental evaluation by an agency "at every important stage in the decision-making process."[165] While the licensure of a nuclear power plant clearly falls within this category, "major federal actions" also include actions with "indirect effects, which . . . are later in time or farther removed in distance, but are still reasonably foreseeable."[166] The court reasoned that the WCD, a generic rulemaking with preclusive effect in all future licensing decisions, is a "pre-determined 'stage'" of each and every licensing decision.[167] Even though site-specific factors can be contested with

[158] *Id.* at 483.
[159] *Id.* at 473.
[160] *Id.* at 476.
[161] *Id.* at 473.
[162] *Id.* at 476.
[163] *Id.*
[164] *Id.*
[165] *Id.*
[166] *Id.* (quoting Calvert Cliffs' Coordinating Comm., Inc. v. U.S. Atomic Energy Comm'n, 449 F.2d 1109, 1118 (D.C. Cir. 1971)).
[167] *New York v. NRC*, 681 F.3d at 476.

each license, the overall conclusions of the WCD apply as fact in every licensing decision. The court expounded, "It is not only reasonably foreseeable but eminently clear that the WCD will be used to enable licensing decisions based on its findings."[168] Therefore, based on the far-reaching and significant effects of the WCD, the court concluded that the WCD constituted a "major federal action" that activated the procedural requirements of NEPA.[169]

None of the parties contested that the WCD lacked an EIS as outlined under NEPA. An agency has discretion whether to prepare an EIS or an EA. The court explained that an EIS is not required under NEPA so long as "the agency conducts an EA and issues a FONSI sufficiently explaining why the proposed action will not have a significant environmental impact."[170] An agency's decision *not* to prepare an EIS is viewed with considerable deference, and may only be overturned if it is "arbitrary, capricious, [or] an abuse of discretion . . . ."[171] The NRC argued that the WCD, viewed in light of NEPA obligations, constituted an EA that ultimately had a finding of no significant environmental impact.[172] The court assessed this argument with respect to both of the challenged Findings—Finding 2 and Finding 4.

Finding 2 in the WCD Update states that a permanent repository for SNF will be made available "when necessary."[173] The petitioners argued that the WCD Update was inadequate for three reasons: first, the NRC did not give proper weight to the social and political barriers that have historically hindered the creation of a repository; second, the NRC failed "to define the term 'necessary' in any meaningful way"; and third, the NRC did not examine "the effects of a failure to establish a repository in time."[174] The NRC responded that it "candidly acknowledged" the social and political challenges, but the agency itself cannot overcome those challenges.[175] Further, the NRC argued that NEPA does not require

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[168] *Id.* at 477.
[169] *Id.* at 476.
[170] *Id.* at 477.
[171] *Id.*
[172] *Id*. at 476.
[173] *Id.* at 478.
[174] *Id.* at 477.
[175] *Id.* at 478.

date-specific predictions, and the agency has used the "when necessary" formulation as far back as 1977.[176]

Ultimately, the court held that the NRC's WCD Update did not produce a sufficient FONSI because it did not assess the environmental effects of failing to establish a repository.[177] Under NEPA, an agency must examine "both the probabilities of potentially harmful events *and* the consequences if those events come to pass."[178] The NRC dismissed the possibility of a failure to secure a geologic repository because it did not discuss the risks or the consequences of such a scenario. The court determined that all aspects of the WCD "presumes the existence of a geologic repository."[179] An agency may issue a FONSI, however, if the probability of occurrence is "so low as to be 'remote and speculative.'"[180] The court reasoned that the NRC rulemaking did not meet this standard, because "reasonable assurance" that permanent storage will become available someday is a "far cry" from finding that the likelihood of *failure* to secure permanent storage is "remote and speculative."[181] Relying on the political history of the federal repository program, the failure to secure permanent storage was no "remote or speculative" idea to the court:

> Due to the government's failure to establish a final resting place for spent fuel, SNF is currently stored on site at nuclear plants. This type of storage, optimistically labeled "temporary storage," has been used for decades longer than originally anticipated. . . . The lack of progress on a permanent repository has caused considerable uncertainty regarding the environmental effects of temporary SNF storage and

[176] *Id.*
[177] *Id.*
[178] *Id.* (emphasis added).
[179] *Id.* at 479.
[180] *Id.* at 478. Computation of environmental risks under NEPA is not uniformly defined, and can result in different and arguable conclusions. The court offered a vague formula for computing risk under NEPA: "The concept of overall risk incorporates the significance of possible adverse consequences discounted by the improbability of their occurrence." *Id.* at 479 (quoting City of N.Y. v. Dep't of Transp., 715 F.2d 732, 738 (2d Cir.1983)).
[181] *Id.* at 479.

> the reasonableness of continuing to license and relicense nuclear reactors . . . .
> . . . .
> . . . The Commission apparently has no long-term plan other than hoping for a geologic repository. If the government continues to fail in its quest to establish one, then SNF will seemingly be stored on site at nuclear plants on a permanent basis. The Commission can and must assess the potential environmental effects of such a failure.[182]

Concluding that the NRC ignored the risks and consequences of a failure to secure permanent storage, the Court held that the NRC did not conduct a sufficient EA under NEPA with respect to the WCD Update.[183]

Finding 4, or the TSR, stated that SNF can be stored safely on-site for sixty years beyond the licensed life of the plant, instead of thirty years. The NRC maintained that this increase in time produced no significant environmental impact,[184] and petitioners objected on two grounds. First, petitioners argued that a generic rulemaking was not appropriate here because the risks of temporary storage largely depend on site-specific factors, thus calling for individual assessments.[185] Second, petitioners argued that even if a generic rule were satisfactory, this generic rule was insufficient because the agency did not thoroughly evaluate the risks of future SNF pool leaks and fires.[186] The NRC countered that it had examined previous SNF pool leaks and the damage from past leaks "have been shown to be quite minimal."[187] The NRC also argued that it has engaged in "exhaustive consideration" of the risk of pool fires and found such an event to be "extremely unlikely," or "so low that the consequences

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[182] *Id.* at 474, 479.
[183] *Id.* at 483.
[184] *Id.* at 476.
[185] *Id.* at 479. These site-specific factors include "pool configuration, leak detection systems, the nature of SNF stored in the pool, and the location of the pool within the plant." *Id.*
[186] *Id.* at 479–80.
[187] *Id.* at 480.

could not possibly overcome the low probability."[188] A site-by-site approach was not necessary, the NRC claimed, because the generic rule was predicated on studies that addressed plant-to-plant variations. According to the NRC, even the "most dangerous combinations of site-specific factors" resulted in an extremely low risk of fire.[189]

Considering these arguments, the court endorsed the use of a generic rulemaking for the temporary storage issue. A comprehensive rule addressing "on-site risks that are essentially common to all plants" is appropriate and well established under NEPA.[190] Although the court upheld the concept of a generic rulemaking to address temporary storage, it rejected the actual rule and its underlying environmental assessment.[191] Acknowledging that *Baltimore Gas* called for the highest level of deference toward agency decisions, the court stated that the NRC "failed to conduct a thorough enough analysis here to merit our deference."[192] The court deemed the NRC's evaluation of pool leaks to be seriously flawed because the agency examined the harm caused by past leaks only, which reveals little about the potential of future leaks.[193] The court explained that "a proper analysis of the risks would necessarily look *forward*" in order to study the impact of thirty additional years of SNF storage.[194] The court also pointed out that the NRC failed to assess any environmental impacts other than near-term health effects.[195] Therefore, the court found that the NRC's environmental analysis of pool leaks was insufficient.[196]

With respect to SNF pool fires, the court faulted the NRC for failing to discuss the consequences of a potential fire.[197] The court recognized that the agency conducted a thorough evaluation of the risks of fire and accepted its conclusion that the risks were extremely

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[188] *Id.*

[189] *Id.*

[190] *Id.* Also, interested parties have an opportunity to raise site-specific differences at the time of an individual plant's licensing. *Id.*

[191] *Id.* at 480–81.

[192] *Id.* at 481.

[193] *Id.*

[194] *Id.*

[195] *Id.*

[196] *Id.*

[197] *Id.* at 482.

low.[198] However, NEPA still requires the agency to examine both the risks and the *consequences* of a fire if it were to occur.[199] The court determined that the NRC "did not undertake to examine the consequences of pool fires at all," so the NRC did not produce a sufficient EA under NEPA.[200]

In sum, the court vacated the WCD Update because it lacked a thorough environmental analysis as required by NEPA. Yet the crucial aspect of this case is not so much the procedural requirements of NEPA, but rather what it says about permanent storage of nuclear waste. The language throughout the opinion exhibits a strong skepticism toward the entire federal repository program,[201] perhaps reflecting the public perception as well. It would appear, if only at a superficial level, that the NRC is simply extending the amount of time that SNF can be stored on-site to cope with the unmet deadlines of a failing repository program. The effect of the WCD Updates cannot be understated—it establishes a total reliance on temporary storage, possibly for the remainder of our lives, under the assumption that permanent storage will be attained "when necessary." Even affording such deference to the NRC, the WCD Updates would seem at least suspect or doubtful. An attentive American public, including the D.C. Circuit Court of Appeals, needs a more comprehensive and convincing assessment of the current nuclear waste disposal program.

C. NRC Responds to New York v. NRC *by Implementing Licensing Freeze*

While *New York v. Nuclear Regulatory Commission* was "another in the growing line of cases"[202] relating to the government's failure to establish a permanent nuclear waste repository, it diverged

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[198] *Id.*

[199] *Id.*

[200] *Id.*

[201] The Court expressed doubt for the program based on the futility of past combined efforts, rather than the fault of any particular agency. "Yet despite years of blue ribbon commissions, congressional hearings, agency reports, and site investigations, the United States has not yet developed a permanent solution." *Id.* at 474. "[W]e share petitioners' considerable skepticism as to whether a permanent facility can be built given the societal and political barriers to selecting a site . . . ." *Id.* at 478.

[202] *Id.* at 473.

from the previous succession of cases in its remarkable result. In August 2012, the NRC issued a Memorandum and Order in which it announced that the agency will not issue final licenses "until the court's remand is appropriately addressed."[203] The NRC explained that the indefinite freeze extended to final license approval only, and all licensing reviews and other proceedings will carry on as usual.[204] Acknowledging the adverse ruling in *New York v. Nuclear Regulatory Commission*, the agency stated that it has not determined a course of action.[205] It is currently "considering all available options for resolving the waste confidence issue, which could include generic or site-specific NRC actions, or some combination of both."[206] The NRC is accepting public comments for any generic determination it makes on remand, whether it be a new rulemaking, policy statement, EA, or EIS.[207]

It is clear that the NRC must revise its environmental analysis to provide a sounder and more convincing rulemaking regarding the waste confidence issue. Although the D.C. Circuit Court of Appeals invalidated the agency's rule, it acknowledged that the NRC is in a difficult position.[208] *New York v. Nuclear Regulatory Commission* exposed the dilemma that the NRC and the entire nuclear sector is

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[203] NRC ORDER, *supra* note 140, at 4.

[204] *Id.* Does this even change anything? Some nuclear energy specialists assert that the licensing freeze will have a "minimal impact" on the industry. *See* James Conca, *Nuclear Waste Confidence—NRC Ruling No Big Deal*, FORBES (Aug. 12, 2012, 12:49 PM), http://www.forbes.com/sites/jamesconca/2012/08/11/nuclear-waste-confidence-nrc-ruling-no-big-deal. The nuclear sector has always been governed by a slow moving regulatory system, and they believe that the NRC will resolve the problem and lift the freeze "before any of the critical licensing deadlines pass." *Id.* The majority of nuclear reactors were relicensed in the last ten years and are relatively protected against the effects of this measure. *Id.* Former NRC Commissioner Peter Bradford stated that "the reactors awaiting construction licenses weren't going to be built anytime soon even without the court decision or today's NRC action." *U.S. Freezes All Nuclear Power Plant Licensing Decisions*, ENVIRONMENT NEWS SERVICE (Aug. 7, 2012, 4:53 PM), http://ens-newswire.com/2012/08/07/u-s-freezes-all-nuclear-power-plant-licensing-decisions/.

[205] NRC ORDER, *supra* note 140, at 4.

[206] *Id.*

[207] *Id.*

[208] *Id.* at 483 ("We recognize that the Commission is in a difficult position given the political problems concerning the storage of spent nuclear fuel.").

facing. For over twenty years, the NRC has derived its authority to license nuclear operations from the theory that the generated waste will someday be put to rest in a geologic repository. The future of nuclear energy demands the creation of a permanent repository. Yet there is a disconnect between the NRC, whose regulatory authority extends to commercial reactors and plants, and the DOE, the agency authorized to construct a federal repository for this commercial waste.

The NRC maintains that a geologic repository will be achieved through "open and transparent" decision-making in the future.[209] It points to the NWPA, and the federal government's continual mandate to construct a repository and uphold its obligations to the nuclear energy sector.[210] The question is whether the NRC is beholden to the long-term federal plan under the NWPA. As the agency at the forefront of nuclear licensing battles, the NRC is under the most direct pressure to come to terms with the state of the federal repository program. Must the NRC continue to follow the protocol of the NWPA, or could the agency take a distinctive approach to safe nuclear waste disposal? The answer depends partly on the agency's authority, but is largely a matter of strategy for the NRC.

V. POSSIBLE STRATEGIES FOR THE NRC TO COMPLY WITH NEPA

The NRC may choose to uphold the precept in the WCD that a geologic repository will be achieved, and the nation's SNF inventory will safely remain at the reactor sites until then. The NRC could continue down this path and still satisfy the procedural requirements of NEPA so long as all of the risks and consequences are accounted for in its environmental impact statement.[211] However, this strategy does not serve the best interests of the nuclear energy sector, and it does nothing for waste confidence. Instead, the NRC must adopt the perspective that a new strategy is needed. The NRC can acknowledge where the political system has failed and recommend the safest options *in light of these political inadequacies*. The DOE now calls for a complete overhaul of the federal waste

[209] *New York v. NRC*, 681 F.3d at 477.
[210] *Id.*
[211] *Id.* at 482.

management program, naming consolidated storage systems as an interim solution for SNF.[212] Indeed, the NRC should incorporate a consolidated storage plan into the next WCD.

A. Acknowledge the Failure of Yucca Mountain & the Need for a New Strategy

At the request of the President, the Secretary of Energy formed the Blue Ribbon Commission on America's Nuclear Future (BRC) to conduct a massive review of previous policies and recommend a new strategy for "managing the back end of the nuclear fuel cycle."[213] This broad language in the preamble (as opposed to a narrow focus on a federal repository) reflects a more progressive approach to the SNF problem than that of past years. First, the BRC confirmed that the U.S. nuclear waste management program is at an impasse.[214] It faulted federal policy tracing back to the 1987 amendments to the NWPA, which "tied the entire U.S. high-level waste management program to the fate of the Yucca Mountain site . . . only to come to a point where continuing to rely on the same approach seems destined to bring further controversy, litigation, and protracted delay."[215] The BRC issued an eight-point plan to revive

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[212] BRC REPORT, *supra* note 3, at 32–45.

[213] *See id.* at iii. Between March 2010 and January 2012, the BRC and its subcommittees convened over two dozen times to hear expert and stakeholder testimony, to visit nuclear waste management facilities, and to hold public meetings to gather feedback on its draft reports. *Id*.

[214] *Id.* at vi.

[215] *Id*. The BRC was not chartered to address and did not issue a conclusion on the suitability of Yucca Mountain as a repository site. The report stated:

> The Obama Administration's decision to halt work on a repository at Yucca Mountain in Nevada is but the latest indicator of a policy that has been troubled for decades and has now all but completely broken down . . . .
> . . . [W]e focused on developing a sound strategy for future storage and disposal facilities and operations that we believe *can and should be implemented regardless of what happens with Yucca Mountain.*

Id. at vi–viii.

the nuclear waste management program, mostly comprised of legislative solutions.[216] Among these proposals was an amendment to the NWPA to establish a consent-based siting process modeled after successfully implemented programs in Finland and Sweden.[217] The BRC also proposed establishing a new, government-chartered corporation, independent from the DOE, that would solely focus on carrying out the waste management program.[218] The BRC proposed changes to the federal budget rules to enable reliable access to the Nuclear Waste Fund by separating it from the annual appropriations process.[219]

In total, the BRC Report portends drastic changes in U.S. nuclear energy policy. Many of these recommendations could only materialize within the legislative branch, and the NRC would have no control over the implementation of these measures.[220] Of course, NEPA does not require the NRC to make political predictions. Yet if

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[216] *Id.* at viii.

[217] *See id.* at 48–55.

[218] *See id.* at 60–69. Other nuclear policy experts have urged that "the DOE should be relieved of the responsibility" of commercial nuclear waste management, and instead focus solely on the waste generated by nuclear weapons and naval reactor programs. *See* Ewing & von Hippel, *supra* note 62, at 152. Rather than shifting management to a new federal government entity, they argue for state governments to pursue consolidated storage options within their regions. *Id.*

[219] *See* BRC REPORT, *supra* note 3, at 70–79. The other points in the plan included:

> 4. Prompt efforts to develop one or more geologic disposal facilities.
> 5. Prompt efforts to develop one or more consolidated storage facilities.
> 6. Prompt efforts to prepare for the eventual large-scale transport of spent nuclear fuel and high-level waste to consolidated storage and disposal facilities when such facilities become available.
> 7. Support for continued U.S. innovation in nuclear energy technology and for workforce development.
> 8. Active U.S. leadership in international efforts to address safety, waste-management, non-proliferation and security concerns.

Id. at vii (footnote omitted).

[220] *Id.*

an agency's rulemaking depends on the occurrence of a future political action, the agency must have some rational basis to rely on that political outcome. This explains why the NRC's decisions have historically aligned with the NWPA's program and timeline. However, NEPA is concerned with the *realistic* environmental outcomes of a major federal action. As *New York v. Nuclear Regulatory Commission* clearly demonstrated, NEPA requires the agency to disclose the probabilities of potentially harmful events and the consequences "if those events come to pass."[221] For the purposes of NEPA, the NRC cannot presume the creation of a federal repository under the NWPA.[222] Due to the prolonged delay in the federal repository program, the NRC should formulate and assess a consolidated storage plan as an interim waste confidence solution to satisfy NEPA's procedural directives.

B. Consolidated Storage: An Interim Solution

Although the BRC Report highlighted many political defects in the nuclear waste management program, the WCD addresses temporary on-site storage and geologic repository disposal. By concentrating exclusively on these two stages, the U.S. nuclear waste management program is conspicuously lacking what a recent Massachusetts Institute of Technology (MIT) study described as "a major component of nuclear fuel cycle policy."[223] This key component is long-term interim storage, or "consolidated storage."

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[221] New York v. Nuclear Regulatory Comm'n, 681 F.3d 471, 478 (D.C. Cir. 2012).

[222] Of course, official legislative approval in the form of an Act adds credence to the agency's prediction. Likewise, federal appropriations to carry out the plan lend further support. But the procedural directives of NEPA remain the same.

[223] PHIL SHARP ET AL., MASS. INST. OF TECH., THE FUTURE OF THE NUCLEAR FUEL CYCLE 5 (2011), *available at* http://mitei.mit.edu/system/files/The_Nuclear_Fuel_Cycle-all.pdf. Waste management programs in other countries, such as France and Sweden, have built consolidated storage facilities to keep SNF for forty to sixty years to reduce radioactivity and heat before disposal. *Id.* The United States lacks consolidated storage as a formal phase, and "[t]he failure to include long term storage as part of the spent fuel management has had major impacts on the design of the proposed Yucca Mountain Repository (YMR)." *Id.*

Instead of densely packing SNF into on-site containment pools that were never designed to be long-term storage facilities,[224] nuclear policy experts are recommending that the U.S. transition toward centralized SNF storage facilities.[225] Consolidated storage would *not* replace the need for a geologic repository. Managed storage is believed to be safe for a century, but eventually the SNF storage casks degrade due to radioactivity, heat load, and external conditions.[226] Consolidated storage would serve as an integral part of a long-term nuclear fuel cycle plan that *includes* a permanent repository as a final destination.[227] Ultimately, long-term storage "provides time" to achieve proper development of one or more repositories while offering certain safety advantages.[228]

"Stranded" SNF, residing at reactor sites that have been shut down, provide the strongest case for consolidated storage.[229] The MIT study recommended that SNF "*should be removed as soon as possible from decommissioned reactor sites* to centralized storage facilities or operating reactor facilities."[230] Although the quantity of stranded SNF is small (roughly equal to one year's worth of U.S. production), the costs to store at decommissioned sites are disproportionately high.[231] This relatively small quantity of SNF must be monitored at the old reactor site, costing between 4.5 and 8 million dollars per year.[232] The BRC Report found that the "*savings achievable by consolidating stranded spent fuel at a centralized*

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[224] "[I]t is clear that today's institutional arrangements and storage technologies were not designed for the lengthy storage timescales that now appear inevitable for at least some of the nation's spent fuel inventory." BRC REPORT, *supra* note 3, at 34.

[225] Echoing the findings of the 2010 MIT interdisciplinary study, the BRC Report also recommended a transition to consolidated storage as one of the points in its eight-point plan. *Id.* at vii.

[226] SHARP ET AL., *supra* note 223, at 6.

[227] BRC REPORT, *supra* note 3, at xii.

[228] SHARP ET AL., *supra* note 223, at 5.

[229] BRC REPORT, *supra* note 3, at xii.

[230] SHARP ET AL., *supra* note 223, at 5.

[231] *Id.* At active reactor sites, SNF storage is a relatively low burden because they already have the necessary security and "only an incremental effort is required" to cover the independent storage installation under their operating licenses. BRC REPORT, *supra* note 3, at 35.

[232] BRC REPORT, *supra* note 3, at 35.

facility would be enough to pay for that facility."[233] Apart from cost, there are some long-term safety issues associated with storage at decommissioned sites. Most decommissioned sites now lack the ability to extract the storage casks for inspection, and over time, degradation of the casks may impair their transportation to other locations.[234] Consolidated storage facilities could be developed to actively manage and inspect the casks.[235] Similarly, future safety and security regulations can be implemented more cost-effectively at a centralized facility.[236]

Consolidated storage does more than simply alleviate the burden on decommissioned sites; it offers much-needed flexibility for the entire waste management program.[237] Even though the current storage arrangements have not been deemed unsafe, reactor sites would at least have the option of lowering their SNF inventory and reducing the heat loads of their reactor pools.[238] In light of the events at Fukushima,[239] it is clear that unforeseen situations can arise and demand immediate responses. The BRC report conceded that the United States "lacks any capability to receive spent fuel in emergency situations."[240] In an accident scenario, SNF could be

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[233] *Id.*

[234] *Id.*

[235] *Id.*

[236] *Id.*

[237] *Id.* at 32.

[238] *Id.* at 38.

[239] In March 2011, an earthquake and fifteen-meter tsunami caused the Fukushima I nuclear power plant to experience a "melt-down"; literally, the nuclear reactors severely overheated and melted. WORLD NUCLEAR ASS'N, *Fukushima Accident 2011*, http://www.world-nuclear.org/info/inf69.html (last visited Mar. 10, 2013). The disaster was primarily caused by the flooding of the emergency generators, which cut off the power supply and inhibited the cooling and water circulation processes of the plant. *Id.* High radioactive releases into the air in the first few days prompted the evacuation of 100,000 people from the area. *Id.* Several employees of the plant were treated for physical injuries, but fortunately, no known deaths or cases of radiation sickness resulted from the Fukushima accident. *Id.*

[240] BRC REPORT, *supra* note 3, at 38. Existing contracts with nuclear utilities companies have created a "queue" for SNF to be accepted by the federal government. *Id.* at 42. The DOE is seeking to revise the queue's current order. *See id.* at 38. Theoretically, this queue could be quickly rearranged in an emergency situation, but this would only be relevant if there were a facility or repository to accept SNF. *Id.*

discharged and moved off-site at a moment's notice to a consolidated storage facility with wet storage space.[241] Consolidated storage also offers more secure placement of nuclear waste than under the present system. Unlike nuclear reactors, which are located near large sources of water, consolidated storage sites would be located in areas of the country with less severe weather patterns.[242] Consolidated storage sites would be placed in isolated areas of the U.S. where the risk of "broad-based population exposures in the event of a disaster are lower, and where local conditions are conducive to effectively monitoring and managing security risks."[243]

From a practical standpoint, the nuclear regulatory structure is able to accommodate a consolidated storage plan. Currently, nuclear power plants are classified into four NRC-created regions: West, Midwest, Southeast, and Northeast.[244] This could also serve as the regional division for future interim storage sites. Nuclear waste-producing states should have the incentive to pursue, or at least cooperate with, the installment of consolidated storage sites to accept SNF within their regions.[245] Also, the federal government will begin meeting its legal obligations under the NWPA by moving SNF into consolidated storage.[246] The removal of SNF from reactor sites is a huge step that would relieve taxpayers of further damage awards resulting from the DOE's failure to perform under its existing contracts.[247]

In terms of NEPA compliance, the NRC can address the major faults of its vacated WCD by embracing a consolidated storage plan. First, a long-term consolidated storage system lessens the gravity of a failure to secure permanent storage under Finding 2. If the NRC formulates a consolidated storage system designed to safely store SNF for at least a century, the necessity of a permanent repository will be lessened and/or extended. Second, the agency's risk-analysis of temporary storage would be bolstered by incorporating a comprehensive consolidated storage plan under

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[241] *Id.*
[242] *Id.*
[243] *Id.*
[244] Ewing & von Hippel, *supra* note 62, at 152.
[245] *See id.*
[246] *See supra* notes 31–32 and accompanying text.
[247] BRC REPORT, *supra* note 3, at 37.

Finding 4. Centralized storage facilities have the ability to accept degrading casks of SNF that pose the highest danger based on factors that the NRC determines, such as the age of the SNF, location at a decommissioned site, and other risk indicators.[248] A generic rulemaking that includes a sixty-year timeline for temporary storage would be more reasonable if consolidated long-term storage facilities existed.

The main legal obstacle that prevents immediate development of consolidated storage facilities is the 1987 Amendment to the NWPA, which authorizes the development of one geologic repository and precludes the development of monitored retrievable storage (MRS) sites.[249] However, the federal government may still site, design, and even obtain construction authorization for MRS (i.e., consolidated storage) facilities.[250] For a consolidated storage facility to fully materialize, though, Congress would have to amend the NWPA to allow *construction* of a storage facility independent of the status of a repository.[251] Because the SNF on hand already exceeds the 70,000 metric tons of storage capacity authorized by the NWPA, and for other reasons, the NWPA is unarguably outdated. An amendment to the NWPA is foreseeable if the nuclear waste issue makes its way onto the political agenda.

What does this mean for the NRC? If the agency wishes to pursue consolidated storage as part of its waste confidence decision, it could wait until Congress amends the NWPA to attain a higher level of certainty. On the other hand, the NRC could set the course for political change by calling for consolidated storage in a new WCD Update. As an independent agency, especially one with such technical expertise, the NRC should preemptively issue its own conclusion on this matter. To do so, the agency will need to research the safety and feasibility of consolidated storage management of SNF for at least a century, as well as the transportation-related issues of cask degradation over extended storage times. The NRC has already made significant headway in researching and promulgating

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[248] *See* BRC Report, *supra* note 3, at xii.

[249] *See supra* Part II.A–B.

[250] BRC REPORT, *supra* note 3, at 37. The BRC posited that "further legislative action would not be required . . . potentially . . . until the construction phase." *Id.*

[251] *Id.*

regulations for independent spent fuel storage installations in the form of dry cask and dry vault storage technologies.[252] Using this knowledge, the NRC should incorporate a formal consolidated storage phase into the nuclear fuel cycle in the revised WCD.

C. Reprocessing: Keeping Options Open for the Future

Another alternative exists in the nuclear fuel cycle, although it has not been pursued in the United States. "Reprocessing" is the treatment of spent nuclear fuel to allow it to be used again in the nuclear process.[253] Commercial reprocessing facilities abroad currently use the Plutonium Uranium Extraction (PUREX) method, in which SNF is dissolved and chemically separated to retrieve uranium and plutonium.[254] The preserved plutonium is used again in mixed oxide (MOX) fuel and inserted back into the reactor to generate nuclear energy.[255] Reprocessing is able to recover ninety-six percent of SNF for new fuel, with four percent remaining as high-level waste.[256] The remaining radioactive material would still need to be isolated; thus, reprocessing does not eliminate the need for a

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[252] *Id.*

[253] *See* Clinton Bastin, *We Need to Reprocess Spent Nuclear Fuel, and Can Do It Safely, at Reasonable Cost*, 21ST CENTURY SCI. & TECH. 10 (2008), *available at* http://www.21stcenturysciencetech.com/Articles%202008/Summer_2008/Reprocessing.pdf (arguing that the concept of "nuclear waste" is a fiction, and that given advanced reprocessing technologies, nuclear energy is a renewable resource).

[254] Szabo, *supra* note 6, at 238. "Regular" SNF contains plutonium and uranium mixed with other highly radioactive elements. The PUREX method yields pure plutonium, which is why reprocessing is considered to pose a heightened security risk of theft for nuclear weapons proliferation. *Costs of Reprocessing Versus Directly Disposing of Spent Nuclear Fuel: CBO Testimony Before the U.S. Senate Subcomm. on Energy and Nat. Resources*, 110th Cong. 4. (2007) (statement of CBO Director Peter Orzsag) [hereinafter *CBO Testimony*]. Further research is needed to strengthen security against proliferation. *See infra* notes 258–259.

[255] WORLD NUCLEAR ASS'N, *Processing of Used Nuclear Fuel*, http://www.world-nuclear.org/info/inf69.html (last visited Mar. 10, 2013) [hereinafter *Processing of Used Fuel*].

[256] Bastin, *supra* note 253, at 12. Although there is some question as to whether the remaining four percent should even be classified as "waste." *Id.* Bastin argues that the remaining radioactive material can be separated to yield valuable isotopes that the U.S. currently imports for medical testing and treatment. *Id.*

permanent repository. However, the total amount of high-level waste is dramatically reduced to about one-fifth of its original volume.[257] Theoretically, reprocessing can "extend[] the world's uranium resources almost indefinitely."[258] While this is useful for energy purposes, reprocessing also breaks plutonium into nonfissionable, shorter-lived isotopes with less explosive properties than "regular" SNF that has not been reprocessed.[259] Over time, reprocessing significantly reduces both the volume and the radiotoxicity of nuclear waste.[260]

Despite these advantages, the United States has not embraced commercial reprocessing because the technology has yet to become

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[257] *Processing of Used Nuclear Fuel*, *supra* note 255.

[258] Richard Rhodes and Denis Beller, *The Need for Nuclear Power*, 79 FOREIGN AFFAIRS 41 (2000). Some may wonder, why was reprocessing not considered previously? Reprocessing is not cutting-edge research; it was first developed during the Manhattan Project while constructing the atomic bomb. *See* Szabo, *supra* note 6, at 235–37. At the time, reprocessing was deemed necessary because uranium was thought to be very scarce. ANTHONY ANDREWS, CONG. RESEARCH SERV., RS 22542, *Nuclear Fuel Reprocessing: U.S. Policy Development* 1 (2008). During the Cold War, though, reprocessing began to take on a threatening connotation because other countries were using this technology for the sole purpose of developing nuclear weapons. *Id.* at 3. In 1976, President Gerald Ford issued a policy statement that condemned reprocessing, fearing that it would increase the risk of nuclear proliferation. *Id.* The next year, President Carter suspended all "commercial reprocessing and recycling of plutonium" in the United States in an effort to curb nuclear escalation. *Id.* This ban was later lifted under President Reagan, but most U.S. facilities never pursued reprocessing technology. *Id.* at 5. Only in recent years has reprocessing technology been suggested in terms of safer, cleaner, and possibly more efficient energy production.

[259] Rhodes & Beller, *supra* note 258, at 41. Various European countries have been researching other advanced reprocessing methods that reduce the risk of proliferation, including the UREX method and pyroprocessing. *See Processing of Used Fuel*, *supra* note 255. In 2006, the U.S. government created the Global Nuclear Energy Partnership (GNEP) to collaborate with other countries on "proliferation-resistant recycling technologies in order to produce more energy, reduce waste and minimise proliferation concerns." *Id.* The U.S. domestic component of this program was cancelled in 2009. *See International Framework for Nuclear Energy Cooperation*, WORLD NUCLEAR ASS'N (July 2012), http://www.world-nuclear.org/info/inf117_international_framework_nuclear_energy_cooperation.html.

[260] Michael Valenti, *Reprocessing Nuclear Fuel a la Francaise*, 117 MECHANICAL ENGINEERING 76–80 (1995).

cost-effective.[261] The cost-benefit analysis of reprocessing versus disposal tends to turn on the price of uranium, and thus far, uranium has been cheap enough to warrant disposal of SNF rather than retrieving the uranium through reprocessing.[262] However, the United States imports nearly all of its uranium from foreign countries, and the average spot price has been relatively unstable.[263] Crucially, the United States lacks special facilities that could accommodate commercial reprocessing technology.[264] Also, some form of long-term storage is necessary to house recycled SNF.[265] For these reasons, commercial reprocessing in the United States is not economically feasible now or in the near future.[266]

The prohibitive costs present in the commercial sector do not signal that reprocessing should be abandoned as a scientific pursuit. Reprocessing is the future of nuclear energy.[267] Currently, France, the United Kingdom, Japan, Russia, and India have their own reprocessing facilities.[268] Several other European countries send their SNF to be reprocessed at La Hague, France—the world's largest reprocessing facility.[269] Most of these countries have chosen to reprocess spent fuel for reasons other than economic efficiency.[270]

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[261] *See CBO Testimony*, *supra* note 254, at 6–11.

[262] A Harvard University study from 2003 concluded that reprocessing "will be more expensive than direct disposal of spent fuel until the uranium price reaches over $360 per kilogram of uranium." Matthew Bunn et al., *The Economics of Reprocessing v. Direct Disposal of Spent Nuclear Fuel*, PROJECT ON MANAGING THE ATOM ix (John F. Kennedy School of Government, Harvard University, December 2003).

[263] *Uranium Purchased by Owners and Operators of U.S. Civilian Nuclear Power Reactors*, U.S. ENERGY INFORMATION ADMIN., http://www.eia.gov/cneaf/nuclear/umar/summarytable1.html (last visited Mar. 10, 2013).

[264] *CBO Testimony*, *supra* note 254, at 6.

[265] *Id.*

[266] *Id.*

[267] However, it may be a very "distant" future. For a fuller discussion of the prospects of nuclear reprocessing, see Szabo, *supra* note 6.

[268] *CBO Testimony*, *supra* note 254, at 5.

[269] *Id.*

[270] Radio Interview with Charles Forsberg, Executive Director of the MIT Nuclear Fuel Cycle Project, entitled *Living on Earth: Should we Recycle Spent Nuclear Fuel?* (Apr. 2011), *available at* http://www.loe.org/shows/segments.html?programID=11-P13-00013&segmentID=3.

Like other major forms of energy, nuclear power relies on discrete quantities of certain elements. Energy resources are finite, and they must be treated as such. The environmental advantages are clear: reprocessing preserves essential resources and reduces radioactive byproducts of the nuclear fuel cycle by eighty percent.[271] Although the full economic advantages have yet to be realized, reprocessing should someday lower the costs of long-term storage (through waste reduction) and front-end uranium mining costs.[272]

Reprocessing also provides a strong case for a consolidated storage system. Should the United States pursue this technology, it will need monitored and retrievable SNF storage systems.[273] The current system of geologic disposal is designed to prevent future human contact and to deny access to these materials.[274] Burial of the U.S. inventory of SNF, containing stocks of uranium and plutonium, is detrimental to potential reprocessing endeavors in the future. Even though the United States has only a limited reprocessing program now, it should not foreclose its ability to pursue commercial reprocessing later—whether it be within a few decades or the next century.

In the upcoming WCD revisions, the NRC should take nuclear reprocessing into consideration. At this point, it would be premature to outright rely on reprocessing technology to have a measurable impact on the amount of accumulating SNF. Reprocessing is so early in its development, particularly in the United States, that it cannot truly provide "reasonable assurance" in terms of waste confidence. However, the *potential* for reprocessing technology is an important factor in formulating a waste management plan. NRC rulemakings must contemplate long-term needs for the industry, as well as the protection of forthcoming generations. A safer and more competitive commercial nuclear energy program will demand a consolidated storage system and the capability to pursue reprocessing technology.

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[271] *See supra* text accompanying note 257.
[272] *CBO Testimony*, *supra* note 254, at 6.
[273] *Id.*
[274] *See supra* note 14.

VI. CONCLUSION

Spent nuclear fuel is a problem that will not subside or fade out; rather, it will continue to grow at a slow, predictable rate. Allowing this material to literally "pile up" on-site at nuclear reactors, in the absence of a long-term solution, should be utterly unacceptable to the public. The federal nuclear waste management program has endured much criticism for its failure to develop a geologic repository, but critics acknowledge that these failures were political rather than scientific or technical errors.[275] Yet the safe storage and disposal of nuclear waste is in everyone's best interest. The federal government must revise the NWPA and resolve the funding issues in order for any aspect of the waste management program to move forward.

As *New York v. Nuclear Regulatory Commission* demonstrated, the NRC can no longer steadfastly rely on the current legislative scheme of the NWPA in its Waste Confidence Decision. The NRC is capable and well-prepared to render its own recommendation regarding waste management. Indeed, no other agency is as familiar with commercial nuclear plants and the existing storage situation. In light of the doubtful status of a geologic repository, the NRC should revise the WCD to incorporate a potential consolidated storage system into its environmental analysis under NEPA. By doing so, the NRC offers a safer and practical interim solution until a geologic repository is built, and integrates a crucial phase in the fuel-cycle system to support a competitive nuclear sector.

[275] *See* G.A.O. 11-229, *supra* note 44, at 11.