

DRAFT SAFETY EVALUATION

BY THE OFFICE OF NUCLEAR REACTOR REGULATION

ELECTRIC POWER RESEARCH INSTITUTE

TOPICAL REPORT - APPENDIX F, "ALTERNATE SSLR SURVEILLANCE CAPSULE

WITHDRAWAL SCHEDULE" TO

BWRVIP-321-A: BOILING WATER REACTOR VESSEL AND INTERNALS PROJECT "PLAN

FOR EXTENSION OF THE BWR INTEGRATED SURVEILLANCE PROGRAM (ISP)

THROUGH THE SECOND LICENSE RENEWAL"

1.0 INTRODUCTION

1.1 Background

By letter dated March 8, 2019 (Agencywide Documents Access and Management System (ADAMS) Package Accession No. ML19071A248), the Electric Power Research Institute (EPRI) submitted for U.S. Nuclear Regulatory Commission (NRC) staff review and approval the Topical Report (TR) TR-3002013097, "BWR [Boiling Water Reactor] Vessel and Internals Project, Plan for Extension of the BWR Integrated Surveillance Program (ISP) Through the Second License Renewal (SLR), (BWRVIP-321)."

By letter dated May 25, 2021 (ADAMS Package Accession No. ML21152A130), EPRI transmitted NRC-approved BWRVIP-321-NP-A, Boiling Water Reactor Vessel and Internals Project (BWRVIP), "Plan for Extension of the BWR Integrated Surveillance Program (ISP) Through The Second License Renewal," which contains the NRC's safety evaluation.

Following issuance of BWRVIP-321-A, by letter dated March 29, 2022 (ADAMS Package Accession No. ML22091A218), EPRI submitted for NRC review and approval an alternate irradiation schedule as documented in Appendix F: Alternate Supplemental Second License Renewal (SSLR) Surveillance Capsule Withdrawal Schedule. Appendix F of BWRVIP-321-A describes the alternate withdrawal schedule for the SSLR capsule that is different from the capsule withdrawal schedules provided in BWRVIP-321-A. Appendix F also provides the underlying technical basis for the proposed change. Additionally, EPRI submitted a markup of the necessary changes to Section 1 and Section 8 of BWRVIP-321-A to reference Appendix F of BWRVIP-321-A.

1.2 Purpose

BWRVIP-321-A was determined by the NRC staff to provide an acceptable reactor pressure vessel (RPV) material ISP in accordance with Appendix H to Title 10 of the *Code of Federal Regulations* (10 CFR). This integrated surveillance program is intended to support all operating U.S. BWR plants participating in the current BWRVIP ISP that decide to pursue operation in the subsequent period of extended operation (i.e., 60 to 80 years of plant operation).

The data from the ISP will be used to monitor changes in the fracture toughness properties of RPV materials due to neutron irradiation and provide adequate information for required RPV integrity evaluations for 80 years of plant operation.

EPRI explained in its transmittal letter dated March 29, 2022, that following the issuance of BWRVIP-321-A in 2021 the flux analysis for the host plant indicated that 12 years of irradiation will be required to obtain the necessary fluence for the Group 3 SSLR capsule. Accordingly, EPRI explained that the capsule withdrawal schedules approved by the NRC in BWRVIP-321-A are no longer suitable for the ISP for subsequent license renewal. EPRI informed the NRC of this issue during a public meeting held on February 3, 2022 (ADAMS Accession No. ML22033A523).

Given the circumstances of the host plant and its impact to the BWRVIP ISP for subsequent license renewal, the alternate withdrawal schedule in Appendix F of BWRVIP-321-A is necessary to support all operating U.S. BWR plants participating in the current BWRVIP ISP that decide to pursue operation in the subsequent period of extended operation (i.e., 60 to 80 years of plant operation).

### 1.3 Regulatory Requirements

The regulation at 10 CFR 50.60 invokes Appendix H to 10 CFR Part 50, which requires licensees to implement an RPV material surveillance program. The purpose of the program is to monitor changes in the fracture toughness properties of ferritic materials in the reactor vessel beltline region, which results from exposure of these materials to neutron irradiation and the thermal environment. In compliance with the requirements of Appendix H, licensees for all operating U.S. BWRs have implemented plant-specific RPV material surveillance programs as part of each facility's licensing basis.

However, an alternative to individual plant-specific RPV surveillance programs is addressed in Paragraph III.C of Appendix H. Pursuant to Paragraph III.C. of Appendix H, an RPV ISP may be implemented, with the approval of Director of the Office of Nuclear Reactor Regulation, by two or more facilities with similar design and operating features.

Paragraph III.C of Appendix H also sets forth specific criteria upon which approval of an ISP shall be based. Those specified criteria include the following:

- a) The reactor in which the materials will be irradiated and the reactor for which the materials are being irradiated must have sufficiently similar design and operating features to permit accurate comparisons of the predicted amount of radiation damage;
- b) Each reactor must have an adequate dosimetry program;
- c) There must be adequate arrangement for data sharing between plants;
- d) There must be a contingency plan to assure that the surveillance program for each reactor will not be jeopardized by operation at reduced power level or by an extended outage of another reactor from which data are expected; and
- e) There must be substantial advantages to be gained, such as reduced power outages or reduced personnel exposure to radiation, as a direct result of not requiring surveillance capsules in all reactors in the set.

In addition, Paragraphs III.C.2 and III.C.3 of Appendix H specify the following, respectively:

1. No reduction in the requirements for number of materials to be irradiated, specimen types, or number of specimens per reactor is permitted.
2. After (the effective date of this section), no reduction in the amount of testing is permitted unless previously approved by the Director, Office of Nuclear Reactor Regulation, or Director, Office of New Reactors, as appropriate.

#### 1.4 Applicability

This safety evaluation is applicable to all U.S. BWRs participating in the NRC-approved BWRVIP ISP that intend to pursue or have been approved for a renewed operating license to 80-years of operation pursuant to 10 CFR Part 54 to reference BWRVIP-321-A.

#### 2.0 SUMMARY OF SUBMITTAL

By letter dated March 29, 2022, EPRI stated that, upon NRC approval of the alternate withdrawal schedule proposed in Appendix F, it will revise BWRVIP-321-A as follows:

- Section 1.0 of BWRVIP-321-A will be revised to state that “Revision 1 of this report incorporates an alternate surveillance capsule withdrawal schedule for SSLR capsules. See Section 8 and Appendix F for details.”
- Section 8 of BWRVIP-321-A will be revised to include Section 8.1, “Alternate SSLR Surveillance Capsule Withdrawal Schedule,” that states that based “on the selection of Peach Bottom Unit 3 as the host plant, and completion of plant unique transport calculations, an alternate SSLR Surveillance Capsule withdrawal schedule has been developed. This alternate withdrawal schedule and associated technical basis are presented in Appendix F.”
- Appendix F will be incorporated into BWRVIP-321-A. Appendix F of BWRVIP-321-A provides a SSLR Capsule Irradiation Withdrawal Schedule for the SSLR Surveillance Capsule Holder that is an alternate to those withdrawal schedule scenarios defined in Section 8 of BWRVIP-321-A and the supporting technical basis, which revises the total irradiation period.

EPRI also stated that it will submit the revision to BWRVIP-321-A to incorporate these changes, which will be published as BWRVIP-321, Revision 1-A and submitted to the NRC.

#### 3.0 NRC STAFF EVALUATION

The staff reviewed Appendix F of BWRVIP-321-A to ensure that either (1) the conclusions previously made in BWRVIP-321-A are not impacted by the proposed alternate withdrawal schedule, or (2) the BWRVIP ISP for subsequent license renewal under the alternate withdrawal schedule is implemented in accordance with Appendix H to 10 CFR Part 50 and will support all operating U.S. BWR plants participating in the current BWRVIP ISP if they decide to pursue operation in the subsequent period of extended operation.

Tables F-2, F-3, and F-4 of Appendix F to BWRVIP-321 provide the catch-up and total projected accumulated neutron fluence values under the alternate withdrawal schedule at the maximum end of the uncertainty range associated with neutron fluence projections for each surveillance material in Groups 1, 2, and 3 capsules, respectively. Tables F-5, F-6, and F-7 of Appendix F to BWRVIP 321 provide the catch-up and total projected accumulated neutron fluence values under the alternate withdrawal schedule at the minimum exposure for each material in Groups 1, 2, and 3 capsules, respectively. Based on its review of these tables, the NRC staff confirmed that the necessary catch-up fluence (i.e., difference between projected 72-effective full power year fluence and the fluence from previous capsules) are consistent with those approved in BWRVIP-321-A. Thus, the NRC staff confirmed that the alternate withdrawal schedule does not impact EPRI's determination of the materials that require additional surveillance data for the subsequent license renewal period, as outlined in Table 4-8 of BWRVIP-321-A.

The NRC staff noted that the alternate withdrawal schedule in Appendix F of BWRVIP-321-A proposes that all three SSLR capsules/groups will be irradiated for 12 years as described in EPRI's transmittal letter dated March 29, 2022. However, the withdrawal schedules in BWRVIP-321-A specifies several potential irradiation schedules depending on the flux that could be attained in the host plant and these irradiation schedules ranged from 2 to 10 years depending on the SSLR capsules/group and flux that could be attained at the host plant. As such, under the alternate withdrawal schedule in the Appendix F of BWRVIP-321-A, the staff noted that the neutron fluence exposures for the surveillance materials in Groups 1, 2, and 3 capsules would be greater than that described in BWRVIP-321-A. Based on its review, the staff finds it reasonable that there will not be any unusual embrittlement trends for the surveillance materials in Groups 1, 2, and 3 capsules due to additional neutron fluence exposure under the alternate withdrawal schedule in the Appendix F of BWRVIP-321-A because of the generally adequate agreement of existing available surveillance data and the embrittlement trend curve in Regulatory Guide 1.99, Revision 2 for neutron fluence levels that are expected in Groups 1, 2, and 3 capsules. Thus, under the alternate withdrawal schedule in the Appendix F of BWRVIP-321-A, the NRC staff finds that the BWRVIP ISP for subsequent license renewal will ensure that surveillance data will be obtained for the necessary materials to support all operating U.S. BWR plants participating in the current ISP that chose to pursue subsequent license renewal.

The NRC staff noted that the specimen reconstitution approach as described in Section 5.0 of BWRVIP-321-A is not impacted by the alternate withdrawal schedule in the Appendix F of BWRVIP-321-A. Thus, the staff confirmed that its review of the specimen reconstitution approach in Section 3.2 of the SE for BWRVIP-321-A remains applicable. Specifically, the staff's review is associated with the EPRI's approach (1) for irradiated specimen reconstitution, (2) to conduct Charpy-impact tests of the reconstituted specimens, and (3) to determine the appropriate use of the available surveillance material inserts, based on specimen sizes at proper test temperatures, to ensure results equivalent to those of virgin material are produced.

Table F-1 summarizes the results of detailed neutron transport calculations associated with the alternate withdrawal schedule conducted using the RAMA Code to estimate the minimum and maximum fluence that is expected at each capsule (i.e., group) location for the host plant. The NRC staff noted that the neutron fluence projections presented by EPRI are not directly used to support a specific plant operating into the subsequent license renewal period.

Rather, these projections are only used to (1) identify the installation location of the SSLR capsules at the host plant and (2) determine the necessary withdrawal date to ensure the specimens in all groups are exposed to sufficient neutron fluence (i.e., target RPV fluence at 80 years of operation) to support ISP participants that decide to pursue subsequent license renewal. Based on this neutron fluence analytical methodology, the staff finds that EPRI has demonstrated that the target RPV fluence for Groups 1, 2, and 3 capsules can be attained in the host plant by the withdrawal date established in the Appendix F of BWRVIP-321-A.

The NRC staff noted that the neutron fluence methods approved by the NRC staff are unique to the individual licensee's current licensing basis and that any proposal by a BWR facility to change its neutron determination methodology is the responsibility of the individual licensee to meet all applicable licensing requirements. The staff also noted that EPRI will perform an evaluation of capsule fluences for each of the SSLR capsules as part of the testing and reporting of results required by Appendix H to 10 CFR Part 50. Specifically, the flux wires will be removed from each capsule and analyzed for radioactivity content by gamma spectroscopy. Additionally, the analysis of dosimeters will be performed using standard, benchmarked methods as described in BWRVIP-321-A.

EPRI will perform SSLR capsule fluence evaluations, as described in Section 9.4 of BWRVIP-321-A, using an RPV neutron fluence calculational methodology that will meet current NRC staff guidance in NRC Regulatory Guide 1.190, "Calculational And Dosimetry Methods for Determining Pressure Vessel Neutron Fluence" (ADAMS Accession No. ML010890301). The staff noted that these SSLR capsule fluence evaluations are not impacted by the alternate withdrawal schedule in Appendix F of BWRVIP-321-A. Thus, the staff confirmed that its review of the SSLR capsule fluence evaluations in Section 3.3 of the SE for BWRVIP-321-A remains applicable.

The NRC staff determined that SSLR capsule design as described in Section 7.0 of BWRVIP-321-A is not impacted by the alternate withdrawal schedule in Appendix F of BWRVIP-321-A. Thus, the NRC staff confirmed that its review of the SSLR Capsule Design in Section 3.4 of the SE for BWRVIP-321-A remains applicable. Moreover, the staff noted that it is incumbent on the host plant (or the alternate host plant, if needed) to comply and fulfill all design and licensing requirements for implementing the installation of the SSLR capsule holder in accordance with the plant's current licensing basis. The NRC staff's review and approval in BWRVIP-321-A is not associated with the approval of the design of the SSLR capsule holder and does not obviate the host plant's responsibility for design and licensing requirements of the SSLR capsule holder.

Figures F-4, F-5, and F-6 of the Appendix F to BWRVIP-321-A illustrates the irradiation periods associated with the alternate withdrawal schedule for the Group 1, 2, and 3 capsules, respectively, compared to the licensed operating periods for the U.S. BWR fleet. As described, in EPRI's letter dated March 29, 2022, the alternate withdrawal schedule proposes that all three SSLR capsules will be irradiated for 12 years with the installation in the host plant during the fall 2023 refueling outage and would be removed from the host plant in 2035.

Based on its review of Figures F-4, F-5, and F-6 of the Appendix F to BWRVIP-321-A, the NRC staff noted the following based on the alternate withdrawal schedule:

- Two BWRs (i.e., Pilgrim and Duane Arnold) are permanently shutdown and no longer require material surveillance data obtained from the BWRVIP ISP for subsequent license renewal.
- The SSLR capsules will be withdrawn for all ISP participants well in advance of the end of the subsequent period of extended operation, if approved for a second renewed license.
  - A majority of currently operating ISP participants will have surveillance data from the ISP prior to entering the “subsequent period of operation,” if approved for a subsequent renewed license.
  - Twelve ISP participants will have surveillance data from the ISP at the onset (i.e., within 3 years) of entering the subsequent period of operation, if approved for a subsequent renewed license.
  - Four ISP participants will have surveillance data from the ISP within 6 years of entering the subsequent period of operation, if approved for a subsequent renewed license.

Based on its review of Figures F-4, F-5, and F-6, the NRC staff finds that the alternate withdrawal schedule in Appendix F of BWRVIP-321-A for the SSLR capsules in Groups 1, 2, and 3 is acceptable because all currently operating ISP participants will obtain the necessary surveillance data to assess reactor vessel integrity for plant operation through 80-years well in advance of the end of the subsequent period of extended operation. The NRC staff noted that any surveillance capsule withdrawal schedule that deviates from those proposed in BWRVIP-321-A and in Appendix F of BWRVIP-321-A must be submitted with a technical justification and approved by the NRC staff prior to implementation in accordance with Paragraph III.B.3 of Appendix H.

The NRC staff reviewed the alternate withdrawal schedule in Appendix F of BWRVIP-321-A to verify continued compliance of the BWRVIP ISP for subsequent license renewal in accordance with Paragraph III.C.1 of Appendix H to 10 CFR Part 50. Based on its review, the staff confirmed that the alternate withdrawal schedule in Appendix F of BWRVIP-321-A does not impact the BWRVIP ISP for subsequent license renewal (i.e., BWRVIP-321-A) and its continued compliance with Paragraphs III.C.1.a, III.C.1.b, III.C.1.c, and III.C.1.e of Appendix H to 10 CFR Part 50; thus, the staff’s review of Section 3.6 of the SE for BWRVIP-321-A remains applicable.

However, the NRC staff noted that Appendix F of BWRVIP-321-A indicates that under certain circumstances (e.g., unexpected extended outages durations or operation at reduced power for an extended period) it may be necessary to revise the withdrawal schedule so that the Group 3 capsule acquires the require total accumulated fluence. The NRC staff noted Section III.C.1.d of Appendix H to 10 CFR Part 50 requires “a contingency plan to assure that the surveillance program for each reactor will not be jeopardized by operation at reduced power level or by an extended outage of another reactor from which data are expected,” which is addressed in Sections 9 and 10 of BWRVIP-321-A. Based on its review of Appendix F of BWRVIP-321-A, the staff confirmed that the contingency plans addressed in Sections 9 and 10 of BWRVIP-321-A are not impacted and notes that it continues to be incumbent on EPRI to assess any potential changes to the approved withdrawal schedules to determine whether it deviates from what is approved in this SE for Appendix F and whether it warrants prior NRC approval in accordance with Appendix H to 10 CFR Part 50.

Thus, the NRC staff confirmed that this alternate withdrawal schedule in Appendix F does not impact BWRVIP-321-A, and the BWRVIP ISP for subsequent license renewal under the proposed alternate withdrawal schedule meets the criterion in Paragraph III.C.1.d of Appendix H to 10 CFR Part 50. This contingency plan has been adequately defined in Section 9.8 of BWRVIP-321-A.

#### 4.0 LIMITATIONS AND CONDITIONS

There are no limitations or conditions identified by the staff.

#### 5.0 USE AND REFERENCING OF THE TR

As addressed in BWRVIP-321-A and in this SE, the use and referencing of the BWRVIP-321-A, including the alternate withdrawal schedule in Appendix F, is an acceptable alternative to all existing BWR plant-specific RPV surveillance programs for the purpose of maintaining compliance with the requirements of Appendix H to 10 CFR Part 50 through the end of current facility 80-year extended operating licenses. The NRC staff noted that plants intending to implement BWRVIP-321-A, including this SE for Appendix F, will do so by submitting requests to the NRC as part of the Subsequent License Renewal Application or license amendment process.

#### 6.0 CONCLUSION

Based on the above evaluation, the NRC staff finds that the alternate withdrawal schedule in Appendix F of BWRVIP-321-A provides an acceptable means to adequately address the need for surveillance data for BWR licensees through the end of a facility's 80-year operating license, if subsequent license renewal is pursued by licensees. Accordingly, BWRVIP-321-A, including the alternate withdrawal schedule in Appendix F, is acceptable for generic use and referencing to satisfy the requirements of Appendix H to 10 CFR Part 50 for BWR licensees through the end of the facility's 80-year operating license, if subsequent license renewal is pursued by licensees.

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