TENNESSEE VALLEY AUTHORITY
1101 Market Street, Chattanooga, Tennessee 37402

CNL-24-016

January 10, 2024

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: **Supplement to 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) (EPID L-2023-LLA-0152)**

Reference: TVA letter to NRC, CNL-23-016, "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)," dated October 30, 2023 (ML23303A095)

In the referenced letter, Tennessee Valley Authority (TVA) submitted 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 2 to the referenced letter contained 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 contained 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 to the referenced letter contained a non-proprietary version of Enclosure 2.

Following the submittal of the referenced letter, TVA was verbally notified by the NRC of the following inconsistencies regarding the proprietary markings in Enclosures 2 and 3:

- On page 3 of 8 of Enclosures 2 and 3 the following text is marked as proprietary: "As noted above, 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." However, on page 2 of 8 of Enclosures 2 and 3, similar text is marked as non-proprietary.

Proprietary Information Withhold Under 10 CFR § 2.390
This letter is decontrolled when separated from Enclosure 1

- On page 3 of 8 of Enclosures 2 and 3, there is a quoted text from WCAP-11916 that is marked as proprietary, but similar text on page 3-163 of WCAP-11916 is non-proprietary.

Enclosure 1 to this submittal contains Westinghouse Electric Company LLC (Westinghouse) Letter Report, LTR-SEE-23-4-P, Revision 2, "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 corrects the proprietary markings noted above. All changes are identified by a revision bar in the left-hand margin of the affected page.

Enclosure 1 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 2 contains a non-proprietary version of Enclosure 1. Enclosure 3 provides the Westinghouse Application for Withholding Proprietary Information from Public Disclosure CAW-23-047 affidavit supporting this 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 Title 10 of the *Code of Federal Regulations* (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-23-047 and should be addressed to Camille T. Zozula, Manager, Regulatory Compliance & Corporate Licensing.

This letter does not change the environmental considerations contained in the referenced letter. In accordance with 10 CFR 50.91(b)(1), TVA is sending a copy of this letter and the enclosure to the Tennessee Department of Environment and Conservation.

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 10th day of January 2024.

Respectfully,

Kimberly D. Hulvey
Digitally signed by Edmondson, Carla
Date: 2024.01.10 10:34:34 -05'00'

Kimberly D. Hulvey
Director, Nuclear Regulatory Affairs

Enclosures

cc: See Page 3

Enclosures

1. Westinghouse Letter Report, LTR-SEE-23-4-P, Revision 2 (Proprietary)
2. Westinghouse Letter Report, LTR-SEE-23-4-NP, Revision 2 (Non-Proprietary)
3. Westinghouse Electric Company LLC Application for Withholding Proprietary Information from Public Disclosure (Affidavit CAW-23-047)

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

Westinghouse Letter Report, LTR-SEE-23-4-P, Revision 2 (Proprietary)

Enclosure 2

Westinghouse Letter Report, LTR-SEE-23-4-NP, Revision 2 (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

December 13, 2023

Author: ***Electronically Approved****
Shaun M. Smith
Fluid Systems and Procedures

Verifier: ***Electronically Approved****
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*Electronically approved records are authenticated in the Electronic Document Management System

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.

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]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 As noted above, 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.

Section 3.10.1 of WCAP-11916 (Reference 1), “Plant Specific Determination of Heatup Rate and Time to Saturation”, demonstrated that previous heat-up calculation results can be altered accounting only for changes in the upper plenum water to reflect changes due to variations in the RCS water level. Based on the data provided for a 4-loop plant, a 6-inch increase would cause a 5% decrease in the initial heatup rate and a corresponding increase in the time to saturation. Thus, small variations in the water level do not have a major impact on initial heatup. Consequently, a water level ≥ 23 feet will also have no negative impact, as it provides additional margin.

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. [

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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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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 3

Westinghouse Electric Company LLC Application for Withholding Proprietary Information from Public Disclosure (Affidavit CAW-23-047)

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 2, "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: 12/14/2023

Signed electronically by
Zachary Harper