TENNESSEE VALLEY AUTHORITY
1101 Market Street, Chattanooga, Tennessee 37402

CNL-22-005

January 24, 2022

10 CFR 50.4
10 CFR 50 Appendix H

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Watts Bar Nuclear Plant, Unit 2
Facility Operating License No. NPF-96
NRC Docket No. 50-391

Subject: Revision to Watts Bar Nuclear Plant, Unit 2, Reactor Vessel Surveillance Capsule Withdrawal Schedule

Reference:
1. TVA letter to NRC, WBL-20-066, “Watts Bar Nuclear Plant Unit 2 - Revised Pressure and Temperature Limits Report (PTLR)," dated December 16, 2020 (ML20351A248)
2. American Society for Testing and Materials (ASTM) E-185-82, "Standard Practice for Conducting Surveillance Tests for Light-Water Cooled Nuclear Power Reactor Vessels," dated July 1, 1982
3. Administrative Letter 97-04, "NRC Staff Approval for Changes to 10 CFR Part 50, Appendix H, Reactor Vessel Surveillance Specimen Withdrawal Schedules," dated September 30, 1997

Pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, Appendix H, "Reactor Vessel Material Surveillance Program Requirements," Paragraph III.B.3, Tennessee Valley Authority (TVA) is requesting Nuclear Regulatory Commission (NRC) approval of the enclosed revision to the reactor vessel surveillance capsule removal schedule for Watts Bar Nuclear Plant (WBN) Unit 2. As noted in Table 4.0-1 of the WBN Unit 2 Pressure Temperature Limits Report (PTLR) (Appendix B to TVA System Description Document SDD-N3-68-4001, “Reactor Coolant System”) (Reference 1), reactor vessel surveillance Capsule W was scheduled to be removed during the WBN Unit 2 Cycle 5 refueling outage (U2R5) scheduled for Fall 2023. However, recent adjustments in lead factors, estimated effective full power years (EFPY) to attain target fluence, and a reconciliation of actual accrued EFPY to date has shown that U2R5 is too early to satisfy the requirements of ASTM E-185-82 (Reference 2). Therefore, TVA requests NRC approval to revise the withdrawal schedule with the latest data regarding lead factors, EFPY, and expected neutron fluence, as well as the deletion of “EOC 5” from the Capsule W schedule line to allow planning of capsule withdrawal based on parameters that are directly applicable to ASTM E-185-82. Additional changes to the PTLR are described in Section 3.0 of Enclosure 1 to this submittal.

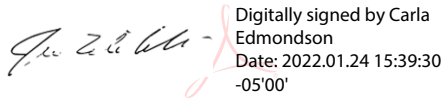
Enclosure 1 to this letter provides the technical justification for this proposed revision to the WBN Unit 2 reactor vessel surveillance capsule withdrawal schedule. Enclosure 2 provides a proposed revision to the WBN Unit 2 PTLR reflecting the proposed revised capsule withdrawal schedule. In accordance with WBN Unit 2 Technical Specification 5.9.6.c, "Reactor Coolant System (RCS) PRESSURE AND TEMPERATURE LIMITS REPORT (PTLR)," TVA will submit the revised WBN Unit 2 PTLR to NRC following NRC approval of the proposed revision to the WBN Unit 2 reactor vessel surveillance capsule withdrawal schedule.

NRC Administrative Letter (AL) 97-04 (Reference 3) clarified the submittal requirements of 10 CFR 50, Appendix H. As stated in AL 97-04, "In this instance, as long as the plant's withdrawal schedule change meets the applicable ASTM standard, the plant will not be exceeding the operating authority already granted in its license. Therefore, a license amendment would not be required, although prior NRC approval to verify conformance with the ASTM standard is required by Appendix H." ASTM E-185-82 is the applicable standard for WBN Unit 2 in accordance with Section 5.2.4.3 of the WBN dual-unit Updated Final Safety Analysis Report (UFSAR). Because the proposed change described in the enclosure to this letter satisfies the requirements of ASTM E-185-82, TVA has determined that a license amendment is not required, which is consistent with the guidance of AL 97-04.

TVA requests NRC approval of the proposed withdrawal schedule within one year following the date of this submittal.

There are no new regulatory commitments associated with this submittal. Please address any questions regarding this request to Kimberly D. Hulvey, Senior Manager, Fleet Licensing, at (423) 751-3275.

Respectfully,



James T. Polickoski
Director, Nuclear Regulatory Affairs

Enclosures:

1. Proposed Revision to the Watts Bar Nuclear Plant (WBN) Unit 2, Reactor Vessel Surveillance Program
2. Proposed Mark-up to the WBN Unit 2 Pressure Temperature Limits Report - Surveillance Capsule Removal Schedule

cc (Enclosure):
NRC Regional Administrator - Region II
NRC Senior Resident Inspector - Watts Bar Nuclear Plant
NRC Project Manager – Watts Bar Nuclear Plant

Enclosure 1

Subject: Proposed Revision to the Watts Bar Nuclear Plant (WBN) Unit 2, Reactor Vessel Surveillance Program

CONTENTS

1.0 INTRODUCTION

Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, Appendix H, "Reactor Vessel Material Surveillance Program Requirements," describes reactor vessel material surveillance program requirements. Paragraph III.B.3 of 10 CFR 50, Appendix H states that a proposed material withdrawal schedule must be submitted with a technical justification per 10 CFR 50.4, and approved prior to implementation.

Accordingly, Tennessee Valley Authority (TVA) is requesting Nuclear Regulatory Commission (NRC) approval of the proposed revision to the reactor vessel surveillance capsule removal schedule for the Watts Bar Nuclear Plant (WBN) Unit 2. As noted in Table 4.0-1 of the WBN Unit 2 Pressure Temperature Limits Report (PTLR) (Appendix B to TVA System Description Document SDD-N3-68-4001, “Reactor Coolant System”) (Reference 1), reactor vessel surveillance Capsule W was scheduled to be removed during the WBN Unit 2 Cycle 5 refueling outage (U2R5). However, recent adjustments in lead factors, estimated effective full power years (EFPY) to attain target fluence, and a reconciliation of actual accrued EFPY to date have shown that U2R5 is too early to satisfy the requirements of American Society for Testing and Materials (ASTM) E-185-82 (Reference 2). TVA requests NRC approval to revise the withdrawal schedule with the latest data regarding lead factors, EFPY, and expected neutron fluence, as well as the deletion of “EOC 5” from the Capsule W schedule line to allow planning of capsule withdrawal based on parameters that are directly applicable to ASTM E-185-82.

As documented in Reference 3, Capsule U was removed during WBN U2R2 in spring 2019. The proposed revision to the PTLR schedule is being updated with the actual EFPY and neutron fluence to maintain historical accuracy of the schedule.

NRC Administrative Letter (AL) 97-04 (Reference 4) clarified the submittal requirements of 10 CFR 50, Appendix H, as follows:

> *"In this instance, as long as the plant's withdrawal schedule change meets the applicable ASTM standard, the plant will not be exceeding the operating authority already granted in its license. Therefore, a license amendment would not be required, although prior NRC approval to verify conformance with the ASTM standard is required by Appendix H."*

ASTM E-185-82 is the applicable standard for WBN Unit 2 in accordance with Section 5.2.4.3 of the WBN dual-unit Updated Final Safety Analysis Report (UFSAR). Because the proposed change described in this enclosure satisfies the requirements of ASTM E-185-82, TVA has determined that a license amendment is not required, which is consistent with the guidance of AL 97-04.

2.0 CURRENT PROGRAM / WITHDRAWAL SCHEDULE

The current withdrawal schedule for reactor vessel surveillance capsules as shown in Table 4.0-1 of the WBN Unit 2 PTLR is provided below.

System Description Document	REACTOR COOLANT SYSTEM Unit 1 / Unit 2 QA Record	SDD-N3-68-4001 Rev. 0044 Page 254 of 268

Appendix B
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TABLE 4.0-1
Watts Bar Unit 2 Surveillance Capsule Removal Schedule [a]

Capsule	Orientation of Capsule	Lead Factor	Removal Time	Expected Capsule Fluence ($n/cm^2, E > 1.0$ MeV)
U	Dual 34°	4.80	2.61 EFPY (EOC 2)	0.7714×10^{19}
W	Single 34°	4.87	6.91 EFPY (EOC 5)	1.901×10^{19} [b]
X	Dual 34°	4.80	Note (c)	Note (c)
Z	Single 34°	4.87	Note (d)	Note (d)
V	Dual 31.5°	4.15	Note (d)	Note (d)
Y	Dual 31.5°	4.15	Note (d)	Note (d)

Notes:

(a) This information is taken from the withdrawal schedule contained in Appendix F of WCAP-18191-NP (Ref. 1). EOC = End-of-Cycle

(b) Approximate Fluence at vessel inner wall at End-of-Life (32 EFPY).

(c) Capsule X should be removed between 11.6 EFPY and 13.5 EFPY if possible. Capsule X must be removed between EOC 6 and 13.5 EFPY in order to satisfy the recommendations of the third capsule end-of-license per ASTM E185-82 (Ref. 7). See WCAP-18191-NP (Ref. 1) for additional details. This removal EFPY should be re-visited at a later date, such as after Capsules U and W are removed.

(d) Capsules Z, V, and Y should remain in the reactor. If additional metallurgical data is needed, withdrawal and testing of these capsules should be considered.

3.0 CHANGES TO PROGRAM / WITHDRAWAL SCHEDULE

Enclosure 2 provides a proposed revision to the WBN Unit 2 PTLR showing the revised reactor vessel surveillance capsule lead factors, EFPY, and expected capsule fluences. The basis for these updates is WCAP-18518-NP, Revision 0, "Analysis of Capsule U from the Watts Bar Unit 2 Reactor Vessel Radiation Surveillance Program," (Reference 5). Specifically, TVA proposes to revise the WBN Unit 2 reactor vessel surveillance capsule removal schedule as follows:

- The lead factors for all six capsules have been revised. The lead factor is the proportional constant by which the capsule fluence leads the vessel's maximum inner wall fluence. These coefficients are being revised to reflect the plant-specific model.
- The removal EFPY and expected neutron fluence for Capsule U has been updated to reflect the actual conditions achieved when the capsule was removed during end of cycle (EOC) 2 in spring 2019.
- The projected EFPY and expected neutron fluence for capsules W and X have been revised. These plant parameters are key indicators when ensuring compliance with ASTM E185-82 scheduling criteria. This change is made consistent with the change in lead factors and is based on the plant-specific model.
- EOC 5 has been deleted from the Capsule W schedule line. This information was originally included as a planning tool to assist the utility with withdrawing the capsule at the expected time. However, recent adjustments in lead factors, estimated EFPY to attain target fluence, and a reconciliation of actual accrued EFPY to date have shown that U2R5 is too early to satisfy the requirements of ASTM E-185-82. Therefore, the (EOC 5) information has been deleted from the schedule to allow planning of capsule withdrawal based on parameters that are directly applicable to ASTM E-185-82.
- Note (a) is being revised to replace WCAP-18191-NP (Reference 6) with WCAP-18518-NP.
- Note (b) is being revised to indicate that Capsule W should be withdrawn at the outage nearest to but following 7.0 EFPY of operation.
- Note (c) is being revised to reflect the projected EFPY for Capsule X and to delete the references to WCAP-18191-NP and Capsule U because it has been removed.
- Note (d) is being revised to reflect that Capsule Z has been identified as a backup to Capsule W in the event that Capsule W cannot be removed during an outage. This change is acceptable because the two capsules are radiologically equivalent (See Section 4.0 to this enclosure).

The proposed withdrawal schedule satisfies the requirements of ASTM E-185-82. Therefore, the withdrawal schedule satisfies the requirements of 10 CFR 50, Appendix H.

In accordance with WBN Unit 2 Technical Specification (TS) 5.9.6.c, "Reactor Coolant System (RCS) PRESSURE AND TEMPERATURE LIMITS REPORT (PTLR)," TVA will submit the revised WBN Unit 2 PTLR to NRC following NRC approval of the proposed revision to the WBN Unit 2 reactor vessel surveillance capsule withdrawal schedule.

4.0 JUSTIFICATION

In accordance with Section 5.2.4.3 of the WBN dual-unit UFSAR, the WBN Unit 2 Reactor Vessel Irradiation Surveillance Program complies with ASTM E-185-82 and 10 CFR 50, Appendix H, with the exception that the reactor vessel irradiation surveillance capsules will receive a fluence that is at least four times the maximum reactor vessel fluence. ASTM E-185-82 recommends a capsule to vessel maximum fluence between 1.0 and 3.0. At the time of the design of the surveillance program, the capsules were positioned as near to the vessel wall as possible and were limited to a fluence of less than 3.0 times the vessel fluence. A more accurate method of calculating vessel and capsule fluence was subsequently developed that results in a lead factor of greater than 3.0 for the capsules. This difference is not considered to be of significant consequence because the test results from the encapsulated specimens will represent the actual behavior of the material in the vessel. Therefore, the evaluation of the effects of radiation on the actual vessel material is not influenced by the larger lead factor.

The current capsule removal schedule is based on WCAP-18191-NP, Revision 0 (Reference 6) and ASTM E-185-82. Table 1 to ASTM E-185-82 lists the recommended number of surveillance capsules and their withdrawal schedule based on the anticipated shift in the reference nil-ductility transition temperature (ΔRT_{NDT}) at the end of life (EOL). For WBN Unit 2, the ΔRT_{NDT} at EOL (i.e., 32 EFPY) for all vessel forgings and welds will be less than 100°F. Therefore, only three surveillance capsules are required to be withdrawn.

The first capsule at WBN Unit 2 was removed in spring 2019 (Capsule U, per Reference 5). Compliance with ASTM E185-82 is based on Reference 5, which shows that the first criteria met for withdrawal of the first capsule was the Capsule U fluence exceeding 5.0×10^{18} n/cm^2.

An opportunity existed after the analysis of Capsule U test data was completed to update the lead factors, fluence estimates and corresponding EFPY of operation for the remaining capsules in operation. This update was based on the latest information available regarding actual EFPY accrued to date, and expectation for future operation to use for projections. For this reason, lead factors have received a slight adjustment for all capsules, and the projected EFPY and expected neutron fluence for capsules W and X have been revised. These plant parameters are key indicators when ensuring compliance with ASTM E185-82 scheduling criteria. This change is made consistent with the change in lead factors and is based on the plant-specific model.

In accordance with Table 1 to ASTM E185-82, the second capsule should be removed when the first of the following criteria is satisfied as shown in Table 1. Based on the information in Table 1, the limiting criterion for WBN Unit 2 is when the fluence will correspond to the approximate EOL fluence at the reactor vessel inner wall location. Table 2 shows the fluence projection for the WBN Unit 2 surveillance capsules.

Table 1 **WBN Unit 2 Capsule W Conformance to ASTM E185-82 Criterion**	
ASTM E185-82 Criterion (whichever comes first)	**WBN Unit 2 Capsule W Conformance**
At 15 EFPY	Assuming 1.5 EFPY per cycle (i.e., 18-month cycles), 15 EFPY will not be reached until at least Cycle 11.
Fluence corresponds to the approximate EOL fluence at the reactor vessel inner wall location	Reference 5 states the EOL fluence at the reactor vessel inner wall location to be 1.94E+19 n/cm^2. Table 2 shows that Capsule W will reach this criterion after 7.0 EFPY of WBN Unit 2 operation.

Table 2
Fast Neutron Fluence Projections at the Geometric Center of the WBN Unit 2 Surveillance Capsules at the Core Midplane

	Neutron (E > 1.0 MeV) Fluence (n/cm^2)					
EFPY	Capsule U (34.0° Dual)	Capsule V (31.5° Dual)	Capsule W (34.0° Single)	Capsule X (34.0° Dual)	Capsule Y (31.5° Dual)	Capsule Z (34.0° Single)
0.74	2.57E+18	2.16E+18	2.56E+18	2.57E+18	2.16E+18	2.56E+18
2.0	6.04E+18	5.07E+18	6.00E+18	6.04E+18	5.07E+18	6.00E+18
7.0	-		1.94E+19	1.94E+19		1.94E+19
13.7	-			3.88E+19		
32	-	7.84E+19	9.10E+19	9.16E+19	7.84E+19	9.10E+19
36	-	8.83E+19	1.03E+20	1.03E+20	8.83E+19	1.03E+20

The fluence projections in Table 2 are repeated from Tables 6-2 and 7-1 in Reference 5, which states that Capsule W will reach a fluence that corresponds to the approximate EOL fluence at the reactor vessel inner wall location after 7.0 EFPY of WBN Unit 2 operation. Therefore, that EFPY value for Capsule W has been adjusted in the schedule in Enclosure 2.

When planning a capsule withdrawal activity during a refueling outage, it is prudent to identify a backup capsule to target for withdrawal in the event that the originally planned capsule is unable to be withdrawn. Capsule Z is radiologically equivalent to Capsule W because they have resided in the reactor for the same amount of time in symmetric “34.0° Single” locations. The estimated fluence for both capsules shown in Table 2 is the same. The lead factors displayed for Capsules W and Z in Enclosure 2 are calculated based on the expected time of removal or EOL (respectively). A review of Table 6-8 in Reference 5 shows that the lead factors for Capsules W and Z are the same when compared in the same outage (4.66). In the event that Capsule W cannot be removed, then Capsule Z may serve as a backup and be removed

instead during the same outage. This contingency plan has been included on the schedule in Enclosure 2 for approval for compliance with ASTM E185-82.

In accordance with Table 1 to ASTM E185-82, the third capsule should be removed at what is described as “EOL.” In accordance with Note E to Table 1 to ASTM E185-82, this criterion is not less than once or greater than twice the peak EOL vessel fluence. Capsule X has been scheduled to meet this criterion. The EFPY values that correspond to the EOL window fluences are provided in Table 2, and they have been repeated on the schedule in Enclosure 2. An intermediate exposure of 11.7 EFPY is included in a note below the revised schedule as a planning tool. This exposure would correlate to a Capsule X fluence that corresponds to the reactor vessel inner wall fluence at the end of a potential license extension (60 years) per ASTM E185-82 and NUREG-1801, Revision 2. Therefore, the Capsule X proposed schedule removal between 7.0 EFPY and 13.7 EFPY meets ASTM E185-82.

5.0 PRECEDENT

The NRC has previously approved the following reactor vessel surveillance program capsule withdrawal schedule revisions for WBN:

- WBN Unit 2 [Safety Evaluation dated November 20, 2017 (Reference 7)]
- WBN Unit 1 [Safety Evaluation dated March 27, 2014 (Reference 8)]

6.0 REFERENCES

1. TVA letter to NRC, WBL-20-066, “Watts Bar Nuclear Plant Unit 2 - Revised Pressure and Temperature Limits Report (PTLR),” dated December 16, 2020 (ML20351A248)
2. ASTM E-185-82, "Standard Practice for Conducting Surveillance Tests for Light-Water Cooled Nuclear Power Reactor Vessels," dated July 1, 1982
3. TVA letter to NRC, WBL-20-004, “Watts Bar Nuclear Plant Unit 2 - Analysis of Capsule U from Watts Bar Unit 2 Reactor Vessel Radiation Surveillance Program,” dated April 16, 2020 (ML20107F717)
4. NRC Administrative Letter 97-04, "NRC Staff Approval for Changes to 10 CFR Part 50, Appendix H, Reactor Vessel Surveillance Specimen Withdrawal Schedules," dated September 30, 1997
5. Westinghouse Report, WCAP-18518-NP, Revision 0, “Analysis of Capsule U from the Watts Bar Unit 2 Reactor Vessel Radiation Surveillance Program,” dated March 2020 (ML20107F717)
6. NRC letter to TVA, “Transmittal of WCAP-18191-NP, ‘Watts Bar Unit 2 Heatup and Cooldown Limit Curves for Normal Operation and Supplemental Reactor Vessel Integrity Evaluations’," dated October 13, 2017 (ML17289A327)
7. NRC letter to TVA, “Watts Bar Nuclear Plant, Unit 2 - Revision to the Reactor Vessel Surveillance Capsule Withdrawal Schedule (CAC No. MG0207; EPID L-2017-LLL-0019),” dated November 20, 2017 (ML17312A260)
8. NRC letter to TVA, “Watts Bar Nuclear Plant, Unit 1 - Review of Reactor Vessel Materials Surveillance Program - Revised Surveillance Capsule Withdrawal Schedule (TAC No. MF3162),” dated March 27, 2014 (ML14083A247)

Enclosure 2

Proposed Mark-up to the WBN Unit 2 Pressure Temperature Limits Report - Surveillance Capsule Removal Schedule

Enclosure 2

Proposed Mark-up to the WBN Unit 2 Pressure Temperature Limits Report - Surveillance Capsule Removal Schedule

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TABLE 4.0-1
Watts Bar Unit 2 Surveillance Capsule Removal Schedule [a]

Capsule	Orientation of Capsule	Lead Factor	Removal Time	Expected Capsule Fluence (n/cm^2,E > 1.0 MeV)
U	Dual 34°	~~4.80~~ 4.70	~~2.61~~ 2.0 EFPY (EOC 2)	~~0.7714~~ 0.604 x 10^{19}
W	Single 34°	~~4.87~~ 4.66	~~6.91~~ 7.0 EFPY (EOC 5)	~~1.901~~ 1.94 x 10^{19} [b]
X	Dual 34°	~~4.80~~ 4.69	~~Note (c)~~ 7.0 EFPY to 13.7 EFPY	~~Note (c)~~ 1.94 x 10^{19} to 3.88 x 10^{19} [c]
Z	Single 34°	~~4.87~~ 4.69	Note (d)	Note (d)
V	Dual 31.5°	~~4.15~~ 4.04	Note (d)	Note (d)
Y	Dual 31.5°	~~4.15~~ 4.04	Note (d)	Note (d)

WCAP-18518-NP (Ref 12)

Notes:

(a) This information is taken from the withdrawal schedule contained in ~~Appendix F of WCAP-18191-NP (Ref. 1)~~. EOC = End-of-Cycle

(b) Approximate Fluence at vessel inner wall at End-of-Life (32 EFPY).

(Add Text): This capsule should be withdrawn at the outage nearest to but following 7.0 EFPY of operation.

(c) Capsule X should be removed between ~~11.6~~ 11.7 EFPY and ~~13.5~~ 13.7 EFPY if possible. Capsule X must be removed between ~~EOC 6 and 13.5 EFPY~~ 7.0 EFPY and 13.7 EFPY in order to satisfy the recommendations of the third capsule end-of-license per ASTM E185-82 (Ref. 7). ~~See WCAP-18191-NP (Ref. 1) for additional details.~~ This removal EFPY should be re-visited at a later date, such as after Capsules ~~U and~~ W ~~are~~ is removed.

(d) Capsules Z, V, and Y should remain in the reactor. If additional metallurgical data is needed, withdrawal and testing of these capsules should be considered.

(Add Text): In the event that Capsule W cannot be removed, then Capsule Z may serve as a backup and be removed instead during the same outage