

Introduction to the DOE's Spent Nuclear Fuel Transportation Cask Performance Demonstration Tests

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1. Introduction

The High Burnup Demonstration Project is a top priority for the United States Department of Energy. The project, sponsored by DOE's Office of Nuclear Energy (NE), is focused on gaining an understanding of the effects of long-term storage and transportation on high burnup (HBU) fuel, which is defined as fuel that has achieved a burnup level greater than 45 gigawatt days per metric ton of uranium (GWd/MTU). The HBU Demonstration project employed a TN-32 cask that was loaded with high burnup spent fuel at Dominion's North Anna Power Station in November 2017. Sixty-three internal thermocouples were installed in the cask to collect temperature data. The cask will be stored for 10 years, after which it will be opened in dry conditions. The cask will be shipped to a yet to be determined location to be opened in dry conditions for examination. The cask is scheduled to be shipped in 2027 using the At-las railcar. the Spent Fuel Transportation Package Performance Demonstration (PPD) project, which will entail the physical testing of a full-size spent fuel transportation rail cask. Therefore, this paper aims to introduce the performance demonstration tests of spent nuclear fuel transportation casks conducted by the DOE.



Fig. 1 HBU Cask at Pad

2. Test Objective

This demonstration project is intended to address stakeholder concerns about the lack of full-scale tests of

transportation casks. By conducting full-scale tests, DOE expects to provide a visual demonstration of the robustness of these casks under accident conditions. The major goals of the project are as follows:

- Build public trust – the PPD aims to address public concerns regarding the safety of spent fuel transportation.
- Comprehensive input – DOE seeks stakeholder input on the types of full-scale demonstrations to be conducted, the selection of transportation casks, potential testing facilities, and how information from the PPD can be used.
- Supplier engagement – DOE is requesting detailed information from potential suppliers regarding the equipment and services necessary for the PPD, including cask vendors, testing facilities, and providers of instrumentation and videography services.

DOE-NE is open to ideas from all respondents for conducting a PPD, including general information from stakeholder input and feedback, as well as specific test parameter information from potential suppliers. Suggestions must be practical and technically feasible, subject to the constraints of authorization and availability of appropriated funds, and must meet DOE-NE's objective of building public trust and confidence in the safety of spent fuel transportation casks and spent fuel transportation.

3. Test Performance

A preliminary Functions and Requirements document was transmitted to DOE in September 2023. It includes potential tests to be performed, potential test sites, potential transportation casks– only current model(s) will be used – and potential analytical tools. Tests under consideration include the regulatory tests described in the US Nuclear Regulatory Commission regulations under 10 CFR Part 71. However, The PPD will not consider terrorism or sabotage scenarios, nor will it include testing that applies forces to a spent fuel transportation cask beyond the 10 CFR Part 71 regulations, often termed “extra-regulatory testing” or “beyond design basis testing.”

- Impact – the cask to be used should be subjected

to an impact equivalent to that of a free drop from a height of 9 meters (30 feet) onto an impact surface that is “essentially unyielding.”

- Puncture – the cask to be used should be dropped from 1 meter onto a mild steel puncture bar.
- Fire – the cask that has been damaged from the drop demonstration and the puncture demonstration should then be subjected to a thermal demonstration that consists of being placed within a fully engulfing hydrocarbon fuel fire for 30 minutes.
- Immersion in water – the cask could be dropped or lowered over the side of a vessel into a body of water at least 200 meters deep; or, alternatively, use a pressure chamber, which could simulate the pressure at 200 meters.

Cask designers must demonstrate to the NRC that its casks are safe – this can be shown by computer analyses, comparisons with other designs, component testing, physical testing of a full-scale or sub-scale model, or a combination of these methods. For a PPD, the full-scale demonstrations could be conducted as a supplemental activity outside of the cask certification because of strong interest of stakeholders and to further demonstrate the validity of prior studies and test conclusions.

4. DOE Plan

DOE is proposing a three-phase approach to the project.

- Phase 1 goes through the summer of 2024. This phase involves preliminary outreach, during which time an RFI (re-request for information) will be developed, outreach to the existing nuclear transportation community will be conducted, and webinars and listening sessions will be held. Initiating support of an Ad Hoc Working Group is also part of Phase 1. The RFI is expected to be issued later this year, possibly in the summer.
- Phase 2 is expected to take place from summer 2024 through spring 2025. This phase will involve publishing the RFI, then gathering responses and reviewing feedback. The breadth of outreach will be increased, and continued working group support will be received. All this information will inform a Request for Proposals (RFP).
- Phase 3 will take place from spring 2025 to the end of 2028, during which time an RFP will be issued, DOE will decide on tests to be performed, and outreach will be even further expanded.

The PPD team includes experts from Pacific Northwest National Laboratory (PNNL), Oak Ridge National Laboratory (ORNL), and Savannah River National Laboratory (SRNL). DOE will continue external engagement regarding the demonstration,

which is dependent on the availability of funding to continue.

The National Academy of Sciences (NAS), in its 2006 re-report – *Going the Distance?* – recommended a PPD be conducted with a full-scale rail cask for the purpose of building public trust and confidence. NAS did not recommend testing packages to destruction.

In 2012, the Blue Ribbon Commission on America’s Nuclear Future recommended conducting a PPD for the same reason – to build public trust and confidence in the robustness of these casks.

3. Conclusions

Based on the conclusions of this paper, the DOE’s (U.S. Department of Energy) performance demonstration tests of spent nuclear fuel transportation casks will provide valuable insights that can assist KHNP in the operation of its dry storage facilities. The project discussed in this study, part of DOE’s High Burnup Demonstration Project, focuses on evaluating the long-term storage and transportation of high burnup spent fuel and addressing potential risks associated with these processes. The data and experience gained from this project can significantly contribute to enhancing the safety and reliability of KHNP’s dry storage operations and ensuring the secure handling of spent nuclear fuel.

In particular, the lessons learned from DOE’s testing plans and execution can inform KHNP’s design and operational strategies for its facilities. This will not only strengthen the safety measures in place but also help build public trust, reassuring stakeholders that KHNP’s facilities are operated with the highest standards of safety. Ultimately, this research will contribute to KHNP’s ability to align with international best practices, thereby enhancing the safety and credibility of its dry storage facility operations.

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