



UNITED STATES  
NUCLEAR WASTE TECHNICAL REVIEW BOARD  
2300 Clarendon Boulevard, Suite 1300  
Arlington, VA 22201  
December 30, 2011

The Honorable Peter B. Lyons  
Assistant Secretary for Nuclear Energy  
U.S. Department of Energy  
1000 Independence Ave., SW  
Washington, DC 20585-1290

Dear Dr. Lyons:

On September 13 and 14, 2011, the U.S. Nuclear Waste Technical Review Board held a public meeting in Salt Lake City, Utah. The majority of the meeting was devoted to presentations by U.S. Department of Energy (DOE) officials and technical experts from six DOE National Laboratories. Those talks provided the Board with a solid overview of the activities being funded by the Office of Used Nuclear Fuel Disposition Research and Development (NE-53).

In addition, the Board heard from an official of DOE's Office of Legacy Management (LM) and from three panels. The first panel discussed the draft *Report to the Secretary* by the Blue Ribbon Commission on America's Nuclear Future (BRC), the second described work undertaken by the Extended Storage Collaboration Program (ESCP), and the third explored some of the waste-management implications of using mixed-oxide fuel (MOX).

This letter conveys Board comments and recommendations related to work being sponsored by NE-53 within the Office of Nuclear Energy and other DOE activities discussed at the meeting.

**Activities Sponsored by the Office of Used Nuclear Fuel Disposition Research and Development**

Three topics were addressed by DOE officials and technical experts:

- Exploration of generic disposition options
- Studies of specific technical issues associated with developing a repository either in crystalline rock (granite) or clay/shale
- Research directed toward understanding the issues associated with extended storage and subsequent transport of spent nuclear fuel (SNF)

*Generic Research on Options for the Disposition of High-Level Radioactive Waste (HLW) and SNF.* Representatives from the NE-53 team, Dr. William Boyle, Dr. Peter Swift, and Dr. Mark Nutt, detailed efforts to develop that organization's strategic direction. Dr. Boyle provided an overview of his unit's administrative structure and budget, spoke about the major accomplishments to date, and set forth both short-term milestones and long-term goals. Dr. Swift described the technical basis for selecting four disposition options that NE-53 will focus on in the near term: deep-mined geologic repositories embedded in salt, granite, and clay/shale formations as well as deep borehole disposal. He also briefly identified several areas of research and development (R&D) that

NE-53 supported during the 2011 fiscal year. Dr. Nutt described the elaborate process, grounded in systems engineering techniques, used to construct the NE-53 “Research and Development Roadmap” to identify knowledge gaps and opportunities that offer the greatest potential contribution to achieving the national goal of disposing of high-activity nuclear waste in a deep geologic repository.

The Board understands and appreciates the rationale that motivated NE-53 to undertake these planning exercises. The results reported by Dr. Swift are consistent with work being undertaken by national waste management programs abroad that has already identified salt, granite, and clay/shale as the most promising host rocks in which to place a mined deep geologic repository. Given the wealth of relevant experience that has been gained in other countries, the Board strongly urges NE-53 to strengthen its technical interactions with the organizations that are responsible for waste management programs in those countries. This might enable DOE to learn from those programs and avoid duplicating their research. DOE also may be able to share costs with other programs on future work, which could free up funds that could be reallocated to other elements of the R&D program, such as research supporting development of the technical basis for extended dry storage of SNF.

In establishing research priorities, the Board believes that when compared with mined deep geologic disposal, the development of deep borehole disposition as a potential waste management option should be given a lower priority. The Board will address issues related to geologic disposal at its meeting planned for March 7, 2012, in Albuquerque, New Mexico, and the potential for deep borehole disposal will be discussed in more detail at that time.

Dr. Nutt’s explanation of the “roadmap” was clear and detailed; however, the rankings were not truly quantitatively derived. They were, as Dr. Nutt acknowledged, based essentially on qualitative expert judgments. Learning more specifically on what basis this “living document” might evolve would have been valuable.

*Studies of specific scientific and technical issues.* Dr. Scott Painter from Los Alamos National Laboratory presented early results on discrete fracture network modeling undertaken in collaboration with the Swedish implementer, SKB. Dr. Jens Birkholzer from Lawrence Berkeley National Laboratory discussed investigations for supporting disposal of HLW and SNF in clay or shale host rocks. He focused on a key technical issue: the evolution of the thermal-hydraulic-mechanical-chemical disturbed zone surrounding the waste package following emplacement. He also described the possibility of validating the results of these studies against field data from studies that might be conducted in Switzerland or Belgium. The Board believes that both these efforts represent cutting-edge R&D. Moreover, both areas of work underscore the Board’s view that NE-53 should intensify its technical interactions with other national programs.

*Extended storage and subsequent transportation of spent nuclear fuel.* Dr. Brady Hanson from Pacific Northwest National Laboratory presented the results of DOE’s analysis of knowledge gaps related to extended storage of SNF from the current US fleet of light-water reactors before transportation to a centralized storage or reprocessing facility or a repository site. The Board’s comments on this analysis, together with observations and recommendations concerning the R&D program that DOE proposes to support a program of extended dry storage, are recorded in the Board’s December 8, 2011, letter to Dr. Monica Regalbuto concerning DOE’s draft gap analysis report.<sup>1</sup>

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<sup>1</sup> *Gap Analysis to Support Extended Storage of Used Nuclear Fuel*, prepared by National Laboratory staff for the Used Fuel Disposition Campaign of the U.S. Department of Energy (DOE) Office of Nuclear Energy, June 30, 2011.

Mr. Paul McConnell from Sandia National Laboratories discussed the R&D priorities identified in the draft gap analysis report as being required in the near term, medium term, and very long term to support transportation of SNF following extended storage. He also identified the lead National Laboratories for the main program components. Dr. John Wagner from Oak Ridge National Laboratory outlined the engineering analysis required to support extended storage and subsequent transportation of SNF, including an integrated approach to addressing safety issues.

Our December 8 letter to Dr. Regalbuto notes that the Board's report<sup>2</sup> on extended storage of SNF identifies R&D requirements similar to those included in DOE's draft gap analysis report. However, the Board believes that there are other issues associated with extended storage of SNF that also should be addressed by DOE in developing an integrated approach to the management of SNF under the Nuclear Waste Policy Act. Three such issues are described below.

- The potential for operations being undertaken today that limit future options in managing SNF and HLW. One example of this is the continued use of a wide range of SNF container designs for dry-storage systems. As was the case in the design of the fuel-handling facilities for the Yucca Mountain repository, the lack of a standardized container design, or at most a small range of designs, can result in additional complexity at later stages of the waste management system.
- The dose and cost implications of the need to repackage SNF. An initial assessment by the Board indicates that there necessarily would be a significant additional dose to operators from the need to repackage fuel after storage and before repository disposal. Reducing the need to repackage SNF before disposal would unquestionably reduce the dose to plant operations staff. Estimating the dollar cost of repackaging is beyond the Board's mandate, but an appropriate observation is that there inevitably are significant costs associated with repackaging SNF, and to the extent this can be avoided those costs can be reduced.
- The implications of a requirement for early removal of SNF from reactor storage pools, in response to the events at the Fukushima site in Japan in March 2011. The Board believes that a careful review of the implications of such a change for the nation's long-term SNF management system should be undertaken. Among the factors that should be considered are the current trend toward larger dry-storage containers and higher fuel burnups that will require longer onsite storage before transportation to a reprocessing or disposal facility and the practicality of establishing the industrial capacity needed to manufacture the large number of additional dry-storage systems that would be required. The Board estimates that moving all SNF that has been discharged for more than 10 years into dry storage, for example by 2020, would require a significant increase in fabrication capacity for dry-storage systems. Once the backlog has been dealt with, however, demand would fall again to a level that matches the actual rate of discharge of SNF. It may be difficult for vendors to respond to this relatively short-term increase in demand, both in terms of the fabrication requirements and in managing the accompanying increase and decrease in the size of the production workforce, the training requirements, and an increase in the need for quality assurance staff. As mentioned above, estimating the dollar cost is beyond the Board's mandate, but an appropriate observation is that there would inevitably be significant cost implications from the need for vendors to recover over a period of only 10 years the capital investment for establishing increased production capacity.

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<sup>2</sup> *Evaluation of the Technical Basis for Extended Dry Storage and Transportation of Used Nuclear Fuel – Executive Summary*, U.S. Nuclear Waste Technical Review Board, December 2010.

## **Office of Legacy Management's Preservation of the Documents from the Yucca Mountain Project**

In its May 24, 2010, response to the Yucca Mountain licensing board, DOE stated that [It] had contacted the Nuclear Waste Technical Review Board about the NWTRB's interest in providing independent oversight of DOE's actions in preserving the scientific information that has been developed by OCRWM [Office of Civilian Radioactive Waste Management]. The NWTRB could thus review the planned disposition of the relevant scientific information before its disposition in accordance with National Archives and Records Administration approved schedules. NWTRB has expressed interest in such an arrangement, and DOE and NWTRB will discuss how such oversight could be accomplished.<sup>3</sup>

Those discussions have been ongoing for more than a year as OCRWM documents have been transferred from Las Vegas, Nevada, to Morgantown, West Virginia, for preservation. Mr. John Montgomery, Site Manager of the Legacy Management Business Center, and his staff lead, Mr. Edwin Parks, briefed the Board on the status of their efforts. Members of the Board staff intend to visit Morgantown in the coming months to carry out a high-level observation of LM's activities and, subsequently, to issue at least one report containing findings and recommendations.

## **Panel on the Draft *Report to the Secretary* by the Blue Ribbon Commission on America's Nuclear Future**

The Board invited Mr. John Kotek, Executive Director of the BRC, to summarize the major conclusions and recommendations in the draft *Report*. They included the following:

- A new approach to siting and repository development
- A new, single-purpose organization with the responsibility for transporting, storing, and disposing of HLW and SNF
- Changes in the way funds from the Nuclear Waste Fund are appropriated so that management of the program is not affected by limited access to funding
- Expeditious development of a deep geological repository for HLW and SNF
- Expeditious development of a centralized interim storage facility

In addition, the Board asked Mr. Ward Sproat, former Director of OCRWM, to reflect upon those key conclusions and recommendations. Mr. Sproat noted that the process used by the BRC was thorough, the draft *Report* generally addressed the major issues, and a number of the recommendations were specific and appropriate. He did observe, however, that the draft *Report* ignored some lessons learned from the Yucca Mountain experience as well as important political realities associated with the siting process. At the end of his presentation, Mr. Sproat urged the BRC to recommend that the Yucca Mountain licensing process be completed and to provide more-specific guidance on how to structure efforts for identifying candidate locations for a repository or a centralized interim storage facility.

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<sup>3</sup>*U.S. Department of Energy Answers to ASLB Questions from Order Dated April 21, 2010, May 24, 2010, pg. 37. In House Report 112-118, Energy and Water Development Appropriations Bill, 2012, the Board was directed to "provide support to the Department of Energy ... to archive and preserve all Yucca Mountain-related documents and physical materials of scientific value."*

The Board subsequently provided the BRC with comments on the draft *Report*. The Board's comments are available on the Board's Web site, [www.nwtrb.gov](http://www.nwtrb.gov).

### **Extended Storage Collaboration Program**

Because of the uncertainty surrounding the future of the Yucca Mountain Project, SNF is now likely to remain in storage for a longer time than previously anticipated. Several groups, including the Board, have begun to explore the implications of this situation. (As mentioned above, the Board released a report, *Evaluation of the Technical Basis for Extended Dry Storage and Transportation of Used Nuclear Fuel*, in late 2010.)

The Electric Power Research Institute (EPRI) has organized an international effort, Extended Storage Collaboration Program (ESCP), to establish the technical bases for continued safe, long-term SNF storage and future transport. The Board is, along with DOE, the Nuclear Regulatory Commission (NRC), the Nuclear Energy Institute, nuclear utilities in the United States and abroad, and nuclear vendors, closely following the work of this collaboration, whose objectives include:

- Reviewing current technical bases and conducting gap analyses for SNF storage and transportation systems
- Conducting experiments, field studies, and additional analyses to address gaps
- Coordinating research that results in a program documenting the performance of a dry-storage system loaded with high-burnup (greater than 45 GWd/MTU) fuel.

During the panel discussion on these issues, Dr. John Kessler from EPRI observed that there appears to be an emerging consensus that more attention needs to be focused on corrosion of the stainless steel canister, especially in marine environments, on the bolted-cask metallic seals, and on delayed hydride cracking of the cladding. Mr. Adam Levin from Exelon Generation Company stated that the demands for R&D could be simplified significantly if changes were made to the established regulatory framework so that the storage canister is considered the waste form for storage, transportation, and disposal rather than just for storage. He also noted that there would be significant benefit from taking full credit for burn-up and encouraged that this be pursued. Finally, Dr. James Rubenstone from the NRC described two on-going activities: (1) establishing a firm technical basis for regulations related to extended storage of SNF and (2) providing support for a potential extension of the waste-confidence decision to more than 60 years beyond the life of a commercial nuclear reactor. Although these activities are complementary, they are not identical.

The Board believes that ESCP is an extremely valuable undertaking and strongly endorses DOE's continued active participation in the collaboration. As noted above, the Board recommends that DOE provide adequate resources to support ESCP's objectives. In that regard, the Board understands that with the decommissioning of the Test Area North Hot Cell at Idaho National Laboratory, opportunities for conducting potentially important investigations on SNF at a National Laboratory may have been foreclosed. If this is so, the Board urges DOE to evaluate other options that might allow those experiments to be conducted.

### **Implications for Waste Management of Using MOX**

Over the last few years, increased attention has been paid to the possibility that the United States might adopt a closed fuel cycle involving reprocessing of light-water reactor SNF and recycling the extracted plutonium in the form of MOX fuel assemblies and perhaps recycling the reprocessed uranium as well. DOE originally investigated this possibility as part of its now-defunct

Global Nuclear Energy Partnership. DOE's Office of Fuel Cycle Technologies continues some of the same work today. To understand better the waste-management implications of using MOX, the Board invited three practitioners to report on lessons learned by their organizations.

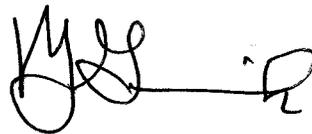
Mr. Daniel Stout from the Tennessee Valley Authority described the process that his utility is employing to determine the implications of using MOX fabricated surplus-weapons plutonium at one or more of its reactors. He noted that the decay heat of a spent MOX fuel assembly would be between 1.3 and 1.7 times higher than that for an equivalent spent-uranium fuel assembly. Consequently, the used MOX would need to be kept in dry cask storage for an additional 56 years to have the same thermal impact on a repository at the time of emplacement. For certain repository designs, that difference could be consequential.

Mr. Patrice Fortier from Transnuclear International, a division of AREVA, indicated that casks have been approved in France for transport of spent MOX and for HLW generated during commercial reprocessing of SNF.

The most detailed technical discussion was provided by Dr. Wolfgang Faber from the German utility EON, which operates eight reactors that have burned MOX. He noted that the use of MOX complicates the on-site management of both unirradiated and irradiated fuel, in part because of the increased security burdens. MOX fuel also requires longer post-discharge cooling time before removal from the spent-fuel pool, and there are other difficulties associated with the intermediate storage period after discharge. In investigating the potential consequences for U.S. utilities of introducing reprocessing and recycling of plutonium and possibly uranium, the Board recommends that DOE take account of the full range of implications for utilities and not just the perceived value of extracting the energy remaining in the spent fuel.

The Board appreciates the effort that NE-53 made to prepare lucid and candid presentations for the September meeting, and we look forward to continued interactions with DOE in future. We would be pleased to meet with you to discuss any of the issues raised in this letter.

Sincerely,

A handwritten signature in black ink, appearing to read 'B. John Garrick', with a stylized flourish at the end.

B. John Garrick  
Chairman