Tennessee Valley Authority, 1101 Market Street, Chattanooga, Tennessee 37402

CNL-20-104

December 23, 2020

10 CFR 50.90

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

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

Subject: **Expedited Application for Approval to Use an Alternate Method of Determining Probability of Detection for the Watts Bar Nuclear Plant, Unit 2 Steam Generators (WBN TS-391-20-024)**

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 No. NPF-96 for the Watts Bar Nuclear Plant (WBN), Unit 2.

The proposed license amendment request revises the WBN dual-unit Updated Final Safety Analysis Report (UFSAR) to apply an eddy current probability of detection (POD) of 0.9 to indications of axial outside diameter stress corrosion cracking 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 to indications of ≥ 6.0 volts in the WBN, Unit 2 steam generators (SG), as described in the enclosures to this submittal, for the beginning of cycle (BOC) voltage distribution in support of the WBN, Unit 2 operational assessment (OA). WBN, Unit 2 Technical Specification (TS) 5.7.2.12, "Steam Generator (SG) Program," and WBN, Unit 2 TS 5.9.9, "Steam Generator Tube Inspection Report," are based on Nuclear Regulatory Commission (NRC) Generic Letter (GL) 95-05, "Voltage-Based Repair Criteria for Westinghouse Steam Generator Tubes Affected by Outside Diameter Stress Corrosion Cracking," which requires the application of a POD of 0.6 to all previous bobbin indications for the determination of the indication voltage distribution for the BOC. Therefore, the use of the proposed POD values for the BOC voltage distribution in support of the WBN, Unit 2 OA, is an exception to GL 95-05 and requires NRC approval. A POD of 0.6, in accordance with GL 95-05, will be used for indications less than 3.2 volts.

The proposed POD values will only be used until the WBN, Unit 2 SGs are replaced, which are planned for the WBN, Unit 2 Cycle 4 refueling outage (U2R4) scheduled for Spring 2022. Based on the results of the SG inspections during U2R3, TVA plans to perform a WBN, Unit 2 mid-cycle SG inspection, at which time the proposed POD values will be reassessed.

Enclosure 1 to this submittal provides a description and technical evaluation of the proposed change, a regulatory evaluation, and a discussion of environmental considerations for the proposed change. Attachment 1 to Enclosure 1 to this submittal provides the existing WBN, UFSAR pages marked up to show the proposed changes. Attachment 2 to Enclosure 1 to this submittal provides the existing WBN, UFSAR pages retyped to show the proposed changes. There are no corresponding TS changes required to apply the proposed alternate POD values, as the associated requirements are only discussed in GL 95-05, and because WBN, Unit 2 TS 5.7.2.12 and TS 5.9.9 do not contain requirements for the bobbin POD. In support of the technical evaluation in Enclosure 1, Enclosure 2 contains Westinghouse Electric Company LLC (Westinghouse) Letter Report, LTR-CDMP-20-41 P-Attachment, Revision 0, "Watts Bar U2R3 Steam Generator Alternate Repair Criteria Generic Letter 95-05 Probability of Detection Methodology for 90-Day Report."

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-20-5136 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 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-20-5136 and should be addressed to Camille T. Zozula, Manager, Regulatory Compliance & Corporate Licensing, Westinghouse Electric Company, 1000 Westinghouse Drive, Suite 165, Cranberry Township, Pennsylvania 16066.

TVA has determined that there are no significant hazard considerations associated with the proposed change and that the change qualifies 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, "Notice for Public Comment; State Consultation," TVA is sending a copy of this letter and the enclosure to the Tennessee Department of Environment and Conservation.

WBN, Unit 2 TS 5.9.9 requires that a report be submitted to the NRC within 90 days after initial entry into MODE 4 following completion of the inspection performed in accordance with WBN, Unit 2 TS 5.7.2.12, when the voltage based alternate repair criteria have been applied. TVA entered Mode 4 following the WBN U2R3 refueling outage on November 16, 2020, wherein a SG inspection was performed in accordance with WBN, Unit 2 TS 5.7.2.12. Because the 90-day report required by WBN, Unit 2 TS 5.9.9 will apply the proposed alternate POD values, TVA requests NRC approval of the proposed license amendment on an expedited basis by February 8, 2021, with implementation by February 14, 2021 (i.e., 90 days following entry into Mode 4).

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

I declare under penalty of perjury that the foregoing is true and correct. Executed on this 23rd day of December 2020.

Respectfully,

James T. Polickoski
Director, Nuclear Regulatory Affairs

Enclosures:

1. Evaluation of Proposed Change
2. Westinghouse Letter Report, LTR-CDMP-20-41 P-Attachment, Revision 0 (Proprietary)
3. Westinghouse Letter Report, LTR-CDMP-20-41 NP-Attachment, Revision 0 (Non-Proprietary)
4. Westinghouse Electric Company LLC Application for Withholding Proprietary Information From Public Disclosure (Affidavit CAW-20-5136)

cc (Enclosures):

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

Enclosure 1

Evaluation of Proposed Change

Subject: **Expedited Application for Approval to Use an Alternate Method of Determining Probability of Detection for the Watts Bar Nuclear Plant (WBN), Unit 2 Steam Generators (WBN TS-391-20-024)**

CONTENTS

Attachments:
1. Proposed UFSAR Changes (Mark-Ups) for WBN, Unit 2
2. Proposed UFSAR Changes (Final Typed) for WBN, Unit 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 requesting a license amendment to Facility Operating License No. NPF-96 for the Watts Bar Nuclear Plant (WBN), Unit 2.

The proposed license amendment request (LAR) revises the WBN dual-unit Updated Final Safety Analysis Report (UFSAR) to apply an eddy current probability of detection (POD) of 0.9 to indications of axial outside diameter stress corrosion cracking (ODSCC) at tube support plates (TSP) 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 to indications of ≥ 6.0 volts in the WBN, Unit 2 steam generators (SG) for the beginning of cycle (BOC) voltage distribution in support of the WBN, Unit 2 operational assessment (OA). WBN, Unit 2 Technical Specification (TS) 5.7.2.12, "Steam Generator (SG) Program," and WBN, Unit 2 TS 5.9.9, “Steam Generator Tube Inspection Report,” are based on Nuclear Regulatory Commission (NRC) Generic Letter (GL) 95-05, "Voltage-Based Repair Criteria for Westinghouse Steam Generator Tubes Affected by Outside Diameter Stress Corrosion Cracking," which requires the application of a POD of 0.6 to all previous bobbin indications for the determination of the indication voltage distribution for the BOC. Therefore, the use of the proposed POD values for the BOC voltage distribution in support of the WBN, Unit 2 OA, is an exception to GL 95-05 and requires NRC approval.

2.0 DETAILED DESCRIPTION

2.1 PROPOSED CHANGES

The “Unit 2 Only” section of the WBN dual-unit UFSAR Section 5.5.2.4, which refers to GL 95-05, is revised to add the following sentence:

> *“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.”*

Additionally, the Reference Section in UFSAR Section 5.5 will be revised to add a new Reference 26 to reflect the NRC approval of this LAR.

Attachment 1 to Enclosure 1 to this submittal provides the existing WBN, UFSAR pages marked up to show the proposed changes. Attachment 2 to Enclosure 1 to this submittal provides the existing WBN, UFSAR pages retyped to show the proposed changes. There are no corresponding TS changes required to apply the proposed alternate POD values, as the associated requirements are only discussed in GL 95-05, and because WBN, Unit 2 TS 5.7.2.12 and 5.9.9 do not contain requirements for the bobbin POD.

2.2 CONDITION INTENDED TO RESOLVE

During the WBN, Unit 2 Cycle 3 refueling outage (U2R3), TVA determined that the WBN, U2R3 inspection results for SG3 represented a conditional burst probability of 3.0×10^{-2}, which exceeds the GL 95-05 based limit of 1×10^{-2} in WBN, Unit 2 TS 5.9.9. Accordingly, on November 11, 2020, TVA reported this information to the NRC in accordance with 10 CFR 50.72(b)(3)(ii)(A). Based on the U2R3 SG inspections, the preliminary OA evaluation has determined that that SG3 and SG4 did not meet the criteria for a full cycle OA utilizing the standard GL 95-05 evaluation methods for POD.

Accordingly, a 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, are needed to support continued operation of the WBN, Unit 2 SG, and will only be used until the WBN, Unit 2 SGs are replaced, which are planned for the U2R4 refueling outage scheduled for Spring 2022. A POD of 0.6, in accordance with GL 95-05, will be used for indications less than 3.2 volts.

3.0 TECHNICAL EVALUATION

3.1 BACKGROUND

The SG tubes constitute more than half of the reactor coolant pressure boundary (RCPB) area. Design of the RCPB for structural and leakage integrity is a requirement under the General Design Criteria (GDC) 10 CFR 50, Appendix A. Specific requirements governing the maintenance and inspection of SG tubes are contained in the WBN, Unit 2 TS and Section XI of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code. TVA also implements the requirements of Nuclear Energy Institute (NEI) 97-06, "Steam Generator Program Guidelines." These include requirements for periodic inservice inspection of the tubing, flaw acceptance criteria (i.e., repair limits for plugging), and primary-to-secondary leakage limits. These requirements have formed the basis for assuring adequate SG tube integrity. SG tube plugging limits are specified in the WBN, Unit 2 TS. WBN, Unit 2 TS 5.7.2.12.c requires that flawed tubes be removed from service by plugging or repair if the depths of the flaws are greater than or equal to 40 percent through-wall, unless the degradation is subject to the voltage-based tube support plate axial ODSCC repair criteria or the F* repair criteria. WBN, Unit 2 TS 5.7.2.12.c repair limits ensure that tubes accepted for continued service will retain adequate structural and leakage integrity during normal operating, transient, and postulated accident conditions, consistent with GDC 14, 15, 16, 30, 31, and 32. Structural integrity refers to maintaining adequate margins against gross failure, rupture, or collapse of the SG tubing. Leakage integrity refers to limiting primary-to-secondary leakage to within acceptable limits.

The generic criteria for voltage-based limits for axial ODSCC at TSP are contained in GL 95-05 in accordance with the WBN, Unit 2 TS. These criteria rely on empirically derived correlations between a nondestructive inspection parameter, the bobbin coil voltage, and tube burst pressure and leak rate. The GL 95-05 guidance ensures structural and leakage integrity continue to be maintained at acceptable levels consistent with the requirements of 10 CFR 50 and 10 CFR 100. GL 95-05 focuses on maintaining tube structural integrity during the full range of normal, transient, and postulated accident conditions with adequate allowance for eddy current test uncertainty and flaw growth projected to occur during the next operating cycle. In order to ensure the structural and leakage integrity of the tube until the next scheduled inspection, GL 95-05 specifies a methodology to determine the conditional burst probability and the total primary to secondary leak rate from an affected SG during a postulated main steam line break (MSLB) event. The methodology in WCAP-14277, Revision 1, "SLB Leak Rate and Tube Burst Probability Analysis Methods for ODSCC at TSP Intersections," dated December 1996, is used to implement the GL 95-05 structural integrity methodology.

A probabilistic analysis to quantify the potential for SG tube ruptures given a MSLB event is performed per WCAP-14277, Revision 1, and compared to a reporting threshold value of 1 x 10^{-2} per cycle as required by GL 95-05. This threshold value provides assurance that the probability of burst (POB) is acceptable considering the assumptions of the calculation and the results of the staff's generic risk assessment for SGs contained in NUREG-0844, "NRC Integrated Program for the Resolution of Unresolved Safety Issues A-3, A-4, and A-5 Regarding Steam Generator Tube Integrity." Failure to meet this threshold value indicates axial ODSCC confined to within the thickness of the TSP could contribute a significant factor of the overall conditional probability of tube rupture for all forms of degradation assumed and evaluated as acceptable in NUREG-0844. The calculation of conditional burst probability is, in part, a function of the POD and the resulting indication voltage distribution at BOC. The indication voltage distribution at BOC is based on consideration of all previous bobbin indications that were detected at the BOC, including those that were plugged. The POB threshold value of 1 x 10^{-2} is contained in WBN, Unit 2 TS 5.9.9.

Accident leakage is determined using the methodology described in Revision 1 of WCAP-14277 to calculate the SG tube leakage from the faulted SG during a postulated MSLB event. The methodology consists of the following two major components:

- a model predicting the probability that a given indication will leak as a function of voltage (i.e., the probability of leakage model)
- a model predicting leak rate as a function of voltage, given that leakage occurs (i.e., the conditional leak rate model).

This methodology for calculating tube leakage is consistent with the guidance in GL 95-05.

3.2 SYSTEM DESCRIPTION

The WBN, Unit 2 SGs have a vertical shell and U-tube evaporator with integral moisture separating equipment. The reactor coolant flows through the inverted U-tubes, entering and leaving through the nozzles located in the hemispherical bottom head of the SG. The head is divided into inlet and outlet chambers by a vertical partition plate extending from the head to the tubesheet. Steam is generated on the shell side and flows upward through the moisture separators to the outlet nozzle at the top of the vessel. The WBN, Unit 2 SG have Alloy 600 mill annealed (Alloy 600MA) tube material. Details of the WBN, Unit 2 SGs are described in the UFSAR Section 5.5.2, “Steam Generator.” Figure 5.5-3b of the WBN UFSAR shows the design of the WBN, Unit 2 SGs. Materials of construction for the WBN, Unit 2 SGs are provided in UFSAR Table 5.2-8, “Reactor Coolant Pressure Boundary Materials Class 1 Primary Components.” Materials are selected and fabricated in accordance with the requirements of ASME Code Section III.

The SG tubes in pressurized water reactors have several important safety functions. The SG tubes are an integral part of the RCPB and, as such, are relied on to maintain the primary system's pressure and inventory. As part of the RCPB, the SG tubes are unique, in that they act as a heat transfer surface between the primary and secondary systems to remove heat from the primary system. In addition, the SG tubes isolate the radioactive fission products in the primary coolant from the secondary system.

The SG tube rupture (SGTR) accident is the limiting design basis event for SG. The analysis of an SGTR event assumes a bounding primary to secondary leakage rate equal to the operational leakage rate TS limit, plus the leakage rate from a double-ended rupture of a single tube. The accident analysis for an SGTR assumes the contaminated secondary fluid is only briefly released to the atmosphere via safety valves. The analysis for design basis accidents and transients other than an SGTR assume the SG tubes retain their structural integrity (i.e., they are assumed not to rupture). In these analyses, the steam discharge to the atmosphere is based on the total primary to secondary leakage from all SGs or is assumed to increase to the TS limit because of accident-induced conditions. For accidents that do not involve fuel damage, the primary coolant activity level is assumed equal to the TS limits. For accidents that assume fuel damage, the primary coolant activity is a function of the amount of activity released from the damaged fuel.

SG tube integrity is necessary to ensure the tubes are capable of performing their intended safety functions. Concerns relating to the integrity of the tubing stem from the fact that the SG tubing is subject to a variety of degradation mechanisms. SG tubes have experienced tube degradation related to corrosion phenomena, such as wastage, pitting, intergranular attack, and stress corrosion cracking, along with other mechanically induced phenomena such as wear. These degradation mechanisms can impair tube integrity if they are not managed effectively. The SG performance criteria are used to manage SG tube degradation.

The industry, working through the Electric Power Research Institute (EPRI) Steam Generator Management Program (SGMP), has implemented a generic approach to managing SG performance referred to as "Steam Generator Degradation Specific Management" (SGDSM). The overall program is described in NEI 97-06, which is supported by EPRI guidelines, including:

- Pressurized Water Reactor (PWR) Steam Generator Examination Guidelines
- SG Integrity Assessment Guidelines
- SG In-Situ Pressure Test Guidelines
- PWR Primary-to-Secondary Leak Guidelines
- PWR Primary Water Chemistry Guidelines
- PWR Secondary Water Chemistry Guidelines

NEI 97-06 and the EPRI Guidelines define a comprehensive, performance-based approach to managing SG performance.

3.3 TECHNICAL ANALYSIS

Enclosure 2 contains Westinghouse Electric Company LLC (Westinghouse) Letter Report, LTR-CDMP-20-41 P-Attachment, Revision 0, "Watts Bar U2R3 Steam Generator Alternate Repair Criteria Generic Letter 95-05 Probability of Detection Methodology for 90-Day Report," which is a technical analysis performed by Westinghouse to determine the appropriateness of the alternate PODs for application specific to the WBN, Unit 2 SGs.

Table 1 provides a listing of indications of axial ODSCC at tube support plates for which the proposed PODs will currently be applied. The indications listed in Table 1 had measured bobbin voltages ≥ 3.2 volts for the SG inspection performed during the WBN U2R3 refueling outage. These indications are located on the hot leg side of the SG tube bundle and were confirmed by rotating pancake coil as axial ODSCC within the confines of the TSP intersections. The tubes identified in Table 1 were removed from service by plugging during U2R3. The alternate POD values to be applied to each specific indication are also indicated in Table 1. A POD of 0.6 is to be applied for all indications < 3.2 volts, which are not shown in Table 1. The proposed POD values will continue to be applied for any future indications of ≥ 3.2 volts.

Table 1 - Indications of Axial ODSCC with Bobbin Voltages ≥ 3.2 Volts

SG	Row	Column	Support	Indication[1]	Bobbin Volts	Plugged	POD
3	17	54	H01	DSV	9.35	Yes	0.95
3	12	111	H02	DSV	8.03	Yes	0.95
3	17	46	H02	DSV	6.87	Yes	0.95
4	6	36	H02	DSV	6.06	Yes	0.95
3	17	47	H02	DSV	5.13	Yes	0.90
3	14	7	H02	DSV	4.83	Yes	0.90
3	7	62	H02	DSV	3.83	Yes	0.90
2	40	53	H03	DSV	3.82	Yes	0.90
3	4	109	H03	DSV	3.64	Yes	0.90
3	48	57	H02	DSV	3.21	Yes	0.90

Note:
1. Bobbin DSV indications are distorted support indications with a measured voltage in excess of the upper voltage repair limit calculated in accordance with GL 95-05.

The indications in Table 1 can be detected with a POD of 0.9 or 0.95 as described in Enclosure 2, and the WBN, Unit 2 specific noise distributions for the TSPs in the limiting SG3.

Further technical information is provided in Enclosure 2, which indicates that the highest noise levels at WBN, Unit 2 will not interfere with the detection of large voltage flaws and that the proposed alternate PODs are appropriate.

<u>Technical Conclusions</u>

A stepped change was considered a conservative approach to develop an alternate POD. As described in Enclosure 2, there is a very high probability of detection for large signals, no new indications throughout the industry were found to have a prior inspection voltage ≥ 3.2 volts and the WBN, Unit 2 specific POD function described within is bounded by this threshold. Therefore, applying an increased POD to ≥ 3.2 volt indications is considered appropriate. For lower voltages, the GL 95-05 specified POD of 0.6 would still be applied.

Similarly, 6.0 volts was selected as the threshold for the next step in the proposed POD because only a limited number of indications exceeded this value during U2R3 and flaws of that magnitude generate response signals, which would not be masked by the highest noise levels observed. This step change also bounds the WBN, Unit 2 specific POD function.

As discussed in Enclosure 2, flaw injection using Data Union Software for larger value signals and noise levels was performed as a supplemental justification for the proposed POD values. The results of this study further indicate that the highest noise levels at WBN, Unit 2 will not interfere with the detection of large voltage flaws and the proposed alternate PODs are appropriate.

4.0 REGULATORY EVALUATION

4.1 APPLICABLE REGULATORY REQUIREMENTS AND CRITERIA

General Design Criteria

The WBN, Unit 2 was 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 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.

<u>Criterion 14, "Reactor Coolant Pressure Boundary"</u>

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.

<u>Criterion 15, "Reactor Coolant System Design"</u>

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 16, "Containment design"

Reactor containment and associated systems shall be provided to establish an essentially leak-tight barrier against the uncontrolled release of radioactivity to the environment and to assure that the containment design conditions important to safety are not exceeded for as long as postulated accident conditions require.
Compliance with GDC 16 is described in Section 3.1.2.2 of the WBN UFSAR.

Criterion 30, "Quality of reactor coolant pressure boundary"

Components, which are part of the reactor coolant pressure boundary, shall be designed, fabricated, erected, and tested to the highest quality standards practical. Means shall be provided for detecting and, to the extent practical, identifying the location of the source of reactor coolant leakage.

Compliance with GDC 30 is described in Section 3.1.2.4 of the WBN UFSAR.

Criterion 31, "Fracture prevention of reactor coolant pressure boundary"

The reactor coolant pressure boundary shall be designed with sufficient margin to assure that when stressed under operating, maintenance, testing, and postulated accident conditions (1) the boundary behaves in a nonbrittle manner and (2) the probability of rapidly propagating fracture is minimized. The design shall reflect consideration of service temperatures and other conditions of the boundary material under operating, maintenance, testing, and postulated accident conditions and the uncertainties in determining (1) material properties, (2) the effects of irradiation on material properties, (3) residual, steady state and transient stresses, and (4) size of flaws.

Compliance with GDC 31 is described in Section 3.1.2.4 of the WBN UFSAR.

Criterion 32, "Inspection of reactor coolant pressure boundary"

Components, which are part of the reactor coolant pressure boundary, shall be designed to permit (1) periodic inspection and testing of important areas and features to assess their structural and leaktight integrity, and (2) an appropriate material surveillance program for the reactor pressure vessel.

Compliance with GDC 32 is described in Section 3.1.2.4 of the WBN UFSAR.

4.2 PRECEDENT

While there is no specific precedent for the proposed POD values in this LAR, in Reference 1, NRC issued a license amendment for Diablo Canyon Power Plant (DCCP), Unit No. 2, which authorized revisions to the Final Safety Analysis Report Update to incorporate the NRC approval of a POD of 1.0 to one bobbin indication, contained in a DCPP Unit No. 2 SG 4 tube at row 44, column 45 at the second tube support plate on the hot leg side (R44C45-2H), for the beginning of cycle voltage distribution for the DCPP Unit No. 2 Cycle 12 operational assessment. This LAR is similar to Reference 1 in that TVA is proposing an alternate POD for a limited number of WBN, Unit 2 SG tubes.

4.3 NO SIGNIFICANT HAZARDS CONSIDERATION

Tennessee Valley Authority (TVA) proposes to revise the Watts Bar Nuclear Plant (WBN) dual-unit Updated Final Safety Analysis Report (UFSAR) to apply an eddy current probability of detection (POD) of 0.9 to indications of axial outside diameter stress corrosion cracking (ODSCC) at tube support plates (TSP) 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 to indications of ≥ 6.0 volts in the WBN, Unit 2 steam generators (SG) for the beginning of cycle (BOC) voltage distribution in support of the WBN, Unit 2 operational assessment (OA). WBN, Unit 2 Technical Specification (TS) 5.7.2.12, "Steam Generator (SG) Program," and WBN, Unit 2 TS 5.9.9, "Steam Generator Tube Inspection Report," are based on Nuclear Regulatory Commission (NRC) Generic Letter (GL) 95-05, "Voltage-Based Repair Criteria for Westinghouse Steam Generator Tubes Affected by Outside Diameter Stress Corrosion Cracking," which requires the application of a POD of 0.6 to all previous bobbin indications for the determination of the indication voltage distribution for the BOC. Therefore, the use of the proposed POD values for the BOC voltage distribution in support of the WBN, Unit 2 OA, is an exception to GL 95-05 and requires NRC approval. The proposed POD values will only be used until the WBN, Unit 2 SGs are replaced. A POD of 0.6, in accordance with GL 95-05, was used for indications of less than 3.2 volts.

TVA has evaluated whether or not a significant hazards consideration is involved with the proposed amendment(s) 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 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 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 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. 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 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 concerns the SG tubes and can only affect the SGTR accident. Because the SGTR accident is already considered in the UFSAR, there in 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 amendment 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 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, TVA concludes 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 Conclusion

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 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 Pacific Gas and Electric Company, “Diablo Canyon Power Plant, Unit No. 2 - Issuance of Amendment - Alternate Method of Determining Probability of Detection for Steam Generator Tubes (TAC No. MB7875),” dated June 3, 2003 (ML031540535)

Attachment 1

Proposed UFSAR Changes (Mark-Ups) for WBN, Unit 2

5.5.2.4 Tests and Inspections

The initial steam generator quality assurance program is given in Table 5.5-4 Unit 1 (historical information) and in Table 5.5-4b for Unit 2.

Radiographic inspection and acceptance standards are in accordance with the requirements of Section III of the ASME Code.

Liquid penetrant inspection was performed on weld deposited tubesheet cladding, channel head cladding, tube to tubesheet weldments, and weld deposit cladding.

Liquid penetrant inspection and acceptance standards are in accordance with the requirements of Section III of the ASME Code.

Magnetic particle inspection was performed on the tubesheet forging, nozzle forgings, channel head casting (Unit 2 Only), and the following weldments:

1. Nozzle to shell

2. Support brackets

3. Instrument connections (primary and secondary)

4. Temporary attachments after removal

5. Accessible pressure containing welds after hydrostatic test.

Magnetic particle inspection and acceptance standards are in accordance with requirements of Section III of the ASME Code.

An ultrasonic test was performed on the tube sheet forging, tube sheet cladding, secondary shell and heat plate and nozzle forgings.

The heat transfer tubing was subjected to eddy current test.

Hydrostatic tests are performed in accordance with Section III of the ASME Code.

In addition, the heat transfer tubes were subjected to a hydrostatic test pressure, prior to installation into the vessel, which is not less than 1.25 times the primary side design pressure, as required by Section III of the ASME Code.

Manways are provided for access to both the primary and secondary sides.

Inservice inspection of steam generator tubes is to be performed in accordance with the Technical Specifications.

Unit 2 Only
Steam Generator tubing Alternate Repair Criteria for F* (F star) at the top of the tubesheet was approved by NRC. [19] Implementation of F* is in accordance with Technical Specification inservice examination requirements and Reference 19.

Steam Generator Tubing voltage-based Alternate Repair Criteria (ARC) for Axial Outside Diameter Stress Corrosion Cracking (ODSCC) at tube support plate intersections was approved by NRC [23]. Implementation of ODSCC ARC using GL 95-05 [24] as guidance is in accordance with Technical Specification inservice examination requirements and Reference 25. 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.

5.5.3 Reactor Coolant Piping

5.5.3.1 Design Bases

The RCS piping is designed and fabricated to accommodate the system pressures and temperatures attained under all expected modes of plant operation or anticipated system interactions. Stresses are maintained within the limits of Section III of the ASME Nuclear Power Plant Components Code. Code and material requirements are provided in Section 5.2.

Materials of construction are specified to minimize corrosion/erosion and ensure compatibility with the operating environment.

The piping in the RCS is Safety Class 1 and is designed and fabricated in accordance with ASME Section III, Class 1 requirements.

Stainless steel pipe conforms to ANSI B36.19 for sizes 1/2-inch through 12 inches and wall thickness Schedules 40S through 80S. Stainless steel pipe outside of the scope of ANSI B36.19 conforms to ANSI B36.10.

The minimum wall thicknesses of the loop pipe and fittings are not less than that calculated using the ASME III Class 1 formula of Paragraph NB-3641.1 (3), with an allowable stress value of 17,550 psi. The pipe wall thickness for the pressurizer surge line is Schedule 160. The minimum pipe bend radius is 5 nominal pipe diameters; ovalness does not exceed 6%.

Butt welds, branch connection nozzle welds, and boss welds are of a full-penetration design.

Processing and minimization of sensitization are discussed in Sections 5.2.3 and 5.2.5.

Flanges conform to ANSI B16.5.

Socket weld fittings and socket joints conform to ANSI B16.11.

Inservice inspection is discussed in Section 5.2.8.

5.5.3.2 Design Description

Principal design data for the reactor coolant piping are given in Table 5.5-5.

Pipe and fittings are cast, seamless without longitudinal welds and electroslag welds, and comply with the requirements of the ASME Code, Section II, Parts A and C, Section III, and

23. NRC Safety Evaluation for Watts Bar Nuclear Plant Unit 2, Amendment 28, for Steam Generator Tubing Voltage Based Alternate Repair Criteria for Outside Diameter Stress Corrosion Cracking (ODSCC) dated June 3, 2019.

24. NRC Generic Letter 95-05, "Voltage-Based Repair Criteria for Westinghouse Steam Generator Tubes Affected by Outside Diameter Stress Corrosion Cracking," dated August 3, 1995.

25. TVA Letter to NRC "Application to Revise Watts Bar Nuclear Plant Unit 2 Technical Specifications for Use of voltage-based Alternate Repair Criteria in Accordance with Generic Letter 95-05 (391-WBN2-TS-17-30)" dated May 14, 2018 and as supplemented by letter CNL-18-128 dated November 8, 2018.

26. NRC letter to TVA, "XXXXX (TAC No. XXXX)," dated MM/DD/YY (MLXXXX).

Attachment 2

Proposed UFSAR Changes (Final Typed) for WBN, Unit 2

5.5.2.4 Tests and Inspections

The initial steam generator quality assurance program is given in Table 5.5-4 Unit 1 (historical information) and in Table 5.5-4b for Unit 2.

Radiographic inspection and acceptance standards are in accordance with the requirements of Section III of the ASME Code.

Liquid penetrant inspection was performed on weld deposited tubesheet cladding, channel head cladding, tube to tubesheet weldments, and weld deposit cladding.

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1. Nozzle to shell

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An ultrasonic test was performed on the tube sheet forging, tube sheet cladding, secondary shell and heat plate and nozzle forgings.

The heat transfer tubing was subjected to eddy current test.

Hydrostatic tests are performed in accordance with Section III of the ASME Code.

In addition, the heat transfer tubes were subjected to a hydrostatic test pressure, prior to installation into the vessel, which is not less than 1.25 times the primary side design pressure, as required by Section III of the ASME Code.

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5.5.3 Reactor Coolant Piping

5.5.3.1 Design Bases

The RCS piping is designed and fabricated to accommodate the system pressures and temperatures attained under all expected modes of plant operation or anticipated system interactions. Stresses are maintained within the limits of Section III of the ASME Nuclear Power Plant Components Code. Code and material requirements are provided in Section 5.2.

Materials of construction are specified to minimize corrosion/erosion and ensure compatibility with the operating environment.

The piping in the RCS is Safety Class 1 and is designed and fabricated in accordance with ASME Section III, Class 1 requirements.

Stainless steel pipe conforms to ANSI B36.19 for sizes 1/2-inch through 12 inches and wall thickness Schedules 40S through 80S. Stainless steel pipe outside of the scope of ANSI B36.19 conforms to ANSI B36.10.

The minimum wall thicknesses of the loop pipe and fittings are not less than that calculated using the ASME III Class 1 formula of Paragraph NB-3641.1 (3), with an allowable stress value of 17,550 psi. The pipe wall thickness for the pressurizer surge line is Schedule 160. The minimum pipe bend radius is 5 nominal pipe diameters; ovalness does not exceed 6%.

Butt welds, branch connection nozzle welds, and boss welds are of a full-penetration design.

Processing and minimization of sensitization are discussed in Sections 5.2.3 and 5.2.5.

Flanges conform to ANSI B16.5.

Socket weld fittings and socket joints conform to ANSI B16.11.

Inservice inspection is discussed in Section 5.2.8.

5.5.3.2 Design Description

Principal design data for the reactor coolant piping are given in Table 5.5-5.

Pipe and fittings are cast, seamless without longitudinal welds and electroslag welds, and comply with the requirements of the ASME Code, Section II, Parts A and C, Section III, and Section IX.

23. NRC Safety Evaluation for Watts Bar Nuclear Plant Unit 2, Amendment 28, for Steam Generator Tubing Voltage Based Alternate Repair Criteria for Outside Diameter Stress Corrosion Cracking (ODSCC) dated June 3, 2019.

24. NRC Generic Letter 95-05, “Voltage-Based Repair Criteria for Westinghouse Steam Generator Tubes Affected by Outside Diameter Stress Corrosion Cracking,” dated August 3, 1995.

25. TVA Letter to NRC “Application to Revise Watts Bar Nuclear Plant Unit 2 Technical Specifications for Use of voltage-based Alternate Repair Criteria in Accordance with Generic Letter 95-05 (391-WBN2-TS-17-30)” dated May 14, 2018 and as supplemented by letter CNL-18-128 dated November 8, 2018.

26. NRC letter to TVA, “XXXXX (TAC No. XXXX),” dated MM/DD/YY (MLXXXX).

Enclosure 2

Westinghouse Letter Report, LTR-CDMP-20-41 P-Attachment, Revision 0 (Proprietary)

Enclosure 3

Westinghouse Letter Report, LTR-CDMP-20-41 NP-Attachment, Revision 0
(Non-Proprietary)

Westinghouse Electric Company

LTR-CDMP-20-41 NP-Attachment
Revision 0

Watts Bar U2R3 Steam Generator Alternate Repair Criteria Generic Letter 95-05 Probability of Detection Methodology for 90-Day Report

December 21, 2020

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Watts Bar U2R3
Steam Generator Alternate Repair Criteria Generic Letter 95-05 Probability of Detection Methodology for 90-Day Report

Executive Summary:

The Probability of Detection (POD) for distorted support indications at tube support plate (TSP) locations for Watts Bar 2 (WB2) application of Generic Letter 95-05 (GL 95-05) is proposed as a function which uses the GL 95-05 default POD value of 0.6 for bobbin signals less than 3.2V, a POD of 0.9 for bobbin signals between 3.2V up to 6.0V, and 0.95 for bobbin signals 6.0V and greater. The proposed stepped POD voltage thresholds are shown to bound a 95% lower bound (5th percentile) Voltage-Based (Volts Peak-to-Peak, Vpp) POD function developed to account for the Watts Bar Unit 2 Steam Generator 3 (SG3) noise distribution. The POD function was generated via Monte Carlo simulation which samples the WB2 SG3 noise distribution into a 95% confidence limit signal-to-noise (S/N)-POD regression equation which is based on ETSS I28411 data including tube specific noise. The proposed POD is also supported by using Data Union Software to inject large flaws at the specified bobbin voltage thresholds into TSP locations with high noise measurements in order to demonstrate that the Watts Bar 2 noise level does not interfere with detection of flaws at sizes where the proposed POD increases to a higher value. The proposed alternate POD function is intended for use in the Watts Bar Unit 2 Refueling Outage 3 (U2R3) GL 95-05 Operational Assessments.

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1.0 Background and Purpose

Watts Bar Unit 2 Refueling Outage 3 (U2R3) was the first implementation of alternate repair criteria in accordance with Generic Letter (GL) 95-05 at the unit. GL 95-05 provides guidance and criteria for the analysis of structural and leak integrity of steam generator (SG) tubes using bobbin detection of eddy current test (ECT) signals associated with axial outside diameter stress corrosion cracking (ODSCC) at tube support plate (TSP) intersections.

The method described in GL 95-05 allows the use of the relationship of the measured eddy current bobbin probe voltage to burst pressure and leak rate to calculate the probability of burst (POB) and predicted leak rate (LR) for a population of flaws at TSP-to-tube intersections. The calculation is performed for each SG using Monte Carlo simulations for both condition monitoring (CM) and operational assessment (OA) cases. These evaluations were performed at U2R3 for WB2 and documented in the U2R3 GL 95-05 Return to Power Report (Reference 4).

The Generic Letter 95-05 OA must demonstrate structural and leakage integrity for each SG over the next planned operating cycle (defined as POB not exceeding $1x10^{-2}$ and predicted leakage below Technical Specification limits for the faulted SG during postulated main steam line break accident conditions). The primary OA inputs include the flaw voltage distribution at the beginning of Cycle 4, the flaw growth distribution based on the change in voltage measurements from U2R2 to U2R3, and the probability of detection of crack-like indications at TSP-to-tube intersections from bobbin probe. Per GL 95-05, "POD should be assumed to have a value of 0.6, or as an alternative, an NRC approved POD function can be used, if such a function becomes available." The default POD of 0.6 for all flaw voltages is conservative for higher voltage indications and does not allow for the demonstration of a reasonable duration Cycle 4 OA for SG3 at Watts Bar Unit 2.

An alternative POD was therefore developed for use in the U2R3 OA calculations. This document defines and provides the technical justification for an alternative POD function which is intended for application in GL 95-05 OA evaluations for WB2. The alternative POD function has been developed specifically for Watts Bar Unit 2 based on the bobbin inspection technique utilized during U2R3 for detection of ODSCC at TSP intersections and the U2R3 SG3 noise measurements. The development methodology and other supporting technical bases for the alternate POD function are contained within this document.

2.0 Method and Technical Basis for Alternate POD Function

The industry precedent for applying an improved POD function to GL 95-05 evaluations is the Probability of Prior Cycle Detection (POPCD) method which is outlined in Section 7 of the EPRI SG ODSCC at TSP Database Report (Reference 1). There are applicability criteria for site-specific application of POPCD, which Watts Bar Unit 2 does not meet for Cycle 4 due to U2R3 being the first application of GL 95-05 at the unit. A generic industry POPCD curve is available for use but the WB U2R3 noise distribution exceeds that of the pulled tube noise used as a basis for applicability of the generic POPCD function. Since WB2 cannot apply POPCD to the Cycle 4 GL 95-05 OA, an acceptable alternate POD approach was pursued.

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Application of site-specific POD functions are commonly applied for various forms of SG tube degradation. The EPRI Model-Assisted Probability of Detection (MAPOD) software (Reference 3) is one tool used for development of such a function. MAPOD relates signal-to-noise ratios proportionally to POD using inspection technique qualification data and site-specific noise measurements and results in a depth-based POD function. For the WB U2R3 GL 95-05 evaluation, a voltage-based POD function applied in peak-to-peak voltage is required in order to relate the POD to flaw voltages measured from bobbin probe at TSP-to-tube intersections during U2R3.

A stepped change that bounds the calculated site-specific POD is considered a conservative approach to adjusting the POD. The GL 95-05 specified POD of 0.6 would still be applied to most indications reported at U2R3 (less than 3.2V). Since no new indications throughout the industry were found to have a prior inspection voltage greater than 3.2V (Reference 1), it is an appropriate threshold value for the first step change to the POD function. Similarly, 6.0V was selected as the threshold for the next step in the proposed POD to 0.95 since only a limited number of indications exceeded this value during U2R3 and flaws of that magnitude generate very large and obvious signals which would not be masked by higher noise levels.

The POD values at these thresholds are shown to be acceptable by bounding the Watts Bar 2 95% lower bound voltage-based POD curve (described in Section 2.1) which accounts for the noise distribution in SG3. This is supported by EPRI ETSS I28411 data which shows a very high probability of detection for large signals. Data Union Software (DUS) flaw injection was also performed as a supplemental justification using flaws representative of the voltage threshold values and noise representative of Watts Bar 2 SG3 in order to demonstrate that the highest WB2 SG3 HL noise values will not interfere with the detection of high voltage flaws. Section 2.2 provides additional details and graphics describing the use of DUS as justification for the POD at the proposed voltage thresholds.

2.1 Voltage Based POD

2.1.1 ETSS 28411 Signal-to-Noise Ratio to POD Regression

Watts Bar U2R3 bobbin detection of axial ODSCC at TSP locations was performed using EPRI technique ETSS I28411 (Reference 5). ETSS I28411 provides a data set with information from tubes pulled from various steam generators operating at different sites which use Alloy 600 mill-annealed tubes. Each indication in the data set includes the Vpp, Volts Vertical Maximum (Vvm), and confirmed through wall depth. In addition, each indication was analyzed by ten separate teams of analysts (primary, secondary, and resolution for each team) who attempted to determine if they would have detected the flaw. [

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]^{a,c,e}, a regression fit for the POD as a function of S/N is determined as follows:

[

]^{a,c,e} was used to create a [ ]^{a,c,e} best fit S/N – POD regression in the following form:

[ ]^{a,c,e}

[

]^{a,c,e}

[ ]^{a,c,e}

Figure 1 shows the hit-miss probability (which is taken as equivalent to the POD) for each S/N ratio based on the ETSS I28411 data and the tube noise value, along with the best fit and 95% lower bound confidence limit S/N-POD regression curves.

[1] Minitab is a registered trademark of Minitab, LLC.

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a,c,e

Figure 1: ETSS I28411 S/N-POD Data Points and Regression Curve

2.1.2 Vvm-Vpp Correlation

In order to use the POD function in the methodology applied to WB2, the POD should be defined as a function of Vpp, which is the peak to peak voltage measurement. The S/N-POD regression is based on Vvm, which is the maximum vertical amplitude of the voltage signal. Since Watts Bar U2R3 noise values were obtained as Vvm, it is necessary to develop a regression equation relating Vvm to Vpp since the phase angles of the future Vpp values are not presently known.

For the data used to perform the regression, all 1240 axial ODSCC Vpp voltage signals from U2R3 across all 4 steam generators are converted from Vpp to Vvm using the phase angle through the following equation:

$$Vvm = Vpp * \sin(\emptyset)$$

By observation, the relationship between Vpp and Vvm for the Watts Bar 2 data reasonably fits a straight line. Therefore, a linear relationship is appropriate to use to convert Vpp to Vvm. A linear regression is performed to define that relationship using the WB U2R3 data. The

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following linear regression correlating Vvm as a function of Vpp was generated in Minitab along with the standard error:

[ ]a,c,e

Figure 2 plots this linear regression of the Vvm-Vpp relationship along with all the Watts Bar U2R3 indications.

a,c,e

[ ]

Figure 2: WB U2R3 Vvm and Vpp Data Points and Linear Regression

2.1.3 Determining POD as a function of Vpp using Monte Carlo Simulation

The commercial software package **Analytica®**[2] Release 5.4.6.167 by Lumina is used to perform a Monte Carlo simulation that develops a POD based on Vpp values. [ ]a,c,e to calculate a 95% lower bound (5th percentile) POD. The Monte Carlo analysis incorporates uncertainty in the form of noise sampled from the WB2 SG3 distributions, regression uncertainty in the Vvm to Vpp regression, as well as using the 95% lower bound confidence POD as a function of S/N regression.

[2] Analytica is a registered trademark of Lumina Decision Systems

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The influence diagram in Figure 3 provides an overview of this methodology, with additional detail provided below.

a,c,e

Figure 3: Site-Specific POD Simulation Influence Diagram

The inputs to the simulation are the Watts Bar 2 SG3 noise distribution, the POD(S/N) log-logistic regression developed in Section 2.1.1, and the Vvm(Vpp) linear regression and standard error developed in Section 2.1.2.

[ ]^{a,c,e} .

The original Vpp value now has resulted in a POD which accounts for uncertainties in the EPRI experimental data, the regression for Vpp and Vvm, and the Watts Bar U2R3 hot leg TSP noise.

[ ]^{a,c,e} the 5th percentile (95% lower bound) POD is determined and is plotted in Figure 4.

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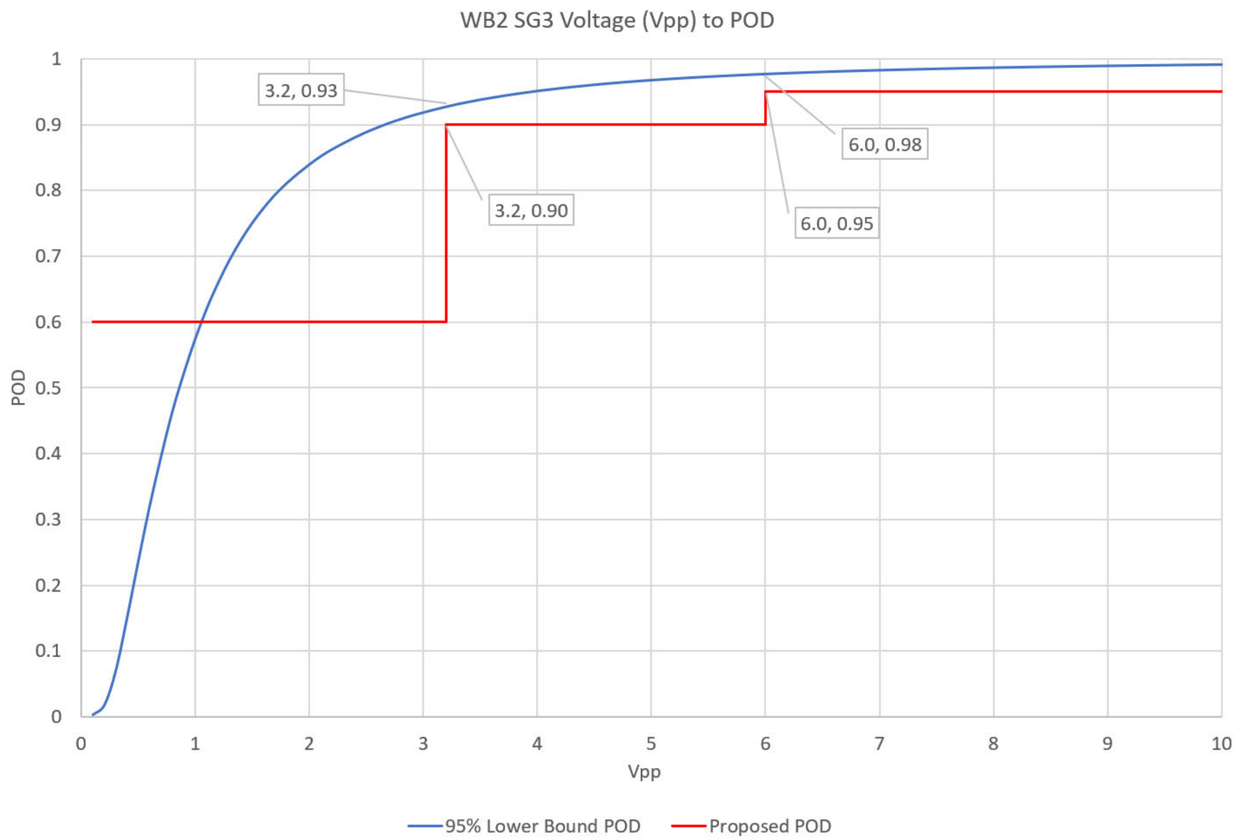

Figure 4: WB2 SG3 Voltage-Based POD Function

2.2 Data Union Software (DUS) Flaw Injection

As a supplemental justification for the stepped POD proposed for Watts Bar 2 GL 95-05 analyses, flaw signals at the two voltages where a higher POD is applied were studied to assess detectability in the WB2 noise environment. This process is done using the DUS which permits a user to merge a donor signal, in this case bobbin DSI/DSV signals from WB U2R3, into host data, in this case TSP intersections with high noise measured during WB U2R3. The DUS is qualified for this use per Reference 2.

The highest noise measured in SG3 at a TSP HL location at the center 1/3 of the TSP during U2R3 was 1.54Vvm in tube R14C41 at H03. Therefore, this tube was selected as the host tube and TSP location for flaw injections using the DUS. Donor bobbin signals of 3.2V and 6.0V flaws were injected into the host TSP location with 1.54 Vvm noise in order to demonstrate that the flaws are still easily detectable, thus supporting the 0.9 (for 3.2V) and 0.95 (for 6V) step changes in the proposed POD function for WB2.

Figure 5 below shows the host tube and TSP location with a measured noise of 1.54 Vvm. Figure 6 shows this location with a donor flaw of 3.2V injected and Figure 7 shows this location with a donor flaw of 6.0V injected in order to assess detectability. As evident from the graphics, the

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flaw is clearly observed in both the strip chart and Lissajous when compared to the signal generated from the TSP with noise alone. Figure 8 shows a comparison of the signals from the three cases. Given the results, it is considered extremely unlikely in either case that the flaw would escape detection even in a high noise environment. As such, the flaw injection study provides practical application to detectability and reinforces the implementation of the stepped POD determined using the method described previously.

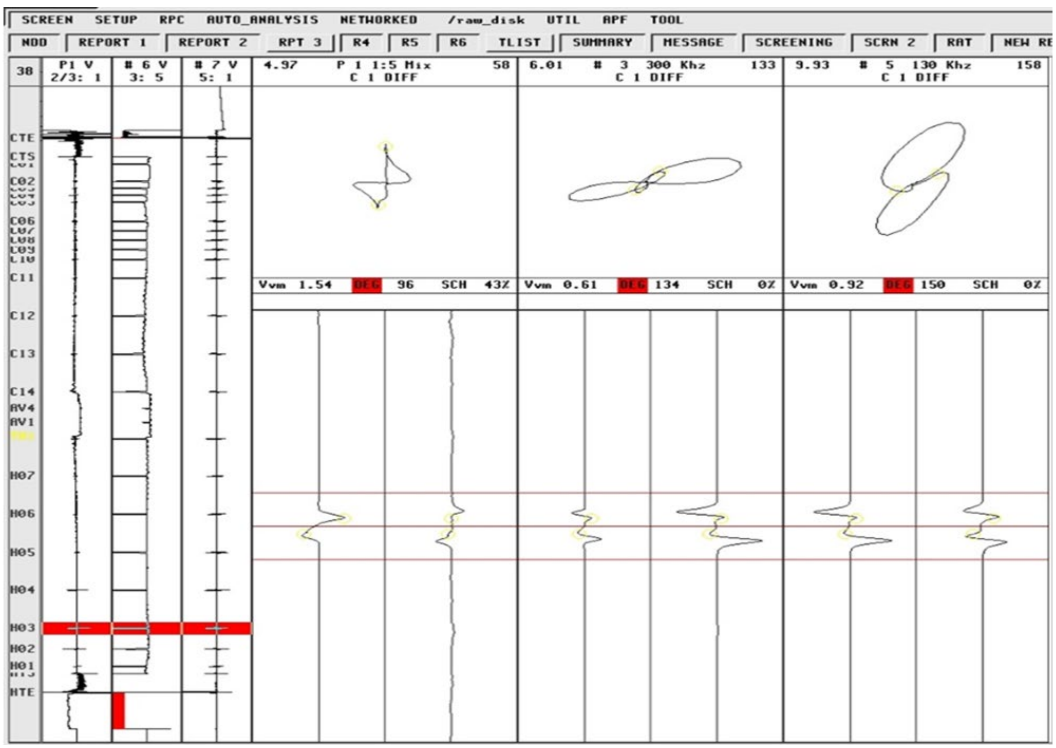

Figure 5: Host Tube/TSP Location with 1.54 Vvm Measured Noise

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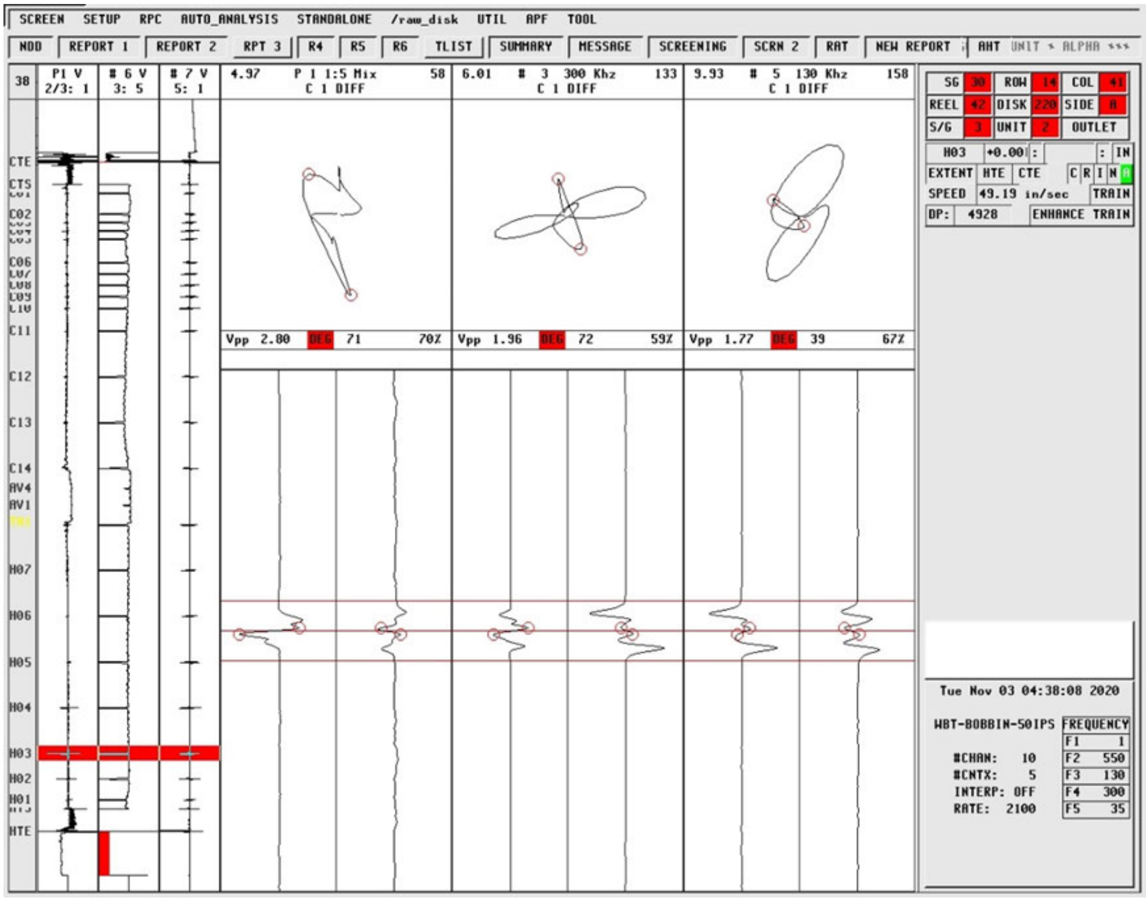

Figure 6: 3.2V Flaw Injection into Host Tube/Noise

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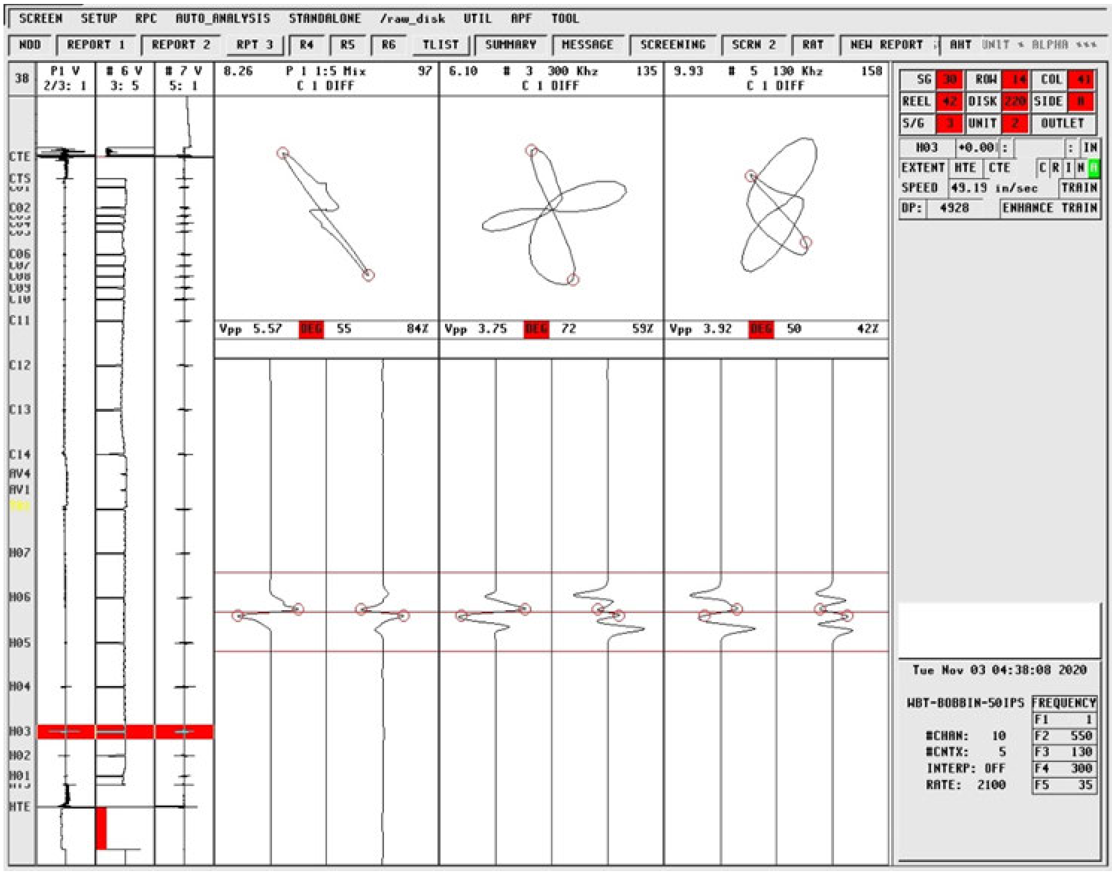

Figure 7: 6.0V Flaw Injection into Host Tube/Noise

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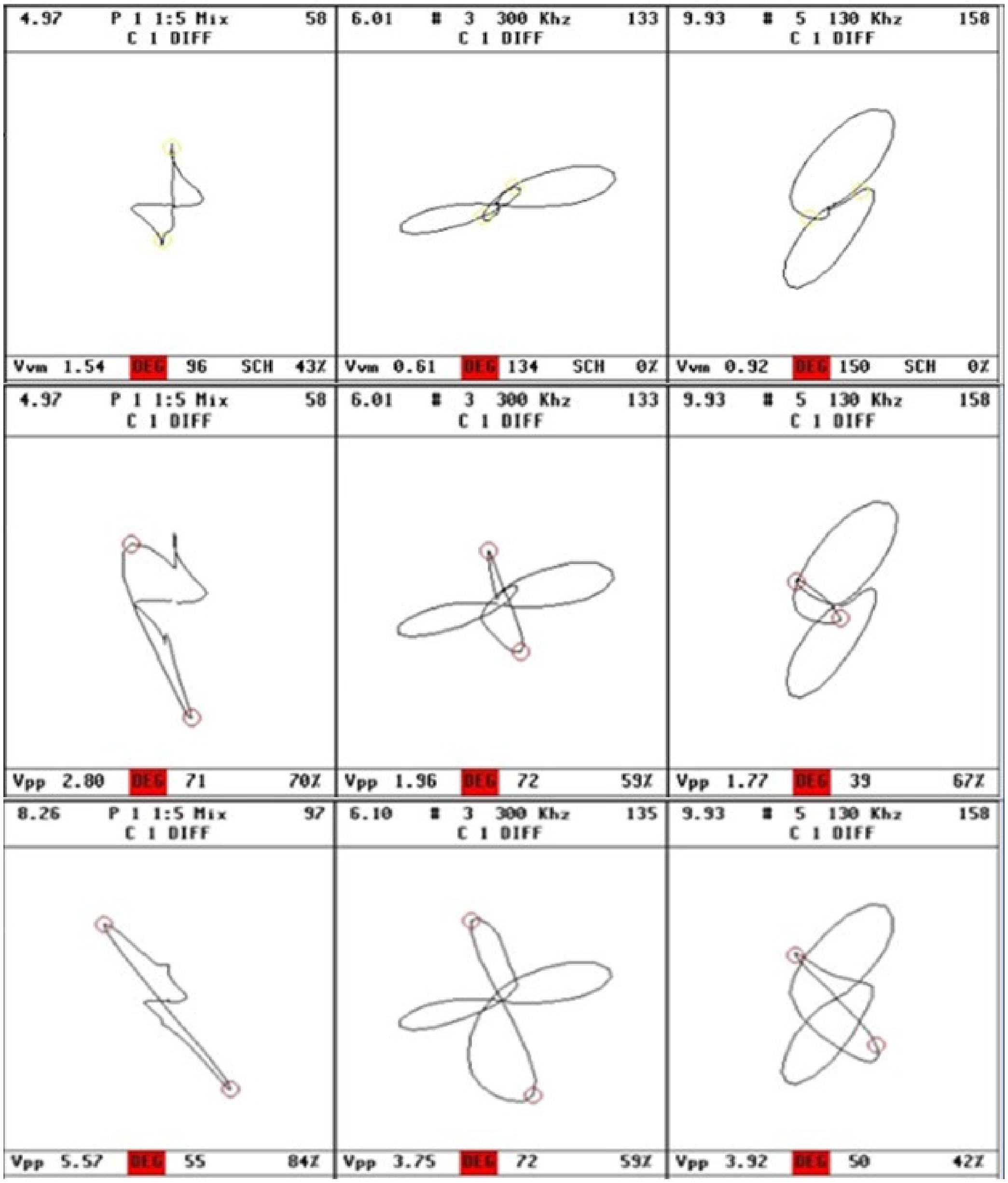

Figure 8: Donor Signals (top row – no donor signal; middle row – 3.2V donor signal; bottom row – 6V donor signal) into TSP with High Noise

2.3 POD Discussion

From Figure 4, it is clear that the proposed POD of 0.9 at signals 3.2V and greater, and then 0.95 at signals 6.0V and greater, is conservative if applied at Watts Bar Unit 2 SG3 since it bounds the 95% lower bound voltage-POD curve which accounts for the noise levels in the SG. This conclusion is also supported by the comparison between the strip charts and Lissajous for representative flaws and noise signals which shows that signals in the range of the increased POD can be distinguished from the noise with a high level of certainty.

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2.3.1 Comparison to Generic Industry POPCD

It is worth discussing that the Watts Bar 2 SG3 voltage-based POD curve is aligned with the POD function generated from industry data (Reference 1) utilizing the Probability of Prior Cycle Detection (POPCD) method. POPCD was developed using a different methodology from what is used for the Watts Bar 2 POD curve, and the comparison is intended to assure the validity of the analytical approach developed in this paper. As shown in Figure 9, the Watts Bar 2 SG 3 POD is significantly lower in the lower voltage regions than the generic industry POPCD function. This is expected since Watts Bar 2 SG3 noise is higher than what is typically found in industry, and higher noise levels in the lower voltage range produce lower S/N ratios with a corresponding lower POD.

a,c,e

Figure 9: Comparison of Watts Bar 2 SG3 POD with Industry Generic POPCD

2.3.2 Comparison to MAPOD Method

As mentioned in Section 2.0, site specific POD functions are commonly applied for various forms of SG tube degradation. MAPOD is a proprietary software application licensed by EPRI which provides one such method of developing site-specific depth-based POD functions using the SG noise distribution (Reference 3). One primary difference between the method used in the voltage based POD function above and the method used in MAPOD is that a S/N-POD relationship specific to ETSS I28411 is created for use in the simulation, while the MAPOD

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method uses [

]a,c,e. The method used in this document is more appropriate for this application because the entire S/N function is used in the simulation with an associated probability at all points between 0 and 1.0. For comparison, [

]a,c,e, significantly less than the MAPOD threshold. This means that the application of the S/N-POD function specific to ETSS I28411 is conservative when compared to the default EPRI threshold values.

2.3.3 Consideration of High Noise Sub-Population

As an additional check, the simulation described in Section 2.1.3 was performed with the noise distribution limited to SG3 TSPs H02 and H03. This subset was selected as a sensitivity case since the noise was higher in this region than in the rest of SG3. As expected, when the highest noise population subset was used in the Monte Carlo simulation the 95% lower bound POD decreased in value. Even so, the entire curve was still bounded by the higher noise level, except for the single point of 3.2V which had a 95% lower bound POD of 0.893. This difference is considered negligible since the noise was sampled from a limited population selected for the higher noise levels and the POD was calculated at the 95% lower bound. This is also appropriate because the POD will be used as an input for the GL 95-05 evaluation which samples from the entire population of SG3 flaws, not just those on H02 and H03. The results of this check confirm the conservatism in the proposed POD.

3.0 Summary of Results and Conclusions

A step-change POD function with values of 0.6 up to 3.2V, 0.9 from 3.2V up to 6V, and 0.95 at 6V and greater is determined to be an appropriate and conservative application of POD for Watts Bar Unit 2 GL 95-05 evaluations.

The POD is demonstrated to be conservative with respect to a 95% lower bound (5^{th} percentile) voltage-based POD curve developed specifically for the inspection technique employed at U2R3 and the limiting SG noise measurements as documented in Section 3.1.

Flaw injection using Data Union Software for large voltage signals at tube and TSP locations with high noise measurements was performed as a supplemental justification for the proposed POD values. These results are described in Section 3.2 and indicate that the highest noise levels at Watts Bar 2 will not interfere with the detection of large voltage flaws (greater than 3.2V).

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References:

1. EPRI Report, NP-7480-L, Addendum 7, Steam Generator Tubing Outside Diameter Stress Corrosion Cracking at Tube Support Plates Database for Alternate Repair Limits, 2007.
2. Westinghouse Letter No. LTR-SGMP-15-46, Revision 1, "Data Union Qualifications," June 2016.
3. EPRI MAPOD-R Software Manual, Version 2.1, 2017.
4. Westinghouse Letter, LTR-CDMP-20-40, Revision 1, "Watts Bar Unit 2 Refueling Outage 3 Steam Generator Alternate Repair Criteria Generic Letter 95-05 Return to Power Report," November 2020.
5. EPRI Appendix I Examination Technique Specification Sheet I28411, Rev. 4, Bobbin Detection of Axial ODSCC at Drilled Tube Support Structures, February 2017.

*** This record was final approved on 12/21/2020 11:26:57 AM. (This statement was added by the PRIME system upon its validation)

Appendix A

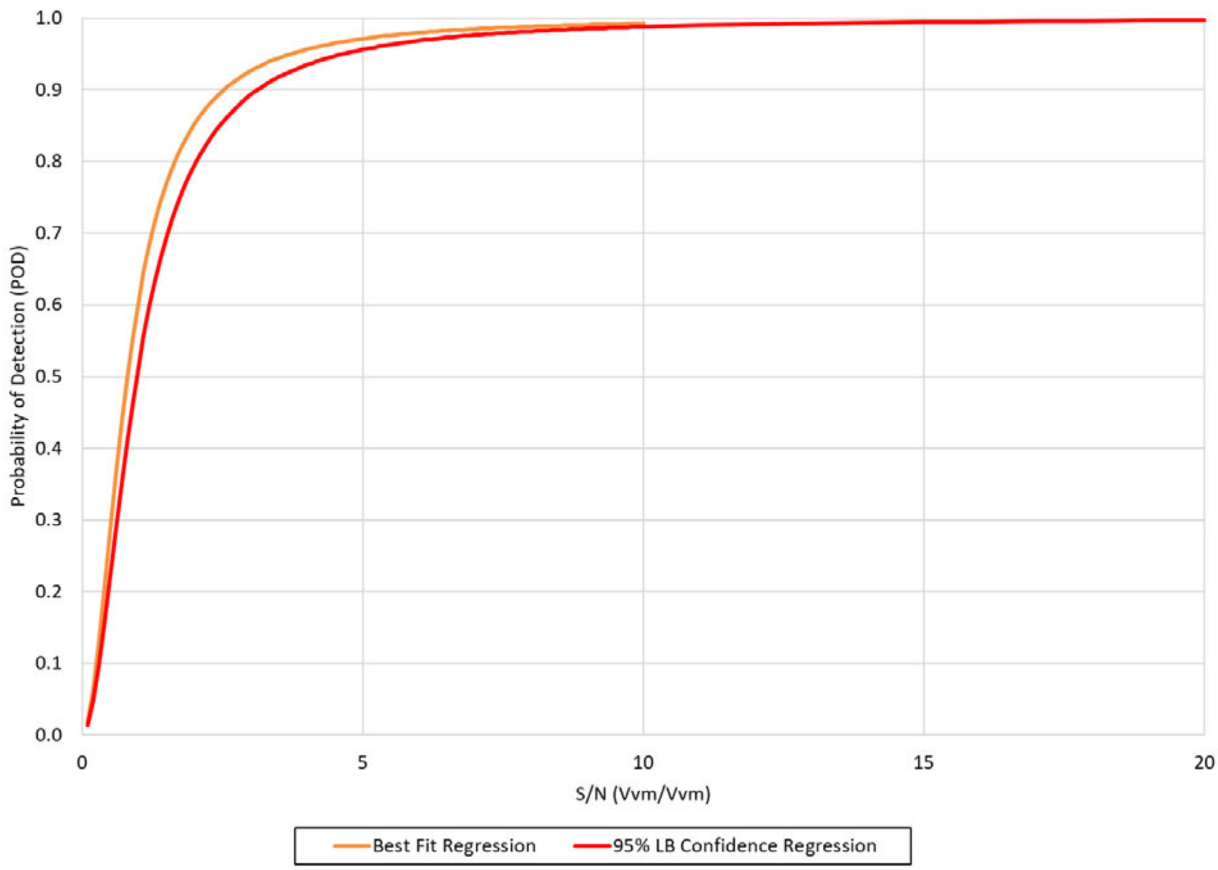

Figure A.1: ETSS I28411 S/N-POD Regression Curve

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Appendix A

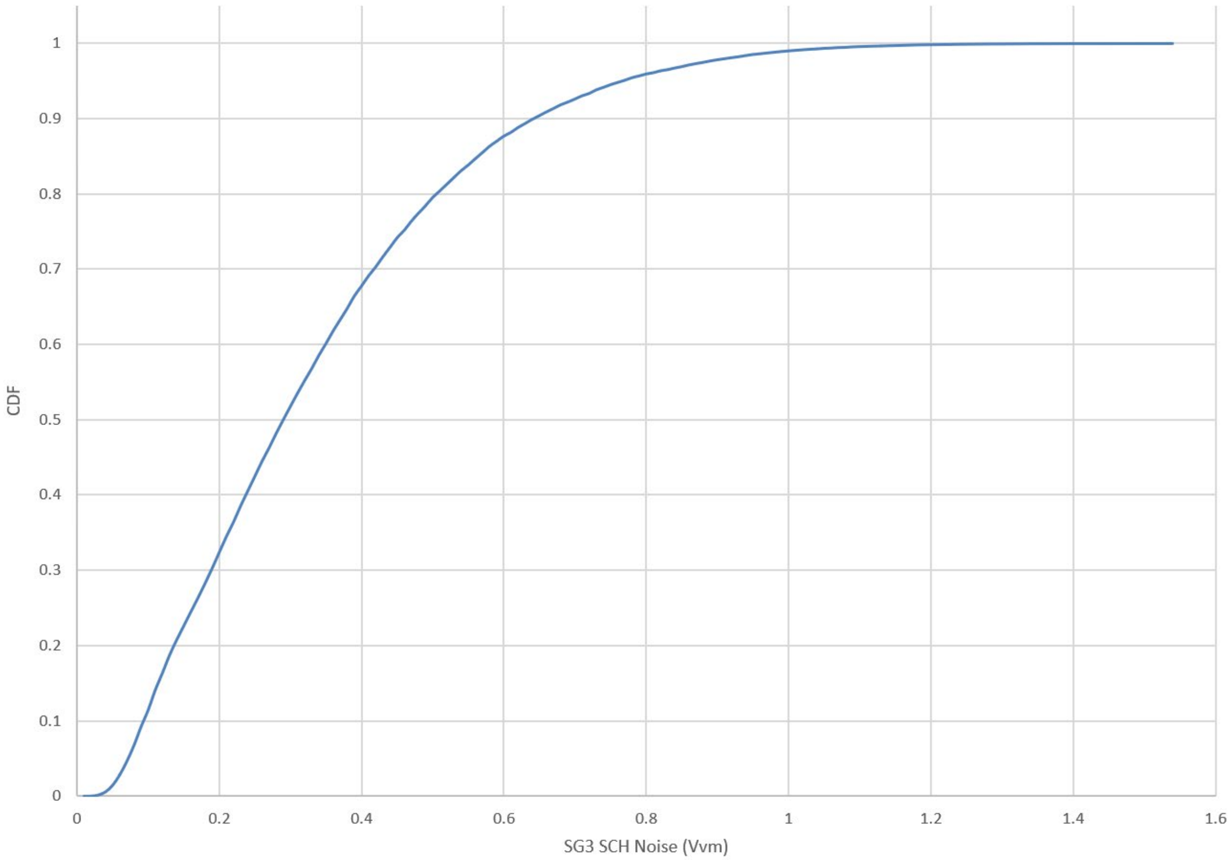

Figure A.2: WB2 SG3 SCH Noise (Vvm)

*** This record was final approved on 12/21/2020 11:26:57 AM. (This statement was added by the PRIME system upon its validation)

Enclosure 4

Westinghouse Electric Company LLC Application for Withholding Proprietary Information From Public Disclosure (Affidavit CAW-20-5136)

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:
COUNTY OF BUTLER:

(1) I, Zachary S. Harper, 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-CDMP-20-41 P-Attachment, Revision 0,"Watts Bar U2R3 Steam Generator Alternate Repair Criteria Generic Letter 95-05 Probability of Detection Methodology for 90-Day Report," 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) 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.

AFFIDAVIT

(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

AFFIDAVIT

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: 12/21/2020

Zachary S. Harper, Manager
Licensing Engineering