UNITED STATES
NUCLEAR WASTE TECHNICAL REVIEW BOARD
2300 Clarendon Boulevard, Suite 1300
Arlington, VA 22201–3367

June 5, 2014

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

Re: U.S. NWTRB Comments on the DOE Research and Development Program Related to Long-Term Dry Storage of High Burnup Spent Nuclear Fuel

Dear Dr. Lyons:

On November 18 and 19, 2013, the U.S. Nuclear Waste Technical Review Board held a technical workshop in Washington, D.C. on the *Impacts of Dry-Storage Canister Designs on the Future Handling, Storage, Transportation, and Geologic Disposal of Spent Nuclear Fuel.* The Board also held a public meeting in Washington, D.C. on November 20, 2013, which focused on the Department of Energy (DOE) Office of Nuclear Energy (NE) research and development (R&D) activities related to its Used Nuclear Fuel Disposition program. At the workshop, you presented an overview of the DOE-NE R&D program related to extended storage of spent nuclear fuel (SNF). During the public meeting, Dr. William Boyle of your staff presented more detail on the test plan for the High Burnup Dry Storage Cask Research and Development Project (CDP) being developed by a team led by the Electric Power Research Institute (EPRI) under contract to DOE. These presentations were very useful to the Board, and I thank you again for your presentation and for your personal involvement and that of your staff in the workshop and the public meeting. Initial comments on the draft test plan were included in the Board's January 29, 2014, letter to you, and you and I discussed these comments when we met on January 31, 2014.

Over the last few months, members of the Board and Board staff have attended other meetings at which the potential consequences of extended dry-cask storage of high burnup SNF were discussed, including (1) the DOE-NE Fuel Cycle Technologies Annual Review Meeting in November 2013; (2) the EPRI Extended Storage Collaboration Program (ESCP) meeting in December 2013; (3) the U.S. Nuclear Regulatory Commission (NRC)/Nuclear Energy Institute (NEI) meeting on extended storage of SNF in January 2014; (4) the NRC/DOE Public Meeting on gas sampling as part of the CDP in March 2014; and (5) the EPRI-ESCP meeting, the NEI Used Fuel Management Conference, and the National Transportation Stakeholders Forum meeting, all held in May 2014. Based on information gathered by Board members and/or staff at

Telephone: 703–235–4473 Fax: 703–235–4495 www.nwtrb.gov

these meetings, I am providing the following additional Board comments on the CDP and the broader DOE-NE R&D program related to extended storage of SNF.

Value of the High Burnup Dry Storage Cask Research and Development Project

The Board sees the CDP as a welcome first step in investigating key issues related to the potential degradation of high burnup SNF and dry-storage systems during extended storage. The condition of dry-storage systems and the SNF they contain will need to be monitored over many decades in order to collect the necessary information for fully understanding degradation mechanisms and for calibrating codes developed to model changes in the condition of the SNF and storage systems over time. The CDP described in the test plan will provide important data to support all of these activities.

Need for Additional Instrumentation

The Board supports DOE efforts to begin monitoring the condition of SNF and storage systems sooner rather than later. However, the Board is concerned that according to the initial scope of the test plan the information to be collected during the first 10-year storage period appears to be very limited. Most of the data to be collected will be derived from measurements made during examination – using non-destructive and/or destructive techniques – of fuel pellets, fuel cladding, fuel assembly hardware, and cask components (*e.g.*, bolts and O-rings) at the beginning and at the end of this 10-year period. Originally, only cask temperature, inter-seal gas pressure, and external dose rates were to be monitored or measured during the storage period. Gas pressure measurements and gas sampling to determine the presence of fission gases, water vapor, oxygen, and hydrogen were planned to be conducted only during the two weeks after the cask is dewatered and the fuel is dried in preparation for moving the cask to the independent spent fuel storage installation (ISFSI) pad for the initial 10-year storage period. Thereafter, no measurements were initially planned that could be used to determine the rate-of-change of high burnup SNF properties or the rate of degradation of storage system materials (if it occurs). However, the final test plan published by DOE on February 27, 2014, states that "the EPRI team will continue to investigate and evaluate methods for performing gas sampling at the ISFSI during the longer-term storage period." If implemented, this sampling may be used to determine if any fuel rods fail during this period. The Board supports efforts to sample and analyze gases that may be released from the fuel rods during the 10-year storage period.

We also note that the use of advanced sensors may provide an opportunity to monitor important parameters continuously. In particular, the Board recommends the utilization or development of instrumentation that can be installed in or attached to the canister when the SNF is loaded. This would allow monitoring of the condition of the SNF and the storage system during extended storage and subsequent transportation. The Board understands that consideration is now being given to the installation of universal ports in the cask lid that would permit installation of additional internal instrumentation during periodic inspections planned over the full term of the project. The Board's view is that this will be a valuable and forward-looking extension to the planned modifications of the cask lid. If not already planned, the Board recommends consideration of basket modifications along with cask lid modifications to facilitate internal instrumentation placement. The Board understands that the development of sensors and instrumentation will take time; however, we endorse the implementation of the planned passive

Telephone: 703–235–4473 Fax: 703–235–4495 www.nwtrb.gov

cask monitoring program at the earliest opportunity after due consideration is given to cask lid and basket modifications.

In establishing priorities for the development of sensors and instrumentation, the results obtained from models of fuel performance could be used initially to identify the most important fuel properties to be monitored. The development of long-term *in situ* monitoring systems will require innovative approaches to overcome technical challenges, including the high-radiation environment inside the cask, the need to transmit data through cask walls if no universal lid ports or other penetrations are available, and the need for power sources that could support measurements for several years or decades. At our January 31, 2014, meeting, you indicated that DOE is engaging other U.S. federal agencies, including the National Aeronautics and Space Administration and the Department of Defense, both of which have expertise in wired and wireless instrumentation, in an effort to benefit from their experiences in developing monitoring systems for harsh environments. The Board supports this initiative and encourages DOE also to look at work being undertaken in other countries that may also support these efforts. For example, the National Nuclear Laboratory in the United Kingdom is researching energy scavenging techniques that may allow the decay heat or gamma radiation from SNF to be used to power monitoring instruments fitted into SNF storage systems.

Need for More Than One Demonstration Cask

The test plan states "that a large scale R&D project using various configurations of dry storage cask systems and experiments would be beneficial." The Board agrees and believes that using a statistically meaningful number of tests – as opposed to the single cask demonstration included in the CDP – would provide additional data and confidence in the results. Tests that are initiated later in an expanded program could employ newly developed monitoring systems that can function in high radiation fields. An alternative approach might be to open, over the next few years, several casks that contain fuels with a range of burnups and storage histories to examine the condition of the fuel and the storage-system materials. Even though the information available on the initial status of the SNF in those casks may not be as extensive as that on the SNF in the CDP cask, important information could be gained from examining the condition of SNF stored in canisters that have been loaded previously. The Board understands that DOE is now considering opening other SNF storage casks or canisters, possibly during the initial 10-year storage period of the CDP, and commends DOE for being prepared to undertake this additional research activity.

Infrastructure Needs

A major issue that could affect the successful completion of the CDP is the current lack of a facility in the U.S. that can be used to unload the demonstration cask and to allow the fuel to be examined in a dry environment. Although the demonstration cask and additional systems that also may be included in the R&D program could be unloaded in existing wet pools, this would result in temperature cycling of fuel and cladding, which could alter the results obtained from examination of the SNF and make them less representative of SNF that has remained in dry storage. Consequently, the Board believes that high priority should be given to establishing a capability to open in a dry environment any of the dry-storage systems currently in use and performing the full range of inspection and monitoring operations that may be required to meet the needs of the R&D program. We note that in its fiscal year 2015 budget, DOE's request for

Telephone: 703–235–4473 Fax: 703–235–4495 www.nwtrb.gov

the Used Fuel Disposition Program includes funding to begin to develop this capability by adapting existing facilities at the Idaho National Laboratory (INL). The Board supports this initiative.

Transportation of the Demonstration Cask

The CDP test plan indicates that certification of a cask for transportation would occur after the cask has been certified for storage and loaded with high burnup SNF. However, as the NRC's transportation requirements are separate from its storage requirements, this leaves open the possibility that the loaded TN-32 cask might not be certified for transportation by the NRC. If this were to occur, the SNF would have to be repackaged prior to shipment to the fuel examination facility, which would reduce the value of the results of the program. The Board understands that there are competing priorities in the CDP and that in the early years the emphasis will be on activities such as modifying the cask lid and examining the fuel. However, we encourage DOE to include early certification of the cask for transportation in the schedule and list of key milestones.

As DOE is aware, transportation of a loaded cask to a facility at INL for examination of the fuel and then subsequent transportation of the cask to a centralized interim storage facility or repository, also could pose problems. This is because shipment of the loaded cask to INL after 10 years of on-site storage may depend on whether the terms of the 1995 Settlement Agreement between DOE, the Navy, and the State of Idaho and the terms of the 2011 Memorandum of Agreement between DOE and the State of Idaho have been met at the time. Also, under the terms of those agreements, DOE may need to use standard canisters when the SNF is eventually transported from the INL site for storage at another facility or disposal at a geologic repository. Currently, however, the DOE standard canister design has not been certified for storage or transportation and high burnup fuel was not considered in developing the initial design for certification. In addition, no certified cask exists that can be used to transport high burnup SNF in DOE standard canisters from INL to an interim storage facility or a repository. Consequently, additional actions are necessary to ensure that the SNF can be transported away from the INL site and the Board recommends that these actions also be included in the list of key milestones.

Separate-Effects Testing and Small-Scale Testing

The separate-effects testing (SET) and small-scale testing (SST) efforts, which were listed in the draft test plan, will be crucial to understanding key factors. They also would provide a wealth of validation data. According to the draft test plan, DOE's used nuclear fuel research, development, and demonstration strategies rely on these activities in implementing the large-scale prototype testing outlined in the test plan. The Board considers it important to set priorities among the SETs and SSTs and to focus on early execution of the higher priority tests.

Additional Parameters and Measurements

According to the test plan, data on the initial high burnup fuel rod properties will be derived from destructive examination of "sister" rods taken from the symmetric partner fuel assemblies or from the fuel assemblies chosen for loading into the storage cask. However, there are many examples of fuel loadings in symmetric core locations that behave differently, so examining fuel in symmetric core locations cannot always be used to correctly infer the state of

Telephone: 703–235–4473 Fax: 703–235–4495 www.nwtrb.gov

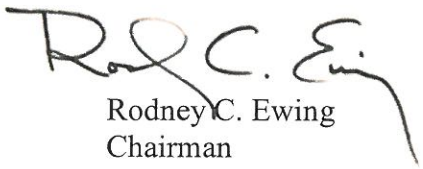
symmetrically located fuel. Thus, the Board suggests that extensive non-destructive post-irradiation examination of the fuel assemblies to be loaded in the cask be undertaken so that as much as possible is known about the fuel at the time of cask loading.

Loading the cask with a range of SNF burnups but the same fuel assembly design may be useful in obtaining information on the differences between the characteristics of the fuel assemblies after being subjected to identical loading, dry storage, shipping, and unloading operations. Also, data obtained from the examination of fuel in other storage systems may prove useful in determining what changes in fuel characteristics are a result of burnup and what changes are a result of transportation or unloading and repackaging operations.

Finally, more coordination with fuel inspection and analysis programs in other countries, such as the International Atomic Energy Agency Coordinated Research Project T13014 on demonstrating performance of SNF and related system components during very long-term storage, would be helpful to access potentially useful data for this program. Coordination also could accelerate progress and avoid duplication of research undertaken elsewhere.

The Board will follow the progress of the CDP with great interest and commends DOE-NE for undertaking this work. We look forward to continuing our ongoing review of the technical and scientific validity of DOE's activities in this important area.

Sincerely,



Rodney C. Ewing
Chairman

Telephone: 703–235–4473 Fax: 703–235–4495 www.nwtrb.gov