

A R T I C L E

Solving the U.S. Nuclear Waste Dilemma

by Richard B. Stewart

Richard B. Stewart is University Professor and John Edward Sexton Professor of Law at the New York University School of Law, where he directs the Hauser Global Law School Program and the Center on Environmental and Land Use Law.

His scholarship and teaching focus on environmental law and policy and administrative law and regulation.

I. Introduction

Current U.S. nuclear waste law and policy is bankrupt. The 1982 Nuclear Waste Policy Act (NWPA) set a 1998 deadline for opening a deep geologic repository to receive spent nuclear fuel (SNF) and high-level waste (HLW) from reprocessing. In 1987, Congress amended the Act to designate Yucca Mountain in Nevada as the only potential site, and severely restricted the development of any federal facility for consolidated storage of nuclear waste. Nevada's unrelenting opposition to the Yucca repository eventually succeeded with the election of Barack Obama as President. The Obama Administration has withdrawn funding for Yucca and withdrawn its application for licensing by the NRC. The bankruptcy of the highly prescriptive and preemptive NWPA leaves large volumes of defense nuclear wastes and mounting inventories of spent nuclear fuel without a destination pathway. The failure of Yucca contrasts with the success of the Waste Isolation Pilot Project (WIPP) repository in New Mexico, which was developed entirely outside of the rigid NWPA framework. WIPP, the only operating deep geologic nuclear waste repository in the world, emerged over a twenty-year period through a largely unplanned process of contestation and negotiation between the federal government and the State of New Mexico. WIPP opened in 1998 and has been receiving substantial volumes of certain defense wastes from Department of Energy (DOE) facilities.

This Article is derived from Richard B. Stewart, U.S. Nuclear Waste Law and Policy: Fixing a Bankrupt System, 17 N.Y.U. ENV'T L.J. 783 (2008). It has been abbreviated, considerably revised, and updated for publication in ELPAR. The history and issues addressed herein are addressed in much greater detail in a forthcoming book, JANE B. STEWART & RICHARD B. STEWART, U.S. NUCLEAR WASTE LAW AND REGULATORY POLICY. This article was produced as part of research projects undertaken by the Consortium for Risk-Based Evaluation with Stakeholder Participation (CRESP) for the U.S. Department of Energy. The support of the Filomen D'Agostino and Max E. Greenberg Research Fund at New York University School of Law is gratefully acknowledged.

At the same time as it cancelled Yucca, the Obama Administration has proposed massive government assistance for the construction of large numbers of new nuclear power plants. The failure of the federal government to honor its promises to dispose of spent nuclear fuel, which continues to accumulate at existing power plants, is a potentially potent political weapon for those who oppose expansion of nuclear power. Obama is looking to the distinguished Blue Ribbon Commission on America's nuclear future recently appointed by Energy Secretary Chu to solve his nuclear dilemma.

The tale of the two repositories—failed Yucca and successful WIPP—has important lessons for future policy. The development of one or more repositories for the wastes once destined for Yucca, as well as arrangements for interim consolidated storage, must be based on a step-by-step approach to decisionmaking that includes the informed assent of the public and of host localities rather than unilateral federal fiat.

II. Overview of Nuclear Waste Types, Sources, and Stocks

Nuclear waste is generally classified into six main categories: SNF, HLW, transuranic waste (TRU), low-level waste (LLW), mixed waste that is both radioactive and chemically toxic and regulated under the Resource Conservation and Recovery Act (RCRA) as well as the Atomic Energy Act (AEA), and uranium mill tailings (UMT). These categories are legal constructs that are often not based on risk-relevant differences in their radioactive and other characteristics or the treatment, management, storage, and disposal issues that they pose. This article focuses on the more highly radioactive wastes in the first three categories.

Spent Nuclear Fuel (SNF) refers to the spent fuel rods that have been irradiated in a nuclear reactor, mostly from civilian nuclear power plants. SNF includes both highly active but short-to-medium-lived fission products (principally cesium and strontium) as well as medium-active but long-lived radionuclides with half-lives of thousands of years.

High-level waste (HLW) is highly radioactive material resulting from the reprocessing of SNF to extract plutonium and uranium. Most of the nation's HLW was created in the course of nuclear weapons production. A limited amount of HLW was generated from reprocessing civilian SNF before such reprocessing was terminated in the 1970s.

Transuranic Waste (TRU). In contrast to HLW and SNF, which are defined by the processes that produce them, TRU is defined by its characteristics. TRU includes waste containing more than 100 nanocuries of alpha-emitting transuranic isotopes with half-lives greater than twenty years per gram of waste, but excluding HLW and certain other wastes. There are two subcategories of TRU: lower radioactivity contact-handled TRU (CH-TRU), which constitutes the great bulk of TRU, and higher radioactivity remote-handled TRU (RH-TRU), which must be handled and transported in shielded casks.

Low-Level Waste (LLW) is a residual category that encompasses a wide variety of wastes, generated by defense activities, nuclear power production, and industrial, medical, and scientific applications. There are comparatively large volumes of low activity wastes, and much smaller volumes of higher activity wastes. Some of these wastes are disposed of at commercial and government landfills, others are stored at generator sites.

The focus of this Article is on the most highly radioactive wastes, HLW, SNF, and TRU. TRU is being disposed of at WIPP, while the other wastes are stored at the sites where they were generated. The current inventories of SNF and HLW in the United States amount to 73,000 metric tons in the form of heavy metal (MTiHM). Of this total, defense HLW at DOE sites amounts to 12,505 MTiHM. Another 2,500 MTiHM consists of defense activity SNF stored at DOE sites. More than 54,000 MTiHM is civilian SNF now being stored in reactor pools or in dry storage air-cooled containers at sites contiguous to the 131 civilian nuclear reactors at sixty-four locations in thirty-nine states. Further, an additional 47,000 MTiHM of civilian SNF will have been generated by 2048 even if no new nuclear power plants are built. The total of all of these categories far exceeds the statutory maximum capacity of Yucca, at 70,000 MTiHM. With the cancellation of Yucca, all of this waste now lacks any disposal pathway.

III. The Path to the Present Impasse: A Short History of U.S. Nuclear Waste Regulation

A. The First Three Decades

In 1946, Congress passed the AEA, which created the Atomic Energy Commission (AEC) to run a federal monopoly on both military and non-military applications of nuclear

power.¹ In the 1950s, the Eisenhower Administration promoted private sector use of nuclear technology for electricity production and other uses; Congress amended the AEA to authorize such use. Although the AEC's broad regulatory authority encompassed wastes,² disposal of defense HLW from weapons production was a low priority and the search for disposal sites progressed very slowly. A seminal 1957 National Academy of Sciences (NAS) report found that a deep geologic repository was the best available option for nuclear waste disposal and that bedded salt was likely the best medium in which to build such a repository.

The first serious federal effort to develop a nuclear waste repository was prompted by a 1969 fire at the AEC's Rocky Flats, Colorado nuclear weapons plant that forced removal of TRU wastes for storage in Idaho, which demanded their relocation. After an aborted attempt to develop a repository in Kansas, the federal government, in 1972, responded to an expression of interest by the economically depressed town of Carlsbad, New Mexico in hosting a repository. The eventual result was the development, over a 25-year period, of the WIPP repository for defense TRU wastes in a salt bed on federal land in southeastern New Mexico.³

Because of the desire to separate nuclear regulation from management and operations, Congress, in 1974, passed the Energy Reorganization Act, which split the AEC into the Nuclear Regulatory Commission (NRC), an "independent" agency with five members,⁴ and the Energy Research and Development Administration (ERDA), whose head answered to the President.⁵ The NRC was put in charge of licensing civilian nuclear reactors and reprocessing facilities, as well as all stages of commercial HLW and SNF management, storage, and disposal. The NRC's licensing authority did not extend to defense facilities and wastes, which were to be managed and regulated solely by ERDA. ERDA subsequently became the DOE in 1977.⁶ Also, on its creation in 1970, the Environmental Protection Agency (EPA) acquired the AEC's authority to issue radioactivity exposure standards to protect public health and the environment.

B. Opposition to Nuclear Power and the End of Civilian SNF Reprocessing

The premise of civilian nuclear power was that SNF would be reprocessed to extract plutonium and uranium for reuse as

1. 42 U.S.C. §2011.
2. *Id.* Section 2201 gives the AEC (now NRC) the power to: "establish by rule, regulation, or order, such standards and instructions to govern the possession and use of special nuclear material, source material, and byproduct material as the Commission may deem necessary or desirable to promote the common defense and security or to protect health or to minimize danger to life or property." 42 U.S.C. §2201.
3. *See, e.g.,* CHUCK McCUTCHEON, NUCLEAR REACTIONS: THE POLITICS OF OPENING A RADIOACTIVE WASTE DISPOSAL SITE 12 (2002); U.S. DOE, PIONEERING NUCLEAR WASTE DISPOSAL (2000), DOE/CAO-00-3124, at 7; Gary L. Downey, *Politics and Technology in Repository Siting: Military Versus Commercial Wastes at WIPP 1972-1985*, 7 *TECH. IN SOC'Y* 47, 53 (1985) (discussing the WIPP repository for defense TRU wastes).
4. 42 U.S.C. §5841.
5. *Id.* §5811.
6. *Id.* §7151(a).

fuel. Although reprocessing produced significant amounts of HLW, reprocessing diverted attention from disposal issues. Civilian reprocessing facilities, however, encountered serious financial, operating, and environmental problems. In 1977, President Carter applied the coup de grace by halting all federal support for civilian SNF reprocessing, due to proliferation and security concerns posed by the plutonium produced. There has been no reprocessing of civilian SNF in the US since then, although a number of other countries have carried out civilian SNF reprocessing. Meanwhile, groups opposed to nuclear power used litigation to block new plants, invoking the SNF waste issue, among others. California and a number of other states passed legislation blocking new nuclear plants until a means for disposing of wastes was demonstrated. These factors, along with economic and other factors, brought construction of new plants to a halt.

The NRC was prompted to initiate a waste confidence rulemaking to address the question of whether or not it should license new nuclear plants because of the environmental risks posed by additional quantities of SNF.⁷ Concerns that the lack of a repository would stifle the future of the nuclear power industry eventually led the industry and the federal government to press for a legislative solution.

C. *The Carter Interagency Review Group and the Push for Nuclear Waste Burial*

Seeking to engage both experts and the broader public in an effort to develop a coherent and comprehensive national nuclear waste disposal policy, President Carter, in 1978, assembled the Interagency Review Group on Nuclear Waste Management (IRG). The IRG issued a report based on the premise that the generation of citizens that has enjoyed the benefits of nuclear energy has an obligation to responsibly dispose of the waste in perpetuity.⁸ It endorsed deep geological storage, and recommended that detailed studies of specific potential repository sites “in different geologic environments” (including salt, shale and tufa) should begin “immediately” in order to identify at least two (and possibly three) repositories that could become operational by the end of the 20th century.⁹ These repositories should be located “ideally in different regions of the country.”¹⁰

D. *The Nuclear Waste Policy Act*

The political saliency of nuclear waste and the work of the IRG also led to Congress’ enactment in 1982 of the Nuclear Waste Policy Act (NWPA).¹¹ It mandated the development of permanent repositories for disposing of SNF and HLW.

NWPA places responsibility on the federal government for the disposal of commercial SNF and HLW in deep geological repositories. The Act required the utilities to pay a fee on nuclear electric generation, with the proceeds to be used to finance repository development. In return, the federal government undertook to take SNF from the utilities no later than January 31, 1998.¹² The Act also provided for disposal of defense HLW in a repository.

In an aim to promote regional equity, the Act provided for the siting and construction of two federal repositories on a tight timetable, with siting of the second repository to be conducted after the first.¹³ The Act provided for a centralized technocratic process of site selection by DOE, based on factors including geological suitability, distances from populations, transportation, and cost. In the first round of siting, DOE was required to nominate five sites suitable for characterization and, by January 1, 1985, to recommend three of these to the President for characterization as candidate sites. It was then to select one of the sites for licensing and construction of a repository with the goal of opening it to receive wastes by 1998.

A limit was placed on the capacity of the first repository (no more than 70,000 metric tons) in order to ensure that the second repository would in fact be selected. It was anticipated that the first round of siting would concentrate on sites in the West and the second round of siting would focus on sites in the East. The NWPA also provides for the development of Monitored Retrievable Storage (MRS) facilities, constructed and operated by DOE. Such facilities would be designed for indefinite storage of SNF and civilian HLW, but also allow for ready retrieval of wastes for further processing or permanent disposal. The Act authorized construction of only one MRS.

The federal government encountered strong opposition from states in which candidate sites were located, and political pushback caused DOE to cancel the search for a second repository in the eastern U.S. It eventually designated three sites in the West for the first repository, located in Nevada (Yucca Mountain), Texas, and Washington. The estimated cost of conducting detailed characterizations of these sites had mushroomed to \$1 billion per site.

E. *Congress Designates Yucca Mountain*

In 1987, Congress amended the NWPA to require that only one site be characterized, and dropped the requirement of a second repository.¹⁴ Senator Bennett Johnson of Louisiana, the powerful Chairman of the Senate Energy Committee, was concerned that escalating costs and intensified opposition from potential host states would scuttle the entire program unless Congress moved swiftly to designate the repository site. DOE’s preliminary rankings placed Yucca over the sites in Washington and Texas, but the scores were

7. LUTHER J. CARTER, *NUCLEAR IMPERATIVES AND PUBLIC TRUST: DEALING WITH RADIOACTIVE WASTE* 88 (1987).

8. INTERAGENCY REVIEW GROUP ON NUCLEAR WASTE MANAGEMENT, U.S. DOE, *REPORT TO THE PRESIDENT BY THE INTERAGENCY REVIEW GROUP ON NUCLEAR WASTE MANAGEMENT* (1979) [hereinafter *INTERAGENCY REPORT*] at 16, 31, Appendix H-4.

9. *Id.* at Appendix H-9.

10. *Id.*

11. 42 U.S.C. §10101.

12. *Id.* §10131(a)(4).

13. *See id.* §§10132(a), 10134(a)(2)(A).

14. *Id.* §10172(a).

all close.¹⁵ Congress' choice of Yucca was driven by the influence of powerful members from Texas and Washington. Nevada lacked clout and was steamrolled.

F. Government and Private Centralized Storage Facilities

Pursuant to the 1982 NWPA, DOE had proposed that a federal MRS facility be built at Clinch River, Tennessee, and also identified two alternative MRS sites in the state. But, bowing to political pressures from the Tennessee delegation, Congress, as part of the 1987 NWPA amendments, revoked the proposal to site a MRS facility in Tennessee. Congress also imposed further limitations on the DOE and MRS facilities, leading DOE to essentially abandon MRS siting.

In the absence of any federal repository or storage facility, a utility-owned Private Fuel Storage (PFS) consortium sought to build a private SNF storage facility on lands of the Skull Valley Band of Goshute Indians in Utah, with the capacity to store 40,000 metric tons of SNF, far more than would be permitted at a federal MRS facility.¹⁶ The PFS facility was granted an NRC license in 2006, following a nine-year licensing process. Construction of the PFS facility, however, has been blocked by the Department of the Interior.¹⁷ The Bureau of Indian Affairs refused to approve the tribe's lease of its land for the facility because of risk that the facility would become a de facto permanent repository, while the Bureau of Land Management also denied a right of way over federal lands for a railway line to the site. The future of the facility is currently in limbo.

G. Nevada's Reversal of Political Fortune and the Demise of the Yucca Mountain Repository

After characterizing the site, DOE recommended Yucca to Present Bush, who selected it for development of repository for HLW and SNF. In accordance with the NWPA, Nevada exercised its right to disapprove the repository, but this disapproval was overridden by a joint resolution of Congress. DOE developed and eventually submitted to NRC an application to license the Yucca repository, in conformity with environmental and safety standards including radioactivity exposure standards issued by EPA. Nevada opposed the repository by every means at its disposal, including litigations and efforts to halt or harass DOE's efforts to characterize the site. The election of President Obama, who had opposed Yucca during and even before the 2008 Nevada Democratic Primary, and the position of Democrat Harry Reid of Nevada as Senate Majority leader, caused a sudden turnaround in Nevada's political fortunes. The Obama Administration has terminated funding for Yucca and DOE has sought to withdraw its application to NRC for licensing the repository. However,

15. CARTER, *supra* note 7, at 175.

16. NWPA limits a federal MRS to storing 10,000 metric tons of heavy metal before licensing of a federal repository and 15,000 metric tons thereafter. 42 U.S.C. §10168(d)(3)-(4).

17. MARK HOLT, CRS REPORT FOR CONGRESS: CIVILIAN NUCLEAR WASTE DISPOSAL 13 (2007).

the NRC Atomic Safety and Licensing Board recently ruled against DOE, holding that the application must go forward for decision by NRC. The Board's ruling will be reviewed by the Commission, the courts, and possibly Congress. Even if sustained, the licensing process itself would take years, followed by appeals, and even if a license is granted, Congress would have to fund construction. Thus, the possibility that Yucca might still be built is highly remote and would occur, if at all, only after long delays.

H. The Successful Development of WIPP

In contrast to the centralized, top-down NWPA strategy for siting a HLW/SNF repository, the WIPP TRU repository did not develop in accordance with any mandated blueprint, but instead as a result of an iterative, often halting, step-by-step process over twenty-five years involving DOE, the State of New Mexico, Congress, the federal courts, and local environmental advocacy groups. Through litigation and leveraging its representation in Congress, New Mexico ensured that its core interests were accommodated. An independent, federally funded technical review body, established and carried out with significant state involvement, promoted state and public confidence and acceptance of key decisions regarding the facility. At various times the disposal at the site of defense HLW, defense TRU, and civilian SNF was considered. Politics in Congress and New Mexico eventually determined that the facility would be restricted to defense TRU.

After DOE was forced to obtain explicit congressional authorization for the facility following a New Mexico court victory, Congress, in 1992, enacted the Waste Isolation Pilot Plant Land Withdrawal Act (WIPPLWA) to authorize operation of the facility and establish a regulatory framework for it. Congress directed EPA to issue site-specific radioactivity exposure standards for WIPP and determine whether the facility was suitable as a long-term disposal repository for TRU. Subsequently, New Mexico also gained and exercised authority under RCRA over shipments of TRU waste to the site,¹⁸ which gave it additional leverage to ensure that its concerns were met. EPA certified WIPP in 1998, and the next year it received its first shipment of waste. EPA recertified WIPP in 2004, five years after opening. WIPP has received and deposited several thousand shipments of TRU wastes since that time without major controversy.

IV. The Current Dilemma and the Way Forward

Under existing law, as set forth in the NWPA, Yucca Mountain is the only candidate site for a permanent repository for SNF and HLW. Yet the Obama Administration has terminated its funding and has sought to withdraw its NRC

18. 42 U.S.C. §6901, ELR STAT. RCRA §1001, provides for federal EPA regulation of chemically hazardous wastes, and for delegation by EPA of such regulatory authority to states with approved regulatory programs. RCRA has been interpreted to grant EPA and delegated states authority to regulate "mixed wastes," including TRU, that are chemically hazardous as well as radioactive.

license application. There is no alternative in sight. Siting and developing a repository at another location will take decades. Neither a federal MRS facility nor a privately owned consolidated storage facility has been developed. Meanwhile, SNF continues to accumulate at reactor sites. Localities and states are growing restive at the prospect of indefinite at-reactor storage of SNF, especially at sites where reactors have shut down. The HLW stored at various DOE sites across the country also lacks a destination pathway. DOE will find it impossible to meet the commitments that it has made in agreements with states hosting these sites to ship the wastes out of state by specified deadlines.

What are the possible solutions to these orphan waste dilemmas? WIPP's mission might be enlarged to include some wastes other than TRU. Earlier studies of the WIPP site and facility indicated that it could well be suitable for disposal of SNF and/or HLW as well as the TRU it already receives. Congress would have to enact legislation to enlarge WIPP's mission. New Mexico could be expected to resist, and its concerns and interests would need to be accommodated. Alternatively, Yucca might possibly be revived and eventually built.

Notwithstanding these possibilities, the nation must move forward with a plan to establish at least one new deep geological repository as well as a strategy for dealing with SNF. Such a strategy should include one or more new public and/or private consolidated storage facilities for SNF that would, at a minimum, store SNF from shutdown reactors and possibly additional SNF as well, pending development of a permanent repository; the option of reprocessing SNF might be considered in the interim. What lessons can be drawn from past experience to develop a successful strategy and retrieve the bankruptcy of the NWPA?

A. *Rethinking the Ethics of Nuclear Waste*

The first step is to rethink the ethical principles embraced by the Carter IRG. It is not the case that the benefits of nuclear power and nuclear weapons have accrued only to past and current generations, and that our responsibilities to future generations require "in perpetuity" disposal of nuclear wastes as promptly as possible. At least a part of the national security and economic benefits of past uses of nuclear technology are embedded in the social and economic capital that future generations will inherit. Because carbon dioxide emissions reside in the atmosphere for centuries, the carbon emissions avoided by the use of nuclear power to date will benefit future generations for many years. Nor is it obvious that the interests of future generations are best served by burying current waste stockpiles as soon as possible. Our ability to evaluate repository sites and the technologies for containing wastes are likely to improve in the future. Moreover, nuclear fuel is a partially renewable resource. Burying this resource irretrievably will deny future generations the option to use it. While repositories can be built to permit retrieval of wastes, incorporating retrievability adds to expense and perhaps performance uncertainty. Moreover, once wastes are bur-

ied in a repository, it may be politically difficult to retrieve them even if retrieval is technically possible. Based on these considerations, a revised ethic is appropriate, along the following lines:

Our obligation is to give succeeding generations a real choice and the opportunity to shape their own decisions while at the same time not imposing a burden those future generations may not be able to manage.¹⁹ This principle points to a step-by-step approach to dealing with nuclear waste, through an iterative process of learning and public deliberation, as opposed to an immediate decision on a final solution.²⁰ This does not mean that we should not start now to develop at least one new repository and one or more consolidated SNF storage facilities. But there should be no artificial deadlines or "final solutions" mandated at the outset.

B. *Securing Informed Public Trust and Host Assent to New Waste Facilities*

The lesson of U.S. experience, confirmed by that in some other nations, including Finland and Sweden, is that nuclear waste storage and disposal must ultimately be based on informed public assent, particularly that of host localities and states. Achieving assent will require a combination of technical competence; true engagement of host local and state stakeholders in risk assessment and management; partnering with states in repository siting, design, and operation planning and decisionmaking; and steps to meet host state and local safety concerns, including those relating to waste transportation and emergency preparedness. It will also be necessary to provide economic and other benefits to the host locality and state, such as investment in economic infrastructure that will support long-term growth, government services, educational and health benefits, and priority under federal programs. Successful siting and facility development will also require a step-by-step approach, one that is flexible, open, and responsive to state and local concerns and needs, rather than a system of unilateral decisions by the federal government that presents states and localities with a fair accompli. Washington must abandon the arrogant and dysfunctional top-down strategy embraced in both the 1982 NWPA and the 1987 NWPA amendments.

This conclusion has both pragmatic and ethical foundations. Notwithstanding the federal government's plenary legal power to build a new nuclear waste repository or storage facility on its own lands, experience shows that this power is counterbalanced by deep political and institutional safeguards of federalism that make it very difficult to impose such facilities against the determined opposition of host jurisdictions. As an ethical matter, such impositions are unfair. Host jurisdictions should not have to bear the burden of other

19. I am indebted to Tom Isaacs, Director of Policy and Planning, Lawrence Livermore National Laboratories, for this formulation.

20. Canada is currently developing such an approach to nuclear waste management. See NUCLEAR WASTE MGMT. ORG., *MOVING FORWARD TOGETHER: ANNUAL REPORT 2007* (for a discussion of the newly developed Canadian approach to nuclear waste management going forward).

jurisdictions' wastes unless they have had a fair opportunity to contest, influence, and ultimately accept a facility.

Future siting decisions will accordingly require federal collaboration with states and localities, open processes, ready public access to information, and public involvement in or opportunity for review of data gathering risk assessment, site evaluation, and facility design. It is only through such processes that informed assent is likely to be secured. The federal government, after considerable prodding, eventually and grudgingly followed this approach in developing the WIPP facility after New Mexico succeeded in repeatedly blocking unilateral decisions by DOE.²¹

Informed public assent requires strong institutional assurances of facility safety and environmental protection, including (as at WIPP) host state regulatory authority over wastes transferred to the facility. It also requires credible, independent technical and scientific oversight and review, with (as at WIPP) a state role in establishing the reviewing body. Gaining host trust and assent also has critical procedural elements. The process for making siting decisions must be transparent and accessible, and include procedures through which a potential state/local host is brought in at the early stages of the planning process and is able, in a timely manner, to voice its concerns and demands and resolve them with the federal government through discussion, deliberation, and negotiation. *Informed* public assent implies full and accurate information about characteristics of the wastes, the risks posed, the site, and the facility that the government proposes to develop, as well as related arrangements such as transportation; it also implies that host states and communities are given the resources to hire their own independent experts to evaluate claims made by the proponents and perform their own investigations and gather information on issues of importance to them. An open, step-by-step process for decisionmaking on new facilities is essential, not only for the reasons discussed above, but also to provide for meaningful state input and influence as a facility develops. The legal and institutional framework for facility siting, design, and construction including state involvement in decisionmaking must secure these requisites.

In addition, the economic interests and the past experience of potential host states and localities must be considered and accommodated. These variables go a long way to explain why WIPP ultimately succeeded in meeting the State's tough requirements and is open for business, whereas Yucca has been tied up in state-generated delaying tactics. Carlsbad and New Mexico were economically needy, and had a generally positive experience with federal nuclear activities. Nevada's experience was the opposite. Long-run benefits that take the form of economic development and jobs for local communities appear to be much more significant than cash transfers, although federal grants to New Mexico were also important.

21. Host assent could take explicit form in an agreement between the federal government and a state/locality, as a memorandum of agreement under which the latter agrees to host the facility on specified terms. But it can also be manifested less formally, for example through de facto acceptance of a facility rather than active resistance to it, following a process of discussion and negotiation and concessions by federal authorities.

Reprocessing facilities and new types of reactors, as well as R&D installations to develop these technologies, are likely to offer long-run economic benefits, and could be coupled with a new repository or consolidated storage facility to help win host acceptance.

C. *Creating New Federal Waste Management and Siting Institutions and Financing Mechanisms*

The third step for dealing with nuclear wastes is to establish new federal institutional structures for nuclear waste management, siting, and regulation. DOE suffers from high turnover, erratic funding, internal stove piping and resource conflicts, a culture of secrecy, and erratic, politically directed congressional funding. The most fundamental difficulty with existing arrangements, however, may be that the task of siting new waste disposal and storage facilities (including facilities for LLW, as well as HLW and SNF) and the task of constructing and managing the new facilities, as well as managing existing waste facilities, are fundamentally different and call for different organizational skills and attributes. Accordingly, serious consideration should be given to taking both of these functions out of DOE and creating two new entities, one responsible for siting and the other for nuclear waste management. Congress, at the same time, needs to address the closely linked issues of developing new mechanisms to finance the development and operation of new and existing facilities, and the resolution of the government's liabilities for failing to take utility SNF beginning in 1998.

Nuclear waste management. Under the proposed reorganization, one new entity would be dedicated to managing nuclear waste. It would not site new storage facilities or repositories, but would be responsible for waste storage, treatment, and transportation; development and application of waste containers; construction and operation of interim consolidated storage facilities; and construction, operation, closure, and post-closure monitoring of a repository. The requisites for such an entity are a clearly defined mission, a business model of management, high-quality technically adept personnel, and assured long-term stable funding. There are several institutional forms that such an entity might take:

- A federal agency with a single head who reports to the President.
- A federal agency with a single head that reports to the Secretary of DOE but located outside DOE (on the model of the Bonneville Power Authority).
- A federal corporation owned by the federal government with a presidentially appointed board that selects a CEO to manage its operations, on the model of the TVA.
- A hybrid federal corporation owned in part by the federal government and in part by the nuclear utilities with a board selected in part by each.

A further option would be a private corporation owned by the nuclear electric utilities, regulated by the government. While this model has been adopted by some European countries, it is probably too radical a departure from the status quo to be politically acceptable in the U.S.

The advantage of a corporate form is that it would most fully realize the business model, and free the entity from federal personnel and procurement requirements, promoting flexibility and efficiency and enabling it to hire and retain highly qualified personnel.²² Continuity of funding could be assured by making a nuclear generation fee payable directly to the entity, or establishing contractual arrangement for utility funding. Alternatively, funding by Congress could be accomplished through long-term appropriations, possibly including a revolving fund separate from the unified federal budget. A further advantage of a hybrid corporate form is that it could build on the commonality of interests in successful waste management on the part of the government and the utilities; the NWPA waste management liability scheme makes them adversaries. Such an entity could assume ownership of wastes once they left the site of a reactor or reprocessing facility. A hybrid federal corporation owned by the government and the nuclear utilities would represent a sensible compromise arrangement, and such a corporation might potentially engage in reprocessing as well as waste management. The federal or hybrid corporate form, however, has disadvantages, most notably lack of clear arrangements for accountability in its policies and finances.²³ The recent financial debacles of FannyMae and FreddyMac must be carefully considered in designing a new model for nuclear waste management. A corporate model could also make it difficult to coordinate waste management decisions with the functionally related decisions of existing federal agencies.

Siting. Siting of storage facilities and repositories calls for different institutional requisites. While technical competence is essential, the NWPA experience indicates that a purely technocratic model is too narrow. Successful development of new storage facilities or repositories will require considerable engagement with states and localities and a wide variety of constituencies, and a capacity for negotiation within those various stakeholders. This will require an institution that is more open, that can represent different viewpoints and stakeholder interests, and that can develop good political connections with Congress and the states. The multimember “independent” commission form may best suit these specifications. Such agencies have typically had closer ties with Congress (and, through Congress, to local interests) than agencies with single heads who report to the President. An office of waste negotiator should be included as a component within such a commission to take the lead in exploring and negotiating siting opportunities, building on experience

gained under the now-expired provision of NWPA establishing the ONWN.

Financing. Congress should resolve the government’s past and future liabilities through statutory arrangements that will at the same time provide a more secure system of financing for SNF management storage and disposal than was achieved under the NWPA Nuclear Waste Fund. The options include the following:

- Industry-financed storage and disposal through a corporation owned and operated by the utilities, with some government/public representation in its governance and financial commitments and financing arrangements by the industry participants. This is the model followed in Canada.
- A federal corporation with utility representation in its governance that would have authority to finance its operations by fees on nuclear electricity generation.
- Funding for a special-purpose government agency funded through dedicated revenues from nuclear electricity fees placed in an escrow account in the Treasury.
- Reclassification of revenues from the nuclear generation fee as offsetting collections and receipts. Under this system, expenditures for SNF management would not be subject to the overall federal spending budget cap, and the SNF program would not have to compete with other federal programs for limited resources.

Environmental regulation. Environmental health and safety (EHS) regulation of nuclear waste and storage facilities and repositories should, of course, be independent of management and siting. But it seems questionable to have two regulators—NRC and EPA—playing this role, as is currently the case. EPA’s primary mission is pollution control, an orientation which is not well-suited for dealing with the problem of the EHS regulatory issues posed by nuclear waste management and disposal, which are based on complex geologic and engineering systems and stochastic risks of systems failures due to the interaction of multiple fault lines. Dealing with such risks, including those posed by nuclear reactors, is NRC’s central mission. While environmentalists tend to distrust NRC, and institutional redundancy can guard against “capture” of regulatory agencies by the regulated industry, duplication of function creates the potential for conflict and muddles accountability. The preferred solution is to take the necessary steps to ensure the independence and ability of a single EHS regulator. At this juncture, however, EPA standard-setting and certification of repositories (as at WIPP) have come to be accepted as an integral part of the regulatory process for disposal of the most highly radioactive wastes, and accordingly may well need to be retained to win host trust and acceptance. For similar reasons, states’ RCRA authority over the chemically toxic component of mixed wastes should be retained. States play an important role in regulating federal facilities, and the WIPP experience suggests that the

22. See A. Michael Froomkin, *Reinventing the Government Corporation*, 1995 U. ILL. L. REV. 543 (1995) (discussing the advantages of the utilization of the corporate form in this context).

23. *Id.* at 560, 594-95, 607-08.

ability to exercise such authority may be essential to states' willingness to accept future nuclear waste facilities.

D. *Instituting a More Performance-Based, Hazard-Informed Approach to Waste Classification and Management*

A final step in rethinking nuclear waste law and policy is to phase in a more performance-based, hazard-informed approach to waste policy and its implementation. Various reports by NAS and government committees have recommended this step.²⁴ The International Atomic Energy Agency has developed a classification framework that reflects practice in a wide range of countries and provides a useful point of reference. The existing U.S. waste classification/regulation represents an amalgam of various provisions in statutes and regulations that has evolved in patchwork fashion over many years. The resulting classifications and their legal consequences do not always reflect relative risks or sensible waste management policies and priorities. Many waste classifications are based not on the wastes' radiological and other characteristics and the risks that they pose, but on the processes by which they are produced. Moreover, these different categories often include a variety of different kinds of wastes posing different levels and kinds of risks and requiring different approaches to treatment, storage, and disposal.

There are a range of opportunities to reclassify wastes to achieve a better fit between hazards on the one hand and regulatory requirements on the other. For example, certain components of reprocessing wastes now managed (at great cost) as HLW could be separated, solidified, and safely disposed of as LLW. Some high-volume types of LLW with very low radioactivity levels could appropriately be disposed of in landfills without the full extent of engineered controls now required. But other LLW pose significant hazards that require even more stringent controls than now exist.²⁵ Steps to build a more hazard-informed, performance-based waste classification scheme, which would point to more stringent regulation in some cases, and less stringent controls in others, should be incremental and should be accomplished through administrative procedures that will allow full opportunity

for public participation and judicial review. The approach should take into account societal views of risk as well as scientific ones. Moving towards such a system of classification and regulation will not solve the most fundamental problems of nuclear waste in the United States, but it would make valuable contributions towards establishing a more rational system of nuclear waste regulation.

V. Conclusion

The failure of the NWPA and the ultimate success of WIPP indicate that our current orphan waste dilemmas must be solved through a patient, step-by-step approach, keeping options open to the extent feasible, learning from experience, and dealing with unforeseen developments through a strategy of adaptive management. Successful development of a new repository and of consolidated storage facilities must also be based on the informed assent of localities and states hosting waste storage and disposal facilities. This approach is radically different from the approach taken under the NWPA of establishing a detailed blueprint at the outset, pushing insistently forward with it heedless of mounting evidence of fundamental design flaws, and imposing facilities on unwilling states. Implementing the new approach will also require some basic legal and institutional changes to establish the necessary infrastructure for moving forward. The Blue Ribbon Commission should flesh out the elements of this strategy as well as the other recommendations in this article. Congress and the Administration should seize the opportunity to make a fresh start rather than tinkering with a broken system and strategy.

24. See generally Nuclear Radiation Studies Board, Committee on Improving Practices of Regulating and Managing Low Activity Radioactive Waste, *Improving the Regulation and Management of Low Activity Radioactive Waste* (2006); Committee on Improving Practices for Regulating and Managing Low-Activity Radioactive Waste, Nuclear and Radiation Studies Board, *Improving the Regulation and Management of Low-Activity Radioactive Wastes* (NAS-NRC 2006); Allen Croff, *Risk-Informed Radioactive Waste Classification*, 91 HEALTH PHYSICS 449 (2006); B. John Garrick, *Contemporary Issues in Risk-Informed Decision Making on the Disposition of Radioactive Waste*, 91 HEALTH PHYSICS 430 (2006); Linsley Gordon, *International Standards Related to the Classification and Deregulation*, 91 HEALTH EFFECTS 470 (2006); Rob Rechar, *Historical Relationship Between Performance Assessment for Radioactive Waste Disposal and Other Types of Risk Assessment*, 19 RISK ANALYSIS 763 (1999) (all discussing the possibility of the implementation of performance-based standards).

25. Nuclear Radiation Studies Board, *supra* note 24.