U.S. Nuclear Waste Technical Review Board

Proceedings of the Board's 2023 International Workshop on Siting of Radioactive Waste Facilities

September 2024

U.S. NUCLEAR WASTE TECHNICAL REVIEW BOARD

PROCEEDINGS OF THE BOARD'S 2023 INTERNATIONAL WORKSHOP ON SITING OF RADIOACTIVE WASTE FACILITIES

September 2024

U.S. Nuclear Waste Technical Review Board

Note: Dr. Paul Turinsky served as a Board member from September 12, 2012 to May 17, 2024. During his time on the Board, he played a role in developing this report.

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Kimberly Brown	*Human Resources Specialist*

Note: Dr. Roberto Pabalan retired in October 2023.
During his time as a Board staff member, he played a role in developing this report.

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Acronyms and Abbreviations

Board	U.S. Nuclear Waste Technical Review Board
BRC	Blue Ribbon Commission on America's Nuclear Future
DOE	U.S. Department of Energy
DOE-NE	U.S. Department of Energy, Office of Nuclear Energy
DNFSB	U.S. Defense Nuclear Facilities Safety Board
EPA	U.S. Environmental Protection Agency
HLW	high-level radioactive waste
MRS	monitored retrievable storage
Nagra	Nationale Genossenschaft für die Lagerung radioaktiver Abfälle (National Cooperative for the Disposal of Radioactive Waste), Switzerland
NWMO	Nuclear Waste Management Organization, Canada
NWPA	Nuclear Waste Policy Act
NWTRB	U.S. Nuclear Waste Technical Review Board
RFI	request for information
SKB	Svensk Kärnbränslehantering AB (Swedish Nuclear Fuel and Waste Management Company)
SNF	spent nuclear fuel
VTT	VTT Technical Research Centre of Finland, Ltd.
WIPP	Waste Isolation Pilot Plant

Acknowledgements

Editors: Dr. Yoonjo Lee and Dr. Bret Leslie served as the editors for these proceedings and were supported by the Board members and staff.

Special Thanks: The Board wishes to express its special thanks to Dr. Piet Zuidema, Zuidema Consult GmbH, Switzerland, who served as a consultant to the Board and participated in the Board's International Workshop on Siting of Radioactive Waste Facilities. Dr. Zuidema's consultant report to the Board provided useful inputs that were incorporated into the proceedings. Dr. Zuidema's report may be found at this link:

https://www.nwtrb.gov/docs/default-source/meetings/2023/august/zuidema_report.pdf?sfvrsn=4

Preface

On August 29, 2023, the U.S. Nuclear Waste Technical Review Board (NWTRB, or "the Board") held an International Workshop on Siting of Radioactive Waste Facilities in Idaho Falls, Idaho, USA. The workshop provided individual speakers from several countries the opportunity to candidly share their viewpoints, insights, experiences, and lessons learned regarding the siting of radioactive waste storage and disposal facilities. A significant focus of the workshop was on the processes for developing consent during the siting of a new facility (consent-based siting). These proceedings summarize the workshop presentations, discussions, key themes and takeaways, and are intended to serve as an informational resource for anyone—policymakers, industry, researchers, communities—interested in the topic of nuclear waste storage and disposal. The summaries are based on a review of the workshop transcript[1] and webcast.[2] Contextual material and presentation slides[3] can be found on the Board's website.

[1] https://www.nwtrb.gov/docs/default-source/meetings/2023/august/usnwtrb-aug-29.pdf?sfvrsn=4 (last visited August 7, 2024)

[2] https://preconvirtual.com/nwtrb-gov-08-29-2023-dayone/ (last visited August 7, 2024)

[3] https://www.nwtrb.gov/meetings/past-meetings/summer-2023-workshop---august-29-2023 (last visited August 7, 2024)

Introduction

Worldwide, the siting of nuclear facilities, especially radioactive waste storage and disposal facilities, has proven to be a challenging and time-consuming endeavor. Nonetheless, a growing number of countries are pursuing such facilities, which are essential components of the nuclear fuel cycle and nuclear power programs in these countries. Many countries are becoming, or propose to become, more reliant on nuclear energy, and their nuclear power programs are expanding in order to address climate change and to satisfy energy security and reliability needs. These points are summarized in a report from the Nuclear Energy Agency, *Management and Disposal of High-Level Radioactive Waste: Global Progress and Solutions*, published by the Nuclear Energy Agency (Nuclear Energy Agency, 2020), which discusses international efforts to develop disposal facilities and notes, in the Annex of that report (page 41), that such efforts can take three to five decades or longer.

With these challenges in mind and with a goal to gather important lessons learned, the U.S. Nuclear Waste Technical Review Board ("the Board") hosted an International Workshop on Siting of Radioactive Waste Facilities, in Idaho Falls, Idaho, USA, on August 29, 2023. The workshop was focused on the processes for developing consent during the siting of a new facility (i.e., consent-based siting). The workshop also fulfilled a broader goal of the Board: to monitor and to be informed by activities in other countries related to programs for the management and disposal of radioactive waste.

U.S. Nuclear Waste Technical Review Board

The U.S. Nuclear Waste Technical Review Board was established as an independent federal agency in the 1987 Nuclear Waste Policy Amendments Act (NWPA) to ". . . evaluate the technical and scientific validity of activities [related to managing and disposing of spent nuclear fuel and high-level radioactive waste] undertaken by the Secretary [of Energy], including

(1) site characterization activities; and

(2) activities relating to the packaging or transportation of high-level radioactive waste or spent nuclear fuel."

As recorded in the Legislative History of the Nuclear Waste Policy Amendments Act, the purpose of the Board is to review the technical and scientific validity of activities undertaken by the U.S. Department of Energy (DOE) to implement the NWPA and to provide independent expert advice to the DOE and the Congress on technical issues related to nuclear waste management. In accordance with this mandate, the Board conducts objective, ongoing, and integrated technical and scientific peer review of DOE activities related to the disposition of commercial and DOE-managed spent nuclear fuel (SNF) and high-level radioactive waste (HLW). According to the Legislative History, the Board is expected to "review the activities [of the Secretary] as they are occurring, not after the fact." The Board reports its findings and recommendations to Congress and the Secretary of Energy.

Background

The Nuclear Waste Policy Amendments Act of 1987 designated Yucca Mountain in Nevada as the sole location in the United States to be considered for a permanent geological repository. However, in 2010, the U.S. Department of Energy's (DOE) efforts on the Yucca Mountain project were suspended and defunded. In the same year, the Blue Ribbon Commission on America's Nuclear Future (BRC) was formed by the Secretary of Energy at the request of President Obama. The BRC conducted a comprehensive review of policies for managing the back end of the nuclear fuel cycle and released its final report in 2012 (BRC, 2012). A key recommendation of the BRC was the development of ". . . a new, consent-based approach to siting future nuclear waste management facilities" (p. vii).

In 2015, the Board published a report, *Designing A Process For Selecting A Site For A Deep-Mined, Geologic Repository For High-Level Radioactive Waste And Spent Nuclear Fuel* (NWTRB, 2015), which is available for download[1] on the Board's website. This report, as part of the Board's continuing efforts to learn from experiences in other countries, is a comparative historical inquiry into two dozen siting efforts that have taken place over the past half-century in ten different nations.

Key among the conclusions of this report was that, as a site selection process proceeds, it should ensure that any proposed site is, simultaneously, technically suitable and socially acceptable. This concept was further explored in the Board's 2021 report, *Six Overarching Recommendations for How to Move the Nation's Nuclear Waste Management Program Forward* (NWTRB, 2021), where the Board also noted a need for the site selection process to be flexible and to evolve with time. A depiction of these concepts is provided in Figure 1.

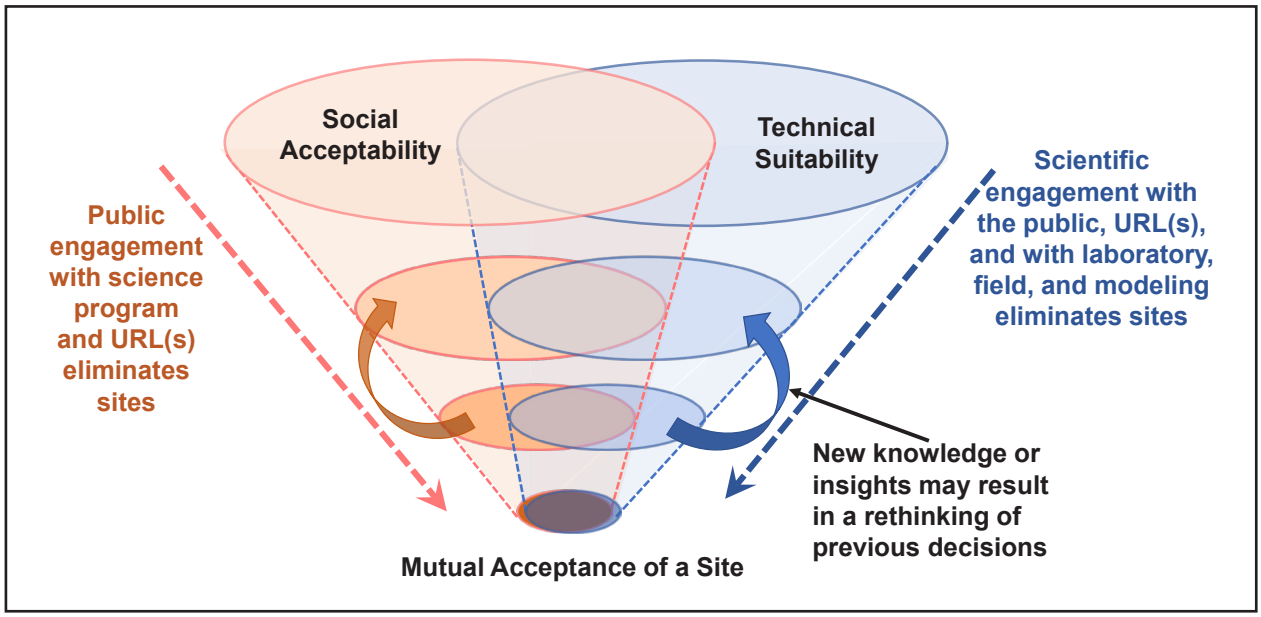

Figure 1
Development of a convergent pathway for siting a repository (NWTRB, 2021)

[1] https://www.nwtrb.gov/our-work/reports/designing-a-process-for-selecting-a-site-for-a-deep-mined-geologic-repository-for-high-level-radioactive-waste-and-spent-nuclear-fuel-an-overview-and-summary-(2015) (last visited August 7, 2024)

In 2020, Congress passed the Consolidated Appropriations Act of 2021, which funded a new initiative within DOE for interim storage activities.[2] Pursuant to enactment of the Consolidated Appropriations Act of 2021, in December 2021, DOE published a broad request for input from the public, industry, academia, and others (i.e., a Request for Information [RFI]) regarding using a consent-based process to site federal interim storage facilities and how best to remove barriers to participation and communication.

In September 2022, DOE announced a Funding Opportunity Announcement to provide resources to communities interested in learning more about consent-based siting, management of SNF, and interim storage facility siting considerations. In June 2023, DOE announced $26 million of funding, divided among 13 (now 12) geographically and institutionally diverse consortia.

As part of its mission to provide a continuing evaluation of the technical and scientific validity of DOE activities, the Board has been following DOE's efforts to develop a consent-based siting approach that can lead to the development of a federal consolidated interim storage facility for commercial SNF. The International Siting Workshop that is the subject of these proceedings was planned by the Board in conjunction with its Summer 2023 Board Meeting, also held in Idaho Falls, Idaho, where the Board heard directly from DOE about its most recent efforts related to the consent-based siting program.

Readers who are interested in more information regarding SNF and HLW disposal programs in other countries are directed to the Board's report, *Survey of National Programs for Managing High-Level Radioactive Waste and Spent Nuclear Fuel: 2022 Update* (NWTRB, 2022), available for download[3] on the Board's website. The report contains updates to 30 technical and institutional attributes of nuclear waste programs in 13 countries (United States, Belgium, Canada, China, Finland, France, Germany, Japan, Republic of Korea, Spain, Sweden, Switzerland, and the United Kingdom).

Workshop Conduct and Topics

After opening remarks by the Board chair and introductory remarks by a Board staff member and DOE, invited speakers made presentations and participated in a midday panel discussion and a final panel discussion. For each presentation and panel discussion, the Board asked participants questions beyond those that were addressed in the workshop agenda. The workshop agenda is provided in Appendix A. A list of workshop speakers and their biographical summaries are provided in Appendix B, and Board member biographical summaries[4] can be found on the Board's website. The presentation files[5] can be found on the Board's website.

The following topics were presented and discussed at the workshop by the speakers:

- *Siting of a Geologic Repository in Canada* (Lisa Frizzell, Nuclear Waste Management Organization [NWMO][6])

[2] P.L. 116-260 (H.R.133) - Consolidated Appropriations Act, 2021.

[3] https://www.nwtrb.gov/our-work/reports/survey-of-national-programs-for-managing-high-level-radioactive-waste-and-spent-nuclear-fuel-2022-update (last visited August 7, 2024)

[4] https://www.nwtrb.gov/about-us/members (last visited August 7, 2024)

[5] https://www.nwtrb.gov/meetings/past-meetings/summer-2023-workshop---august-29-2023 (last visited August 7, 2024)

[6] The Nuclear Waste Management Organization (NWMO) is a not-for-profit organization tasked with the safe, long-term management of Canada's used nuclear fuel. For more information about NWMO and its mission, please visit: https://www.nwmo.ca/ (last visited August 7, 2024).

- *Siting of a Geologic Repository in Sweden* (Saida Engström)
- *Siting of a Geologic Repository in Switzerland* (Piet Zuidema, Zuidema Consult GmbH)
- *United States Past Siting Experience, Focused on Monitored Retrievable Storage and the Nuclear Waste Negotiator* (Daniel Bullen, Technical Staff Member at the U.S. Defense Nuclear Facilities Safety Board [DNFSB][7])
- *Incorporating International Siting Best Practices and Lessons Learned* (Natalia Saraeva and Angelica Gheen, DOE-NE)
- *Incorporating Domestic Best Practices and Lessons Learned* (Natalia Saraeva and Angelica Gheen, DOE-NE)
- *Using Best Practices and Lessons Learned in Environmental Justice* (Marissa Bell, DOE-NE)

After the presentations and panel discussions, there was a 15-minute public comment period. In addition, public comments were submitted online and were posted to the Board's website after the meeting and are available for download.[8] The final activity for the Board's workshop was a 30-minute Open House, which allowed workshop attendees to freely interact with the Board members, invited speakers, DOE staff and contractors, and to explore DOE's in-person visual aids and virtual reality tour of a conceptual SNF interim storage facility.

Figure 2
At the Open House and during the breaks, workshop attendees socialized around DOE's interactive consent-based siting information booth and display.

[7] Dr. Daniel Bullen was acting in his own individual capacity and not in his role at the U.S. Defense Nuclear Facilities Safety Board. His views are his own.

[8] https://www.nwtrb.gov/docs/default-source/meetings/2023/august/comments-submitted-online-by-virtual-attendees-during-the-workshop---aug-29-2023.pdf?sfvrsn=2 (last visited August 7, 2024)

Summaries: Presentations and Discussions

This section provides summaries of the workshop presentations, panel discussions, and subsequent questions and answers. The summaries are informed by a review of the workshop transcript[9] and archived webcast.[10]

Nathan Siu, Board Chair

Dr. Siu made opening remarks for the Board, stating that the purpose of the workshop was to learn more about DOE's consent-based siting efforts and about other siting efforts, domestic and international. He stated that the Board was also interested in how DOE plans to incorporate lessons learned from other countries' siting efforts into its consent-based siting activities.

Bret Leslie, Board Staff

Dr. Leslie provided context for the Board's review of DOE's efforts on consent-based siting and the Board's perspective on siting. He stated that DOE is using a consent-based siting process that, in later stages of the process, is meant to identify one or more federal consolidated interim storage facilities for SNF, consistent with congressional directions and funding. He presented Figure 1, taken from the Board's Report, *Six Overarching Recommendations for How to Move the Nation's Nuclear Waste Management Program Forward* (NWTRB, 2021), which illustrates an approach to achieving mutual acceptance of a repository site by addressing both the technical and social aspects of siting in an iterative manner until a site is selected. He noted that while other countries have different waste management approaches, the Board often hears from other countries' experts on current lessons learned in their programs that could be transferable to the U.S. program. He stated that the Board found siting to be a socio-technical challenge. That is, each country is faced with having to address both social acceptability and technical suitability while working to find a site.

Natalia Saraeva, DOE, Office of Nuclear Energy (DOE-NE)

Ms. Saraeva, Office of Integrated Waste Management, introduced DOE's consent-based siting approach to siting one or more federal interim storage facilities.[11] The effort, initiated in 2021, builds on earlier DOE consent-based siting work that ended in 2017. Ms. Saraeva stated that the current effort is in its early stages (Stage 1), the planning and capacity-building stage.[12] DOE is not looking for site volunteers at this time. She also noted that DOE has released a revised consent-based siting process document.[13]

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[9] https://www.nwtrb.gov/docs/default-source/meetings/2023/august/usnwtrb-aug-29.pdf?sfvrsn=4 (last visited August 7, 2024)

[10] https://preconvirtual.com/nwtrb-gov-08-29-2023-dayone/ (last visited August 7, 2024)

[11] Ms. Saraeva is no longer serving in her role as Consent-Based Siting Team Lead at DOE.

[12] During this stage of the process, DOE is building relationships, engaging in mutual learning, and developing a common understanding of waste management-related topics. For more information, please see https://www.energy.gov/ne/articles/infographic-consent-based-siting-roadmap (last visited August 7, 2024).

[13] This document, released by DOE in April 2023 and available at https://www.energy.gov/sites/default/files/2023-05/Consent-Based%20Siting%20Process%20Report-0424%203.pdf (last visited August 7, 2024), was discussed in more detail during the Board's August 2023 public meeting the following day. For more information, please see the archived webcast and meeting materials, available here: https://www.nwtrb.gov/meetings/past-meetings/summer-2023-board-meeting---august-30-2023 (last visited August 7, 2024).

Siting of a Geologic Repository in Canada
Lisa Frizzell, Nuclear Waste Management Organization (NWMO), Canada

Ms. Frizzell described siting of a geologic repository in Canada. Canada has been discussing and studying the need for long-term management of nuclear waste for decades. She started by emphasizing the importance of these projects globally.

> ". . . These projects are important not only to each of our countries, but in the global context. . . . The success of one nuclear waste project is a success for all . . ."

There were some early setbacks, but Canada is now making significant progress based on lessons learned from these setbacks. She described how Canada's program was progressing in the 1980s and leading the world for developing a concept for deep geological disposal. Then, in the 1990s, the Canadian government formed an independent Environmental Assessment Commission called the Seaborn Panel to assess the concept for deep geological disposal, which a private company called Atomic Energy of Canada, Limited, had fully developed. The panel found the safety of deep geological disposal had been adequately demonstrated from a technical perspective but had not been demonstrated from a social perspective. Because the concept had not been demonstrated to have broad public support, it did not move forward, setting Canada's program back by decades.

Ms. Frizzell noted that Canada applied the lessons learned from the earlier siting effort and reset the national program. The government passed the Nuclear Fuel Waste Act of 2002, which required owners and stewards of used nuclear fuel to establish NWMO as the organization responsible (the "implementer") for siting and constructing a deep geologic repository for the fuel. From the onset, NWMO's activities have relied heavily on public engagement and public input, and its efforts have resulted in a continuing dialogue with communities over the years to determine values and priorities for Canada, and much common ground was identified to form the basis of Canada's plan. Canada's government in 2007 adopted an adaptive phased management approach to ensure an inclusive, open, transparent, and fair process. For example, Canadians and Indigenous peoples have made clear that

- there is a need for a long-term plan for the SNF;
- the country should assume this responsibility *now*, because it is not acceptable to leave the burden of the waste they created to future generations;
- safety and security are paramount and should align with international best practices;
- the technical plan should be flexible and adaptive to change; and
- the repository should be built in an area with informed and willing hosts.

Other factors that have led to progress in Canada's program are the government's commitment to respecting the rights of Indigenous peoples and implementing the "Learn More Approach" during the siting process in which communities and Indigenous peoples are not committing to anything other than agreeing to learn more about the project until siting decisions are ready to be made by a potential host community and the Indigenous peoples.

Siting of a Geologic Repository in Sweden
Saida Engström, Sweden

Ms. Engström discussed the Swedish geological repository siting effort, which uses a stepwise, adaptive, and iterative approach. She described some of the historical context of Sweden's nuclear program, noting that its national policy has fluctuated between supporting more or less nuclear power over the decades, and how the Swedish Nuclear Fuel and Waste Management Company (SKB) was formed in the 1970s.[14] SKB submits a report every three years to the government about how the program is advancing (or else nuclear power plant owners could face shutdown of their reactor), which has always helped tie the producers of waste directly to their responsibility to manage the waste. Early in the process in the 1970s, there was little community support for siting a repository, even in the communities that already hosted nuclear reactors. In other communities, there was silence or low public engagement.

One lesson learned from the Swedish experience and also observed in other countries' programs was the importance of *how* the dialogue with the public commenced. Ms. Engström noted that key elements of success in Sweden's repository siting efforts included the following attributes:

- the project was explained in an understandable way to the public;
- financing was key from the beginning and began in the 1980s with deposits to a waste fund;
- the nuclear waste management structure was clearly organized with clearly defined roles among different actors; and
- there was "openness" about the challenges and advantages of the project in the dialogue with stakeholders.

Ms. Engström described Sweden's siting process which is a consent-based process in which safety is paramount, and the communities would still have the power of veto (ability to remove themselves from the process at any time). She mentioned the timing and how it took 20 years of hard work to create and maintain relationships with municipalities. She provided details and examples of the types of public interactions, which included one-on-one visits to schools to speak with students and even door-to-door visits to homes in communities. Ms. Engström emphasized several times that, in Sweden, it was important for communities to be able to see continuity within the program.

> "People trust people. . . . You have to have a set of individuals that everybody knows in these communities because they keep coming . . . the same faces . . . and also they want continuity from the upper management."

She recommended that the face of the program (or "main actor," in her words) should be one or more of the scientists and technical people actually working in the program rather than using a communicator.

[14] The Svensk Kärnbränslehantering AB [Swedish Nuclear Fuel and Waste Management Company] (SKB) is owned and formed by nuclear power companies in Sweden. SKB has a statutory duty to conduct activities that deal with disposal of Swedish nuclear waste and to pay for those operations. For more information on SKB and its mission, please visit: https://skb.com/ (last visited August 7, 2024).

Siting of a Geologic Repository in Switzerland
Piet Zuidema, Zuidema Consult GmbH, Switzerland

Dr. Zuidema presented highlights from the Swiss geological repository siting efforts, based on his many years of experience as the former Director for Science and Technology at Nagra[15] (Dr. Zuidema has retired from that position.), where he was involved in the first two stages of site selection in Switzerland.[16] He explained that the Swiss government adopted a stepwise approach and started working with Nagra in 1978 on preliminary disposal feasibility studies at a demonstration site. This initial work revealed that geologic disposal would be safe and feasible but also that siting in Switzerland was limited due to its geology. When he reflected on early setbacks, he mentioned that there was a lack of ownership or control of the process by the participants/applicants and that communication of the plan was unilateral with no real community feedback. In 1993, Nagra had proposed Wellenberg (Canton Nidwalden) as a site for a low- and intermediate-level waste repository. In 1995, the Wellenberg project was rejected by 52% of voters in a canton referendum, which resulted in abandoning plans for the site.[17]

Dr. Zuidema emphasized the importance of gaining credibility with the public. He noted and agreed with previous speakers that the public needs to be informed of what is and what is not possible. Underground research laboratories were of crucial importance to develop the scientific basis of the technical plans in Switzerland but also to convince the public of their efficacy. Switzerland operates two underground research laboratories, the Mont Terri Rock Laboratory and the Grimsel Test Site.

Rather than merely seeking consultation with stakeholders, the concept for the siting process was developed together with stakeholders in face-to-face meetings. Dr. Zuidema emphasized that the "key actors" in government and Nagra had clear roles.[18] He noted a few times that it was very important to have convincing geological arguments (because the public often asked, "Why here and not there?"). He also noted that it was important that interaction with the public was at an equal level, including listening, such that the public becomes familiar with the organization and is able to contribute to the project and have a sense of ownership in the process.[19]

Dr. Zuidema felt that completing consent-based siting in less than 10 years or even 20 years was very ambitious from his experience and his observation of others, and he referred to the hardship it would cause communities in trying to rush the process.[20] In his concluding remarks, Dr.

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[15] Nagra, also known as Nationale Genossenschaft für die Lagerung radioaktiver Abfälle (National Cooperative for the Disposal of Radioactive Waste), is the Swiss radioactive waste disposal implementer. Currently, Nagra reports to the Swiss government on its progress about every 3 to 5 years. For more information on Nagra and its mission, please visit: https://nagra.ch/en/why-nagra/ (last visited August 7, 2024).

[16] Dr. Zuidema also prepared a consultant report for the Board, which is available for download on the Board's website: https://www.nwtrb.gov/docs/default-source/meetings/2023/august/zuidema_report.pdf?sfvrsn=4 (last visited August 7, 2024).

[17] For more information on Nagra's history, please visit: https://nagra.ch/en/key-dates-in-nagras-history/ (last visited August 7, 2024).

[18] In his report (p. 2), Dr. Zuidema elaborates on this point. He observed that the U.S. consent-based siting process has an insufficient separation of roles and responsibilities for the implementer, DOE, but he also noted a lack of a neutral entity that could keep the process on track. For instance, DOE has significant roles in designing the consent-based siting process but also implementing it, while states appeared not to have a formal role. The report is available for download on the Board's website: https://www.nwtrb.gov/docs/default-source/meetings/2023/august/zuidema_report.pdf?sfvrsn=4 (last visited August 7, 2024).

[19] In Switzerland, the government has a role as the siting "process owner," Nagra is the implementer, and the Swiss cantons are analogous to states in the U.S.

[20] Switzerland's process commenced in the 1980s, and the site license is expected in 2030. Thus, the process for Switzerland is about 50 years.

Zuidema mentioned the need for having a well-defined process before the start of site selection and having clarity in the overall waste management program with respect to:

- roles and responsibilities to reach sustainable decisions at the highest level;
- phases and milestones with adequate objectives (stepwise refinement of options); and
- suitable criteria to develop and evaluate the options with "first priority to safety."

Dr. Zuidema's final summary slide highlights that there needs to be a "national commitment to progress with disposal of radioactive waste," and his report goes into further details about suggestions on how to address some of the challenges.[21] Furthermore, there needs to be "clarity in a stepwise process," which is defined before the start of site selection and includes a clear definition of the "phases and milestones" of the overall program. According to Dr. Zuidema, the overall waste management program needs to be explained to the public with more convincing arguments (i.e., why new consolidated interim storage facilities are needed, and that waste will eventually be disposed of in a repository with transportation from a current site to a possible consolidated interim storage facility and eventually to a disposal site). In this way, the overall intent and direction of the national nuclear waste management program will be clear to all stakeholders.

United States Past Siting Experience, Focused on Monitored Retrievable Storage and the Nuclear Waste Negotiator
Daniel Bullen, Technical Staff Member at DNFSB

Dr. Bullen described some of the early siting processes in the United States and public participation in the siting process for Yucca Mountain, Waste Isolation Pilot Plant (WIPP), monitored retrievable storage (MRS) sites,[22] and lessons learned. He also discussed his experience with the Office of the Nuclear Waste Negotiator[23] in the early 1990s and lessons learned. The U.S. siting experience dates back to the 1950s with the first proposed repository site in Lyons, Kansas, which had to be abandoned because of strong local opposition and partly due to poorly characterized geology and unmapped oil wells. In each of his U.S. examples of siting efforts, Dr. Bullen noted that there was "essentially zero participation" by the public in the early process, and it was no exception for Yucca Mountain. Dr. Bullen stated that the Yucca Mountain effort was a typical example of the U.S. government's "Decide, Announce, Defend" approach in the siting process. For the WIPP siting, there were eight public hearings around the country, only

[21] In his report (p. 4), Dr. Zuidema observed that the assumed motivation by the public in the U.S. site selection process seems to focus on the benefits to the community overweighing the drawbacks without much mention of the important role a hosting community plays in contributing to solving an issue of national importance. The report is available for download on the Board's website: https://www.nwtrb.gov/docs/default-source/meetings/2023/august/zuidema_report.pdf?sfvrsn=4 (last visited August 7, 2024). In his presentation, Dr. Zuidema noted that disposal projects are for society as a whole to consider, which makes them different from other industry projects.

[22] As defined in 10 CFR Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater Than Class C Waste," Monitored Retrievable Storage Installation, or MRS, means a complex designed, constructed, and operated by DOE for the receipt, transfer, handling, packaging, possession, safeguarding, and storage of spent nuclear fuel aged for at least one year, solidified high-level radioactive waste resulting from civilian nuclear activities, and solid reactor-related GTCC [greater than class C] waste, pending shipment to a HLW repository or other disposal.

[23] Under the 1987 amendments to the Nuclear Waste Policy Act, states could receive up to $20M per year for hosting a repository and up to $10M per year for hosting a MRS facility, which is a federal interim storage facility for SNF. The amendments also created the Office of the United States Nuclear Waste Negotiator to reach agreements with states or "Indian Tribes" to host nuclear waste facilities under any "reasonable and appropriate terms." By 1995, the federal government's efforts to site a MRS facility through the Office of the Nuclear Waste Negotiator were abandoned.

one of which was in New Mexico.

Dr. Bullen discussed several past efforts to develop an MRS site for SNF (e.g., the Mescalero Apache Tribe effort in New Mexico). Key lessons learned were that

- siting and development processes take decades;
- political support and stability are needed;
- actions in governance created challenges and forced changes, but federal legislation has also stopped programs (see, e.g., MRS and Yucca Mountain projects); and
- ". . . states have to have a larger role in determining whether a facility can be sited and operated."

Dr. Bullen felt that there is a history of mistrust throughout the nuclear program in the United States. In the question-and-answer period following his presentation, he stated that an independent agency or organization, not unlike SKB in Sweden which has a steady and predictable funding source, and also in line with the BRC's recommendations in its 2012 report, was probably needed. Such an independent entity, with responsibility for implementing a nuclear waste disposal program, would communicate with federal, state, and local governments, etc., and would address the relevant technical and social aspects of siting nuclear waste facilities. Dr. Bullen also agreed with the international speakers that direct (i.e., face-to-face) communication was needed in siting processes. He suggested that credibility and public trust could be enhanced by enlisting the services of university professors as communicators because of their presence and influence in their communities.

> ". . . You're there to basically provide the technical bases for what you're doing. . . . Those kinds of people who are in your community, who are there, can actually answer the questions that have been raised and follow along the concerns that might be raised."

Facilitated Panel Discussion
Facilitator: Dr. Bret Leslie (Board staff)
Panelists: Ms. Saida Engström (Sweden), Dr. Piet Zuidema (Zuidema Consult GmbH, Switzerland), Dr. Daniel Bullen (Technical Staff Member at DNFSB, United States)

Each of the panelists first discussed their main takeaways and impressions from the morning workshop presentations. From her experience, Ms. Engström felt that many lessons learned are transferable from program to program despite the fact that each country is different. She stated that rather than "reinvent the wheel, just steer with pride" as she felt that small or local communities react in similar ways to siting efforts in each country. She noted that the forms of government in countries like Switzerland and U.S. (which include cantons or states, respectively) add complexities to those countries' programs, unlike Sweden where there are only the national level and communal levels of government. Dr. Zuidema highlighted Canada's experience and progress, noting the importance of forming a consensus in society to do something now rather than leaving the waste for their children. He felt that for a waste disposal program to be successful, there needed to be national recognition (high up in government) of this point. Then, he suggested that DOE work with Congress to move more urgently on the nuclear waste issue. He also agreed with the notion that there should be clear roles and responsibilities defined for all of the "actors" and not to put those roles into one organization. Dr. Bullen also agreed that there needs to be a "political will" in the U.S. to do something about the nuclear waste.

Figure 3
A facilitated panel discussion allowed participants to candidly share their viewpoints, insights, and lessons learned.

Ms. Engström commented on how Sweden's underground research laboratory, which is built in the same way the final repository will be built, became a popular attraction for the public. On the tour, the public can see what the repository will look like and how it will be constructed.

> ". . . [The underground research laboratory] became so popular that we had actually to hire extra staff just to manage these kinds of trips." –Saida Engström

She also commented on the issue of compensation for host communities and explained that it was very important for the success of the Swedish process that compensation was not discussed early in the process. Two facilities will be built in Sweden: an encapsulation facility, where SNF is packaged for disposal, and the final repository. After building relationships with communities for over 25 years, compensation was not discussed by SKB until the last year before the site selection was announced. At the end, two communities in Sweden, both with vested interests in the disposal program, were competing to host the repository, and both recognized the benefits of job growth, the influx of engineers and new people for their small communities, and that the communities would be "shouldering responsibility for a national challenge locally."

> "The prize was getting the final repository, and compare that to 25 years earlier when we were persona non grata and nobody would even talk to us, . . . but now they're competing to have it." –Saida Engström

It was decided between the two mayors that the community hosting the repository would get 25% of the compensation and the one that did not would get 75% of the compensation along with the encapsulation facility. Panelists concurred on a final point that face-to-face engagement was a key success factor.

Incorporating International and Domestic Siting Best Practices and Lessons Learned
Natalia Saraeva, Consent-Based Siting Team Lead (DOE-NE)[24]
Angelica Gheen, Physical Scientist, DOE-NE

Ms. Gheen,[25] in her first presentation at the workshop, described how DOE will be incorporating international siting best practices and lessons learned in its consent-based approach to siting one or more federal interim storage facilities. Her second presentation described how DOE will be

[24] Ms. Saraeva provided introductory remarks.

[25] Ms. Gheen is no longer serving in her role as Physical Scientist at DOE.

incorporating domestic best practices and lessons learned. Ms. Gheen explained that DOE is leveraging the experiences of international colleagues by creating easy-to-navigate resources for use by DOE staff and developing in-depth case studies of international experiences. For fiscal year 2023, the case study reports include Canada, the UK, Switzerland, Finland, and Germany. The reports provide an analysis of the countries' waste programs, and insights into the historical and sociopolitical environments of these countries along with basic technical information. The information will be collected from direct sources like interviews[26] and secondary sources like NWTRB and BRC reports.

> "We also acknowledge that international efforts are mainly focused on disposal facilities at the moment, whereas our current focus is on a federal consolidated interim storage facility. Nevertheless, given that the siting of waste management facilities in general has proven to be less of a technical and more of a sociopolitical challenge, these international experiences are still going to provide really valuable insights to us."

DOE is also developing "fact sheets" that provide one-page primers on a country's SNF management activities and program status. In addition, in 2023, DOE signed two bilateral instruments for cooperation in the areas of nuclear technology development and nuclear waste management, including a memorandum of understanding with VTT Technical Research Centre of Finland, Ltd.,[27] and a Statement of Intent with NWMO, the Canadian waste program implementer. The agreements are intended to help maximize mutual learning between the signatory organizations.

> ". . . This [Statement of Intent] concerns cooperation on spent nuclear fuel and waste management specifically, so it's very focused on our offices, and we're really excited about it. The [Statement of Intent] will support mutual learning, information exchange on consent-based siting processes, science and technology programs, engagement activities, and joint technical studies."

In the question-and-answer period, Board members asked about DOE's plan to provide the case study reports to the public. In response, DOE indicated that it currently plans to use the resources internally.

In her second presentation, Ms. Gheen described DOE efforts to apply lessons learned from siting of domestic facilities and to adopt best practices (BRC report, WIPP lessons learned, etc.) to inform its consent-based siting process. DOE took a broad look at exemplars outside of the nuclear sector, including biological, solar, petrochemical, mining, and wind sectors. The number of exemplar sites was narrowed down by scope of the project and size of the public response to that project.

> "The objective is to collect information from a variety of sectors, not just the nuclear sector, and consolidate that knowledge."

Ms. Gheen stated one primary lesson learned was that siting a waste facility is a highly politicized issue, and changing political climates can impact the success or failure of any initiative. She also noted that current opposition, particularly at the state level, to hosting an

[26] Interviews of people who were doing the siting and the members of the communities who were involved at the sites themselves.

[27] VTT is the VTT Technical Research Centre of Finland, Ltd., and its stated mission is, in part, to advance the utilization and commercialization of research and technology in commerce and society. VTT supports the development of the ONKALO SNF repository in Finland. For more information, please see: https://www.vttresearch.com/en (last visited August 7, 2024).

SNF interim storage facility seems to stem from a lack of trust in the federal government. She observed that "bottom-up" approaches are critical for gaining community support. As demonstrated by the experience of the Nuclear Waste Negotiator, another key lesson learned is that careful and thoughtful engagement with stakeholder groups and across all sectors of government, academia, and industry are essential for a program's success.

> "A consent-based siting program should be adaptive . . . to changes in policy, politics, culture, society, and funding, because it's impossible to predict what will happen decades into the future."

> "Developing a balanced siting process that is locally driven while also gaining support from state-level leaders is critical."

> "Giving communities resources and flexibility to conduct their own research that they deem necessary according to their own needs and their own concerns will lead to better decision-making outcomes for potential host communities."

In the question-and-answer period, Board members asked about the applicability of DOE's non-nuclear exemplars to the nuclear industry and whether the key lessons learned are transferable. At the time of the workshop, DOE stated it will focus on nuclear exemplars in the next fiscal year.

Using Best Practices and Lessons Learned in Environmental Justice
Marissa Bell, Social Scientist, DOE-NE

Dr. Bell described how DOE is using best practices and lessons learned in environmental justice, which is a key consideration in developing a large federal program or project. Environmental justice is integral to a socio-technical challenge. DOE uses the U.S. Environmental Protection Agency (EPA) definition of environmental justice, which is "the just treatment and meaningful involvement of all people, regardless of race, color, national origin, Tribal affiliation, or disability" with respect to development, implementation, and enforcement of environmental laws, regulations, and policies.[28] The three facets of environmental justice Dr. Bell touched on are distributive justice, procedural justice, and recognition justice. Dr. Bell added that intergenerational justice, which is not mentioned in the EPA definition, is important for consent-based siting, because siting is a multigenerational effort that involves looking at historical events and also planning for future events.

> ". . . Intergenerational justice is incredibly important for consent-based siting, . . . not just delving into what has happened in the past, but also the well-being of future generations."

Dr. Bell explained that distributive justice (i.e., the benefits and drawbacks or risks from a project) is tied to the notion of fair treatment, and procedural justice (i.e., equitable access of stakeholders and entities to processes of decision-making) is tied to the notion of meaningful involvement. Recognition justice refers to the recognition of all people, including their histories, perspectives, ways they were marginalized in the past, etc. DOE received 225 responses to its RFI on consent-based siting issued in 2021, and Dr. Bell added that listening was a key aspect of carrying out procedural justice in the RFI process. She stated:

[28] For more information on the definition of environmental justice from the EPA, please visit: https://www.epa.gov/environmentaljustice (last visited August 7, 2024).

> ". . . A Request for Information . . . has been DOE's first step towards procedural justice in terms of getting feedback and input into our consent-based siting process."

In the question-and-answer period, the Board asked how DOE would ensure that its consent-based siting process is informed by environmental justice principles and whether there were metrics or success factors for how effectively it has addressed environmental justice concerns. DOE acknowledged that these are some of the challenges ahead.

Closing Facilitated Panel Discussion on All Workshop Topics
Facilitator: Dr. Bret Leslie (Board staff)
Panelists: Ms. Saida Engström (Sweden), Dr. Piet Zuidema (Zuidema Consult GmbH, Switzerland), Dr. Daniel Bullen (Technical Staff Member at DNFSB, USA), Ms. Natalia Saraeva (DOE-NE), Dr. Marisa Bell (DOE-NE), Mr. Juan Uribe (Senior Program Manager, DOE-NE)

The panel discussion started with reactions to the DOE speaker presentations. With respect to intergenerational justice, Dr. Bullen asked whether DOE had looked at the impact on communities after the closing of nuclear power plants. Such an assessment could provide examples and data regarding the benefits (that have been lost) from hosting a facility, including jobs and tax revenues, which had been funding schools, hospitals, roadways, fire departments, etc.

Ms. Engström emphasized that continuity in the implementing organization (including continuity of personnel) was key for the success of the siting process in Sweden. However, she wondered, "Who's sitting in the driving seat?" in reference to DOE's consent-based siting process.

> "Continuity is key. All these communities want to know who's in charge, and it's not a corporation, and it's not an organization." –Saida Engström

Dr. Zuidema felt that the non-nuclear exemplars identified by DOE were not directly applicable to DOE's program, because the exemplar projects do not have to meet the specific requirements of the Nuclear Waste Policy Act that a nuclear waste storage or disposal facility will have to meet. He and Ms. Engström also felt that DOE was trying to move the consent-based siting process too quickly.

Following these comments, DOE representatives Mr. Uribe, Dr. Bell, and Ms. Saraeva asked the non-DOE panelists questions. Mr. Uribe, with the potential needs of the consent-based siting consortia in mind, asked the panelists what resources proved to be key in the beginning of the siting process and later in the process. Ms. Engström noted that a key factor was having a person who was recognizable by the communities and actually building relationships in the communities. Dr. Zuidema noted it was important for the implementer not to have too many roles:

> ". . . One of the most important things is that there was a neutral process . . . that it was very clear each organization has one clear role, not several roles for the same person." –Piet Zuidema

Dr. Bell asked about how to have continuity within a program, given the difficult U.S. political climate. The panelists acknowledged there were some challenges outside of DOE's control. The importance of having the right person in charge was key in Sweden's and Switzerland's programs, but also the importance of their nuclear waste disposal project as a whole was recognized at a national level. Ms. Saraeva asked the panelists about the factors that might

have led to negative perceptions about a project being changed over time in the community. In Sweden, for example, emphasizing the importance of a national challenge being solved locally was a good start, according to Ms. Engström.

In the question-and-answer period, the Board asked DOE what could be done about the low public trust in government (compared to other countries like Switzerland, Finland, and Sweden, etc.) and what ways DOE can help improve the public perception of nuclear energy, including the waste management aspects. The Board also asked whether DOE could leverage a growing recognition and concern for climate change to positively impact their activities toward interim storage. DOE, through its national labs, has a project that relates to collecting data on public perception, including perspectives from youth and intergenerational justice councils as seen in other countries.

The workshop concluded with a 15-minute public comment period for members of the public who were attending in person.

Workshop Insights and Takeaways

The authors' analyses of the workshop presentations and discussions shows that despite important differences between countries and organizations, there are many points of commonality and lessons learned (including failures and success factors) that may be transferable from countries that have well-developed programs for SNF and HLW disposal to those that are not as far along. Some of these lessons are scientific and technical. Others are sociopolitical. Still others are a blend.

In order that these proceedings provide a complete record of discussions and outcomes potentially useful to anyone—policymakers, industry, researchers, communities—interested in the topic of nuclear waste storage and disposal, we have made no attempt to explicitly filter the workshop lessons. Rather, we have organized these lessons into four general success factors:

- gaining public trust through public engagement and communication,
- mutual learning and listening,
- being prepared for a long process, and
- having a well-defined process that is both technically and socially acceptable.

Specific examples of each success factor are provided below.

Gaining public trust through public engagement and communication

> "We are a nuclear waste management business, but actually, we are in the trust business."
> –Saida Engström

Some of the most important success factors and lessons learned from the experiences of other countries' siting programs and processes are public trust in the key actor(s)/implementer, public trust in the safety of the technology, and social acceptability of a siting process. Early setbacks in a country's program due to a lack of public support was a fairly common theme throughout the workshop, but in the three international cases discussed at the workshop, public engagement activities that were aimed at building (or even rebuilding) trust supported program advances.

These engagement activities were extensive and required significant resources. For example, Sweden's program hired experts to train their scientists to be excellent communicators, to become more credible to a community, and to be known by that community as trustworthy people associated with the organization. Swedish scientists developed and maintained a dialogue with communities for decades. In Switzerland, scientists went door-to-door in potentially affected communities during seismic surveys. This involved face-to-face interactions with at least 10,000 landowners. Public tours were provided of various laboratories and central interim storage facilities in Switzerland, and courses were offered to the public.

> ". . . The most important [factor] is to define the responsibilities and rights of the waste producers and explain the role allocated to each stakeholder." –Saida Engström

In Canada, NWMO supports several initiatives to ensure its work is informed by public input, centering around creating a community dialogue with Canadians and Indigenous peoples. The community dialogue was used to determine the values and priorities important to Canadians and how Canada manages its SNF. Early in its siting process, NWMO actively engaged with communities to support learning activities and information events, where the general public could ask NWMO questions and share their thoughts about NWMO's work. These activities have helped the general public make more informed decisions about NWMO's project.

The workshop participants recognized that there are continuing challenges for DOE in building public trust, and there are some approaches and activities that might help. For example, the discussion touched on ways that DOE might better engage with the public after hearing the presentations from other countries, such as maintaining continuity in the waste management program, having a well-defined process, having metrics for measuring public engagement, and other points that are elaborated further below.

Mutual learning and listening

> "All of the stakeholders had to learn that it's not only talking, it's also to listen, if you interact with the public." –Piet Zuidema

Mutual learning and listening amongst the implementer, public, and stakeholders relate to important environmental justice concepts in the consent-based siting process. Listening is a key activity for procedural justice and meaningful involvement in a process. Mutual learning ensures that participants are well-informed and aligned in their decision-making.

From the experiences of the Canadian and Swedish programs, it was important for the implementer to clarify how the environmental justice concepts were being used during the process and how they would be put into practice. In those programs, there was a special emphasis on engaging with the public early to incorporate the public's expectations and to capture community values.

For example, in Canada, NWMO spent three years working with the public to define what an open, fair, and transparent process looks like. According to NWMO's "Learn More Approach," the communities were only asked to agree to learn more about the project, and resources were provided to the communities to explore their interest in siting a repository.

> ". . . Consent-based siting really means it's up to the communities themselves to decide the best way to define their willingness to host the repository, to decide whether they're ultimately willing to host it, and if so, how they'll express that willingness." –Lisa Frizzell

DOE has generated internal case study reports on lessons learned and best practices in other countries, including direct interviews of those involved in the siting process. DOE signed contracts in 2023 to collaborate with NWMO via a Statement of Intent and with Finland via a

Memorandum of Understanding. The panelists emphasized the importance of making reports and case studies available to the public and to think about the utility of the information to different audiences when designing new studies to allow those audiences to have access to the same information. The effectiveness of different forms of engagement and how DOE would measure its own program effectiveness (i.e., assessing whether, and how well, consent-based siting consortia are addressing environmental justice issues) are remaining challenges.

Being prepared for a long process

> ". . . This is a journey of 40 years . . ." –Saida Engström

For successful programs in other countries, the siting process was a long process that took decades. The duration includes time for early preparations and delays associated with setbacks. DOE's consent-based siting process plan has allotted 2 to 3 years for the first phase, which is the planning and capacity-building phase. Compared to the experiences of the Canadian, Swiss, and Swedish programs, which have been doing the work for decades, the workshop participants observed that the time allotted for community and state involvement in the DOE consent-based siting process is too short.

> ". . . Consent-based siting in less than 10, 20 years is very, very, very ambitious." –Piet Zuidema

In addition, the workshop participants recognized that factors outside the Department's control, such as the lack of streamlined funding from Congress, could cause further delays and uncertainties for planning detailed activities. The repository siting process took 40 years of research, development, and demonstration in Sweden. This helped ensure a scientific and engineering approach that is stepwise, adaptive, and iterative, but also created continuity in their program that was key to its success. The initial lack of social acceptability set Canada's program back by decades, but these early setbacks eventually helped form and guide NWMO, which has committed to shape its repository siting program around public input to have both social and technical acceptability, work toward reconciliation with Indigenous nations, and activities that support new nuclear reactors (e.g., small modular reactors, advanced reactors, etc.).

Having a well-defined process that is both technically and socially acceptable

> "And to move forward, the project we're working on has to be acceptable, not only from a technical perspective, but from a social perspective as well." –Lisa Frizzell

Finally, a key success factor raised by all of the workshop participants is the concept of having a well-defined process that is simultaneously technically and socially acceptable for siting of radioactive waste facilities. The process must be well-defined, and it must clearly identify the roles and responsibilities of key participants in the process. Although many lessons learned regarding the siting process come from other countries, where socio-political environments are different from those in the U.S., the participants representing those countries believe the lessons

can be applied in the U.S. Some participants also noted that states and local officials need to have a more formal role in the siting process.

The failure of Canada's first attempt to site a repository was caused by a lack of public consultation. The lessons from this setback eventually helped form and shape Canada's NWMO, which is implementing adaptive phased management in its siting program. This approach centers around public input to achieve both social and technical acceptability. Noting keys to success in the Swedish program, Saida Engström emphasized the many years of work spent building relationships in the potential host communities and a commitment by the implementer to maintaining openness about the siting process.

Workshop participants from the Swedish and Swiss programs also noted the importance of having a well-defined process with key actors who have clear roles in the process. For example, in Switzerland, the government has a role as the siting process owner, Nagra is the implementer, and the Swiss cantons (analogous to American states) have been assigned key roles, like implementing expert review panels, during the siting process.

> ". . . The most important [factor] is to define the responsibilities and rights of the waste producers and explain the role allocated to each stakeholder." –Saida Engström

The participants emphasized the importance of explaining the overall waste management program to the public as a part of gaining broad social acceptability. For example, if a consolidated interim storage facility is to be used, there should be convincing arguments for why interim storage is needed, an explanation of how waste will eventually be transported from the storage facility to a repository for disposal, and a credible time frame for implementation. Similar points were highlighted by the workshop participants:

> "You have to be able to explain your project in [an] understandable way to the [public]. . . . You will be meeting an extremely nonhomogeneous crowd." –Saida Engström
>
> ". . . It was recognized that [a repository] also is an issue of national importance and broad public support is essential, and this requires a specific site selection process." –Piet Zuidema

DOE now supports an iterative, adaptive, and phased approach to gaining public acceptance of a federal interim storage facility and, in this approach, has applied lessons from the Canadian experience. DOE is using, in part, the consent-based siting consortia to assist with these plans. The workshop participants observed that DOE recognizes the need for clear roles in its process and also for developing metrics for tracking the success of its consent-based siting activities, including measuring public engagement, but these remain continuing challenges for DOE. A key element missing from the U.S. program is a national commitment, with reliable funding, to develop a final repository for nuclear waste.

Conclusions

After a full day of presentations, panel discussions, question-and-answer periods, and public comments, workshop participants gained a detailed update on best practices and lessons learned from siting of international (Canada, Switzerland, Sweden) and domestic radioactive waste facilities. The workshop discussions focused on the processes for developing consent during the siting of a new facility, and the participants discussed the various lessons learned (including failures and success factors) that led to developing consent for a long-term project. The panel discussion highlighted some success factors and lessons learned for the implementer, which include:

- gaining public trust through public engagement and communication,
- mutual learning and listening,
- being prepared for a long process, and
- having a well-defined process that is both technically and socially acceptable.

In closing, the Board appreciates the contributions of all presenters and participants. Based on the interest and information-sharing at this workshop, the Board looks forward to monitoring future developments in the area of consent-based siting for international siting programs and reviewing such programs in the United States.

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Appendix A: Agenda

UNITED STATES
NUCLEAR WASTE TECHNICAL REVIEW BOARD
2300 Clarendon Boulevard, Suite 1300
Arlington, VA 22201
703-235-4473

AGENDA

International Workshop on Siting of Radioactive Waste Facilities

August 29, 2023

Snake River Event Center
780 Lindsay Blvd, Idaho Falls, ID 83402

https://preconvirtual.com/nwtrb-gov-08-29-2023/

Tuesday, August 29, 2023 (Pocatello Room)

8:00 a.m. MDT **Call to Order and Introductory Statement**
Nathan Siu (Board Chair)

8:15 a.m. MDT **Workshop Objectives and Board Perspectives on Siting of Radioactive Waste Facilities**
Bret Leslie (Board staff)

8:20 a.m. MDT **Introduction to U.S. Department of Energy's (DOE) Consent-Based Approach to Siting One or More Federal Consolidated Interim Storage Facilities**
Natalia Saraeva [DOE, Office of Nuclear Energy (DOE-NE)]

QUESTIONS TO BE ADDRESSED BY EACH INTERNATIONAL SPEAKER:

- What factors led to the initiation of the siting process and how did the federal government participate in defining the siting process?
- How was the siting process developed and implemented?
- How did the siting process include decisionmakers and address the decisions that needed to be made to achieve an operating radioactive waste facility?
- What were the key scientific and technical issues that needed to be addressed?
- What were the siting criteria and when were they developed in relation to the siting process?
- What were the unanticipated challenges, problems, and developments that had implications to the siting program?
- What were the key components of the siting program, lessons learned during the siting process and keys to success?

- What were the elements of the program that led to success and are they transferable?
  - How did you define and assess whether the siting process was successful (e.g., degree of consent, community sentiment, etc.)?
  - What elements are most crucial in the consent process?

8:25 a.m. MDT **Siting of a Geologic Repository in Canada**
Lisa Frizzell (Nuclear Waste Management Organization, Canada)

8:45 a.m. MDT *Questions, discussion*

9:00 a.m. MDT **Siting of a Geologic Repository in Sweden**
Saida Engström (Sweden)

9:30 a.m.MDT *Questions, discussion*

9:40 a.m. MDT **Break**

9:50 a.m. MDT **Siting of a Geologic Repository in Switzerland**
Piet Zuidema (Zuidema Consult GmbH, Switzerland)

10:20 a.m. MDT *Questions, discussion*

10:30 a.m. MDT **United States Past Siting Experience, Focused on Monitored Retrievable Storage and the Nuclear Waste Negotiator**
Daniel Bullen [Defense Nuclear Facilities Safety Board (DNFSB) staff, United States]

TOPICS/QUESTIONS TO BE ADDRESSED:
Monitored Retrievable Storage and Nuclear Waste Negotiator effort
- A summary of the siting process.
- How did the siting process include decisionmakers and address the decisions that needed to be made to achieve an operating radioactive waste facility?
- What were the unanticipated challenges, problems, and developments that had implications to the siting program?
- What were the key components of the siting program, lessons learned during the siting process and keys to success or failure?

Other past siting efforts for repositories and storage facilities
- Summarize their status and any key broad lessons learned.

11:00 a.m. MDT *Questions, discussion*

11:10 a.m. MDT **Facilitated Panel Discussion**
Panelists: *Piet Zuidema* (Zuidema Consult GmbH, Switzerland), *Saida Engström* (Sweden), and *Daniel Bullen* (DNFSB, United States)
Facilitator*: Bret Leslie* (Board staff)

11:55 a.m. MDT **Lunch Break (1 hour)**

12:55 p.m. MDT **Incorporating International Siting Best Practices and Lessons Learned**
Natalia Saraeva and *Angelica Gheen* (DOE-NE)

QUESTIONS TO BE ADDRESSED:
- How are you identifying international best practices and lessons learned (e.g., literature reviews, case studies, in-person interviews, etc.)?
- Which countries and types of facilities has DOE assessed and which does DOE plan to assess?
- What are the international siting best practices and lessons learned that you have identified and how are you determining their transferability to the United States (e.g., are the practices applicable for a situation where federal and state government and Tribal nations could be involved in decision-making)?
- Are the best practices and lessons learned solely focused on the siting process or do they also address the decision-making process that would be required to construct one or more federal interim storage facilities?

1:35 p.m. MDT *Questions, discussion*

1:55 p.m. MDT **Incorporating Domestic Best Practices and Lessons Learned**
Natalia Saraeva and *Angelica Gheen* (DOE-NE)

QUESTIONS TO BE ADDRESSED:
- How are you identifying domestic best practices and lessons learned (e.g., literature reviews, case studies, in-person interviews, etc.)?
- Which types of facilities has DOE assessed and which does DOE plan to assess?
- How is DOE addressing the different perceptions of risk for nuclear versus non-nuclear facilities in determining and implementing best practices and lessons learned?
- What are the best practices and lessons learned that you have identified?
- Are the best practices and lessons learned solely focused on the siting process or do they also address the decision-making process that would be required to construct one or more federal interim storage facilities?

2:30 p.m. MDT *Questions, discussion*

2:45 p.m. MDT **Break**

2:55 p.m. MDT **Using Best Practices and Lessons Learned in Environmental Justice**
Marissa Bell (DOE-NE)

QUESTIONS TO BE ADDRESSED:
- What is the definition of environmental justice that DOE is using?
- What are the best practices that DOE has identified that it plans to use?
- How are those best practices going to be integrated with existing tools and practices that DOE is using?
- What were the Tribal commenters' recommendations on the siting process?
- How is DOE implementing or planning to implement the Tribal recommendations on the siting process?
- How are DOE efforts addressing Tribal considerations?

3:30 p.m. MDT *Questions, discussion*

3:45 p.m. MDT **Closing Facilitated Panel Discussion on All Workshop Topics**
Panelists: *Piet Zuidema* (Zuidema Consult GmbH, Switzerland), *Saida Engström* (Sweden), *Daniel Bullen* (DNFSB), *Natalia Saraeva, Marissa Bell*, and *Juan Uribe* (DOE-NE)
Facilitator*: Bret Leslie* (Board staff)

4:45 p.m. MDT **Public Comments**

5:00 p.m. MDT **Adjourn Public Meeting and Begin Open House**

5:30 p.m. MDT **End of Open House**

Appendix B: Workshop Speakers

Speakers from the U.S. Department of Energy (DOE), Office of Nuclear Energy, Office of Integrated Waste Management

Marissa Bell, Social Scientist

Angelica Gheen, Physical Scientist

Natalia Saraeva, Consent-Based Siting Team Lead[29]

Juan Uribe, Consent-Based Siting Team Senior Program Manager

Speakers from the U.S. (non-DOE) and other countries

Daniel Bullen, Technical Staff Member at U.S. Defense Nuclear Facilities Safety Board[30]

Saida Engström, Sweden

Lisa Fizzell, Nuclear Waste Management Organization, Canada

Piet Zuidema, Zuidema Consult GmbH, Switzerland

Speaker from the U.S. Nuclear Waste Technical Review Board

Bret Leslie, Senior Professional Staff

[29] Ms. Saraeva is no longer serving in her role at DOE.

[30] Dr. Bullen was acting in his own individual capacity and not in his role at the U.S. Defense Nuclear Facilities Safety Board. His views are his own.

Marissa Bell, PhD

Dr. Marissa Bell is a Social Scientist in the Department of Energy's (DOE) Office of Integrated Waste Management. She supports the Consent-Based Siting team by leading environmental justice and social science work. Prior to joining DOE, Dr. Bell conducted research on community engagement, equity and inclusion, and procedural justice of nuclear waste siting in Canada, and on the political economy of consolidated interim storage facilities and spent fuel management in the U.S., among other topics. She also conducted a postdoctoral fellowship at Cornell University, where she led research projects on community engagement, science communication, and public understanding of science. Dr. Bell received her PhD in Geography from the State University of New York at Buffalo, during which time she also held a research fellowship at the Institute for International Science and Technology Policy at George Washington University.

Angelica Gheen

Angelica Gheen is a Physical Scientist in the Department of Energy's (DOE) Office of Integrated Waste Management, supporting the Consent-Based Siting team. Prior to her service at DOE, she was based at the National Institute for Occupational Safety and Health Radiation Dose Reconstruction Program, where she worked as a Health Physicist drafting individual energy employee dose reconstructions as well as site profiles and Technical Basis Documents. Angelica is a doctoral student in Public Health at Indiana University-Purdue University, Indianapolis. Her research interests include the relationships between public health, public health policy, and the nuclear energy industry. She received her master's degree in Radiation Health Physics from Oregon State University and a BS in Physics from Portland State University.

Natalia Saraeva

Natalia Saraeva is the Team Lead for Consent-Based Siting in the U.S. Department of Energy's (DOE) Office of Integrated Waste Management. Prior to working at DOE, she was an advisor with the Pacific Northwest National Laboratory (PNNL), was on detail to DOE's Office of Spent Fuel and Waste Disposition, and served as a senior advisor to the Deputy Assistant Secretary. Her over 15 years of experience includes working at National Labs (PNNL and Argonne) and supporting DOE-NE and National Nuclear Security Administration programs, serving as a staffer for the Blue Ribbon Commission on America's Nuclear Future, being a fellow with the U.S. Nuclear Industry Council, and more. She received her MS degree in Foreign Service from Georgetown University and holds a BS in Nuclear Engineering and an MS in Nuclear Security from Moscow Engineering Physics Institute. She resides in Silver Spring, Maryland, with her husband, son, and their cat.

Juan Uribe

Juan Uribe is a Senior Program Manager on the Consent-Based Siting team in the U.S. Department of Energy's (DOE) Office of Integrated Waste Management, where he has led work on the Department's funding opportunity for consent-based siting consortia and the revised Consent-Based Siting Process for Federal Consolidated Interim Storage of Spent Nuclear Fuel. Prior to joining DOE, Juan spent 14 years working at the U.S. Nuclear Regulatory Commission. He holds a BS in Civil Engineering from the University of Puerto Rico-Mayaguez and an MS in Mechanical Engineering from the University of Maryland.

Daniel B. Bullen, PhD, P.E.

Daniel B. Bullen is an experienced engineering executive, educator, researcher, consulting engineer, and expert witness with over 40 years of experience in engineering practice, leadership, research, and teaching. He is a licensed mechanical, metallurgical, and nuclear engineer with extensive expertise and experience in nuclear safety, nuclear engineering, mechanical engineering, metallurgical engineering, failure analysis, radiation detection and measurement, and engineered barrier system design and analysis for radioactive waste disposal. As a recognized international expert in nuclear engineering and radioactive waste management, Dr. Bullen has served as a consultant to the nuclear waste management programs in the countries of Japan, Sweden, Finland, and Canada. Dr. Bullen is a member of the technical staff of the U.S. Defense Nuclear Facilities Safety Board (Board) in Washington, DC, and currently serves as the Board's cognizant engineer for Lawrence Livermore National Laboratory and Sandia National Laboratories. From 2012 to 2015, he served as a member of the Senior Executive Service of the U.S. federal government as the Group Lead for Nuclear Programs & Analysis at the Board. Immediately prior to his Board service, Dr. Bullen was a Senior Managing Engineer at Exponent, a premier scientific and engineering consulting firm. He has previously held faculty positions in nuclear engineering and/or mechanical engineering at Iowa State University, the Georgia Institute of Technology, and North Carolina State University. He was twice appointed by President William Jefferson Clinton to serve as a Member of the U.S. Nuclear Waste Technical Review Board.

Saida Engström

After chemical engineering and nuclear chemistry studies at Chalmers Engineering School, in 1988 I joined the nuclear safety authority, SKI, where I carried out safety inspections at all nuclear installations in Sweden both for nuclear power production and nuclear waste management. In 1998, I was recruited to join Nuclear Fuels and Waste Management company, SKB, to be part of establishing a new and more adjusted strategy for a final repository for spent nuclear fuel in Sweden. I oversaw feasibility studies in candidate municipalities as well as coordinating dialogue with all stakeholders, from the government, parliament, NGOs, local politicians, authorities, and citizens at large in those municipalities. Under the site characterization in the chosen municipalities of Oskarshamn and Östhammar, I was also in charge of leading the work on the environmental impact assessment and licensing. This work led to a positive decision from the government in 2022 to construct the repository in Östhammar after 11 years' review by the environmental court and safety authorities. I am currently advising Vattenfall on innovations and nuclear strategies in Sweden. I am also a member of the French commission for nuclear materials and nuclear waste management in France, CNE2, which advises the government on nuclear matters.

Lisa Frizzell

Lisa Frizzell is the Vice-President of Communications at the Nuclear Waste Management Organization (Canada). Before joining the organization as Director of Corporate Affairs in 2012, Ms. Frizzell worked in communications for a number of corporate, academic, and government organizations in Canada and the United States. Her focus is in strategic communications, and she brings extensive experience as a communications leader, primarily in the energy sector. Ms. Frizzell holds a Bachelor of Public Relations from Mount Saint Vincent University and an Executive Master of Business Administration from the University of Calgary's Haskayne School of Business.

Piet Zuidema, PhD

Piet Zuidema has a degree in civil and environmental engineering from ETH Zürich, Switzerland. He also received his PhD from ETH Zürich. Piet has worked for more than 30 years at Nagra, the Swiss National Cooperative for the Disposal of Radioactive Waste. For about 20 years, he was director of Science & Technology. In that position, he had the responsibility for the whole Science & Technology program at Nagra. This included the responsibility for Nagra's RD+D program, work on the inventory of radioactive wastes, the design of the repositories, the geoscience program (including field work), and safety analyses for both the operational phase and post-closure phase. Piet Zuidema was in charge of several major repository projects within the Swiss deep geological repository program. He was also responsible for Nagra's scientific-technical work within the first and second phases of the Swiss site selection process. Furthermore, he had the responsibility for the periodic updates of the cost estimates for the whole disposal program.

During his time at Nagra, he was a member of several committees of international organizations (e.g., NEA/OECD), where he also served as chairperson. He participated in several expert advisory groups and committees in other waste management programs in a broad range of different countries.

By the end of 2017, Piet had retired from Nagra. Since then, he has had his own advisory company (Zuidema Consult GmbH) and acts as an independent advisor to several national programs, international organizations, and companies, including Nagra. He currently also acts as the Chief Scientific Officer for EURAD, the European Joint Programme on Radioactive Waste Management.

Bret Leslie, PhD

Dr. Bret Leslie is senior professional staff at the U.S. Nuclear Waste Technical Review Board. He developed the Board's international workshop on siting of radioactive waste facilities. Dr. Leslie is the staff lead for the Board's review of the U.S. Department of Energy's (DOE) consent-based siting efforts for a consolidated interim storage facility for commercial spent nuclear fuel. At the Board, he has been staff lead on reviews of deep borehole disposal, underground research laboratories, and the management and disposal of DOE spent nuclear fuel. Prior to 2014, Dr. Leslie worked on radioactive disposal issues for the U.S. Nuclear Regulatory Commission, U.S. Environmental Protection Agency, Institute for Energy and Environmental Research, and at the Center for Nuclear Waste Regulatory Analyses. He is the author of numerous publications dealing with coupled thermal-hydrologic-chemical processes, natural analogs of components of geologic repositories, uranium-series isotopes, management and disposal of nuclear waste, performance and risk assessments, and public outreach. He holds a BS in Geology from the University of Rochester and an MS and PhD in Geology from the University of Southern California.

U.S. NUCLEAR WASTE TECHNICAL REVIEW BOARD

2300 Clarendon Boulevard
Suite 1300
Arlington, VA 22201

(703) 235-4473
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