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

June 3, 2016

Mr. John Kotek
Acting Assistant Secretary for Nuclear Energy
U.S. Department of Energy
1000 Independence Ave., SW
Washington, DC 20585

Re: U.S. Nuclear Waste Technical Review Board Comments on *Post Irradiation Examination Plan for High Burnup Demonstration Project Sister Rods*

Dear Mr. Kotek:

In accordance with its mandate to review the technical and scientific validity of activities undertaken by the Secretary of Energy related to nuclear waste management, the U.S. Nuclear Waste Technical Review Board (Board) reviewed the report *Post Irradiation Examination* [PIE] *Plan for High Burnup Demonstration Project Sister Rods.*[1] The PIE plan describes the characterization and experimental test activities proposed to be undertaken on 25 high-burnup spent nuclear fuel (SNF) "sister rods" having characteristics similar to SNF "test rods"[2] being used in the High Burnup Dry Storage Cask Research and Development Project (HDRP). According to the report, these activities will be part of a multiyear experimental program to collect data needed to understand important changes that may occur in high-burnup fuel and cladding behavior during long-term dry storage. In this letter, the Board provides initial high-level comments on the PIE plan. In two previous letters to the Department of Energy (DOE),[3,4] the Board commented on the draft test plan[5] for the HDRP and on the broader DOE Office of Nuclear Energy research and development program related to extended storage of SNF.

The Board believes the characterization and experimental test activities described in the PIE plan will provide important data on potential degradation of high-burnup SNF (HBF) during extended storage. However, the Board believes that the plan should be revised to address a number of additional issues.

1. **Justification for Proposed Sister Rod Examinations and Testing** – The PIE plan proposes an extensive suite of non-destructive and destructive tests on the sister rods.

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[1] Scaglione, J.M., R.A. Montgomery, and B.B. Bevard. 2016. *Post Irradiation Examination Plan for High Burnup Demonstration Project Sister Rods*, FCRD-UFD-2016-000422, ORNL/SR-2016/111, April 1.
[2] Rods that will be removed from the HDRP cask after 10 years.
[3] Ewing, R.C. 2014. Board letter to Dr. Peter Lyons with comments from November 2013 Board meeting (January 29, 2014). http://www.nwtrb.gov/corr/rce019.pdf.
[4] Ewing, R.C. 2014. Board letter to Dr. Peter Lyons with comments on long-term dry storage of high-burnup spent nuclear fuel (June 5, 2014). http://www.nwtrb.gov/corr/rce024.pdf.
[5] Electric Power Research Institute, 2014. *High Burn-up Dry Cask Research and Development Project – Final Test Plan*, January 20.

However, it is not evident how the results from each test will be used to fill the information gaps identified in previous reports (*e.g.*, FCRD-UFD-2014-000050, *Used Nuclear Fuel Extended Storage and Transportation R&D Review and Plan*, August 9, 2014). The PIE plan should a) link each proposed test to one or more information gaps identified in the most recent gap analysis and b) explain how the results of each proposed test will be used to fill the gap or support modeling of HBF performance during dry storage.

2. **Establishing a Baseline**[6] – The PIE plan should emphasize, as the first priority, the characterization necessary to establish a baseline for the HDRP and should show how the results will be used to assess degradation of the test rods from the HDRP cask. It is expected that, at a minimum, profilometry, visual inspection, gamma scans, measurement of fission gas release, microscopy, and characterization of mechanical properties will be necessary. Any additional techniques should be justified as described in Item #1.

3. **Whole Rod Heating Tests** – The PIE plan includes heating some of the sister rods to simulate the temperature changes experienced by the fuel in the storage cask, followed by monitoring those rods until the end of the HDRP. Assuming this is the case, the PIE plan should provide details on a) the purpose of the tests, b) how measurements on the conditions inside the test cask (*e.g.*, temperature, radiation, gas composition) will be obtained, and c) how the conditions to which the sister rods are exposed will be simulated to match those in the test cask. If the heat-treated rods will not be stored under conditions similar to those for the test rods, then the relevance of the test needs to be explained.

4. **Test Method Verification** – All test methods to determine mechanical properties of the cladding that are not currently approved by the ASTM should be fully developed and verified to assure that they produce valid data that will be defensible and acceptable to regulators. The PIE plan could be streamlined by eliminating duplicative mechanical properties testing activities that do not meet this criterion.

5. **Preservation of Sister Rods** – Obtaining and characterizing the sister rods will be an expensive undertaking. These rods constitute a valuable resource for research and development to meet presently unforeseen needs related to SNF management and disposal in the future. DOE should consider preserving selected sister rods, or rod segments and components, for future use.

6. **Low Temperatures in the HDRP Cask** – The Board is concerned that the maximum cladding temperature in the HDRP predicted by modeling is substantially below what was originally anticipated. One study now estimates the maximum cladding temperature will be below 280°C[7]. This calls into question the usefulness of the HDRP to determine the effects of hydride reorientation during storage of HBF, which might experience temperatures as high as 400°C. Before any fuel is loaded into the HDRP cask or sister rod characterization is initiated, the Board recommends that DOE look into methods to

[6] The characteristic of the fuel as it is placed in the dry storage cask for the purpose of comparing the characteristics of the test rods after 10 years to determine if any degradation has taken place.

[7] Hanson, B., *Peak Cladding Temperatures: Conservative Licensing Approach vs. Actual* PNNL-SA-117853, presented at the Nuclear Energy Institute Used Fuel Management Conference, May 3, 2016, Orlando, FL

raise the cladding temperatures, for example, by means external to the cask or including some fuel assemblies with shorter cooling times. If the maximum cladding temperature cannot be raised, DOE should re-evaluate the utility of the HDRP as planned and consider delaying the project until the issues associated with maximum temperature can be resolved.

7. **Modeling** – DOE should undertake a detailed analysis of how the data obtained from the HDRP and the sister rod testing program will be used to develop models for the behavior of spent fuel rods under other conditions reflective of the expected population of HBF in dry storage. This would include rods that have other cladding types, have been irradiated to higher burnups, or have experienced higher cladding temperatures.

This letter contains only the Board's most important comments to ensure that you receive them before your June 6th meeting to review the sister rod PIE plan. The Board looks forward to receiving the next revision of the plan in sufficient time to review it prior to the upcoming technical fact-finding meeting with DOE and its technical experts on July 12–14, 2016.

Sincerely,

Rodney C. Ewing
Chairman