UNITED STATES
NUCLEAR WASTE TECHNICAL REVIEW BOARD
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August 7, 2025

Mr. Roger Jarrell
Principal Deputy Assistant Secretary, Office of Environmental Management
U.S. Department of Energy
1000 Independence Ave., SW
Washington, DC 20585

Dear Mr. Jarrell:

The U.S. Nuclear Waste Technical Review Board (Board) is charged with evaluating the technical and scientific validity of activities undertaken by the U.S. Department of Energy (DOE) in implementing the Nuclear Waste Policy Act.[1] On behalf of the Board, I want to thank you, your staff, as well as the staff from the national laboratories and site contractors, for supporting the Board's Summer 2024 Meeting in North Augusta, South Carolina, on August 29, 2024. One purpose of the meeting was to receive information on DOE management and plans for disposal of DOE spent nuclear fuel.[2] This letter[3] presents the Board's review of DOE spent nuclear fuel-related presentations during the Summer 2024 Meeting and information obtained during the Board's August 28, 2024, tour of facilities at the Savannah River Site and from DOE Spent Nuclear Fuel Working Group meetings.

The Board also thanks DOE staff for supporting the Board's participation in DOE's Spent Nuclear Fuel Working Group meetings, including the group's April 2024 meeting and tour at the Savannah River Site. These meetings enabled the Board to better prepare for the Summer 2024 Meeting. Finally, the Board would like to thank the staff at the Savannah River Site for supporting the extensive tour of the Savannah River Site facilities that provided detailed information related to spent nuclear fuel storage, conditioning (drying), and preparation for disposition—this information significantly complemented the Summer 2024 meeting presentations.

In the meeting, DOE Office of Environmental Management (DOE-EM) staff provided an overview of DOE spent nuclear fuel storage, transportation, and plans for disposal that

[1] The Board reports its findings, conclusions, and recommendations related to the management and disposition of spent nuclear fuel and high-level radioactive waste to Congress and the Secretary of Energy.

[2] The other purpose of the meeting was to receive a program update from DOE's Office of Nuclear Energy (DOE-NE) Office of Spent Fuel and High-Level Waste Disposition on its reprioritization of storage, transportation, and disposal research and development (R&D) activities. The Board provided feedback on DOE-NE's reprioritization effort to DOE-NE in a separate letter (https://www.nwtrb.gov/docs/default-source/correspondence/pns007vf-board-letter-to-doe-ne-summer-2024-meeting.pdf?sfvrsn=aaf6c205_3). The meeting agenda, presentation materials, transcript, and an archived recording of the webcast are available online at https://www.nwtrb.gov/meetings/past-meetings/summer-2024-board-meeting---august-29--2024.

[3] Current and past members of the Board who have contributed to this letter include P. Swift (Chair), R. Ballinger, S. Becker, A. Croff, T. Illangasekare, K.L. Peddicord, N. Siu, S. Tyler, and B. Woods.

highlighted program successes, challenges, and DOE's management plans. DOE-EM and Idaho National Laboratory staff described DOE-EM's spent nuclear fuel technology development program. Presentations by Savannah River Nuclear Solutions explained the accelerated basin de-inventory project and spent nuclear fuel management at the L-Basin facility. DOE-EM and Savannah River National Laboratory staff described management alternatives at Savannah River Site for the spent nuclear fuel expected to remain in L-Basin after completion of the accelerated basin de-inventory project. Staff from DOE-EM Idaho Operations Office and the Idaho Environmental Coalition described spent nuclear fuel management activities at Idaho National Laboratory, including a Road-Ready Demonstration Project.

Based on the information presented at the Summer 2024 Meeting and associated tour, the DOE Spent Nuclear Fuel Working Group meetings, and in related technical reports, the Board developed observations on DOE-EM's management and plans for disposal of DOE spent nuclear fuel.

DOE's Spent Nuclear Fuel Working Group

The DOE Spent Nuclear Fuel Working Group began just over ten years ago and includes representatives from every DOE office and site that manages spent nuclear fuel or will create spent nuclear fuel that DOE must manage and dispose of.[4] The Board commends DOE for its efforts to assemble and integrate the scientific, technical, and management personnel and expertise needed. Through its periodic meetings and task-defined subgroups, the working group has advanced DOE's efforts by providing actionable advice to manage and plan for disposal of its spent nuclear fuel by:

- Developing and implementing a strategic framework for DOE spent nuclear fuel.
- Identifying scientific and technical gaps on the management of aluminum-clad (Al-clad) spent nuclear fuel and implementing a technology development program to address the issues and obtain the needed information.
- Creating and implementing an integrated project team that assessed spent nuclear fuel management alternatives at the Savannah River Site, which led to the implementation of the advanced basin de-inventory project that is reducing the site's inventory of spent nuclear fuel using existing infrastructure.
- Completing an integrated project team assessment of spent nuclear fuel management alternatives at the Idaho National Laboratory.
- Assessing whether all the current inventory of DOE materials managed as spent nuclear fuel should continue to be managed as spent nuclear fuel or could be dispositioned differently and recommending changes to DOE Order 435.1 (Radioactive Waste Management).[5]

[4] Staff from DOE-EM and DOE-NE co-chair this multi-office organization.

[5] DOE. 2021. DOE Order 435.1 Change 2 (Administrative Change). Radioactive Waste Management. https://www.directives.doe.gov/directives-documents/400-series/0435.1-BOrder-chg2-AdminChg/@@images/file.

The Board notes that DOE's Spent Nuclear Fuel Working Group has been, and will be, if continued, integral to DOE's success in managing and planning for disposal of DOE spent nuclear fuel.

DOE-EM technology development related to dry-storage of aluminum-clad spent nuclear fuel

In the mid-1990s DOE developed but did not employ a multi-purpose (storage, transportation, and disposal) canister system for use in managing its spent nuclear fuel. The DOE standard canister[6] was intended for use at a U.S. Nuclear Regulatory Commission (NRC) licensed, but unconstructed, spent nuclear fuel storage facility at Idaho National Laboratory and at the proposed repository at Yucca Mountain, Nevada. The DOE standard canister functions as a containment barrier for radionuclides during transportation and provides criticality control during storage, transportation, and disposal.[7]

DOE intends to use the DOE standard canister in two DOE spent nuclear fuel packaging pilot programs. The Road-Ready Demonstration at Idaho National Laboratory would package carbide-based spent nuclear fuel from the Fort St. Vrain high-temperature gas-cooled reactor. DOE would also use the DOE standard canister in a proposed dry storage pilot program at the Savannah River Site that would serve as verification and validation of results from technology development activities associated with Al-clad spent nuclear fuel that DOE has been conducting since 2018. DOE conducted these activities to ensure the viability and safety of extended dry storage (greater than 50 years) of sealed or vented Al-clad spent nuclear fuel canisters and partially in response to the Board's 2017 recommendations on management and disposal of DOE spent nuclear fuel.[8]

DOE-EM, Savannah River National Laboratory, and Idaho National Laboratory presentations included details on, and results from, the Al-clad spent nuclear fuel drying technology development program, which included experimental and modeling activities. The latest experimental data suggests that very little pressure increase (oxygen/hydrogen) will be observed after drying of Al-clad spent nuclear fuel, and the likelihood of a combustible mixture of hydrogen and oxygen, while theoretically possible, is very low. The presentations also described the development of packaging pilot programs. The proposed Savannah River Site packaging pilot would demonstrate the drying of Al-clad spent nuclear fuel under prototypic conditions.

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[6] The Board adopts DOE's nomenclature for this canister even though it is not standard by any conventional definition. The DOE standardized canister, renamed after 2017 as the DOE standard canister, is a canister system that consists of four cylindrical stainless steel canisters with two different diameters (18 inches and 24 inches) and two different lengths (10 feet and 15 feet). The different sizes and eight internal basket designs of the multi-purpose canisters accommodate the wide dimensional variability of DOE spent nuclear fuel.

[7] All spent nuclear fuel in storage, transportation, and disposal systems are evaluated to demonstrate that sub-critical configurations are maintained. Criticality evaluations to demonstrate that storage systems remain subcritical during storage, transportation, and repository pre- and post-closure times are highly dependent on storage system design and configuration, transportation accident scenario considerations (e.g., whether moderator exclusion is allowed), and repository design and related assumptions (e.g., no cladding credit and instantaneous release).

[8] NWTRB. 2017. *Management and Disposal of U.S. Department of Energy Spent Nuclear Fuel*. https://www.nwtrb.gov/docs/default-source/reports/nwtrb-mngmntanddisposal-dec2017-508a.pdf?sfvrsn=e3b3f305_14. Through annual appropriations, Congress directed DOE to address the Board's recommendations.

The Board observes that DOE's Al-clad spent nuclear fuel technology development program has demonstrated that Al-clad spent nuclear fuel canister over-pressurization and accumulation of flammable atmospheres will be precluded if proposed drying processes are implemented. The Board notes that ongoing technology development activities continue to provide data needed to validate computer models that can be used to predict the behavior of the various types of Al-clad spent nuclear fuel that will not or cannot be physically tested. Additionally, planned spent nuclear fuel canister drying demonstrations will provide confidence that drying systems and components will operate as expected.

Using the DOE standard canister for management and disposal of DOE spent nuclear fuel

In its 2017 report,[9] the Board evaluated DOE's proposed use of the DOE standard canister for management and disposal of DOE spent nuclear fuel. Standard engineering and design practices applied to nuclear applications suggest that an important first step is to determine all the regulatory requirements that apply to an expected operation (e.g., packaging of spent nuclear fuel into DOE standard canisters) and then ensure that the design of the system will meet regulatory requirements for all its intended purposes (e.g., storage, transportation, and disposal). The NWTRB recommended that DOE adopt such an approach for packaging non-naval DOE spent nuclear fuel in 2017. The Board then stated:

> To minimize complications in developing and operating a packaging facility for DOE spent nuclear fuel at Idaho National Laboratory, the Board recommends that **DOE complete** research, development, and **licensing-related activities for the DOE standardized canister**—and any other canisters that may be used—**prior to completing the facility's preliminary design** [**emphasis added**]. In particular, DOE should complete the following tasks related to the DOE standardized canister …
>
> e. obtain NRC approval that the DOE standardized canister meets the transportation moderator exclusion requirements or receive an exemption to these requirements;
> f. analyze an existing NRC-certified rail transport cask or develop a new one, and obtain NRC approval to transport DOE standardized canisters to ensure that any canister packaging design features needed inside the rail cask (e.g., a supplemental impact limiter) to meet regulatory requirements are considered in the design of the packaging facility … .

In 2019, the Board assessed DOE's progress in its technology development program and in addressing the Board's 2017 recommendation relative to NRC licensing. The Board noted that DOE had not pursued NRC licensing and recommended that "DOE should engage early with NRC to ensure that the DOE Standard Canister project is aware of all applicable regulatory requirements, including requirements for criticality safety and limiting hydrogen concentrations,

[9] NWTRB. 2017. *Management and Disposal of U.S. Department of Energy Spent Nuclear Fuel*. https://www.nwtrb.gov/docs/default-source/reports/nwtrb-mngmntanddisposal-dec2017-508a.pdf?sfvrsn=e3b3f305_14.

and develop a firm path forward and schedule for completing development of the DOE Standard Canister and obtaining the necessary NRC approvals."[10]

At the Board's August 2024 meeting, DOE-EM described the proposed path forward for spent nuclear fuel management at the Idaho National Laboratory. The presenters described identifying facility and infrastructure upgrades/modifications needed to support the spent nuclear fuel packaging demonstration effort (described as ongoing) and developing a proposed regulatory compliance framework (also described as ongoing) as part of the proposed path forward. Mr. Paul Murray (DOE-NE) also described how DOE-NE is collaborating with DOE-EM including that DOE-NE was considering completing licensing of the DOE standard canister, which is not currently licensed for transportation. The speaker from the Idaho Environmental Coalition who described the proposed packaging demonstration also noted that the timeframe for DOE engagement with the NRC is yet to be determined.

Based on the Board's previous recommendations, and on the uncertainty of when DOE will engage with NRC to address licensing-related issues that will affect use of the DOE standard canister for transportation and disposal, the Board notes that engagement with NRC and early completion of necessary NRC licensing actions would be prudent.

As noted in the Board's 2017 report, determining the acceptability for disposal of a multi-purpose canister (i.e., the DOE standard canister) requires addressing disposal requirements, such as identifying materials required to be packaged with the DOE spent nuclear fuel in the DOE standard canister to address post-closure criticality. The disposal requirements for the DOE standard canister historically have been documented in a waste acceptance system requirements document.[11] In the Board's 2017 report, the Board noted both DOE-EM and the naval nuclear propulsion program continued to manage their waste according to the waste acceptance system requirements that were applied for the Yucca Mountain repository. In the August 2024 meeting, DOE-NE noted that the "waste acceptance criteria for Yucca Mountain is a very good basis for which to plan against."[12] For the Yucca Mountain repository, any waste package containing DOE spent nuclear fuel would contain only one DOE standard canister. DOE completed criticality analyses based on this requirement and determined the types and amounts of neutron absorbers that needed to be added to DOE standard canisters during packaging for different groups of DOE spent nuclear fuel.[13]

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[10] Bahr, J.M. 2020. Board letter to DOE following the Board's November 2019 meeting. January 10. https://www.nwtrb.gov/docs/default-source/correspondence/jmb022.pdf?sfvrsn=4933f205_6.

[11] DOE. 2008. *Civilian Radioactive Waste Management System Waste Acceptance System Requirements Document.* DOE/RW-0351. Revision 5, ICN 01.

[12] Murray, P. 2024. Transcript of Summer 2024 Meeting. Lines 5871-5874. August 29. https://www.nwtrb.gov/docs/default-source/meetings/2024/august/nwtrb-summer-2024-meeting_8-29-24.pdf?sfvrsn=7244c305_3.

[13] Table 2-2 of the Board's 2017 report summarized the results of DOE analyses and identified the neutron absorbers that were required to be added during packaging for different groups of DOE spent nuclear fuel. DOE projected that neutron absorbing baskets were required to be placed into about 1,080 DOE standard canisters and for another 214 DOE standard canisters both neutron absorbing baskets and gadolinium-bearing pellets would be added during packaging. The Board also noted gadolinium phosphate chemisorbed water would also affect the drying process for DOE standardized canisters containing this neutron absorber.

The Road-Ready Demonstration Project is intended to demonstrate how DOE standard canisters could be packaged to meet a road-ready criterion, which remains to be finalized. The Idaho Environmental Coalition speaker noted that the goal was to have the spent nuclear fuel packaged in a configuration that was transportable and disposable. The demonstration would package four Fort St. Vrain spent nuclear fuel elements into a DOE standard canister that would be welded closed. A total of seven DOE standard canisters would be packaged with Fort St. Vrain spent nuclear fuel elements during the demonstration. The demonstration would include packaging the seven DOE standard canisters into a single dual-purpose (storage and transportation) canister[14] that would be welded closed. The welded dual-purpose canister then would be placed into a storage overpack and stored outdoors on a storage pad. After the demonstration was complete and when transportation was needed, the dual-purpose canister would be transferred to a transportation overpack. Under this packaging concept, the dual-purpose canister effectively becomes the waste package for disposal once a waste package overpack (e.g., a corrosion resistant outer barrier) is placed onto the dual-purpose canister.

The Board notes that for the packaging demonstration, and any future packaging based upon this packaging concept, DOE has not yet determined whether a dual-purpose canister with seven DOE standard canisters would be disposable or what materials need to be added to the dual-purpose canisters during packaging to meet disposal criticality requirements. Because all materials contained in a dual-purpose canister need to be evaluated for safety implications, including criticality safety, during NRC's licensing review of containers for storage and transportation, it is wise to ensure that the design of the system will meet regulatory requirements for all its intended purposes (i.e., storage, transportation, and disposal) before implementing a packaging concept.

As the Board recently noted, when DOE prepares its ADVANCE Act[15] report on liabilities and projected lifecycle costs, a key cost consideration will be the potential need to repackage dual-purpose (storage and transportation) canisters containing commercial spent nuclear fuel to facilitate disposal of commercial spent nuclear fuel.[16] Should DOE forgo assessing the disposability of the welded dual-purpose canisters containing seven DOE standard canisters prior to packaging, then DOE may need to later open these welded dual-purpose canisters and repackage the DOE standard canisters into disposable waste packages, which could entail substantial costs and schedule delays.

Thank you again, on behalf of the Board, for the participation of DOE staff and technical experts from the national laboratories and site contractors at our Summer Meeting in August 2024.

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[14] There are numerous commercially available dual-purpose canisters that have been licensed (i.e., certified) by NRC for storage and transportation. The speaker noted that some modifications to an NRC-approved system might be necessary and that DOE would need to amend the existing NRC certificate of compliance of the dual-purpose canister used for packaging the seven DOE standard canisters.

[15] Accelerating Deployment of Versatile, Advanced Nuclear for Clean Energy Act of 2024, Pub. L. No. 118-47. https://www.congress.gov/118/plaws/publ67/PLAW-118publ67.pdf.

[16] Swift, P. 2025. Board letter to DOE-NE following the Board's August 2024 meeting. June 9. https://www.nwtrb.gov/docs/default-source/correspondence/pns007vf-board-letter-to-doe-ne-summer-2024-meeting.pdf?sfvrsn=aaf6c205_3.

We look forward to continuing our ongoing evaluation of the technical and scientific validity of DOE's activities related to managing and disposing of spent nuclear fuel and high-level radioactive waste.

Sincerely,

Peter Swift
Chair

cc: Dr. Michael Goff, Principal Deputy Assistant Secretary, Office of Nuclear Energy
Mr. Paul Murray, Deputy Assistant Secretary, Office of Spent Fuel and High-Level Waste Disposition