Statement of Rodney C. Ewing, Chairman
U.S. Nuclear Waste Technical Review Board

Before the

Subcommittee on Energy and Water Development
Committee on Appropriations
U. S. House of Representatives
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Chairman Frelinghuysen, Ranking Member Kaptur, and members of the Subcommittee, good morning. My name is Rodney Ewing. I am Chairman of the U.S. Nuclear Waste Technical Review Board. I am also a professor in the Departments of Earth & Environmental Sciences, Nuclear Engineering & Radiological Sciences, and Materials Science & Engineering at the University of Michigan. Thank you for holding this hearing on Nuclear Programs and Strategies. I appreciate being invited to discuss, from the Board's technical perspective, the following questions from the Subcommittee:

1. What do international and U.S. experiences tell us about consent-based siting?
2. What can we learn from Yucca Mountain, technically and otherwise?
3. What is the current thinking and consensus around preferable options for nuclear waste disposal and the siting of a geologic repository?

About the Board

Before I address those questions, I would like to briefly describe the Board and its role related to the management and disposal of spent nuclear fuel (SNF) and high-level radioactive waste (HLW).

According to the Legislative History of the Nuclear Waste Policy Amendments Act (1987), which established the Board, the Board was created to be a source of objective, expert technical and

scientific advice to Congress and the Secretary of Energy on nuclear waste issues and to review the technical and scientific validity of U.S. Department of Energy (DOE) activities related to implementing the 1982 Nuclear Waste Policy Act (NWPA), including the packaging, transportation, and disposal of SNF and HLW. The Board reports its findings, conclusions, and recommendations to Congress and the Secretary of Energy.

The Board prizes its independence and objectivity. The process for nominating and appointing Board members underscores and ensures the nonpolitical character of the Board; its 11 members are nominated by the National Academy of Sciences (NAS) solely based on their eminence and expertise and appointed by the President. I should note that the current Board is relatively new; all but three of the members were appointed this past September. The remaining three of us have been on the Board for less than two years.

The current focus of the Board's activities is the evaluation of technical and scientific work that DOE will undertake to implement its recently announced "Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste." In particular, the Board will review DOE's disposal-related research that was noted in the Strategy, such as evaluating whether direct disposal of existing storage containers used at utility sites can be accomplished in a variety of geologic media; evaluating various types and design features of back-filled engineered barriers systems and materials; evaluating different types of geologic media for their impacts on waste isolation; evaluating thermal management options for various geologic media; and developing a research and development plan for deep borehole disposal. The Board also reviews DOE's work related to the disposal of DOE-owned SNF and HLW. We will be gathering information on that topic at a meeting, which will be held at Hanford next week.

In addition to the work I just described, the Board is engaged in analysis of the following topics that we believe will provide useful technical and scientific information to program managers and decision-makers in Congress and at DOE who are involved in developing nuclear waste management policies.

- Office of Legacy Management's Preservation of Data and Information from the Yucca Mountain Project
- Consent-Based Repository-Siting Process: International Experience and Lessons Learned
- The System-Wide Implications of Repackaging SNF Currently in Dry-Storage at Nuclear Utility Sites
- A Survey of DOE-Owned SNF
- Issues Associated with Deep Borehole Disposal of SNF
- International Experience: Update and Expansion of the Board's Previous Report, *Survey of National Programs for Managing High-Level Radioactive Waste and Spent Nuclear Fuel*

I will now turn to the questions posed by the Subcommittee.

Questions from the Subcommittee

My responses to the Subcommittee's questions are based primarily on information provided in three Board publications: *Survey of National Programs for Managing High-Level Radioactive Waste and Spent Nuclear Fuel*, issued in October 2009; *Experience Gained From Programs to Manage High-Level Radioactive Waste and Spent Nuclear Fuel in the United States and Other Countries*, issued in April 2011; and *Technical Advancements and Issues Associated with the Permanent Disposal of High-Activity Waste*, issued in June 2011. Here I should call attention to the

fact that the Board as currently constituted was not involved in the development of any of the reports. I will, therefore, update or supplement the report material from my own experience and from Board analyses or evaluations that are currently underway. As I mentioned earlier, the *Survey Report* will be updated, as necessary, to reflect current developments and changing circumstances in international programs.

I will address the questions in the order they were presented by the Subcommittee:

Question One: What do international and U.S. experiences tell us about consent-based siting?

In general, most national programs for siting a deep-mined geologic repository for SNF and HLW are attempting to use some form of consent-based siting process – for very good reasons, but with varying degrees of success. As has been learned from siting efforts in this country, not having the consent of the affected units of government at the potential host site, including the state, community, and Native American Tribe(s) can create problems that delay or stop the process altogether. But using a consent-based process does not guarantee that a repository will be successfully sited, as was most recently demonstrated by the experience in the United Kingdom that I will discuss in more detail later in my testimony.

In the last 40 years, roughly two-dozen efforts to identify or create processes for identifying potential repository sites have been initiated in the United States and other countries. Of those, only three have identified a potentially suitable site *and* are still on track. In no case has a license been issued to construct a deep-mined geologic repository for high-activity radioactive waste by the responsible regulatory authority.

I will summarize briefly the experiences of some of the countries that are attempting to site a deep-mined geologic repository for the disposal of SNF and HLW.

Sweden – Perhaps the most encouraging example of the efficacy of a consent-based siting process is the approach used in Sweden. After an earlier siting effort failed, in 1992, the Swedish Nuclear Fuel and Waste Management Company (SKB) invited approximately a dozen Swedish communities to participate in a process meant to explore their interest in hosting a repository for high-activity waste. At the end of a very extensive engagement process, two municipalities, Osthammar and Oskarshamn, signaled that they were prepared to host such a facility. SKB ultimately selected Osthammar.

France – Early on, two French communities, one with a clay site and one with a site in granite, stepped forward to host an underground research laboratory with the understanding that, if the geologies proved suitable, a repository might be located there. However, the granite formation proved technically unsuitable for repository development and no other volunteer community with a granite site was found. In 2006, Parliament designated an area near Bure in Meuse/Haute Marne as the repository site in clay. It is interesting to note, however, that when the National Radioactive Waste Management Agency (ANDRA), called for volunteers to host a separate repository for long-lived, intermediate-level waste, several communities in the same province as Bure declined.

United Kingdom – In 2006, the United Kingdom approved a new approach for developing a repository, which included inviting willing communities to express interest in hosting such a facility. Several borough and county councils near the Sellafield reprocessing site in West Cumbria formed a partnership to investigate the possibility of participating. In January 2013, the local authorities voted on whether to proceed to the next stage in the process. Although the Borough Councils in Copeland and Allerdale voted overwhelmingly to move forward, the Cumbria County Council rejected the proposal. Immediately after the County Council vote, the UK Department of

Energy and Climate Change announced that it was halting all activity related to siting a repository in Cumbria.

Canada – A promising national consent-based initiative is unfolding in Canada. Adopting a deliberate and careful approach to understanding the views of Canadians, especially Canada's aboriginal people, the Nuclear Waste Management Organization (NWMO) put forward a plan for adaptive management of Canada's high-activity waste. NWMO is working with twenty-one communities that have expressed interest in learning more about the implications of hosting a deep-mined geologic repository.

Japan – In sharp contrast to the Canadian experience, more than a decade ago, Japan's Nuclear Waste Management Organization (NUMO), called for volunteer communities to participate in a stepwise repository-siting process. Although the mayor of one southern Japanese town accepted NUMO's offer, opposition quickly developed at both the local and prefecture levels. The mayor was recalled, and no other community has come forward since. After the damage caused to the Fukushima-Daiichi reactors by last year's earthquake and tsunami, the prospects for volunteers coming forward now appear to be even slimmer.

Switzerland – In Switzerland, the typical siting approach of starting with a call for volunteers has been reversed. The government authority first identified five regions where the Opalinus clay might be suitable for locating a repository. Now, in the plan's second phase, discussions are under way with communities in the regions to determine if any of them are prepared to host a repository. Ultimately, the Swiss Federal Government will decide where a repository will be sited, but that decision could be overturned by a national referendum.

Germany – In the 1970s, the State of Lower Saxony invited the German Federal Government to develop a repository in salt near the community of Gorleben. That expression of

interest aroused considerable controversy nationally. Although the site is still under consideration, 35 years later there is no decision about whether or not to proceed with development of a repository there.

United States – In the U.S., the experience of *the Nuclear Waste Negotiator* may be especially relevant because that effort was truly consent-based. The Negotiator was given authority to search for a voluntary host for a storage facility or a permanent repository site and to negotiate a benefits package with any acceptable incentives. Approval by act of Congress would be required to complete the process. Some local communities expressed interest, but the states in which they were located prevented them from pursuing an agreement with the negotiator. Some Native American Tribes sought agreements, but in 1995, funding for the Office of the Negotiator was eliminated by Congress. It is not clear what factors would lead to a different outcome if that effort were reinitiated today.

The experience of the *Waste Isolation Pilot Plant* (WIPP) also is instructive when looking at consent-based programs for siting nuclear repositories. This is a subject I know about from personal experience: A committee of the NAS National Research Council continuously reviewed the WIPP project for several decades, and I was a member of that committee from 1984 to 1996. During that time, I lived in New Mexico, having become a member of the faculty at the University of New Mexico in 1974. As a result, I had a front row seat from which to observe the evolution of the WIPP project.

The WIPP facility in New Mexico is the only operating deep-mined geologic repository for radioactive waste in the world. The transuranic-contaminated (TRU) radioactive waste disposed of at WIPP is very different from the SNF and HLW that was intended for disposal in a repository at Yucca Mountain. The regulator also was different; EPA regulated the WIPP site, while the NRC is

responsible for Yucca Mountain licensing. The siting experience was different, as well. In a 1957 report, the NAS identified salt formations as the "most promising" medium for the long-term management of HLW. In the 1970s, municipal leaders in Carlsbad, New Mexico, who were facing a decline in the local potash industry, advocated strongly for a site near their town to be considered as the location of a repository for TRU waste. Congress authorized the development of WIPP and directed DOE to enter into a "consultation and cooperation" agreement with the State of New Mexico. The State created the Environmental Evaluation Group (EEG) to advise on health and safety effects of the proposed repository and to ensure that technical issues were rigorously addressed. Despite its inability to enforce its recommendations, the EEG did prompt changes in DOE's plans. Nonetheless, DOE's decision to proceed with WIPP was challenged by the state and non-government organizations until the passage of the WIPP Land Withdrawal Act in 1992. The State of New Mexico's cooperation has depended, at least until now, on an agreement that precludes the disposal of HLW and SNF at the facility or near the site, and the Land Withdrawal Act includes a provision that limits WIPP's mission to the disposal of TRU waste. However, Carlsbad's leaders have expressed considerable interest in expanding the facility's mission.

The important observations to be made about these national programs may be that what characterizes them most is their variety and that there is no consistent formula for success. In some cases, efforts to identify candidate sites have focused from the beginning on specific host-rock formations dictated by a country's geology or land-use patterns, by a view that particular host-rock formations possess distinctive advantages, or a combination of these factors. In other cases, countries use qualifying and disqualifying conditions to determine the suitability of a site. In addition, a country can evaluate sites serially or in parallel.

Since the early 1990s, nations other than the United States increasingly have developed approaches that empower local jurisdictions. How power is distributed among the affected units of government can be very consequential, as demonstrated by the situations in Japan, Germany, Switzerland, the United Kingdom, and the United States. Experiences in the United States and other nations also suggest that communities already hosting nuclear facilities and communities where benefits might make a significant economic or social difference may be especially receptive to being considered as a candidate repository site.

An important lesson that can be taken from the experiences of national programs, and in particular from the experience of the WIPP facility in the U.S., is the importance of ongoing independent technical review and evaluation. It is not clear whether without such oversight a consent-based process could be successful in this country, regardless of whether it was conducted by DOE or by another organization inside or outside the government.

Question Two: *What can we learn from Yucca Mountain, technically and otherwise?*

Given the Board's technical and scientific mandate, I will focus first on some of the technical and scientific lessons that can be taken from the Board's June 2011 "Technical Advancements and Issues" Report, which looked at the technical and scientific experiences of the Yucca Mountain Program (YMP) and other programs world-wide:

- A variety of geologies can be viable candidates for a repository, including intrusive or extrusive igneous rocks (e.g., granite and tuff), metamorphic (e.g., basement rocks of the Canadian Shield), and sedimentary rocks (e.g., salt and clay).
- There may be alternatives to the "one-size fits all" approach used by the Yucca Mountain Program for the disposal of SNF and HLW.

- Expect surprises in any underground site investigation.
- Engineered barriers can delay reliance on the waste-isolation capabilities of the natural system.
- In general, in the presence of water, the higher the temperature, the more rapid will be the degradation (corrosion) of the waste package.
- When compared with oxidizing environments, emplacement of high-activity waste in reducing environments has important advantages that enhance long-term isolation of the waste from the environment.
- Natural analogs were invaluable for evaluating the Yucca Mountain site. Natural analogs should be identified and studied early as part of the site-characterization process.

Some non-technical lessons from the report include:

- A deep-mined geologic repository for the disposal of SNF and HLW is needed under all realistically foreseeable circumstances.
- An implementing waste management organization that has continuity of funding, management, and personnel is very important.
- Undue delay makes it difficult to implement a concept of waste management that depends on institutional stability.
- Implementing a permanent repository could take decades.

I would add that, as mentioned earlier, successfully siting a repository for disposal of SNF and HLW is difficult or impossible without the consent of the affected units of government that will

be hosting the facility. To be acceptable to the affected units of government, the technical suitability of the site also must be established.

Question Three: *What is the current thinking and consensus around preferable options for waste disposal and siting?*

Repository Options: The international consensus, confirmed by the Blue Ribbon Commission on America's Nuclear Future (BRC) and many previous reports from national and international organizations, is that disposal in a deep-mined geologic repository is a workable and safe solution for SNF and HLW. Regardless of the fuel cycle selected, some fraction of the nuclear waste generated will require geologic disposal.

There are other options for disposal of SNF and HLW in addition to deep-mined geologic disposal, including deep borehole disposal of SNF, HLW, or "orphaned," special waste streams. In its final report, the BRC recommended that DOE should undertake studies on the use of deep borehole disposal for some forms of waste that essentially have no potential for reuse.

The Board is a preparing a fact sheet and letter on this subject, and its analysis so far indicates that deep borehole disposal, if it proved to be physically feasible, might have some advantages for disposing of SNF and HLW that has little potential for reuse. However, vitrified waste as it currently exists in metal canisters filled with glass may be too large for the boreholes envisioned for deep borehole disposal. Also, commercially generated SNF and DOE-owned SNF is stored in canisters with a wide-range of sizes and shapes, so repackaging into smaller canisters also would be required for that waste. There are other daunting challenges associated with deep borehole disposal related to developing new drilling technologies, the emplacement and effective sealing of waste packages at great depth, and the need to address the potential retrieval of the emplaced waste.

Because of the present uncertainties associated with deep-borehole technologies, the Board recommends that deep borehole research and development not distract the U.S. program from vigorously pursuing the siting and characterization of a deep-mined geologic repository.

Repository-Siting - A top legislative priority should be to establish a clear path for a consent-based repository-siting process. The Board presently is developing its own recommendations on this topic. Already, from my personal perspective, a few basic requirements are clear:

1. There must be a set of technical criteria by which sites are evaluated.
2. There should be a clear statement of how all affected units of government (e.g., local community, Native American Tribe, and state) will be engaged in the consent-based process.
3. There should be a clearly understood process by which the affected units of government can opt out of the siting process.
4. There should be a clear understanding of the time after which the affected units of government can no longer withdraw their consent.

DOE Preservation of Yucca Mountain Data and Documents

Finally, I want to update the Subcommittee on an upcoming Board report on DOE's efforts to preserve Yucca Mountain data, documents, and other materials. The report is both appropriate to the subject of the hearing and is being drafted by the Board as the final phase of a review activity that was prompted, in large part, by direction from the Appropriations Committee.

For almost 30 years, DOE studied the Yucca Mountain site. In 2010, when the Yucca Mountain program was shut down, responsibility for archiving and preserving Yucca Mountain scientific and engineering information was transferred to the DOE Office of Legacy Management (LM).

The Board began evaluating DOE activities related to archiving and preserving Yucca Mountain data and information in 2010, as part of its ongoing technical and scientific review. The following year, the Report accompanying the Fiscal Year 2012 Energy and Water Development Appropriations bill directed the Board to "give support to" DOE as it archived and preserved scientific data, documents, and other materials from the YMP.

In accordance with its mandate and consistent with the Committee's direction, the Board has conducted a review of DOE's data-preservation activities, including a limited number of retrieval spot checks, and will soon send its report to Congress and the Secretary. The report is currently being finalized; the following is an "unofficial" overview of the Board's findings:

- Yucca Mountain documents have been preserved and can be accessed and retrieved.
- With significant time and effort, LM personnel can search and retrieve relevant e-mail records.
- LM does not have the capability to load and execute most of the analytical software used on the YMP.
- Some boxes of YMP records being stored by LM contain physical objects, but the inventories of the contents vary in how detailed they are. Consequently, it is unclear what measures might be needed to preserve them or to create searchable databases for the objects.
- LM has used approved NARA schedules to identify what YMP records should be preserved permanently and what records should be preserved temporarily.
- The general public can access written records held by LM, but only through a Freedom of Information Act request.

The Board plans to issue its report in the near future.

Summary

To summarize some key points from my testimony, I would observe that not using a consent-based approach for repository siting can slow the process or lead to delay or failure, but using a consent-based process does not guarantee that a repository will be successfully sited. Programs in other countries are using a variety of consent-based approaches, with mixed results. Deep-mined geologic disposal remains the approach that is being pursued by most of the countries with nuclear waste programs, worldwide, and a deep geologic repository will be needed regardless of the fuel cycle option selected. The only operating deep-mined geologic repository in the world for disposal of radioactive waste is the WIPP facility in New Mexico, and important lessons can be taken from the development of that facility. Finally, ongoing, independent technical oversight of the activities undertaken by the implementer of a consent-based repository-siting program is crucial, regardless of whether the implementing entity is a government agency, a non-governmental organization, or a federal corporation.

Thank you very much. I will be happy to respond to questions.