Searching for Science in the Past and Present Discussion on Commingling Policy in the US – 15083

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ABSTRACT

Since 1985, the policy in the United States for disposing of nuclear waste has included commingling defense and civilian spent nuclear fuel (SNF) and high-level radioactive waste (HLW) in a mined geologic repository. Commingling policy is under discussion again because of developments over the last several years in the nuclear waste management and disposal program. The authors reviewed the extent to which scientific and technical information was involved in considerations of commingling from the 1950s to the present. Evaluations undertaken by the US Department of Energy (US DOE) in 1985 and April 2014 are compared and the technical issues of *health and safety*, *transportation*, and *national security* are addressed in both evaluations.

INTRODUCTION

Commingling, as used in this review, is the combined disposal of defense and civilian spent nuclear fuel (SNF) and high-level radioactive waste (HLW) in a deep geologic repository.[c] Defense waste results from activities related to the production of nuclear weapons, other defense-related activities, and government-sponsored research. The US Department of Energy's (DOE) Office of Environmental Management manages defense waste. Civilian waste, commonly referred to as commercial waste, consists primarily of SNF that is generated by nuclear power. Civilian SNF is owned by the nuclear utilities and is presently stored at the commercial nuclear reactor sites. The US DOE is responsible for the permanent disposal of both civilian SNF and defense SNF and HLW. In 2010, US DOE's program to license and develop a repository for the permanent disposal of these wastes at Yucca Mountain in Nevada was discontinued [2].

The United States established a policy on commingling the disposal of civilian and defense SNF and HLW in 1985 [3] that remained unchanged as DOE focused on developing the Yucca Mountain repository. In this paper, we trace the history of the commingling issue, including the evaluation bases for the 1985 commingling decision, and describe recent events that have resulted in reconsideration of the commingling policy. Included in the discussion is a comparison of factors analyzed in the 1985 decision with the criteria used in a US DOE study released in April 2014 [4]. The April study served as a technical basis for informing option strategies described in an October 2014 paper released by the US DOE Office of Nuclear Energy.[d]

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[a] The views expressed in this paper are those of the authors and do not necessarily represent the views of the U.S. Technical Review Board. The first author, while a staff intern for the Board during the summer of 2014, completed this study under the guidance of the second author who is a member of the Board's Senior Professional Staff.

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[c] Liquid HLW results from reprocessing SNF. HLW liquid is converted through vitrification into a glass HLW product for disposal. Limited commercial reprocessing took place in the United States between 1966 and 1972 at the Western New York Nuclear Service Center (West Valley). In the early 1980's, the federal government assumed that all defense SNF would be reprocessed and the resulting HLW would be vitrified [1]. Reprocessing initiatives ended before all defense SNF could be reprocessed, leaving about 2500 metric tons of unreprocessed defense SNF.

[d] The US DOE Assessment of Disposal Options for DOE-Managed High-Level Radioactive Waste and Spent Nuclear Fuel released in October 2014 is not discussed within this document.

DISCUSSION

Commingling History: 1950s to 1985

In 1954, the Atomic Energy Commission (AEC) became the first regulator of nuclear activities in the United States. To address the management of waste created by these activities, the AEC assigned its division of Production the responsibility to coordinate and direct programs for storage and disposal of wastes from defense activities [5]. The AEC assigned its Division of Reactor Development and Technology the responsibility for a research and development program on processes for the treatment and storage of high-level radioactive waste resulting, or expected to result, from chemical-processing operations in connection with the nuclear power industry [5]. The AEC planned for weapons production sites to permanently dispose of defense waste on site, whereas civilian waste would be disposed of in a geologic repository. A report by the National Academy of Sciences Committee on the Geologic Aspects of Radioactive Waste questioned the technical soundness of establishing defense sites as disposal facilities [6], and the AEC eventually redirected the disposal of defense waste to a repository with civilian waste. Initially, the AEC promoted an abandoned salt mine at Lyons, Kansas as the location for the first repository. Scientific studies uncovered significant technical uncertainties with the salt formation at Lyons, and that repository effort was abandoned [7].

In 1975, the AEC dissolved into the Energy Research and Development Administration (ERDA), which assumed responsibility for developing and producing nuclear weapons and promoting nuclear power. Programs for managing defense and civilian waste were consolidated for the first time under ERDA [8]. In 1977, ERDA merged with the Federal Energy Administration to form a cabinet-level agency, the US DOE, and DOE assumed responsibility for nuclear waste disposal.

Before the merger that created US DOE, ERDA had pushed for commingling waste forms for disposal in the Waste Isolation Pilot Plant (WIPP), a repository then under development in New Mexico [9]. However, the idea of disposing of civilian SNF at WIPP ran into strong opposition from the New Mexico congressional delegation, state officials, and stakeholders, who were intent on limiting the repository to disposal of defense waste. After several years of dispute and discussion, SNF and HLW were excluded from disposal at WIPP [10], and the WIPP facility eventually opened in 1999 as a repository for defense transuranic waste only.

With the intention of establishing a national policy for disposing of SNF and HLW, members of Congress introduced the first version of a national nuclear waste policy bill on January 3, 1980. The legislation considered the commingling of civilian and defense waste in a future repository and included provisions for low-level radioactive waste disposal. In February of that year, President Carter supported the commingling policy in a message to the Congress, stating, “For reasons of economy, the first and subsequent repositories should accept both defense and commercial wastes” [11]. The comprehensive nuclear waste policy bill met obstacles when members of Congress, recalling WIPP’s difficult siting history, disagreed over whether to grant some control over the disposal of defense HLW to the states. Opponents pushed to exclude the disposal of defense waste from the bill’s purview, which halted progress on the legislation in 1980 [12].

The attempt to establish a policy for SNF and HLW disposal continued in 1981 when Congress introduced a revised version of a national nuclear waste policy bill. The updated bill included revisions to state controls over repositories, including the disposal of defense wastes. An amendment offered by Congressman Samuel S. Stratton of New York in 1982 added a provision on commingling, making it contingent on an evaluation and decision by the President [13]. The Nuclear Waste Policy Act (NWPA) passed into law, with this provision, in 1982 [14].

Section 8 of the NWPA defines commingling as “disposal of high-level radioactive waste resulting from

atomic energy defense activities" in a repository with civilian SNF. Although this definition does not include defense SNF, it is important to note that reprocessing initiatives in the United States ended before all defense SNF could be reprocessed and converted into HLW [1]. Section 8 also includes a deadline and factors to be considered in a commingling evaluation. These factors include, but are not restricted to *cost efficiency*, *health and safety*, *regulation*, *transportation*, *public acceptability*, and *national security*. According to the NWPA, unless after considering all these factors the President decides that a repository for defense waste only is required, defense and civilian wastes are to be co-disposed in a repository [14].

After enactment of the NWPA, the Reagan Administration directed the US DOE to undertake an evaluation of commingling and to provide a recommendation by the January 1985 deadline established in the NWPA. After evaluating each of the six factors identified in the NWPA, the US DOE recommended commingling based on *cost efficiency* [15]. The effects of the other five factors were not distinct enough to provide a basis for decision-making. President Reagan released a Presidential memorandum accepting the recommendation on commingling in 1985 [3]. According to the NWPA, the costs for a combined repository will be shared by the users of nuclear power for disposal of civilian SNF and the federal government for disposal of defense waste.

Recent Events Related to Commingling—2010 to April 2014

Blue Ribbon Commission on America's Nuclear Future

The commingling policy remained uncontested for 25 years as the country worked toward developing a deep geologic repository for the permanent disposal of SNF and HLW. In early 2010, President Obama directed Secretary of Energy Chu to establish a Blue Ribbon Commission on America's Nuclear Future (BRC) to look at the back end of the nuclear fuel cycle and make recommendations [16]. The BRC deliberated for two years, during which it heard from federal agencies, the public, and stakeholders with various points of view on a wide-range of issues related to nuclear waste management. One of the issues raised at the BRC public meetings was whether the policy on commingling should be revised. With the termination of funding for the Yucca Mountain repository program [2], some stakeholders advocated for a reversal of the 1985 commingling decision. Stakeholders with defense waste facilities in their states were particularly interested in this possibility. Several states, such as Idaho, Washington, and South Carolina, have agreements with the federal government on scheduled milestones for cleanup and removal of waste from facilities located in their states. These three states host the nation's largest stockpiles of DOE SNF and HLW. Other stakeholders, including some local officials from Carlsbad, New Mexico who supported disposing of defense HLW and SNF at WIPP,[e] also advocated revisiting the commingling policy.

Proponents for continuing the commingling policy voiced their support for continuing the policy during the BRC public meetings. Among the supporters were nuclear utility and state regulatory organizations, such as the Nuclear Energy Institute and the National Association of Regulatory Utility Commissioners. Their testimony in support of the commingling policy emphasized cost and time efficiency for a single repository. Some citizen groups, including the Southwest Research Information Center, the Snake River Alliance, and the West Valley Citizen Task Force, also spoke at the BRC meetings in support of maintaining the commingling policy. The latter two groups act as watchdog organizations of the Idaho National Laboratory and West Valley Demonstration Project site, respectively. Their support for a commingled repository paralleled the 1985 US DOE recommendation for a single repository based on cost efficiency. The organizations reasoned that there have been no changes of significance that would require a change in

[e] The NWPA mandates that any repository for HLW and SNF, whether defense or civilian, must undergo U.S. Nuclear Regulatory Commission licensing [14]. The WIPP repository does not accept SNF and HLW for disposal and is governed by the Waste Isolation Pilot Plant Land Withdrawal Act that requires certification by the U.S. Environmental Protection Agency and not licensing by the U.S. Nuclear Regulatory Commission [17]. Therefore an expansion of WIPP's mission that included disposal of SNF or HLW would require modifications to existing laws.

policy since the original decision. The groups also stated that segregating waste by origin would lead to a more complex waste management program.

Noting the interest in commingling, in May 2011, the BRC formed an ad hoc subcommittee of its Disposal Subcommittee to look more closely at the issue. BRC staff members released a background paper on the topic and most of the available comments from proponents and opponents of commingling are included in the document [18]. In the 2012 Final Report of the BRC [19], one of the key elements of the new approach recommended by the BRC included the development of a new organization dedicated solely to implementing the waste management program. The BRC addressed commingling in its discussion of the scope of responsibilities for a new waste management organization [19]. The BRC did not make a specific recommendation on commingling but instead, identified the facts and factors that should be considered in a re-evaluation of the commingling policy. These facts and factors include the criteria identified in the NWPA and five others:

- Sharp shift in focus from the US DOE production of materials for nuclear weapons to the cleanup and disposal of legacy wastes from the Cold War
- Establishment of legally binding site cleanup commitments, which require the removal of some defense wastes from storage sites by 2035
- Current lack of statutory authority to develop a repository at a site other than Yucca Mountain under the NWPA
- Successful development and operation of a geologic repository at WIPP, with a mission explicitly limited to the disposal of transuranic waste from defense nuclear activities
- Recommendation to establish a new organization outside of US DOE to develop and operate repositories under an amended NWPA

US DOE Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste

In January 2013, the US DOE released its "Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste," which includes the Administration's response to the BRC final report [20]. The Strategy stated, "Disposal of defense wastes alongside commercial wastes is the current policy in accordance with the 1985 decision to use a single repository for both commercial and defense wastes." The Strategy went on to note that the "issue of 'commingling' of wastes in a repository will be the subject of analysis moving forward."

Nuclear Waste Fund Fee Adequacy Assessment Report

Under the NWPA, the US DOE is required to estimate the cost for the repository program and assess the sufficiency of the Nuclear Waste Fund in an annual report. The US DOE addressed commingling in the 2013 Nuclear Waste Fund Fee Adequacy Assessment Report by considering the possibility of a defense-only repository [21]. The NWPA requires that civilian and defense waste generators pay the disposal costs of their respective waste [14]. The report includes cost sharing scenarios that describe how much defense waste generators would pay for a commingled repository. Since the original Adequacy report in 1983, the costs for defense waste generators have fluctuated in percentage of total program cost. The 2013 report estimates a 20% cost sharing scenario as well as an unprecedented 0% cost sharing scenario for defense waste owners, accounting for the possibility that civilian and defense wastes are not commingled [21].

Senate Hearing

In answer to a question during a July 2013 hearing of the Senate Energy and Natural Resources Committee on a bill titled the Nuclear Waste Administration Act of 2013, the Secretary of Energy indicated that a

report on commingling was underway at the agency [22].

Evaluation of Options for Permanent Geologic Disposal of SNF and HLW

In April 2014, Sandia National Laboratories released a study prepared for the US DOE titled, "Evaluation of Options for Permanent Geologic Disposal of SNF and HLW" [4]. Although the study did not use the word "commingling," it addressed technical questions associated with the disposal of defense and commercial waste packages in a single repository. The report is described as a technical basis for informing policy decisions regarding strategies for the management and permanent disposal of SNF and HLW in the United States requiring geologic isolation. Three key questions are posed by the study [4]:

- "Is a "one-size-fits-all" repository a good strategic option for disposal?"
- "Do different waste types and forms perform differently enough in different disposal concepts that they warrant different treatment?"
- "Do some disposal concepts perform significantly better with or without specific waste types or forms?"

To answer the key questions, the Sandia report qualitatively evaluated potential impacts of waste forms on the feasibility and performance of representative generic concepts for geologic disposal.[f] Sandia categorized all commercial and defense SNF and HLW into 10 waste groups, based on disposal characteristics. A group of multi-disciplinary experts used existing information and expert knowledge to evaluate the performance of each waste group against six primary criteria for each disposal option. The primary criteria include *disposal option performance, confidence in expected performance bases, operational feasibility, secondary waste generation, technical readiness,* and *safeguards and security.*

The report concluded that a single geologic repository could technically hold many different waste forms and that the disposal of civilian and defense SNF and HLW in a combined repository is technically feasible in any of the mined repository concepts [4].

Comparison of 1985 Evaluation Factors and 2014 Sandia Study Criteria

The NWPA directed an evaluation of commingling to include the factors of *cost efficiency, health and safety, regulation, transportation, public acceptability, and national security*. In 1985, the US DOE analyzed these six factors in a comparative evaluation of two geologic disposal options for defense HLW [15]. The April 2014 Sandia report, which addresses relevant commingling questions, did not use the 1985 criteria but used original criteria throughout their evaluation [4]. The two evaluations are compared using the 1985 factors to identify any overlapping considerations between the 1985 and 2014 evaluations.

Cost Efficiency

The 1985 evaluation analysis [15] compared the costs associated with a single repository containing both commercial and defense HLW with the costs for two separate repositories. *Cost efficiency* was the basis for the US DOE's 1985 recommendation for commingling but the remaining five evaluation factors were included in the decision process. The US DOE estimated that commingling the waste in a single repository would save $1.5 billion dollars, when compared with constructing two separate repositories.[g]

[f] The study evaluated four disposal concepts: mined repositories in three geologic media (salt, clay or shale, and crystalline rock) and deep borehole disposal.

[g] The total cost and savings estimate did not include the cost of siting and licensing a repository or transportation of the waste to a repository; however, in 1985, the US DOE estimated that these costs would be $4 billion, per repository [15]. The inclusion of this information would have increased the cost savings of a commingled repository by $4 billion, providing additional support for cost efficiency as the basis for the DOE recommendation.

The 2014 Sandia report [4] uses the repository cost analysis provided by the US DOE's 2013 Nuclear Waste Fund Fee Adequacy Report [21]. The cost for both a commingled and commercial-only repository is estimated, however, the report does not discuss cost efficiency for a defense-only repository.

Health and Safety

The 1985 analysis [15] considered short-term and long-term impacts. Short-term impacts were addressed through a health and safety analysis focused on construction and operation efforts in the development of a repository. The analysis revealed that short-term health and safety impacts are related both to the capacity of the repository and to the choice of geologic media but not to whether defense or commercial waste is emplaced in the geologic repository. Long term impacts included the effects of different disposal scenarios on radionuclide releases to the accessible environment. The US DOE "assumed release rates for commercial wastes were set equal to the 10 CFR 60 criterion of 10^{-5} per year" [15]. For defense waste, leaching rates were allowed to vary with the repository temperature at the time of containment failure. Using that approach, the US DOE showed that defense waste in a commercial repository can be expected to exhibit a lower release rate of radionuclides to the environment than commercial waste.

The *disposal option performance* criterion from the 2014 Sandia study [4] assesses the overall safety of the disposal option relative to expected health and safety requirements and is comparable to the long-term impacts in the 1985 evaluation. The *operational feasibility* criterion focuses on "the health and safety of workers starting with the generation of the waste form from the waste type all the way through the disposal of the waste form and the physical considerations involved with handling, transporting, storing, emplacing and ultimately disposing of the waste forms". Therefore, the *operational feasibility* criterion is similar to the short-term impacts of the previous commingling evaluation.

Regulation

The 1985 analysis [15] noted that a commingled repository and separate commercial and defense repositories were subject to the same U.S. Nuclear Regulatory Commission disposal regulation (10 Code of Federal Regulations, Part 60). Thus, the 1985 analysis of the regulation factor focused on the difference in the number of procedural steps required under the NWPA for a defense-only repository as compared to a commingled repository.

The Sandia report states that "programmatic constraints, including legal, regulatory, and contractual requirements, are acknowledged where applicable, but are not considered in the technical evaluations, consistent with the goal of the study to provide technical input to strategic decisions" [4].

Transportation

The 1985 assessment [15] of the *transportation* factor addressed the quantity of waste in the shipments, total miles traveled, and mode of transportation as key factors in determining risk and costs [15]. While costs are universally important, the analysis was a general comparison of truck versus rail transportation for all waste packages. No significant advantage or disadvantage for a defense-only repository was noted for this criterion. However, the US DOE concluded the actual repository location will have an effect on the total transportation costs and total risk.[h]

[h] Although the results of the transportation analysis were not a deciding factor in the US DOE's 1985 recommendation, an analysis of lessons learned from WIPP and Navy shipments may prove informative for future considerations of commingling.

The *technical readiness* criterion utilized in the 2014 assessment [4] considers the current state of the technology needed to implement a disposal option from the stage of waste form generation, transportation and handling systems, through the closure of a disposal concept.

Public Acceptability

The 1985 analysis [15] of the *public acceptability* factor assessed the probable or likely positions that specific segments of the public will take with regard to the different disposal options. The analysis focused on social issues, including economic impacts. The US DOE report suggested that different levels of confidence could be placed on the technical analysis supporting licensing decisions for the different disposal options, and that could influence public acceptability.

The Sandia report "acknowledges existing plans, commitments, and requirements where applicable, but the study evaluates options for disposal based primarily on technical, rather than programmatic or regulatory constraints" [4].

National Security

The 1985 assessment [15] of the *national security* factor addressed two, primarily non-scientific issues. First US DOE assessed whether an interruption of, or delay, or U.S. Nuclear Regulatory Commission involvement in the defense material production process or nuclear weapons activities could occur. Second, US DOE assessed the potential for disclosure of classified information. However, US DOE did use scientific information, for example, the quantity and characteristics of the liquid and solid HLW, to determine that disclosure of classified information on the defense HLW was unlikely in either disposal option.

The *safeguards and security* criterion of the 2014 Sandia study [4] considers the difficulty of implementing national security technology and is similar to NWPA *national security* factor. Although both studies assessed technical issues in the analysis of *national security*, the Sandia report reveals some consideration of the concept of self-protection that was not considered in 1985.[i]

Additional Criteria

Although the 2014 Sandia report's *confidence in expected performance bases* criterion does not directly correspond to any of the 1985 factors, the criterion does deal with technical issues [4]. For example, the criterion considers simplicity versus the complexity of the safety bases and the level of difficulty in generating confidence in the conclusions regarding safety. The criterion also specifies whether the analyses are from an existing site, a generic study, or from a qualitative assessment, and if clear knowledge gaps exist for the disposal option. Likewise, the Sandia report's *secondary waste generation* criterion is concerned with technical issues, but not an NWPA factor [4]. For example, the criterion considers the amount of low-level waste generated during handling and treatment and the amount of mixed waste generated, as the waste is prepared for disposal.

CONCLUSIONS

[i] Because of the passage of time, since 1985 the concept of self-protection has become more important. "Self-protection" is attributed to SNF, "which is not readily separable from other radioactive material and which has a total external radiation dose rate in excess of 100 rem per hour at a distance of 3 feet from any accessible surface without intervening shielding." Previous studies have shown that the dose rate for typical discharged commercial SNF will fall below the current self-protection limit between 70 and 120 years after discharge from a reactor [4].

The initial call for a commingling evaluation in the NWPA can be traced back to a regulatory debate in the Congress, as opposed to any scientific or technical concerns for disposal of defense and civilian wastes together. In 1985, the US DOE recommended commingling based on *cost efficiency* and assessed technical information by evaluating *health and safety, transportation,* and *national security*. The Sandia Evaluation of Options report in April 2014, reiterates that technically all defense and civilian waste packages can be disposed of in any repository. The scientific and technical areas addressed in the 1985 evaluation are also addressed in the recent Sandia analysis, involving short-term and long-term impacts on health and safety, transportation, confidence in expected performances bases, and applied national security considerations.

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