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

February 9, 2021

Mr. James Barstow
Vice President, Nuclear Regulatory Affairs
and Support Services
Tennessee Valley Authority
1101 Market Street, LP 4A-C
Chattanooga, TN 37402-2801

SUBJECT: WATTS BAR NUCLEAR PLANT, UNIT 2 - ISSUANCE OF AMENDMENT NO. 48 REGARDING USE OF ALTERNATE PROBABILITY OF DETECTION VALUES FOR BEGINNING OF CYCLE IN SUPPORT OF OPERATIONAL ASSESSMENT (EPID L-2020-LLA-0273)

Dear Mr. Barstow:

The U.S. Nuclear Regulatory Commission (Commission) has issued the enclosed Amendment No. 48 to Facility Operating License No. NPF-96 for the Watts Bar Nuclear Plant (Watts Bar), Unit 2. This amendment is in response to your application dated December 23, 2020, as supplemented by letter dated January 19, 2021.

This amendment revises the Watts Bar Updated Final Safety Analysis Report to apply alternate eddy current probability of detection values to indications of axial outer diameter stress corrosion cracking at tube support plates in the Watts Bar, Unit 2, steam generators for the beginning of cycle voltage distribution in support of the Watts Bar, Unit 2, operational assessment.

A copy of our related safety evaluation is also enclosed. Notice of issuance will be included in the Commission's monthly *Federal Register* notice.

Sincerely,

/RA/

Kimberly J. Green, Senior Project Manager
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-391

Enclosures:
1. Amendment No. 48 to NPF-96
2. Safety Evaluation

cc: Listserv

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

TENNESSEE VALLEY AUTHORITY

DOCKET NO. 50-391

WATTS BAR NUCLEAR PLANT, UNIT 2

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 48
License No. NPF-96

1. The U.S. Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment by Tennessee Valley Authority (TVA, the licensee) dated December 23, 2020, as supplemented by letter dated January 19, 2021, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, by Amendment No.48, the license is amended to authorize revision to the Updated Final Safety Analysis Report (UFSAR), as set forth in the application dated December 23, 2020, as supplemented by letter dated January 19, 2021. The licensee shall update the UFSAR to incorporate the new probability of detection values as described in the licensee's application, as supplemented, and the NRC staff's safety evaluation enclosed with this amendment.

3. This license amendment is effective as of the date of its issuance, and shall be implemented by February 14, 2021. The UFSAR changes shall be implemented in the next periodic update to the UFSAR in accordance with 10 CFR 50.71(e).

FOR THE NUCLEAR REGULATORY COMMISSION

Undine S. Shoop

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Date: 2021.02.09 15:31:46 -05'00'

Undine S. Shoop, Chief
Plant Licensing Branch II-2
Division of operating Reactor Licensing
Office of Nuclear Reactor Regulation

Date of Issuance: February 9, 2021

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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 48 TO FACILITY OPERATING LICENSE NO. NPF-96

TENNESSEE VALLEY AUTHORITY

WATTS BAR NUCLEAR PLANT, UNIT 2

DOCKET NO. 50-391

1.0 INTRODUCTION

By letter dated December 23, 2020 (Reference 1), as supplemented by letter dated January 19, 2021 (Reference 2), the Tennessee Valley Authority (TVA, the licensee), submitted a license amendment request (LAR) to revise the Watts Bar Nuclear Plant (Watts Bar), dual-unit Update Final Safety Analysis Report (UFSAR). The requested changes would revise UFSAR Section 5.5.2.4, "Test and Inspections," for Watts Bar, Unit 2 only, to introduce the new probability of detection (POD) values to evaluate the results of eddy current inspections performed on steam generator (SG) tubes in accordance with the Generic Letter (GL) 95-05 (Reference 3) alternate repair criteria (ARC) in Technical Specifications (TS) 5.7.2.12.2.

The supplement dated January 19, 2021, provided additional information that clarified the application, did not expand the scope of the application as originally noticed, and did not change the U.S. Nuclear Regulatory Commission (NRC, Commission) staff's original proposed no significant hazards consideration determination as published in the *Federal Register* on January 8, 2021 (86 FR 1545).

2.0 REGULATORY EVALUATION

2.1 System Description

The tubes within a SG function as an integral part of the reactor coolant pressure boundary (RCPB) and, in addition, isolate fission products in the primary coolant from the secondary coolant and the environment. For the purposes of this safety evaluation, SG tube integrity means the tubes are capable of performing this safety function in accordance with the plant design and licensing basis.

2.2 Licensee's Requested Changes

The licensee requested NRC approval to modify Section 5.5.2.4 of the Watts Bar dual-unit UFSAR for Watts Bar, Unit 2 only, to specify plant-specific values of the POD for eddy current

bobbin probe indications of axial outside diameter stress corrosion cracking (ODSCC) in SG tubes at intersections with tube support plates (TSPs). Use of the alternative, i.e., plant-specific, POD values, is considered to be an exception to GL 95-05.

2.3 Regulatory Requirements and Guidance

The NRC staff considered the following regulations and guidance during its review of this amendment.

Fundamental regulatory requirements with respect to the integrity of the SG tubing are established in Title 10 *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization." Specifically, the general design criteria (GDC) in Appendix A to 10 CFR Part 50 provide regulatory requirements that state, in part, the RCPB shall have "an extremely low probability of abnormal leakage and of gross rupture" (GDC 14), "shall be designed with sufficient margin" (GDCs 15 and 31), shall be of "the highest quality standards practical" (GDC 30), and shall be designed to permit "periodic inspection and testing…to assess…structural and leak tight integrity" (GDC 32).

Section 50.55a, "Codes and standards," of 10 CFR, specifies that components that are part of the RCPB must meet the requirements for Class 1 components in Section III of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), except as provided in 10 CFR 50.55a(c)(2), (3), and (4). Section 50.55a further requires that throughout the service life of pressurized-water reactor (PWR) facilities like Watts Bar, Unit 2, ASME Code Class 1 components must meet the Section XI requirements of the ASME Code to the extent practical, except for design and access provisions, and pre-service examination requirements. This requirement includes the inspection and repair criteria of Section XI of the ASME Code. The Section XI requirements pertaining to in-service inspection of SG tubing are augmented by additional requirements in the TS.

Section 182(a) of the Atomic Energy Act requires nuclear power plant operating licenses to include TS as part of any license. In 10 CFR 50.36, "Technical specifications," the NRC regulatory requirements related to the content of the TS are established. The TSs for all current PWR licenses require that an SG Program be established and implemented to ensure that SG tube integrity is maintained. Programs established by the licensee, including the SG Program, are listed in the administrative controls section of the TS to operate the facility in a safe manner.

GL 95-05 provides guidance to licensees who may wish to request a license amendment to the plant TSs to implement alternate SG tube repair criteria applicable specifically to ODSCC at the tube-to-tube support plate intersections in Westinghouse-designed steam generators having drilled-hole TSPs and alloy 600 tubing. The GL 95-05 guidance relies on empirically derived correlations between a nondestructive inspection parameter (eddy current bobbin probe voltage) and tube burst pressure and leak rate. Although the total tube integrity margins may be reduced following application of a voltage-based repair criteria, the guidance in GL 95-05 ensures structural and leakage integrity continue to be maintained at acceptable levels, consistent with the requirements of 10 CFR Part 50 and 10 CFR Part 100, "Reactor Site Criteria." Since the voltage-based repair criteria do not require minimum tube wall thickness, tubes with through-wall cracks might remain in-service. The NRC staff included provisions for augmented SG tube inspections and restrictive operational leakage limits because of the increased likelihood of such flaws.

3.0 TECHNICAL EVALUATION

3.1 Background

For Watts Bar, Unit 2, the requirements for performing SG tube inspections and plugging are in TS 5.7.2.12, "Steam Generator (SG) Program," while the requirements for reporting the SG tube inspections and plugging are in TS 5.9.9, "Steam Generator Tube Inspection Report." SG tube integrity is maintained by meeting the performance criteria specified in TS 5.7.2.12.b for structural and leakage integrity, consistent with the plant design and licensing basis. TS 5.7.2.12.a requires that a condition monitoring assessment be performed during each outage in which the SG tubes are inspected, to confirm that the performance criteria are being met. TS 5.7.2.12.d includes provisions regarding the scope, frequency, and methods of SG tube inspections. These provisions require that the inspections be performed with the objective of detecting flaws of any type that may be present along the length of a tube, and that may satisfy the applicable tube plugging criteria.

The applicable depth-based tube plugging criterion, specified in TS 5.7.2.12.c.1, is that tubes found during in-service inspection to contain flaws with a depth equal to or exceeding 40 percent of the nominal wall thickness shall be plugged. Watts Bar, Unit 2 also has an ARC, specified in TS 5.7.2.12.c.2, to apply the criteria for voltage-based plugging limits for axial ODSCC contained in GL 95-05. GL 95-05 applies only to predominantly axially oriented ODSCC at tube-to-TSP intersections in Westinghouse-designed SGs with Alloy 600 tubes and drilled-hole TSPs. The NRC reviewed and approved the use of this ARC at Watts Bar, Unit 2 on June 3, 2019 (Reference 4). The licensee implemented the ARC at Watts Bar, Unit 2 for the first time during the Unit 2 Refueling Outage 3 (U2R3) in fall 2020. TS 5.9.9 includes reporting criteria specific to the GL 95-05 ARC.

Requirements related to SG tube and leakage integrity are also contained in TSs 3.4.13, "RCS Operational LEAKAGE," and TS 3.4.17, "Steam Generator (SG) Tube Integrity." TS 3.4.17 requires SG tube integrity to be maintained, and tubes meeting the tube repair criteria are to be plugged in accordance with the SG Program. TS 3.4.13 includes a limit on operational primary-to-secondary leakage, beyond which the plant must be promptly shutdown. Should a flaw exceeding the tube plugging limit not be detected during the periodic tube in-service inspection required by the plant TS, the operational leakage limit provides added assurance of timely plant shutdown before tube structural and leakage integrity are impaired, should such a flaw result in primary-to-secondary leakage.

As part of the plant's licensing basis, applicants for PWR licenses are required to analyze the consequences of postulated design-basis accidents, such as a SG tube rupture and a steam line break. These analyses consider primary-to-secondary leakage that may occur during these events and must show that the radiological consequences do not exceed the applicable limits of 10 CFR 50.67, "Accident source term," or 10 CFR 100.11, "Determination of exclusion area, low population zone, and population center distance," for offsite doses; GDC 19 of 10 CFR Part 50, Appendix A for control room operator doses (or some fraction thereof as appropriate to the accident); or the NRC-approved licensing basis (e.g., a small fraction of these limits). No accident analyses for Watts Bar, Unit 2 are being changed because of the proposed amendment and, thus, no radiological consequences of any accident analysis are being changed. The proposed changes maintain the accident analyses and consequences that the NRC has reviewed and approved for the postulated design-basis accidents for SG tubes.

3.1.1 Steam Generator Design

The four Model D3 SGs at Watts Bar, Unit 2 were designed by Westinghouse. Each SG contains 4,674 mill-annealed Alloy 600 tubes with a nominal outside diameter of 0.75 inches and a nominal wall thickness of 0.043 inches. The tubes are supported by anti-vibration bars (AVBs) and carbon steel drilled TSPs. Each SG has an integral preheater section with flow distribution baffle (FDB) plates.

3.1.2 Inspection Experience

Fall 2017 and Spring 2019 Inspections

During the Unit 2 Refueling Outage 1 (U2R1) inspection in fall 2017 (Reference 5), primary-side eddy current inspections were performed over the full length of the in-service tubes in each SG using a combination of bobbin probes, array probes, and +Point™ rotating probes. Primary side visual inspections of installed tube plugs, the divider plate to channel head weld, and all visible clad surfaces were performed in the hot leg and cold leg sides of the channel head of each SG. On the secondary-side, visual inspections were performed in all SGs to evaluate the effectiveness of the cleaning process in removing deposits and foreign objects at the top of the tubesheet. In addition, foreign object search and retrieval (FOSAR) was performed in all four SGs at the top of the tubesheet, and visual inspection of the upper internals was performed in SG1 and SG4.

The only degradation mechanisms detected in U2R1 were wear at TSPs and AVBs. No tubes were plugged because of wear, but a total of eight tubes were plugged as a result of a pre-service volumetric indication (one tube), a permeability variation with the potential to mask degradation signals (one tube), restrictions in the tube that complicated inspection (two tubes), and a foreign object that was lodged between tubes and could not be retrieved (four tubes). No wear was detected from the foreign object, which was identified as weld slag. Because 72 tubes were plugged prior to service, the cumulative number of tubes plugged following U2R1 was 80.

During the Unit 2 Refueling Outage 2 (U2R2) inspection in spring 2019 (Reference 6), the primary side and secondary-side inspections were the same as in the U2R1 outage, except visual inspection of upper internals was performed in SG2 and SG3. The following degradation mechanisms were detected: wear at tube support structures (both TSPs and AVBs), circumferential ODSCC at the hot leg top-of-tubesheet (TTS), and axial ODSCC at TSPs. With respect to axial ODSCC at TSPs, which is the degradation mechanism addressed by GL 95-05, eight indications were detected in eight different tubes. Because the GL 95-05 ARC was not yet implemented during the U2R2 outage, all eight tubes were plugged. Five tubes were plugged due to circumferential ODSCC at the hot leg TTS, and one tube with a volumetric pre-service indication was plugged. Therefore, a total of 14 tubes were plugged during the U2R2 outage, resulting in a cumulative total of 94 tubes plugged among the four SGs.

Fall 2020 Inspection

As documented in a summary of two conference calls between the NRC staff and the licensee during the Unit 2 Refueling Outage 3 (U2R3) inspections in fall 2020 (Reference 7), the scope of the inspections was approximately the same as that of the first two inspections. The primary-side eddy current inspections were conducted with a combination of bobbin probes, array probes, and +Point™ rotating probes. Visual inspection was performed in the primary

channel head, including visible clad surfaces and the divider plate to channel head weld. Secondary-side sludge lancing, visual inspections, and FOSAR were performed in all four SGs.

The amount of degradation in the SG tubes increased during the third operating cycle. The degradation mechanisms detected in the U2R3 inspections included the previously detected mechanisms – wear from tube support structures, circumferential ODSCC at the hot leg TTS, and axial ODSCC at TSPs – as well as SCC mechanisms detected for the first time. The newly detected mechanisms were axial ODSCC at the hot leg TTS, axial primary water stress corrosion cracking at the hot leg TTS, circumferential ODSCC at freespan dings, axial ODSCC at freespan dings, and axial ODSCC at the FDB. At the time of the first call, which was conducted when the inspections were approximately 99 percent complete, the licensee identified 191 tubes that would be plugged and 71 tubes that would be stabilized. The GL 95-05 ARC is applicable to most of the indications of ODSCC detected in U2R3 at the TSPs and FDB, and the ARC was implemented to allow the tubes with those indications to remain in-service if they met the GL 95-05 structural and leakage integrity criteria. The GL 95-05 criteria and application to the U2R3 inspection are discussed below in Sections 3.1.3 and 3.1.4.

3.1.3 GL 95-05 Criteria

The GL 95-05 voltage-based ARC for axial ODSCC at TSPs and FDB is applied by using axial ODSCC indication voltages from eddy current bobbin probe inspection in probabilistic analyses relating voltage to the conditional burst probability and leakage probability under conditions of a postulated main steam line break event. To relate voltage to burst and leakage, the licensee uses the empirically derived correlation in WCAP-14277, Revision 1 (Reference 8). Use of this methodology was included in the approval to implement the GL 95-05 ARC at Watts Bar, Unit 2 (Reference 4). The performance criterion in GL 95-05 for conditional burst probability is a maximum of $1x10^{-2}$, and the criterion for leakage is the allowable limit determined in the plant's accident analysis.

Based on the results of each SG inspection, the licensee is required to perform these analyses of conditional burst probability and leakage to determine if the acceptance limits were met during the just-completed operating cycle (condition monitoring), and to ensure they will be met during the next operating cycle (operational assessment). These analyses utilize Monte Carlo statistical analysis techniques and indication voltage distributions for both condition monitoring and operational assessment. The operational assessment uses, in part, an indication voltage distribution at the beginning of cycle (BOC) and a voltage growth rate distribution to project the end-of-cycle (EOC) voltage distribution. The projected EOC voltage distribution is then used with the empirically derived correlations between the voltage (i.e., bobbin coil voltage) and tube burst pressure and leak rate to ensure the acceptance limits are met. The indication voltage distribution at BOC is based on consideration of all bobbin indications identified during that outage. This POD is used, in part, to account for missed indications (i.e., present but not detected). GL 95-05 states that a POD of 0.6 should be assumed unless an alternative POD function is approved by the NRC.

3.1.4 GL 95-05 Application to the Fall 2020 Inspection

Applying the GL 95-05 criteria following the U2R3 inspection, the licensee calculated a conditional burst probability of $3x10^{-2}$ for SG3, based on the bobbin probe voltage for the axial ODSCC indications at TSP intersections. As a result of exceeding the condition monitoring acceptance criterion of $1x10^{-2}$ for conditional burst probability, the licensee reported this to the NRC in Licensee Event Report 2020-004-00 on January 7, 2021 (Reference 9). The conditional

burst probability for the other three SGs and the calculated leakage rates for all four SGs met the performance criteria.

The GL 95-05 criteria include a determination of the upper voltage repair limit for each inspection. This is based on allowing for flaw growth and voltage measurement uncertainty. During a public teleconference with the NRC staff on November 17, 2020, TVA reported that there were 14 indications with voltages greater than the U2R3 2.8-volt upper repair limit (Reference 10). The indications with voltages higher than the upper repair limit caused the conditional burst probability to exceed $1x10^{-2}$ at the end-of-Cycle 3. All the tubes with indications exceeding the upper voltage repair limit were plugged.

Although the tubes with voltage indications greater than the upper voltage repair limit were plugged, the indications are included in the calculation for the distribution of indications at the BOC for Cycle 4, which is used for projecting EOC voltage distribution, probability of burst, and leakage. With a POD of 0.6 in the projections, the conditional burst probability criterion would be met for only a short period of operation. Therefore, in its December 23, 2020, LAR, the licensee requested the use of alternative POD values that more accurately reflect the higher detectability of voltage indications greater than the upper repair limit, and thereby enable a longer period of operation before performing a mid-cycle inspection.

3.2 Proposed FSAR Changes

The application of GL 95-05 for Watts Bar, Unit 2 currently requires the use of a POD of 0.6 for all indications based on the criteria in the GL. However, in general, POD increases with the voltage signal from an eddy current flaw indication. For axial ODSCC at TSPs, studies of both actual flaws in tubes removed from SGs and simulated flaws have shown POD increases with indication voltage (References 11 and 12). The licensee requested approval of the following POD values according to the indication bobbin voltage amplitude (peak-to-peak):

- POD 0.6 for indications less than 3.2 volts
- POD 0.9 for indications greater than or equal to 3.2 volts and less than 6.0 volts
- POD 0.95 for indications greater than or equal to 6.0 volts

The licensee's basis for the proposed POD values is described and evaluated in Section 3.3 below, and the values would be used until replacement of the SGs, which is planned for the Unit 2 Refueling Outage 4 (U2R4) in spring 2022. The licensee presented its plans for license amendment requests related to the SG replacement in a public meeting on January 21, 2021 (Reference 13). Using these PODs, the licensee calculated an operating time of approximately 270 calendar days before the conditional burst probability would be exceeded.

The licensee requested that these alternative POD values be approved as a revision to Section 5.5.2.4 of the dual-unit UFSAR, immediately following the existing description of the approval of the GL 95-05 ARC for Unit 2 only. If approved, the revision would include a reference to the NRC letter issuing the license amendment for use of the alternative POD values. The proposed UFSAR wording is as follows, in which Reference 26 would be the amendment issuance letter:

> As an alternative to the probability of detection of 0.6 required by GL 95-05, a probability of detection (POD) of 0.9 will be applied to indications of axial ODSCC at tube support plates with bobbin voltage amplitudes of greater than or equal to 3.2 volts, but less than 6.0 volts, and a POD of 0.95 will be applied to indications

of axial ODSCC at tube support plates with bobbin voltage amplitudes of greater than or equal to 6.0 volts until the Unit 2 Steam Generators are replaced(26). A POD of 0.6, in accordance with GL 95-05, will be used for indications less than 3.2 volts.

3.3 Staff Evaluation of Proposed UFSAR Changes

3.3.1 Precedents for GL 95-05 Alternative POD

The application of a POD to the distribution of indications found during an inspection accounts for potential flaws that were present but not detected in the inspection and would therefore be returned to service. The use of a constant POD of 0.6, as specified in GL 95-05, is conservative in that it does not account for the increase in POD with increasing indication voltage. As a precedent for the use of a plant-specific GL 95-05 POD, the licensee referenced the NRC approval of a POD of 1.0 for one 21.5-volt indication at the Diablo Canyon Power Plant, Unit 2 in 2003 (Reference 14). In that review, the NRC staff concluded that it is unlikely that an indication of this voltage would be missed in an inspection.

The licensee also referenced an industry database report on axial ODSCC at TSPs published by the Electric Power Research Institute (EPRI) that includes an alternative POD function for GL 95-05 evaluations called the Probability of Prior Cycle Detection (POPCD) method (Reference 11). POPCD considers the number of indications reported in the prior inspection and the total found in the current inspection to determine the POD at the current inspection. The Watts Bar, Unit 2 U2R3 inspection did not meet the criteria in the EPRI report for applying POPCD; however, the licensee also referred to the EPRI database for the summary of detection as a function of voltage. The database shows there were no newly detected indications found by reanalysis to have a prior voltage greater than 3.2 volts, meaning no bobbin probe indications greater than 3.2 volts were missed. This is the licensee's basis for proposing 3.2 volts as a threshold value for applying a POD greater than 0.6. The licensee proposed the second POD threshold of 6.0 volts based on having only four indications with voltages above that value, and the higher detectability with higher voltage.

3.3.2 Staff Evaluation of Proposed POD Values

POD Methodology

The NRC staff reviewed the alternative POD methodology in Enclosures 1-3 of the LAR. The licensee described a process to use the POD, and signal-to-noise ratio (S/N) of the EPRI qualified eddy current examination technique to calculate a POD curve for Watts Bar, Unit 2 based on the U2R3 indication voltages and S/N. The voltage indications reported for the U2R3 inspection of axial ODSCC at TSPs are peak-to-peak amplitude (V_{pp}) values measured using Examination Technique Specification Sheet (ETSS) I28411. This examination technique, which is specifically for detection of this degradation mechanism, was developed using tubes pulled from SGs at multiple plants and ten teams of analysts.

The licensee used the tube noise data and indication voltages from the development of ETSS I28411 to determine the POD of ETSS I28411 as a function of S/N. The licensee then determined the relationship between the U2R3 V_{pp} and maximum vertical amplitude (V_{vm}) indication values because noise was measured as V_{vm} and indication voltages are reported as V_{pp} according to the technique. Using all the axial ODSCC indications from all four SGs in U2R3, the relationship was found to be linear, and the regression uncertainty was applied to the

POD function. The V_{pp}-V_{vm} relationship was used to convert indication voltages (in V_{pp}) to V_{vm} values and calculate S/N values for the U2R3 inspection data using the V_{vm} noise values.

By relating the V_{pp} indication signals to the S/N values for the U2R3 inspection and relating the S/N to POD in the ETSS I28411 data, the licensee could relate POD for the U2R3 inspection to the V_{pp} indication voltage in a way that incorporates the uncertainty from noise. This was done by Monte Carlo simulation using the U2R3 SG3 TSP noise distribution, the POD-S/N function from ETSS I28411, and the V_{pp}-V_{vm} linear regression as inputs. The simulation used the noise from the SG3 hot leg because it had the highest noise values among the four SGs. In addition to sampling the SG3 noise, the simulation accounted for uncertainty by incorporating the standard error in the V_{pp}-V_{vm} linear regression and using the 95 percent lower bound confidence POD in the ETSS POD-S/N function.

The result of the simulation is a POD as a function of V_{pp} that accounts for uncertainties in the qualified inspection technique data (ETSS I28411), the V_{pp}-V_{vm} regression, and the noise from the Watts Bar, Unit 2, SG3 hot leg TSPs. The licensee used this POD function to specify the alternative POD values proposed for Watts Bar, Unit 2.

Proposed POD Values Derived from the Methodology

Figure 4 of Enclosure 3 to the LAR illustrates the function (smooth blue curve) relating the 95 percent lower bound POD to indication voltage for Watts Bar, Unit 2 using the eddy current noise for SG3. Figure 4 also shows the red stepped function representing the licensee's proposed alternative POD values for Watts Bar, Unit 2. The licensee's proposed POD values are related to the indications from the U2R3 inspection that limit plant operating time when a POD of 0.6 is used in the GL 95-05 projected EOC flaw distribution. As noted in Section 3.3.1 above, the licensee proposed 3.2 volts as a threshold voltage based on the industry database (Reference 11) that reports no indications larger than 3.2 volts were missed in plant inspections. The licensee indicated the selection of 6.0 volts as a threshold was a judgment based on the small number of indications with that voltage and the large size of such signals.

Table 1 below is based on Table 1 in Enclosure 1 of the LAR and lists the indications from the U2R3 inspection with bobbin voltages 3.2 volts and higher. All these tubes were plugged as required based on the indications exceeding the upper voltage repair limit of 2.8 volts calculated according to the GL 95-05 methodology. Table 1 shows that the proposed POD value of 0.90 would apply to six indications from 3.21 volts to 5.13 volts, and the proposed POD value of 0.95 would apply to four indications from 6.06 to 9.35 volts.

Table 1: Watts Bar Unit 2 Fall 2020 (U2R3) SG Indications ≥3.21 volts

SG	Row	Column	Support Plate	Bobbin Voltage, V_{pp}	Proposed POD
3	17	54	Hot leg 01	9.35	0.95
3	12	111	Hot leg 02	8.03	0.95
3	17	46	Hot leg 02	6.87	0.95
4	6	36	Hot leg 02	6.06	0.95
3	17	47	Hot leg 02	5.13	0.90
3	14	7	Hot leg 02	4.83	0.90
3	7	62	Hot leg 02	3.83	0.90
2	40	53	Hot leg 03	3.82	0.90
3	4	109	Hot leg 03	3.64	0.90
3	48	57	Hot leg 02	3.21	0.90

Referring to the POD curve in Figure 4 of Enclosure 3 of the LAR, the proposed alternative POD values are conservative with respect to the curve. That is, at the threshold values of 3.2 volts and 6.0 volts, the POD values the licensee proposed in the LAR are lower than the lower bound 95 percent POD values developed for Watts Bar, Unit 2. For all indications less than 3.2 volts, the licensee proposed to continue using the GL 95-05 POD value of 0.6.

To supplement the POD curve, in Section 2.2 of Enclosure 3, "Data Union Software (DUS) Flaw Injection," the licensee assessed the ability to identify complex eddy current indication signals in the presence of high eddy current noise. Injecting the 3.21-volt and 6.06-volt indication signals from the U2R3 inspection (listed in Table 1 above) into the eddy current data for tubes with the highest noise showed that the indications could be readily discerned. The information in Section 2.3.1 of Enclosure 3, "Comparison to Generic Industry POPCD," showed that the licensee's methodology for the proposed PODs bounds the generic POPCD methodology.

NRC Evaluation Summary of Proposed POD Values

The NRC staff finds the proposed POD values acceptable based on the licensee's methodology for the site-specific POD function, the supplemental information provided about the proposed POD, the industry experience with detection of axial ODSCC at TSPs, and NRC-sponsored testing of detection of laboratory-produced axial ODSCC at TSPs. The probabilistic methodology the licensee used to develop the site-specific POD curve is based on the indication and eddy current noise data in the qualified industry inspection technique (ETSS I28411) used for detection of axial ODSCC at Watts Bar, Unit 2. The methodology accounts for uncertainty by using 95 percent lower bound confidence limits in the POD-S/N regression for ETSS I28411, by sampling noise from the Watts Bar, Unit 2 SG with the highest noise, and by incorporating the uncertainty from the V_{pp}-V_{vm} correlation.

The proposed alternative POD values and thresholds of 0.9 at 3.2 volts and 0.95 at 6.0 volts are conservative with respect to the POD curve. Both the industry inspection database of axial ODSCC at TSPs and NRC-sponsored testing of laboratory-produced axial ODSCC at TSPs show that indications of 3.2 volts and greater have a high POD with the bobbin probe. The NRC-sponsored testing, performed at Argonne National Laboratory using a SG mock-up with laboratory-grown cracks, including axial ODSCC at TSPs, is documented in Reference 12. A task group evaluated the eddy current signals from the cracks to ensure they were realistic, and eleven teams of industry analysts performed the analysis on the test data. For axial ODSCC at TSPs, the indication voltage ranged from less than 0.5 volt to greater than 3 volts, and the resulting POD was approximately 0.95 for indications with voltage greater than 2.5 volts.

To supplement the POD methodology, the licensee included eddy current graphics to illustrate the ability to identify flaw indications despite the noise in the Watts Bar, Unit 2 inspection data. The staff finds these figures support the proposed POD values because they showed actual indications with the lowest S/N for each alternative POD value (0.9 and 0.95) can be readily identified. The staff finds the proposed UFSAR changes acceptable because they accurately represent the acceptable alternative POD structure presented in the LAR.

The licensee also referenced the EPRI Model-Assisted Probability of Detection (MAPOD) software as a site-specific method for developing a POD function for various tube degradation mechanisms (Reference 15). The MAPOD analysis uses the relationship between voltage and degradation with S/N values from the inspection, to develop the POD function. The licensee's POD methodology produced lower values than the EPRI default MAPOD methodology, which

showed that the licensee's proposed values are more conservative than the MAPOD results. In addition, the licensee showed the proposed POD values are more conservative than the generic POPCD curve developed by industry (Reference 11).

3.4 Technical Evaluation Conclusion

Based on the information submitted, the NRC staff concludes that the GL 95-05 acceptance criteria can be met using the licensee's proposed POD values, and the staff has reasonable assurance that the Watts Bar, Unit 2, SG tubes will continue to maintain structural and leakage integrity. Therefore, the staff finds it acceptable for the licensee to apply the proposed POD values to the GL 95-05 ARC and to make the proposed revisions to the UFSAR.

4.0 FINAL NO SIGNIFICANT HAZARDS CONSIDERATION

The NRC's regulation in 10 CFR 50.92(c) states that the NRC may make a final determination, under the procedures in 10 CFR 50.91, "Notice for public comment; State consultation," that a license amendment involves no significant hazards consideration if operation of the facility, in accordance with the amendment, would not: (1) involve a significant increase in the probability or consequences of an accident previously evaluated; or (2) create the possibility of a new or different kind of accident from any accident previously evaluated; or (3) involve a significant reduction in a margin of safety.

The licensee's evaluation of the issue of no significant hazards consideration is presented below:

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

   Response: No.

   The use of the alternate POD values for the bobbin indications measuring ≥ 3.2 volts for the BOC voltage distribution for the WBN, Unit 2 OA [operational assessment] does not pose a significant increase in the probability of a steam generator tube rupture (SGTR) event. Based on industry and plant specific bobbin detection data for ODSCC within the SG [steam generator] TSP region, large voltage bobbin indications can be detected with a POD greater than 0.6. Because large voltage ODSCC bobbin indications within the SG TSP can be detected, they will not be left in service; therefore, these indications should not be included in the voltage distribution for the purpose of OA [operational assessment]. An eddy current POD of 0.9 to indications of axial ODSCC at TSP with bobbin voltage amplitudes of ≥ 3.2 volts, but < 6.0 volts and a POD of 0.95 to indications of ≥ 6.0 volts in the WBN, Unit 2 SG for the BOC voltage distribution is justified. The use of the proposed step change POD methodology offers no significant increase in steam line break (SLB) tube burst probability because it will be utilized in conjunction with the GL [Generic Letter] 95-05 methodology that predicts a conservative operational cycle in terms of effective full power days in compliance with the acceptance criteria for tube burst in the faulted SG.

Therefore, TVA concludes that this 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 use of the alternate POD values for the limited number of bobbin indications for WBN, Unit 2 for the BOC voltage distribution for the WBN, Unit 2 OA [operational assessment] concerns the SG tubes and can only affect the SGTR accident. Because the SGTR accident is already considered in the UFSAR, there in [is] no possibility to create a design basis accident, which has not, been previously evaluated.

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

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

   Response: No.

   The use of the alternate POD values for the limited number of bobbin indications for WBN, Unit 2 for the BOC voltage distribution for the WBN, Unit 2 OA does not involve a significant reduction in a margin of safety. The applicable margin of safety potentially impacted is the WBN, Unit 2 TS [Technical Specification] 5.9.9 projected end-of-cycle leakage for a main steam line break (MSLB) accident and the projected end-of-cycle probability of burst. Based on industry and plant specific bobbin detection data for ODSCC within the SG TSP region, large voltage bobbin indications can be detected and will not be left in service. Therefore, these indications should not be included in the voltage distribution for the purpose of operational assessments. This results in a reduction in numbers of larger indications potentially left in service at the BOC and will not result in a significant increase in the actual end-of-cycle leakage for an MSLB accident or the actual end-of-cycle probability of burst.

   Therefore, TVA concludes that this proposed change does not involve a significant reduction in a margin of safety.

Based on the above evaluation, the NRC staff concludes that the three standards of 10 CFR 50.92(c) are satisfied. Therefore, the NRC staff has made a final determination that no significant hazards consideration is involved for the proposed amendment and that the amendment should be issued as allowed by the criteria contained in 10 CFR 50.91.

5.0 STATE CONSULTATION

In accordance with the Commission's regulations, the Tennessee State official was notified of the proposed issuance of the amendment on January 8, 2021. The State official had no comments.

6.0 ENVIRONMENTAL CONSIDERATION

The amendment changes a requirement with respect to installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20, "Standards for Protection Against Radiation." The NRC staff has determined that the amendment involves no significant increase in the amounts, and no significant change in the types, of any effluents that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has made a finding that the amendment involves no significant hazards consideration. Accordingly, the amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendment.

7.0 CONCLUSION

The Commission has concluded, based on the considerations discussed above, that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) there is reasonable assurance that 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.

8.0 REFERENCES

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Date: February 9, 2021

SUBJECT: WATTS BAR NUCLEAR PLANT, UNIT 2 - ISSUANCE OF AMENDMENT NO. 48 REGARDING USE OF ALTERNATE PROBABILITY OF DETECTION VALUES FOR BEGINNING OF CYCLE IN SUPPORT OF OPERATIONAL ASSESSMENT (EPID L-2020-LLA-0273) DATED FEBRUARY 9, 2021

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