TENNESSEE VALLEY AUTHORITY
1101 Market Street, Chattanooga, Tennessee 37402

CNL-23-016

October 30, 2023

10 CFR 50.90

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

Watts Bar Nuclear Plant, Units 1 and 2
Facility Operating Licenses Nos. NPF-90 and NPF-96
NRC Docket Nos. 50-390 and 50-391

**Subject: Application to Modify the Watts Bar Nuclear Plant, Unit 1 and Unit 2 Technical Specification Surveillance Requirement 3.9.5.1 (WBN-TS-21-14)**

In accordance with the provisions of Title 10 of the *Code of Federal Regulations* (10 CFR) 50.90, "Application for amendment of license, construction permit, or early site permit," Tennessee Valley Authority (TVA) is submitting a request for an amendment to Facility Operating License Nos. NPF-90 and NPF-96 for the Watts Bar Nuclear Plant (WBN), Units 1 and 2, respectively.

The proposed change revises WBN Units 1 and 2 Technical Specification (TS) Surveillance Requirement 3.9.5.1, “Residual Heat Removal (RHR) and Coolant Circulation - High Water Level,” to revise the current flow rate of 2,500 gallons per minute (gpm) to 2,000 gpm.

Enclosure 1 to this submittal provides a description and technical evaluation of the proposed change, a regulatory evaluation, and a discussion of environmental considerations. Attachment 1 to the enclosure provides the existing WBN Units 1 and 2 TS pages marked up to show the proposed changes. There are no changes to the WBN Units 1 and 2 TS Bases.

In support of the technical evaluation in Enclosure 1, Enclosure 2 contains Westinghouse Electric Company LLC (Westinghouse) Letter Report, LTR-SEE-23-4-P, Revision 1, “Technical Evaluation in Support of Watts Bar Units 1 & 2 Residual Heat Removal System (RHRS) Flow Rate Reduction During Mode 6 Operation at Refueling Water Level ≥ 23 Feet.” Enclosure 2 contains information that Westinghouse considers to be proprietary in nature pursuant to 10 CFR 2.390, "Public inspections, exemptions, requests for withholding," paragraph (a)(4). Enclosure 3 contains a non-proprietary version of Enclosure 2. Enclosure 4 provides the Westinghouse Application for Withholding Proprietary Information from Public Disclosure CAW-23-033 affidavit supporting this

**Proprietary Information Withhold Under 10 CFR § 2.390**
**This letter is decontrolled when separated from Enclosure 2**

proprietary withholding request. The affidavit sets forth the basis on which the information may be withheld from public disclosure by the NRC and addresses with specificity the considerations listed in paragraph (b)(4) of Section 2.390. Accordingly, TVA requests that the information, which is proprietary to Westinghouse, be withheld from public disclosure in accordance with 10 CFR Section 2.390. Correspondence with respect to the copyright or proprietary aspects of the items listed above or the supporting Westinghouse affidavit should reference CAW-23-033 and should be addressed to Camille T. Zozula, Manager, Regulatory Compliance & Corporate Licensing.

TVA has determined that there are no significant hazards considerations associated with the proposed changes and that the TS changes qualify for a categorical exclusion from environmental review pursuant to the provisions of 10 CFR 51.22(c)(9). In accordance with 10 CFR 50.91(b)(1), TVA is sending a copy of this letter and enclosure to the Tennessee State Department of Environment and Conservation.

TVA requests approval of the proposed license amendment within one year from the date of submittal, with implementation within 30 days of issuance of the amendment.

There are no new regulatory commitments associated with this submittal. Please address any questions regarding this request to Stuart L. Rymer, Senior Manager, Fleet Licensing, at slrymer@tva.gov.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 30th day of October 2023.

Respectfully,

Digitally signed by Edmondson, Carla
Date: 2023.10.30 11:26:04 -04'00'

Kimberly D. Hulvey
Director, Nuclear Regulatory Affairs

Enclosures

1. Evaluation of Proposed Change
2. Westinghouse Letter Report, LTR-SEE-23-4-P, Revision 1 (Proprietary)
3. Westinghouse Letter Report, LTR-SEE-23-4-NP, Revision 1 (Non-Proprietary)
4. Westinghouse Electric Company LLC Application for Withholding Proprietary Information from Public Disclosure (Affidavit CAW-23-033)

cc: See Page 3

cc (Enclosures):

NRC Regional Administrator – Region II
NRC Senior Resident Inspector – Watts Bar Nuclear Plant
NRC Project Manager – Watts Bar Nuclear Plant
Director, Division of Radiological Health – Tennessee State Department of Environment and Conservation

Enclosure 1

Evaluation of Proposed Change

Subject: Application to Modify the Watts Bar Nuclear Plant Unit 1 and Unit 2 Technical Specification Surveillance Requirement 3.9.5.1 (WBN-TS-21-14**)**

**CONTENTS**



Attachment

1. Proposed TS Changes (Mark-Ups) for WBN Units 1 and 2

## 1.0 SUMMARY DESCRIPTION

In accordance with the provisions of Title 10 of the *Code of Federal Regulations* (10 CFR) 50.90, "Application for amendment of license, construction permit, or early site permit," Tennessee Valley Authority (TVA) is submitting a request for an amendment to Facility Operating License Nos. NPF-90 and NPF-96 for the Watts Bar Nuclear Plant (WBN), Units 1 and 2, respectively.

The proposed change revises WBN Units 1 and 2 Technical Specification (TS) Surveillance Requirement (SR) 3.9.5.1, “Residual Heat Removal (RHR) and Coolant Circulation - High Water Level,” to revise the current flow rate of 2,500 gallons per minute (gpm) to 2,000 gpm. The proposed change is consistent with a similar SR in WBN Units 1 and 2 SR 3.9.6.1, “Residual Heat Removal (RHR) and Coolant Circulation - Low Water Level,” and Sequoyah Nuclear Plant (SQN) SRs 3.9.5.1 and 3.9.6.1.

## 2.0 DETAILED DESCRIPTION

### 2.1 System Design and Operation

The purpose of the RHR System (RHRS) in Mode 6 is to remove decay heat and sensible heat from the reactor coolant system (RCS), as required by 10 CFR 50 Appendix A, General Design Criterion (GDC) 34, to provide mixing of borated coolant and to prevent boron stratification. Heat is removed from the RCS by circulating reactor coolant through the RHR heat exchangers, where the heat is transferred to the Component Cooling Water System. The coolant is then returned to the RCS via the RCS cold leg(s). Operation of the RHRS for normal cooldown or decay heat removal is manually accomplished from the control room. The heat removal rate is adjusted by controlling the flow of reactor coolant through the RHR heat exchangers and the bypass. Mixing of the reactor coolant is maintained by this continuous circulation of reactor coolant through the RHRS. Portions of the RHRS also serve as parts of the emergency core cooling system (ECCS) during the injection and recirculation phases of a loss of coolant accident (LOCA). The RHRS is also used to transfer refueling water between the refueling cavity and the refueling water storage tank at the beginning and end of the refueling operations.

Only one RHR loop is required for decay heat removal in Mode 6, with the water level ≥ 23 ft above the top of the reactor vessel flange. Only one RHR loop is required to be operable, because the volume of water above the reactor vessel flange provides backup decay heat removal capability. At least one RHR loop must be operable and in operation to provide:

a. Removal of decay heat;

b. Mixing of borated coolant to minimize the possibility of criticality; and

c. Indication of reactor coolant temperature.

2.2 Current Technical Specifications Requirements

WBN Units 1 and 2 SR 3.9.5.1 currently state:

| SURVEILLANCE | | FREQUENCY |
|---|---|---|
| SR 3.9.5.1 | Verify one RHR loop is in operation and circulating reactor coolant at a flow rate of ≥ 2500 gpm. | In accordance with the Surveillance Frequency Control Program |

2.3 Reason for the Proposed Change

The proposed change to WBN Units 1 and 2 SR 3.9.5.1 incorporates a reduction in the minimum RHR flow requirement from 2,500 gpm to 2,000 gpm during refueling operations with high water level conditions [Mode 6 with the water level greater than or equal to (≥) 23 ft above the top of the reactor vessel flange]. The proposed change allows operation of the RHR system at reduced flow during refueling operations with high water level conditions and is consistent with similar RHR flow requirements in WBN Units 1 and 2 SR 3.9.6.1 and SQN SRs 3.9.5.1 and 3.9.6.1.

The current RHR flowrate in WBN Units 1 and 2 SR 3.9.6.1 has been in existence since the issuance of the original WBN Unit 1 TS (Reference 1) and the original WBN Unit 2 TS (Reference 2).

2.4 Description of the Proposed Change

WBN Units 1 and 2 SR 3.9.5.1 is being revised as follows:

| SURVEILLANCE | | FREQUENCY |
|---|---|---|
| SR 3.9.5.1 | Verify one RHR loop is in operation and circulating reactor coolant at a flow rate of ≥ ~~2500~~2000 gpm. | In accordance with the Surveillance Frequency Control Program |

Attachment 1 to the enclosure provides the existing WBN Units 1 and 2 TS pages marked up to show the proposed changes. There are no changes to the WBN Units 1 and 2 TS Bases.

## 3.0 TECHNICAL EVALUATION

Enclosure 2 contains Westinghouse Electric Company LLC (Westinghouse) Letter Report, LTR-SEE-23-4-P, Revision 1, “Technical Evaluation in Support of Watts Bar Units 1 & 2 Residual Heat Removal System (RHRS) Flow Rate Reduction During Mode 6 Operation at Refueling Water Level ≥ 23 Feet,” which is a technical evaluation performed by

Westinghouse to support the proposed change to WBN Units 1 and 2 SR 3.9.5.1. Enclosure 3 contains a non-proprietary version of Enclosure 2.

As noted in Enclosures 2 and 3, check valve 8948 (which is a Westinghouse valve identification number) was added to the WBN In-service Inspection Program. The corresponding TVA valve identification numbers are 1/2-CKV-63-560, 561, 562, and 563. These valves are also in the WBN Inservice Testing Program.

Additionally, TVA has not experienced any RHR pump cavitation or valve chattering at the lower flow rate and water level in SR 3.9.6.1. While at hot mid-loop with only one RHR pump in service at 2,000 gpm (SR 3.9.6.1), enough flow is provided to maintain decay heat removal from a core with a high decay heat load. Therefore, with cavity level ≥ 23 ft, there is little or no chance to cavitate a RHR pump and there is more than adequate inventory and flow to provide for decay heat removal (SR 3.9.5.1) and adequate mixing.

3.1 Conclusion

As noted in Enclosure 2, the WBN Units 1 and 2 RHR pumps will operate satisfactorily with the reduced Mode 6 flowrate as low as 2,000 gpm. TVA has determined that the reduced flowrate will have no effect on the pump's ability to operate through and after a seismic event.

## 4.0 REGULATORY EVALUATION

4.1 Applicable Regulatory Requirements and Criteria

**General Design Criteria**

WBN Units 1 and 2 were designed to meet the intent of the "Proposed General Design Criteria for Nuclear Power Plant Construction Permits" published in July 1967. The WBN construction permit was issued in January 1973. The WBN updated Final Safety Analysis Report (UFSAR), however, addresses the GDC published as Appendix A to 10 CFR 50 in July 1971. Conformance with the GDCs is described in Section 3.1.2 of the UFSAR.

Each criterion listed below is followed by a discussion of the design features and procedures that meet the intent of the criteria. Any exception to the 1971 GDC resulting from the earlier commitments is identified in the discussion of the corresponding criterion.

> *Criterion 14-Reactor coolant pressure boundary.* The reactor coolant pressure boundary shall be designed, fabricated, erected, and tested so as to have an extremely low probability of abnormal leakage, or rapidly propagating failure, and of gross rupture.

Compliance with GDC 14 is described in Section 3.1.2.2 of the WBN UFSAR.

> *Criterion 15-Reactor coolant system design. The reactor coolant system and associated auxiliary, control, and protection systems shall be designed with sufficient margin to assure that the design conditions of the reactor coolant pressure boundary are not exceeded during any condition of normal operation, including anticipated operational occurrences.*

Compliance with GDC 15 is described in Section 3.1.2.2 of the WBN UFSAR.

*Criterion 34 - Residual Heat Removal (RHR). A system to remove residual heat shall be provided. The system safety function shall be to transfer fission product decay heat and other residual heat from the reactor core at a rate such that specified acceptable fuel design limits and the design conditions of the reactor coolant pressure boundary are not exceeded.*

*Suitable redundancy in components and features, and suitable interconnections, leak detection, and isolation capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure.*

Compliance with GDC 34 is described in Section 3.1.2.4 of the WBN UFSAR.

4.2 Precedent

The proposed change is similar to a license amendment for SQN Units 1 and 2 (Reference 3), which also approved a reduction in the RHR flowrate from 2,500 gpm to 2,000 gpm for all water levels. As previously noted, the proposed change is also consistent with WBN Units 1 and 2 SR 3.9.6.1 and SQN SRs 3.9.5.1 and 3.9.6.1.

4.3 No Significant Hazards Consideration Analysis

Tennessee Valley Authority (TVA) is requesting an amendment to Facility Operating Licenses NPF-90 and NPF-96 for the Watts Bar Nuclear Plant (WBN), Units 1 and 2, respectively. The proposed change revises WBN Units 1 and 2 Technical Specification (TS) Surveillance Requirement (SR) 3.9.5.1, “Residual Heat Removal (RHR) and Coolant Circulation - High Water Level,” to revise the current flow rate of 2,500 gallons per minute (gpm) to 2,000 gpm. The proposed change is consistent with a similar SR in WBN Units 1 and 2 SR 3.9.6.1, “Residual Heat Removal (RHR) and Coolant Circulation - Low Water Level,” and Sequoyah Nuclear Plant (SQN) SRs 3.9.5.1 and 3.9.6.1.

TVA evaluated whether or not a significant hazards consideration is involved with the proposed amendments by focusing on the three standards set forth in 10 CFR 50.92, "Issuance of Amendment," as discussed below:

1. *Does the proposed amendment involve a significant increase in the probability or consequence of an accident previously evaluated?*

   **Response: No.**

   The proposed change to WBN Units 1 and 2 SR 3.9.5.1 incorporates a reduction in the minimum RHR flow requirement from 2,500 gpm to 2,000 gpm during refueling operations with high water level conditions (Mode 6 with the water level ≥ 23 ft above the top of the reactor vessel flange).

   The probability and consequence of an accident previously evaluated during Mode 6 operation is limited to fuel handling accidents, and RHR flow rate is not a consideration in fuel handling accidents. The reduction of the minimum RHR flow rate in Mode 6 should increase the availability of decay heat removal pumps and therefore be a safety enhancement.

The primary function of the RHRS is to remove decay heat during the second phase of plant cooldown. However, at reduced RHRS flowrates, the decay heat removal capacity of the RHRS will be decreased. Therefore, lower flowrates require that the reactor be shutdown for a longer period of time before the RHRS can remove all of the decay heat generated. For the same heat exchanger inlet temperature and flow rate, and component cooling water system (CCWS) supply temperature and flow rate, the elevation height of the refueling canal does not affect the amount of heat removed. Also, increased cavity levels ≥ 23 ft will increase pressure in the core and departure from nucleate boiling (DNB) margin. Thus, the impact of a refueling water level ≥ 23 ft on decay heat removal is not a safety concern.

Small variations in the refueling water level do not have a major impact on initial heatup calculations. Consequently, a water level ≥ 23 feet will also have no negative impact, as it provides additional margin.

The reactor coolant enters the reactor vessel from two cold leg nozzles, passes through the downcomer region and enters the lower plenum region. It is expected that the coolant is adequately mixed from the flow of two branch lines and therefore, the temperature across the core entrance is uniform. Thus, thermal stratification is minimized.

Reactor coolant system thermal stratification is not a concern with reduced RHR flow rate because there is no mechanism within the core to cause thermal stratification. The RHR pumps will operate satisfactorily with the reduced Mode 6 flowrates as it has been determined that the reduced flowrate will have no effect on the pump's ability to operate through and after a seismic event. Similarly, a refueling water level ≥ 23 ft will not negatively impact the conditions previously evaluated.

Therefore, the proposed change does not involve a significant increase in the probability or consequences of an accident previously evaluated.

2. *Does the proposed amendment create the possibility of a new or different kind of accident from any accident previously evaluated?*

**Response: No.**

The proposed change does not involve significant changes to the design basis of WBN. Reducing RHR flow is a manual operation from the main control room and does not include any modifications or irreversible actions.

The primary function of the RHRS is to remove decay heat during plant cooldown. Also, increased cavity levels ≥ 23 ft will increase pressure in the core and DNB margin. The elevation height of the refueling canal does not affect the amount of heat removed. Thus, the impact of a refueling water level ≥ 23 ft on decay heat removal is not a concern.

Therefore, the proposed change does not create the possibility of a new or different kind of accident from any previously evaluated.

*3. Does the proposed amendment involve a significant reduction in a margin of safety?*

**Response: No.**

The proposed reduction of the minimum RHR flow rate in Mode 6 to 2,000 gpm provides sufficient decay heat removal following shutdown at refueling water levels specified in WBN TS 3.9.5. Small variations in the water level do not have a major impact on initial heatup calculations. The possibility of thermal stratification is minimized and boron stratification will not occur.

The most limiting non-decay heat technical issues for establishing a minimum RHR flow rate during Mode 6 operation at refueling water levels ≥ 23 ft are the valve issues. Hanger pin and hanger pin assembly wear may occur because of chattering that develops at low flows. For reduced RHR flowrates, a potential exists for disc chatter against the open stop and excessive hanger pin assembly wear of the 10-inch check valve. However, check valve chatter results in audible noise which can easily be identified. Additionally, the associated check valves are in the scope of the WBN Inservice Inspection and Inservice Testing Programs. The RHR pumps will operate satisfactorily with the reduced Mode 6 flowrates.

Therefore, the proposed change does not involve a significant reduction in a margin of safety.

Based on the above, it is concluded that the proposed amendment does not involve a significant hazards consideration under the standards set forth in 10 CFR 50.92(c), and, accordingly, a finding of “no significant hazards consideration” is justified.

4.4 Conclusions

In conclusion, based on the considerations discussed above, (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

## 5.0 ENVIRONMENTAL CONSIDERATION

A review has determined that the proposed amendment would change a requirement with respect to installation or use of a facility component located within the restricted area, as defined in 10 CFR 20, or would change an inspection or surveillance requirement. However, the proposed amendment does not involve (i) a significant hazards consideration, (ii) a significant change in the types or significant increase in the amounts of any radioactive effluents that may be released offsite, or (iii) a significant increase in individual or cumulative occupational radiation exposure. Accordingly, the proposed amendment meets the eligibility criterion for categorical exclusion set forth in 10 CFR 51.22(c)(9). Therefore, pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the proposed amendment.

## 6.0 REFERENCES

1. NRC letter to TVA, “Issuance of Facility Operating License No. NPF-20, Watts Bar Nuclear Plant, Unit 1 (TAC M91489),” dated November 9, 1995 (ML020780254)
2. NRC letter to TVA, “Issuance of Facility Operating License No. NPF-96, Watts Bar Nuclear Plant, Unit 2,” dated October 22, 2015 (ML15251A587)
3. NRC letter to TVA, “Minimum Residual Heat Removal Loop Flowrate in Mode 6 (TAC 75745/75746) (TS 89-02) - Sequoyah Nuclear Plant, Units 1 and 2,” dated April 2, 1990 (ML013300379)

Enclosure 1

Attachment 1

Proposed TS Changes (Mark-Ups) for WBN Units 1 and 2

ACTIONS

| CONDITION | REQUIRED ACTION | COMPLETION TIME |
|---|---|---|
| A. (continued) | A.4 Close all containment penetrations providing direct access from containment atmosphere to outside atmosphere. | 4 hours |

SURVEILLANCE REQUIREMENTS

| SURVEILLANCE | | FREQUENCY |
|---|---|---|
| SR 3.9.5.1 | Verify one RHR loop is in operation and circulating reactor coolant at a flow rate of ≥ 2~~50~~00 gpm. | In accordance with the Surveillance Frequency Control Program |

ACTIONS

| CONDITION | REQUIRED ACTION | | COMPLETION TIME |
|---|---|---|---|
| A. (continued) | A.4 | Close all containment penetrations providing direct access from containment atmosphere to outside atmosphere. | 4 hours |

SURVEILLANCE REQUIREMENTS

| SURVEILLANCE | | FREQUENCY |
|---|---|---|
| SR 3.9.5.1 | Verify one RHR loop is in operation and circulating reactor coolant at a flow rate of ≥ 2~~5~~000 gpm. | In accordance with the Surveillance Frequency Control Program |

Enclosure 2

Westinghouse Letter Report, LTR-SEE-23-4-P, Revision 1 (Proprietary)

Enclosure 3

Westinghouse Letter Report, LTR-SEE-23-4-NP, Revision 1 (Non-Proprietary)

**Westinghouse Electric Company**

# Technical Evaluation in Support of Watts Bar Units 1 & 2 Residual Heat Removal System (RHRS) Flow Rate Reduction During Mode 6 Operation at Refueling Water Level ≥ 23 Feet

## September 5, 2023

**Author:** ***Electronically Approved****
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## 1.0 TECHNICAL ANALYSIS

An evaluation has been performed to determine the acceptability of reducing the residual heat removal (RHR) flow from 2500 to 2000 gpm while in MODE 6 with reactor vessel water level greater than or equal to 23 feet above the top of the reactor vessel flange. The following areas are evaluated to determine if the lower flow rate is acceptable:

1. The RHRS can remove decay heat such that RCS temperature can be controlled.
2. The reactor coolant is mixed such that significant thermal stratification does not occur.
3. The reactor coolant is mixed such that significant boron stratification does not occur.
4. RHR bypass flow control valve (HCV-618) potential for cavitation is reduced.
5. The RHRS check valves are maintained in a full-open position to preclude disc chatter.
6. Adequate RHR pump motor thrust bearing life margin is maintained.

As described in Technical Specification 3.9.6.1, RHR operation as low as 2000 gpm with refueling water level < 23 ft. is acceptable. The non-decay heat related technical issues evaluated (Items 2 through 6 above) are less limiting for refueling levels ≥ 23 ft. due to the increased reactor coolant inventory and increased net positive suction head for the RHR pumps.

Compared to the lower water level of <23 ft. in TS 3.9.6.1, the high water level of ≥ 23 ft. in proposed TS 3.9.5.1 improves butterfly valve backpressure which reduces cavitation. Check valve chatter is affected by flow and not by inlet or outlet pressure. The static pressure or pump suction boundary condition elevation is not a factor in bearing life.

### THERMAL CONSIDERATIONS

#### Decay Heat Removal

The primary function of the RHRS is to remove decay heat during the second phase of plant cooldown. However, at reduced RHRS flowrates, the decay heat removal capacity of the RHRS will be decreased. Therefore, lower flowrates require that the reactor be shut down for a longer period of time before the RHRS can remove all of the decay heat generated. Operators typically set RHR flow as needed to maintain desired RCS temperature. As the time after plant shutdown increases, the decay heat removal requirements for RHR flow are reduced.

For any given combination of heat exchanger inlet temperature and flow rate and component cooling water system (CCWS) supply temperature and flow rate, the elevation height of the refueling canal does not affect the amount of heat removed. Thus, the minimum RHR flow of 2000 gpm at water level ≥ 23 ft. is not a concern for decay heat removal.

#### Thermal Stratification

The potential for thermal stratification in the reactor core region at reduced RHR flowrates has been evaluated. Thermal stratification refers to the temperature gradient across the core. The evaluation assumed a maximum RCS temperature of 200°F (reactor exit temperature) and a significant residual heat load (time after shutdown plant would reduce flow is based on the capacity of the RHRS and internals

delta T) at atmospheric pressure (12°F margin). Note that increased cavity levels ≥ 23 ft. will increase pressure in the core and DNB margin.

[

]$^{a,c,e}$ Thus, it is possible for the local coolant temperature to exceed 200°F and approach the point of nucleate boiling. However, for the worst-case scenario evaluated, it was concluded that DNB would not be a concern at the Watts Bar Units 1 and 2 at a reduced RHR flowrate during MODE 6 operation (Reference 2). The reactor coolant enters the reactor vessel from two cold leg nozzles, passes through the downcomer region and enters the lower plenum region. It is expected that the coolant is adequately mixed from the flow of two branch lines and therefore, the temperature across the core entrance is uniform. Thus, thermal stratification is minimized.

In addition to potential thermal stratification, a reduction in RHR flowrate will increase the reactor coolant temperature rise through the core during RHR cooling. The decay heat load is removed by increasing the temperature of the coolant as it passes through the core. As the mass flowrate is decreased, the temperature rise must increase to maintain constant heat removal. Certain structural considerations of the reactor vessel internals limit acceptable core temperature rise. In particular, the most limiting components in terms of core temperature rise are the [

]$^{a,c,e}$

**BORON MIXING AND STRATIFICATION**

Sufficient RHR flow must be provided to maintain a uniform boron concentration throughout the RCS. “Boron stratification” refers to the localized variations in boron concentration. Boron stratification is most likely to occur in the RCS when a controlled boration (or dilution) operation is first initiated. During this operation, the RHR flow ensures mixing within the RCS volume. Thus, as RHR flow is reduced, the mixing rate decreases, and the time required to obtain a uniform RCS boron concentration increases. Typically, however, the RCS boron concentration is stabilized at the required shutdown margin prior to reducing RHR flowrate, ensuring a uniform boron concentration.

Provided that the reactor coolant is not intentionally diluted during MODE 6 operations, precipitation and local evaporation would be the most likely mechanisms for inducing a boron gradient in the reactor

vessel. However, during refueling operations the boron concentration would be in the range of 2000 ppm (under one percent concentration). Since the saturation temperature of a one percent solution is less than 32°F, boric acid precipitation would not occur (Reference 5).

**CONTROL VALVE CAVITATION**

The RHR flowrate is reduced during MODE 6 operation by fully closing the RHR bypass flow control valve (HCV-618); and then slowly closing the associated hand control valve (HCV-606 or 607). The pressure drop across the control valve (HCV-618) increases as flow is reduced. Eventually, cavitation of the reactor coolant could result. Cavitation that occurs in control valves under high pressure drop conditions is due to a portion of the liquid transforming into the vapor phase during rapid acceleration of the fluid inside the valve, and the subsequent collapse of these vapor bubbles downstream of the valve. Severe cavitation could cause excessive wear and vibration in the piping downstream of the control valve.

[

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Therefore, it may be possible to reduce the RHR flowrate below 2000 gpm without the occurrence of severe control valve cavitation. Minor cavitation may be tolerated for short periods of time (e.g., the time required to establish mid-loop operation flowrates) with minimal or negligible long-term damage. Any cavitation that would be severe enough to cause damage, would be evident due to the excessive noise and vibration in the piping downstream of the valve.

As the refueling water level increases, cavitation across the butterfly valve decreases for the same pressure drop and flow across the control valve**.** As the backpressure increases due to the refueling canal level of ≥23 feet, the backpressure on the butterfly valve is higher than the vapor pressure compared to the backpressure and vapor pressure used in the < 23 ft. level cavitation condition analyzed. If excessive vibration or audible noise is observed, it may be necessary to establish a higher minimum RHR flowrate, based on the cavitation concerns. In addition, during MODE 6 only one train of RHR is in operation. With only one train of RHR, the coolant would be returned to only two reactor coolant loops, thus providing a higher backpressure to the control valve. Notably, butterfly valve backpressure is higher when the canal is full than the analysis performed supporting TS 3.9.6.1. A higher backpressure minimizes the potential for the control valves to cavitate.

## CHECK VALVE CHATTERING

Sufficient RHR flow ensures that the check valves located within the RHRS will be maintained in a full-open position. If the RHR flowrate through the valves' is insufficient to maintain them in a full-open position, there is a potential for the following problems to occur.

- Fatigue and wear in the hanger pin assembly could result from excessive disc movement, if the disc remains in the flow stream.

- The disc may oscillate and repeatedly strike the open stop, resulting in wear of the disc assembly.

The impact of a reduced RHR flow on the operability of the check valves located within the Watts Bar RHRS has been evaluated. [

]$^{a,c,e}$.

For reduced RHR flowrates, a potential exists for disc chatter against the open stop and excessive hanger pin assembly wear of the 10-inch valve. Check valve chatter results in audible noise which can easily be identified.

Note that during the first operation at reduced RHR flowrates, the 10-inch valve was locally monitored. The effect of wear on the assembly could be detected through disassembly and visual inspection of the hanger pin. As such check valve 8948 has been added to the in-service inspection program.

## RESIDUAL HEAT REMOVAL PUMP MOTOR THRUST BEARING EVALUATION

RHR operation at 2000 gpm at refueling water level greater than or equal to 23 ft is less limiting than the seismic analysis and bearing life evaluations which support the current TS 3.9.6.1 operation at 2000 gpm with $\leq$ 23 ft. water level.

### Seismic Evaluation

A seismic evaluation of the motor thrust bearing to demonstrate that the bearing could withstand the full magnitude of the combined seismic, hydraulic and deadweight loads while operating at the reduced flow conditions has been performed.

The seismic qualification report was evaluated to confirm adherence to original analysis (Reference 4). [

]a,c,e Operation under seismic conditions was found to have an insignificant effect on the overall bearing life (Reference 7).

**Bearing Life**
The static pressure or pump suction boundary condition elevation is not a factor in bearing life.

Pump motor L10 bearing life was documented in Reference 3 to be in accordance with the original motor design. The bearing L10 life expresses how many hours a bearing is expected to last under design loads and speeds with a failure rate of 10%. Another common expression for bearing life is called bearing average life or mean time between failure (MTBF). These two expressions for bearing life are not the same, as the Mean Time Between Failure life is typically five times the L10 life. The shop order design specification utilizes pump loads from the pump OEM, Ingersoll-Rand, to dictate the bearing design and arrangement for the motor to support the rotating assembly for proper operation and bearing life. [

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[

]a,c,e

## CONCLUSION

In summary, the following areas have been evaluated and the lower RHR flow rate of 2000 gpm during Mode 6 operation at refueling water level ≥ 23 feet is found to be acceptable:

- The RHRS can remove decay heat such that RCS temperature can be controlled.
- The reactor coolant is mixed such that significant thermal stratification does not occur.
- The reactor coolant is mixed such that significant boron stratification does not occur.
- RHR bypass flow control valve (HCV-618) potential for cavitation is reduced.
- The RHRS check valves are maintained in a full-open position to preclude disc chatter.
- Adequate RHR pump motor thrust bearing life margin is maintained.

Compared to the lower water level of <23 ft. in TS 3.9.6.1, the high water level of ≥ 23 ft. in TS 3.9.5.1 improves butterfly valve backpressure which reduces cavitation. Check valve chatter is affected by flow and not by inlet or outlet pressure. The static pressure or pump suction boundary condition elevation is not a factor in bearing life.

The most limiting criteria for establishing a minimum RHR flowrate of 2000 gpm at water level ≥ 23 feet are the valve issues. As additional conservative measures, the following actions were taken to accommodate low flow operations for Watts Bar Units 1 and 2:

1. The 10-inch check valve (i.e., Check valve 8948) was monitored during the first time RHR flowrate was reduced to a value below 2500 gpm.
2. Check valve 8948 was added to the Watts Bar in-service inspection Program.

## 2.0 REFERENCE DOCUMENTS

1. Westinghouse WCAP-11916, “Loss of RHRS Cooling while the RCS is Partially Filled,” Revision 0, July 1988.
2. FSSE/CWBS-1145, “RHRS Operation During Midloop at Watts Bar,” December 7, 1989.
3. Westinghouse Letter No. LTR-RES-21-76, “Watts Bar Residual Heat Removal (RHR) Pump Motor Bearing Life,” July 6, 2021.
4. BUFFALO LMD Shop Order 74F2682, “Seismic Analysis of Residual Heat Removal Pump Motors for Watts Bar No. 1 & 2 Nuclear Stations Tennessee Valley Authority Manufactured on S.O. Numbers 74F12184,” May 30, 1975.
5. Westinghouse Letter No. WAT-D-8252, “Tennessee Valley Authority Watts Baur Units Number 1 and 2 Minimum RHRS Flow Rate During Midloop Operation Safety Evaluation (SECL-89-893), June 1990.
6. Westinghouse Equipment Specification Number 678815. Revision 2.
7. Westinghouse WNEP-8402, “Generic Stress Report of 3 Loop XL Reactor Core Support Structures –Structural and Fatigue Analysis,” September 2008.

Enclosure 4

Westinghouse Electric Company LLC Application for Withholding Proprietary Information from Public Disclosure (Affidavit CAW-23-033)

Commonwealth of Pennsylvania:
County of Butler:

(1) I, Zachary Harper, Manager, Licensing Engineering, have been specifically delegated and authorized to apply for withholding and execute this Affidavit on behalf of Westinghouse Electric Company LLC (Westinghouse).

(2) I am requesting the proprietary portions of LTR-SEE-23-4-P, Revision 1, "Technical Evaluation in Support of Watts Bar Units 1 & 2 Residual Heat Removal System (RHRS) Flow Rate Reduction During Mode 6 Operation at Refueling Water Level ≥ 23 Feet," be withheld from public disclosure under 10 CFR 2.390.

(3) I have personal knowledge of the criteria and procedures utilized by Westinghouse in designating information as a trade secret, privileged, or as confidential commercial or financial information.

(4) Pursuant to 10 CFR 2.390, the following is furnished for consideration by the Commission in determining whether the information sought to be withheld from public disclosure should be withheld.

(i) The information sought to be withheld from public disclosure is owned and has been held in confidence by Westinghouse and is not customarily disclosed to the public.

(ii) The information sought to be withheld is being transmitted to the Commission in confidence and, to Westinghouse's knowledge, is not available in public sources.

(iii) Westinghouse notes that a showing of substantial harm is no longer an applicable criterion for analyzing whether a document should be withheld from public disclosure. Nevertheless, public disclosure of this proprietary information is likely to cause substantial harm to the competitive position of Westinghouse because it would enhance the ability of competitors to provide similar technical evaluation justifications and licensing defense services for commercial power reactors without commensurate expenses. Also, public disclosure of the information would enable others to use the information to meet NRC requirements for licensing documentation without purchasing the right to use the information.

(5) Westinghouse has policies in place to identify proprietary information. Under that system, information is held in confidence if it falls in one or more of several types, the release of which might result in the loss of an existing or potential competitive advantage, as follows:

(a) The information reveals the distinguishing aspects of a process (or component, structure, tool, method, etc.) where prevention of its use by any of Westinghouse's competitors without license from Westinghouse constitutes a competitive economic advantage over other companies.

(b) It consists of supporting data, including test data, relative to a process (or component, structure, tool, method, etc.), the application of which data secures a competitive economic advantage (e.g., by optimization or improved marketability).

(c) Its use by a competitor would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing a similar product.

(d) It reveals cost or price information, production capacities, budget levels, or commercial strategies of Westinghouse, its customers or suppliers.

(e) It reveals aspects of past, present, or future Westinghouse or customer funded development plans and programs of potential commercial value to Westinghouse.

(f) It contains patentable ideas, for which patent protection may be desirable.

(6) The attached documents are bracketed and marked to indicate the bases for withholding. The justification for withholding is indicated in both versions by means of lower-case letters (a) through (f) located as a superscript immediately following the brackets enclosing each item of information being identified as proprietary or in the margin opposite such information. These lower-case letters refer to the types of information Westinghouse customarily holds in confidence identified in Sections (5)(a) through (f) of this Affidavit.

I declare that the averments of fact set forth in this Affidavit are true and correct to the best of my knowledge, information, and belief. I declare under penalty of perjury that the foregoing is true and correct.

Executed on: 9/6/2023

Signed electronically by
Zachary Harper