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# Watts Bar Nuclear Plant Unit 2

Pre-Submittal Teleconference for Proposed License Amendment to Revise the Updated Final Safety Analysis Report (UFSAR) to use a Temperature Adjustment Growth Rate Methodology in the Generic Letter 95-05 Analysis

February 11, 2021

# Agenda

- Opening Remarks and Purpose of the Proposed License Amendment Request (LAR)
- Introduction
- Generic Letter (GL) 95-05 Alternate POD and Temperature Adjustment Growth Rate
- Watts Bar Nuclear Plant (WBN) Unit 2 Temperature Adjusted Growth Rate Methodology Technical Discussion
- Estimated Operating Interval Extension with Temperature Adjustment
- Steam Generator 3 Temperature Adjusted Limiting Voltage Growth Distribution
- Preliminary Operational Assessment (OA) Sensitivity Case Results
- Proposed UFSAR Section 5.5.2.4 Change
- Regulatory Precedent
- Schedule for Submittal
- Path Forward

# Opening Remarks and Purpose of the Proposed LAR

- The proposed LAR revises the WBN dual-unit UFSAR Section 5.5.2.4 to allow the use of a temperature adjustment growth rate calculation for GL 95-05 OAs.
  - Implementation will use the Arrhenius equation described in Section 5.2 of EPRI Report 3002007571, Steam Generator Management Program: Steam Generator Integrity Assessment Guidelines Revision 4,” applying the adjustment of voltage growth described in Section 10.5.6.1.6 of EPRI Report 1018047 (Addendum 7 to NP-7480-L), Steam Generator Tubing Outside Diameter Stress Corrosion Cracking at Tube Support Plates Database for Alternate Repair Limits.
- Use of the proposed temperature adjusted growth rate calculation represents an adverse change to an element of an evaluation methodology in GL 95-05 as margin is gained to conditional burst probability.
  - Permits an extension to the operating interval when  $T_{\text{hot}}$  reduction is considered
  - Used in concert with the alternate probability of detection (POD) values as approved by the Nuclear Regulatory Commission (NRC).
  - Allows WBN Unit 2 to operate until a planned mid-cycle inspection in mid-September 2021 after peak electrical demand .
- Proposed temperature adjusted growth rate (and alternate POD) will only be used until the WBN Unit 2 steam generators (SGs) are replaced.

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# Introduction

- The WBN Unit 2 Cycle 3 refueling outage (U2R3) was the third in-service inspection (ISI) for the Unit 2 Model D3 SGs (Alloy 600MA).
- This was the first outage to implement GL 95-05 voltage-based repair criteria (ARC).
- Significant in-service inspection scope was performed.
- Condition monitoring requirements met for all degradation mechanisms except for GL 95-05 conditional burst probability in SG3 [WBN, Unit 2 Technical Specification (TS) 5.9.9 Item 5].

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# GL 95-05 Alternate POD and Temperature Adjustment Growth Rate

- The NRC approved Alternate POD supports ~285 calendar days operation until mid-cycle inspection is required.
  - Results in mid-cycle inspection near peak electrical demand in August 2021.
- Implementation of the temperature adjustment growth rate calculation methodology permits an approximate 27-day extension in operating interval above the operating interval calculated for the recently approved alternate POD.

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# WBN Unit 2 Temperature Adjusted Growth Rate Methodology Technical Discussion

- For some degradation mechanisms, such as primary water and outer diameter-initiated stress corrosion cracking, growth rates are dependent on the reactor coolant system (RCS) temperature.
- Temperature adjustment growth rate methodology based on the Arrhenius equation.
  - The Arrhenius equation describes the relation between the rate of reaction and temperature for many physical and chemical reactions

# WBN Unit 2 Temperature Adjusted Growth Rate Methodology Technical Discussion (Cont'd)

- The Arrhenius equation is written in general terms as:
- $\text{Rate} = A \exp (-\Delta H/RT)$ 
  - where A is a constant,  $\Delta H$  is the activation energy, R is the ideal gas constant and T is the absolute temperature. If  $\Delta H$  is expressed in units of cal/mol then R is 1.985 cal/(mol K) and T is the absolute temperature in Kelvin.
- For outside diameter stress corrosion cracking (ODSCC) an activation energy of 30 kcal/mole for combined initiation and propagation is used for A600MA tubes.

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# WBN Unit 2 Temperature Adjusted Growth Rate Methodology Technical Discussion (Cont'd)

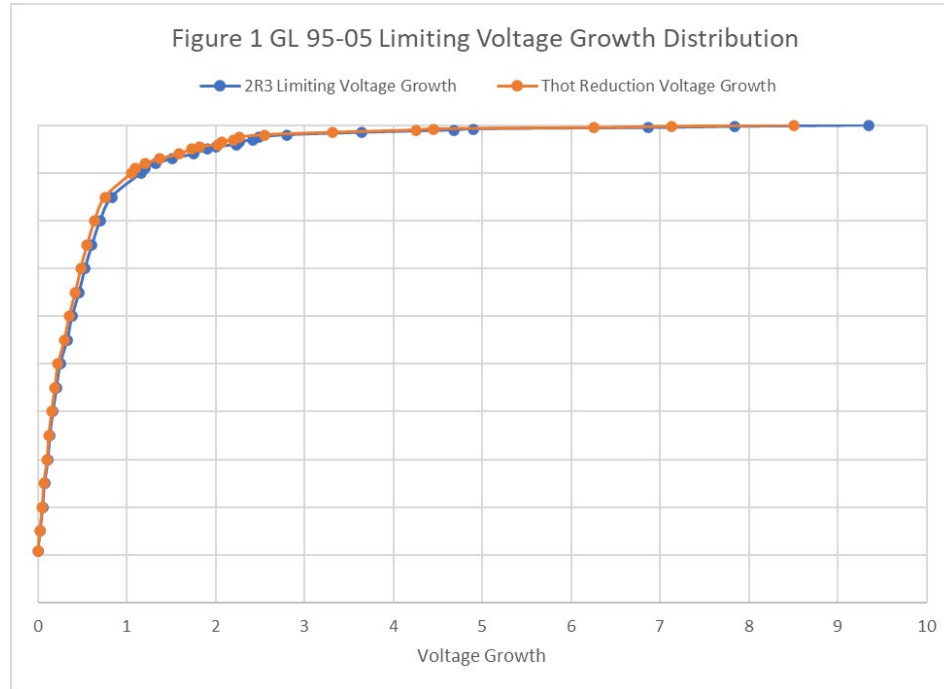
- As described in Section 10.5.6.1.6 of Addendum 7 of EPRI Report 1018047, the growth of the indications is taken to be a linear function of the length of the operating cycle per the ODSCC ARC references.
  - Temperature adjustment of the voltage-based growth data is discussed in Addendum 7 of EPRI Report 1018047.
  - This same temperature adjustment methodology will be used to modify the average growth rate used to determine the upper voltage repair limits.



# Estimated Operating Interval Extension with Temperature Adjustment

- Using the Arrhenius correlation discussed previously, an adjustment factor is applied to the growth to account for a lower hot leg temperature.
  - For example, WBN Unit 2 is currently operating at an approximate 4°F reduction in  $T_{hot}$  as compared to Cycle 3.
  - An adjustment factor of 0.91 is applied to the Cycle 3 growth to account for a 4°F reduction.
- This results in an overall shift of the growth distribution function that is supplied as input to the GL 95-05 OA calculations.
  - Figure 1 displays the limiting voltage growth distribution for WBN Unit 2 Cycle 3, which is exhibited by SG-3 compared against the same voltage distribution when adjusted for a Cycle 4  $T_{hot}$  reduction of 4°F.
- Because the Arrhenius correlation provides a linear correction factor to the indication growth, the effect is greater in the regions of larger growth.

# Steam Generator 3 Temperature Adjusted Limiting Voltage Growth Distribution



Note: adjusted for a Cycle 4 Thot reduction of 4°F.

# Preliminary OA Sensitivity Case Results

Case Description	Duration	Temperature	POD Function	Approximate OA Duration
No Change in $T_{hot}$ /Alternate POD	Note 1	Same as Cycle 3	0.9 at 3.2V 0.95 at 6V	285 days
$T_{hot}$ Change/Alternate POD	Note 2	$T_{hot}$ reduction of 4°F from Cycle 3	0.9 at 3.2V 0.95 at 6V	312 days (Note 3)
$T_{hot}$ Change/Alternate POD	From Mid-cycle outage to U2R4	$T_{hot}$ reduction no greater than 9°F from Cycle 3 (Note 4)	0.9 at 3.2V 0.95 at 6V	To be evaluated

## Notes:

1. Will result in a mid-cycle outage to perform the next SG inspection in August 2021 (not desirable due to high peak demands).
2. Will result in a mid-cycle outage to perform the next SG inspection in September 2021 (more desirable).
3. The operating interval is reduced from approximately 27 days if a  $T_{hot}$  reduction of less than 4°F is used.
4. Maximum reduction in  $T_{hot}$  to ensure margins exist with no safety analysis impact.

# Proposed WBN Unit 2 UFSAR Section 5.5.2.4 Change

## Unit 2 Only

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 <sup>(23)</sup>. Implementation of ODSCC ARC using GL 95-05 <sup>(24)</sup> as guidance is in accordance with Technical Specification inservice examination requirements and Reference 25. [(recently approved by NRC) 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<sup>(26)</sup>. A POD of 0.6 in accordance with GL 95-05, will be used for indications less than 3.2 volts.] *Also, when operating temperature differences exist from cycle-to-cycle, an exception to the GL 95-05 analysis in the form of a temperature adjustment to the growth rate calculation in accordance with Section 10.5.6.1.6 of Reference 27 will be applied. The temperature adjustment methodology will be used to determine the End of Cycle voltage distribution of axial indications for comparison to the conditional probability of tube burst of less than or equal to  $1 \times 10^{-2}$  and to determine the total primary-to-secondary leak rate from an affected SG during a postulated main steam line break event. This same temperature adjustment methodology will be used to modify the average growth rate used to determine the upper voltage repair limits. This exception applies until the Unit 2 Steam Generators are replaced <sup>(28)</sup>.*

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## Proposed WBN, Unit 2 UFSAR Section 5.5.2.4 Change

- Additionally, the Reference Section in UFSAR Section 5.5 will be revised to add new Reference 27 for EPRI Report 1018047 and new Reference 28 to reflect the NRC approval of this LAR.
- There are no corresponding TS changes required to apply the proposed temperature adjustment to the voltage growth rates, 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 a description of the growth rate calculation methodology to be used.

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# Regulatory Precedent

- No known requests to apply the proposed temperature adjustment growth rate methodology as described in this LAR.
- However, the practice to adjust growth rates for temperature using the Arrhenius equation for data for operating at a lower or higher  $T_{\text{hot}}$  is discussed in Section 5 of the EPRI Report 3002007571, Steam Generator Management Program (SGMP): Steam Generator Integrity Assessment Guidelines, Revision 4.

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# Schedule for Submittal

- February 11, 2021 – Pre-submittal teleconference with NRC
- February 28, 2021 - Submit LAR to NRC
- Request NRC approval by April 30, 2021, in support of mid-cycle outage planning.

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# Path Forward

- Revised OA to be submitted to NRC to reflect use of the proposed temperature adjusted growth rate methodology.
- Following the WBN Unit 2 mid-cycle outage, continued operation until the U2R4 outage (March 2022) will be assessed based on the alternate POD values and the proposed temperature adjusted growth rate methodology.
- WBN Unit 2 SGs are scheduled to be replaced during U2R4.





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