



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

January 24, 2024

Ms. Laura Basta
H. B. Robinson Steam Electric Plant
Site Vice President
Duke Energy Progress, LLC
3581 West Entrance Road, RNPA11
Hartsville, SC 29550

SUBJECT: H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2 – REVISION TO
REACTOR VESSEL MATERIAL SURVEILLANCE CAPSULE WITHDRAWAL
SCHEDULE (EPID L-2023-LLL-0013)

Dear Ms. Basta:

By letter dated July 12, 2023 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML23193A368), Duke Energy Progress, LLC (Duke Energy, the licensee) submitted a request to revise the reactor vessel material surveillance capsule withdrawal schedule for the surveillance program that applies to the H. B. Robinson Steam Electric Plant, Unit No. 2 (Robinson), in accordance with Title 10 of the *Code of Federal Regulations* (CFR), Part 50, Appendix H, "Reactor Vessel Material Surveillance Program Requirements," Section III.B.3.

The NRC staff has reviewed the submittal and concludes that the proposed changes are acceptable and consistent with the intent and requirements of the applicable regulations and guidance found in Appendix H of 10 CFR Part 50. The NRC staff makes no conclusion regarding the future use of the subject capsule in any potential future licensing applications or license periods and makes no conclusion regarding the additional analyses which were not within the scope of the licensee's request. The NRC staff's safety evaluation is enclosed.

L. Basta

- 2 -

If you have any questions, please contact Luke Haeg at 301-415-0272 or via email at Lucas.Haeg@nrc.gov.

Sincerely,

David J. Wrona, Chief
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-261

Enclosure:
Safety Evaluation

cc: Listserv



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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION
REVISION TO REACTOR VESSEL SURVEILLANCE CAPSULE WITHDRAWAL SCHEDULE

DUKE ENERGY PROGRESS, LLC

H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2

DOCKET NO. 50-261

1.0 INTRODUCTION

By letter dated July 12, 2023 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML23193A368), Duke Energy Progress, LLC (Duke Energy, the licensee) submitted a request to revise the reactor vessel material surveillance capsule withdrawal schedule for the surveillance program that applies to the H. B. Robinson Steam Electric Plant, Unit No. 2 (Robinson). This program is required to be designed and implemented in accordance with Title 10 of the *Code of Federal Regulations* (CFR), Part 50, Appendix H, "Reactor Vessel Material Surveillance Program Requirements" (henceforth Appendix H). The licensee submitted this programmatic change in accordance with requirements specified in Section III.B.3 of Appendix H.

Specifically, the licensee proposed a change to the schedule for withdrawing surveillance capsule U in accordance with the licensee's activities for implementing the surveillance program. The licensee's current surveillance capsule withdrawal schedule was requested on May 2, 2019 (ML19122A012) and approved by the U.S. Nuclear Regulatory Commission (NRC) on February 19, 2020 (ML20021A013). The NRC staff's safety evaluation (SE) of the May 2, 2019, submittal included the licensee's basis to withdraw capsule U at 41.3 effective full power years (EFPY), or at the next scheduled refueling outage after the capsule achieves neutron fluence exposure equal to the peak, projected inside surface fluence for the reactor pressure vessel (RPV) at 80-years operation, based upon a migration to 24-month operating cycles and a design change eliminating part length shield assemblies in the reactor. In support of the development of a subsequent license renewal application (SLRA), a new fluence analysis showed that capsule U will not achieve a neutron fluence exposure equal to the peak, projected inside surface fluence for the RPV at 80 years until 44.4 EFPY, necessitating a change to the withdrawal schedule of capsule U.

2.0 REGULATORY EVALUATION

2.1 Applicable Regulatory Requirements

As specified in 10 CFR 50.60, "Acceptance criteria for fracture prevention measures for lightwater nuclear power reactors for normal operation," all light-water nuclear power reactors must meet the material surveillance program requirements of Appendix H. Section I of Appendix H states that the objective of the program is to monitor for changes in the fracture

toughness properties of ferritic materials that are included in the beltline of the RPV due to exposure of the materials to a neutron irradiation and thermal environment. Section III.B of Appendix H establishes the requirements for the design of the surveillance program and for implementing capsule withdrawals and performing material testing in accordance with the program.

Section III.B.1 of Appendix H requires the design of the surveillance program and the surveillance capsule withdrawal schedule to meet the requirements specified in the edition of American Society for Testing and Materials (ASTM) Standard Practice E185 that is current on the issue date of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) to which the RPV was purchased. Appendix H permits later editions of ASTM E185 to be used for these objectives, but only for editions up to and inclusive of ASTM E185-82. Section III.B.1 of Appendix H also requires that, for each capsule withdrawal, the procedures for performing tests of capsule specimens and for reporting test results must meet the requirements of ASTM E185-82 to the extent practical for the configuration of the specimens in the capsules.

Section III.B.2 of Appendix H establishes specific requirements for placing the surveillance capsules inside of the RPV cavity. The rule requires the capsules to be located at positions so that the capsule irradiation history duplicates (to the extent practical within the physical restraints of the system) the neutron spectrum, temperature history, and maximum fluence experienced by the RPV at the inside surface of the vessel. Appendix H states that if capsule holders are used and attached to the vessel wall or vessel cladding, construction and inspection of the attachments and attachment welds must be done in accordance with the requirements of the licensee's ASME Code Section III and Section XI editions of record. Appendix H also requires the design and location of the capsule holders to permit for insertion of replacement capsules. Appendix H permits the use of accelerated irradiation capsules in addition to the normal number of capsules that are required by Appendix H.

Section III.B.3 of Appendix H requires a proposed RPV surveillance capsule withdrawal schedule to be submitted with a technical justification and to be approved by the staff prior to implementation. Paragraph IV.A of Appendix H states that "Each capsule withdrawal and the test results must be the subject of a summary technical report to be submitted, as specified in §50.4, within eighteen [18] months of the date of capsule withdrawal, unless an extension is granted by the Director, Office of Nuclear Reactor Regulation."

The submittal of the proposed change also serves to satisfy condition 3.L, "Reactor Vessel Surveillance," of Robinson renewed operating license number DPR-23 that states:

All capsules in the reactor vessel that are removed and tested must meet the test procedures and reporting requirements of ASTM E 185-82 to the extent practicable for the configuration of the specimens in the capsule. Any changes to the capsule withdrawal schedule, including spare capsules, must be approved by the NRC prior to implementation. All capsules placed in storage must be maintained for future insertion. Any changes to storage requirements must be approved by the NRC.

2.2 Current Licensing Basis for Complying with Appendix H

Attachment 1 to the submittal, Westinghouse Report No. CPL-RV000-TM-ME-000001, Revision 1, "H.B. Robinson Unit 2: Recommended Changes to the Surveillance Capsule

Withdrawal Schedule” (Attachment 1), outlines the current licensing basis for compliance with Appendix H in Section 5.3.1.6, “Material Surveillance” of Robinson’s updated final safety analysis report (UFSAR, ML23145A162). The UFSAR states that the design and implementation of the current program complies with the requirements in Appendix H and the criteria in ASTM E185-82. The UFSAR clarifies that the licensee has removed five capsules (i.e., capsules S, Z, V, T, and X) in accordance with the program and has tested the material specimens in four of these capsules (i.e., capsules S, V, T, and X), with the latest test results for all capsules and the previously authorized capsule withdrawal schedule detailed in WCAP-18215-NP, “H.B. Robinson Unit 2 End-of-License Extension Reactor Vessel Integrity Evaluations and Feasibility Study.” Capsule Z is omitted from these results because it was inadvertently removed from the RPV per WCAP-15805, Revision 0, “Analysis of Capsule X from the Carolina Power & Light Company H.B. Robinson Unit 2 Reactor Vessel Radiation Surveillance Program.” The Robinson capsule withdrawal schedule was originally designed to ASTM E185-66 and the requirements of that specification are also met with consideration to 60 and 80 years of operation.

3.0 TECHNICAL EVALUATION

3.1 Proposed Surveillance Capsule Withdrawal Schedule Change

In the submittal, the licensee requested NRC approval to change the time for withdrawing capsule U from the RPV in accordance with the following basis defined in the submittal:

Capsule U will be withdrawn at either 44.4 effective full-power years (EFPY) or during the scheduled refueling outage after the capsule achieves a neutron fluence exposure equal to the peak, projected inside surface fluence for the reactor pressure vessel at 80 years of operation.

3.2 Licensee’s Justification for Proposed Withdrawal Schedule Change

Section 7.6 of ASTM E185-82 requires a sufficient number of surveillance capsules be provided and reviewed to monitor the effects of neutron irradiation on the reactor vessel. Table 1 of ASTM E185-82 requires that the end of life (EOL) capsule be withdrawn during a window of time when the capsule fluence is not less than once, or greater than twice, the peak EOL vessel fluence. Additionally, Robinson is currently licensed to 60 years of operation and entered the period of extended operation in August of 2010. NUREG-1801, Revision 2, “Generic Aging Lessons Learned (GALL) Report,” Section XI.M31, Program Element 4, reiterates the requirement from ASTM E185-82 regarding the EOL capsule fluence requirements.

As reported in Attachment 1 of the submittal, the Robinson reactor vessel surveillance capsule withdrawal schedule (associated with operation of 60 years) presently includes removal and testing of capsule U at either 41.3 EFPY or during the scheduled refueling outage after the capsule achieves a neutron exposure equal to the peak, projected inside surface fluence for the reactor vessel at 80 years of operation. At 41.3 EFPY, capsule U is projected to achieve a fluence of 8.09×10^{19} neutrons/square centimeter (n/cm²). As seen below, this is consistent with the ASTM E185-82 capsule withdrawal window requirement that capsule fluence is not less than once, or greater than twice, the peak EOL vessel fluence. However, recent fluence calculations performed in support of the development of an SLRA to operate for 80 years show an update to the surveillance capsule withdrawal schedule is required.

Capsule withdrawal window for 60 years of operation:

- One times the peak vessel wall neutron fluence: 6.19×10^{19} n/cm²
- Two times the peak vessel wall neutron fluence: 1.24×10^{20} n/cm²

Capsule withdrawal window for 80 years of operation:

- One times the peak vessel wall neutron fluence: 8.85×10^{19} n/cm²
- Two times the peak vessel wall neutron fluence: 1.77×10^{20} n/cm²

Surveillance capsule U is projected to attain a fluence of 8.85×10^{19} n/cm² at 44.4 EFPY, which is projected to occur on August 6, 2027. Capsule U will be withdrawn at 44.4 EFPY or during the scheduled refueling outage after the capsule achieves a neutron fluence exposure equal to the peak, projected inside surface fluence for the reactor pressure vessel at 80 years of operation. The next refueling outage after capsule U attains 44.4 EFPY is scheduled for the Fall of 2028. The proposed withdrawal schedule will ensure capsule U receives a neutron fluence of between one and two times the peak reactor vessel wall neutron fluence at the end of the period of extended operation.

3.3 NRC Staff Evaluation

As discussed above and as shown in Table 2 of the recommended surveillance capsule withdrawal schedule report as shown in Attachment 1 of the submittal, the licensee's proposed RPV surveillance capsule withdrawal schedule involves a change related to capsule U based on the updated RPV fluence analysis performed in support of the development of an SLRA. The updated RPV fluence analysis is provided in Attachment 2 of the submittal, Westinghouse Non-Proprietary Class 3 Report No. CPL-REAC-TM-AA-000001, Revision 1 (Attachment 2). The staff examined this report and confirmed that neutron fluence values were determined using NRC-approved methods that meet the guidance in Regulatory Guide (RG) 1.190, "Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence." Specifically, the neutron transport methodology used to generate the results provided is consistent with WCAP-18124-NP-A, "Fluence Determination with RAPTOR-M3G and FERRET" (ML18204A008), and WCAP-18124-NP-A, Revision 0, Supplement 1-NP-A, "Fluence Determination with RAPTOR-M3G and FERRET – Supplement for Extended Beltline Materials" (ML22153A136). The staff assessed the fluence analysis and results provided in Attachment 2 of the submittal and verified that (1) the analysis was performed consistent with the guidance in RG 1.190 and the staff's safety evaluations for the methods employed, and (2) changing the capsule withdrawal schedule to 44.4 EFPY will increase the projected neutron exposure of the capsule at the time of removal from a projected fluence exposure of 8.09×10^{19} n/cm² (E > 1.0 million electron volts (MeV)) to a projected fluence exposure of 8.85×10^{19} n/cm² (E > 1.0 MeV). The staff notes that the updated projected fluence is between one and two times the peak, projected inside radius fluence for the RPV.

Therefore, the staff finds that the updated withdrawal schedule for capsule U is acceptable for implementation because (1) the updated withdrawal schedule is based on fluence analysis results determined via an NRC-approved RAPTOR-based methodology that meets RG 1.190 guidance, (2) the licensee has demonstrated that the capsule will achieve a capsule fluence exposure at 44.4 EFPY that is between one and two times the peak, projected inside radius fluence for the RPV, which meets the intent of the capsule withdrawal schedule criteria in ASTM

E185-82, and (3) the updated withdrawal schedule will comply with the requirements in 10 CFR 50, Appendix H. Once capsule U has been withdrawn from the RPV in accordance with the revised schedule approved in this SE, testing of the specimens in the capsule is subject to the post-removal testing requirements specified in Section III.B.1 of Appendix H and the reporting requirements for submitting the reactor pressure vessel surveillance material test results to the Director, Office of Nuclear Reactor Regulation, as specified in Section IV of Appendix H.

Additionally, the staff notes that the fluence analyses provided in Attachment 2 were only reviewed for the purpose of evaluating the schedule change for withdrawal of capsule U. Attachment 2 also contains fluence analyses in support of an SLRA, which cover topics beyond the scope of this request, such as fluence impacts on RPV supports and bioshield concrete. The staff have not reviewed these additional analyses. The NRC staff makes no conclusion regarding the future use of the subject capsule in any potential future licensing applications or license periods and makes no conclusion regarding the additional analyses which were not within the scope of the licensee's request.

4.0 CONCLUSION

The staff finds that Duke Energy's requested withdrawal schedule change for capsule U is consistent with 10 CFR Part 50, Appendix H and that the proposed withdrawal schedule change for capsule U is consistent with the requirements of Section III.B.3 in Appendix H. Based on these findings, the staff authorizes Duke Energy to withdraw capsule U in accordance with the following withdrawal schedule requirement:

Capsule U will be withdrawn at 44.4 EFPY or during the scheduled refueling outage after the capsule achieves a neutron fluence exposure equal to the peak, projected inside surface fluence for the reactor pressure vessel at 80-years operation.

Principal Contributors: Steven Levitus, NRR/DNRL/NVIB
Kevin Heller, NRR/DSS/SNFB

Date: January 24, 2024

SUBJECT: H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2 – REVISION TO REACTOR VESSEL MATERIAL SURVEILLANCE CAPSULE WITHDRAWAL SCHEDULE (EPID L-2023-LLL-0013) DATED JANUARY 24, 2024

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