Department of Energy

Washington, DC 20585

July 5, 2023

Dr. Nathan Siu
Chair
Nuclear Waste Technical Review Board
2300 Clarendon Boulevard
Suite 1300
Arlington, VA 22201-3367

Dear Dr. Siu,

The U.S. Department of Energy's (DOE) Office of Nuclear Energy (NE) appreciates your letter of June 7th, 2022, which summarized the Nuclear Waste Technical Review Board's 2022 Winter Meeting. In that virtual meeting, held on March 1-2, 2022, information was presented by DOE and national laboratory participants on DOE's research and development (R&D) activities related to storage, transportation, and disposal of spent nuclear fuel (SNF) and high-level radioactive waste (HLW). In the area of integrated waste management, DOE and supporting participants presented information on the development of decision-support tools used to assist in developing and managing an integrated waste management system. DOE also provided the Board with an update on efforts to develop a consent-based approach for siting one or more federal consolidated interim storage facilities for SNF.

The Board's letter provided observations, findings, and recommendations on these DOE activities. DOE appreciates the Board's input to our program and looks forward to its future insights on DOE's activities related to the management and disposal of SNF and HLW.

The enclosure provides the DOE's responses to the Board's specific findings and recommendations. If you have any questions on these responses, please contact Timothy Gunter (NE-81) at timothy.gunter@nuclear.energy.gov or Erica Bickford (NE-82) at erica.bickford@nuclear.energy.gov.

Sincerely,

Kathryn Huff
Assistant Secretary
For Nuclear Energy

Enclosure

U.S. Department of Energy (DOE) Response to the Nuclear Waste Technical Review Board (NWTRB) Report from the NWTRB 2022 Winter Meeting

NWTRB findings and recommendations, and DOE responses:

1. The Board finds that additional analyses and quantitative information regarding the potential pros and cons of the DPC direct disposal option will be useful to decision-makers.

To provide decision-makers with information about the pros and cons of direct disposal of DPCs versus repackaging of SNF assemblies currently in DPCs, the Board recommends that DOE complete quantitative assessments for both concepts spanning the waste management lifecycle. These assessments should include estimates of costs and radiation doses related to packaging (or repackaging) of SNF, transportation, interim storage, and repository operations, including the ramifications of disposal in alternative geological media.

DOE Response:

DOE agrees that the recommended assessments would be useful to decision makers and will consider these in the future. However, current activities are focused on whether direct disposal of dual-purpose canisters (DPCs) is even technically feasible. Additionally, these types of assessments would require much more detailed repository design information, all of which does not currently exist.

Some information has been developed. With regard to costs, SAND2019-6999 Rev 1 provides a quantitative comparison of life cycle costs for a single assumed repository type (a Yucca Mountain-like repository) for various options, including direct disposal and repackaging. A Yucca Mountain-like repository was chosen because the total system life cycle cost (TSLCC) (DOE 2008) provided reliable cost estimates for that specific repository design. There is insufficient information available for comparable size spent nuclear fuel (SNF)/high-level radioactive waste (HLW) repositories in other geologic media in the U.S., and extrapolation from international cost estimates and designs would not provide as reliable comparisons as is provided by the TSLCC cost information.

Regarding dose, SAND2022-15262PE (Slide 5) provides an estimate of collective worker dose from repackaging – ~250 mrem/canister for a wet handling facility and 220-393 mrem/canister for a dry handling facility, based on Weck (2013). For context, 10 CFR 63 limits worker dose to 5 rem/year. More detailed life cycle dose estimates would require more specific design information.

References:

DOE (US Department of Energy) 2008. *Analysis of the Total System Life Cycle Cost of the Civilian Radioactive Waste Management Program, Fiscal Year 2007*. DOE/RW-0591. U.S. Department of Energy, Office of Civilian Radioactive Waste Management, Washington, DC.

Freeze, G., E.J. Bonano, E.A. Kalinina, J. Meacham, L. Price, P.N. Swift, A. Alsaed, D.A. Beckman, and P.G. Meacham 2019. *Comparative Cost Analysis of Spent Nuclear Fuel Management Alternatives*. SAND2019-6999 Revision 1. Sandia National Laboratories, Albuquerque, NM.

Freeze, G. 2022. *Dual-Purpose Canister (DPC) Direct Disposal – Operations, Engineering, and Thermal Management*. SAND2022-15262PE. Presented at EPRI ESCP Winter 2022 Meeting Direct Disposal Workshop, Charlotte, NC, November 7, 2022.

Weck, P.F. 2013. "Worker exposure for at-reactor management of spent nuclear fuel", *Radiation Protection Dosimetry, Vol. 156, No. 3*, pp. 386–393.

2. The Board finds that DOE has not yet provided evidence for making this conclusion [that DOE still believes that pressurized water reactor (PWR) data for high-burnup fuels bound boiling water reactor (BWR) behavior].

The Board recommends that DOE either demonstrate that existing data and modeling regarding the behavior of high burnup PWR SNF bound the behavior of BWR and ATF SNF and SNF containing IFBAs or complete the necessary testing and modeling for these fuel types.

DOE Response:

The DOE Spent Fuel and Waste Science and Technology (SFWST) Storage and Transportation R&D program is exploring options to obtain data to confirm that high burn-up (HBU) PWR behavior bounds HBU BWR behavior, accident tolerant fuel (ATF) SNF, and SNF containing integral fuel burnable absorbers (IFBAs). We are participating in the Studsvik Cladding Integrity Project (SCIP) IV program with a goal to obtain BWR data, as well as IFBA data. We are also considering obtaining HBU BWR SNF to perform testing in Oak Ridge National Laboratory (ORNL) hot cells. Additionally, we are collaborating within DOE's ATF program to plan future testing of ATF SNF within ORNL and/or Pacific Northwest National Laboratory (PNNL) hot cells.

3. The Board finds that DOE has not fully considered whether a different localized corrosion mechanism such as crevice corrosion could be a precursor process for initiation of CISCC in addition to pitting corrosion.

As DOE continues to develop the two full-scale canister demonstrations, the Board recommends that DOE consider whether localized corrosion such as crevice corrosion could be a precursor to CISCC and determine how that precursor mechanism could be assessed in the field demonstrations.

DOE Response:

The main goal of the full-scale canister demonstrations is to gain realistic data on deposition of dust on canister surfaces. However, DOE plans to incorporate a rack of material samples to evaluate corrosion near the canisters during the full-scale demonstrations. During the full-scale demonstrations, areas of the canister that might be candidates for crevice corrosion (e.g., contact with the rails) will not be

accessible for inspection. However, DOE plans to be able to evaluate the canisters for corrosion after the completion of the tests. Additionally, DOE will continue lab-scale testing to evaluate localized corrosion mechanisms.

4. As DOE conducts R&D to support its consequence assessment of canister failure, the Board recommends that DOE complete refinements that it has described for its aerosol transmission experiments, including conducting some experiments using a single effect approach to facilitate easier model development, validation, and interpretation of results. In the near-term, DOE should clearly define the events and processes that affect aerosol generation within a sealed cask that can lead to potential aerosol transmission when a crack forms to subsequently guide the R&D needed to realistically assess the consequence of a canister failure.

DOE Response:

DOE agrees that continuing refinements of aerosol transmission experiments, including conducting some experiments using a single effect approach to facilitate easier model development, validation, and interpretation, is important. Because of the importance of R&D to realistically assess the consequence of canister failure, DOE is funding such R&D at several National Laboratories and universities. Work is being done to better define events and processes that affect aerosol generation within a sealed cask, such as gathering spent fuel rod aerosol release data from the sibling pins project, and refining estimates of internal canister conditions, such as the amount of water remaining after drying and the subsequent effects on cladding degradation. Given the understanding of hypothetical aerosol releases into the canister interior developed from previous testing, additional SFWST R&D is being pursued to better define fuel-to-canister release fractions from fuel cladding failure. Complementary modeling of aerosol deposition inside dry storage systems is also ongoing and will be used to delineate internal aerosol sources and to evaluate potential aerosol release mechanisms.

5. The Board finds that there is value in expanding NGSAM capabilities and analyses to more completely address possible integrated waste management systems options and in renewing the development of MOEF as a part of understanding and addressing stakeholder objectives in support of consent-based-siting activities.

The Board recommends that DOE expand NGSAM capabilities and analyses to better address disposal of DPCs, including waste packaging operations and cost requirements, and that it include stakeholders involved in the consent-based siting process to inform NGSAM development and use.

DOE Response:

DOE fiscal year 2023 plans include applying the Next Generation System Analysis Model (NGSAM) capabilities towards analyzing scenarios involving direct disposal of DPCs, including analysis of cost and waste packaging considerations. DOE also plans to take into account stakeholder input received through the consent-based siting process to inform development and use of its system analysis tools and,

in turn, apply system analysis results to inform consent-based siting. We see this as an iterative process that facilitates communication and understanding between DOE and its external stakeholders.

6. The Board finds that there are additional opportunities for developing and using START as a training tool and to improve outreach using the knowledge bases of other agencies.

The Board recommends that DOE consider how START might be utilized as a resource to familiarize and train emergency response personnel for nuclear waste transport and as a component in tabletop exercises aimed at exploring emergency scenarios. Likewise, the Board recommends that DOE engage with other agencies involved in similar transportation efforts to leverage their experiences and approaches to stakeholder interactions and addressing hazards.

DOE Response:

DOE has spent the past 4 years working on migrating the Stakeholder Tool for Assessing Radioactive Transportation (START) to a new cloud server hosting platform at DOE headquarters that can better support expanded features and functions. Now that that migration is complete, the DOE Office of Integrated Waste Management (IWM) is returning to a backlog of planned updates to features and functions, as well as providing training opportunities. As part of the server migration, START is undergoing security testing that could allow for the removal of its official use only designation and enable START to be accessed by a wider audience of approved users. IWM staff hosted the first post-migration START training opportunity at the American Nuclear Society's International High-Level Radioactive Waste Management Conference in November 2022 and provided trainings for the Tribal Radioactive Materials Transportation Committee and the Council of State Governments Midwestern Radioactive Materials Transportation Committee in spring 2023.

IWM routinely engages with other radioactive material shipping programs to integrate lessons learned and best practices and to inform DOE's approaches to transport operations, public outreach, and emergency response training for future DOE shipments of SNF. IWM staff have spoken with program staff from the Office of Environmental Management's Waste Isolation Pilot Plant (WIPP) program about coordinating future training along any overlapping shipping corridors to avoid concentrating training resources in some areas while leaving gaps in others. START includes up-to-date data (updated every 6 months) on locations of personnel trained through DOE's Transportation Emergency Preparedness Program (TEPP). By overlaying transportation route layers with TEPP-trained responder layers, areas that may need additional training resources can be readily identified. IWM staff have also coordinated with personnel from the Naval Nuclear Propulsion Program on rail transportation operations and attended multiple Navy SNF transportation training exercises, which IWM plans to use as a model for future DOE SNF shipment training exercises. IWM is also considering proposing joint training exercises with both programs once DOE is closer to shipping. As a first step in coordination with those programs, IWM has added current highway shipping routes for WIPP and rail shipping routes for Navy SNF as layers in START. In the future, once DOE shipping routes begin to be identified, START can be used to see where there is overlap between DOE SNF shipping corridors and other shipping corridors and identify potential locations for joint training exercises. The START team also has plans to incorporate additional first responder information into START – expanding on the TEPP-trained personnel

information layer to include Tribal, State, and local personnel trained through other programs, using Federal Emergency Management Agency (FEMA) data for a more comprehensive understanding of where trained personnel are located or where additional training is needed. The START team also plans to look at including Tribal emergency operation center information to expand on Tribal readiness information.

7. The Board finds that there are additional actions that DOE could take to meet its stated commitments, learn from domestic siting experiences and from siting processes in other nations, and strengthen its overall consent-based siting effort.

Although the Board applauds DOE for undertaking significant consent-based siting activities, the Board recommends that DOE significantly strengthen and improve its efforts. A larger and broader range of participants should be engaged, and expanded efforts to include historically underrepresented communities should be undertaken. DOE should also make systematic use of the large body of scientific and technical literature in such fields as the social/behavioral sciences and the public health sciences. By informing all consent-based siting efforts with relevant outside scientific/technical knowledge and expertise on risk communication, risk perception, effective outreach, inclusiveness, and public engagement, DOE can identify ways to engage a broader range of participants, better understand public views and concerns, and improve the overall effectiveness and face validity of its consent-based siting work. The Board also recommends that DOE produce a candid "lessons learned" document on its deep borehole demonstration siting effort and review key lessons that have been learned from siting processes in other nations.

DOE Response:

The DOE consent-based siting process builds upon best practices from domestic and international siting cases, and DOE is continuing to examine how domestic and international siting experiences and/or collaborations can be used to support successful advancement of consent-based siting in the US. This includes lessons learned from DOE's siting efforts for the Deep Borehole Field Test from 2015 to 2017. Additionally, DOE leverages international collaboration by participating in many international forums and technical meetings, engaging in bi-lateral collaborations and discussions to exchange information, sharing best practices, and identifying areas for more in-depth collaboration.

To reach a broader range of participants, DOE has issued a $26 million funding opportunity to provide resources for communities interested in learning more about consent-based siting, management of spent nuclear fuel, and interim storage facility siting considerations. The award recipients will help DOE to advance mutual learning, provide ease of access to information, foster mutual understanding, and lay the foundations for wider-reaching community participation and engagement. The awardees will also help to reduce barriers to participation by providing grants to community organizations and partners. Additionally, DOE is expanding its strategy to develop relationships and build trust with historically underrepresented communities. For example, work is underway to fund partnerships with Tribal-serving Institutions, Historically Black Colleges and Universities, and a Hispanic Serving Institution.
The Department has conducted extensive literature reviews to understand and implement the rich and diverse social/behavioral science literature from a range of fields and disciplines, with recommendations

developed from this research to aide DOE's process design, engagement practices, and communication strategies. Additionally, DOE has hired social scientists with subject matter expertise in these fields who are implementing and operationalizing lessons learned from the scientific literature. Finally, in addition to the analysis of the 225 responses to the 2021 *Request for Information on Using a Consent-Based Siting Process to Identify Federal Interim Storage Facilities (86 FR 68244)* (see *Consent-Based Siting Request for Information Comment Summary and Analysis*), DOE is conducting wide-ranging research to better understand public perceptions and concerns, including analyses of national surveys, traditional media, social media, citizen science, and information gathering from diverse groups.