Watts Bar Nuclear Plant

Watts Bar Nuclear Plant (WBN)
Pre-submittal Meeting for the License Amendment Request (LAR) for Increased Tritium Production at WBN

February 22, 2023

TVA TENNESSEE VALLEY AUTHORITY

Agenda

- Opening Remarks
- Background
- Project Scope
- Proposed Technical Specification (TS) Changes
- License Amendment Request (LAR) Content
- Interface Items with New Analyses
- Post-LOCA Subcriticality Evaluation
- Proposed Updated Final Safety Analysis Report (UFSAR) and Capsule Withdrawal Revisions
- Basis for Changes to WBN Units 1 and 2 TS 5.9.6
- Precedents
- Schedule Milestones
- Closing Remarks

Opening Remarks

- WBN Units 1 and 2 are currently licensed to allow up to 1,792 tritium producing burnable absorber rods (TPBARs).
- At the request of the Department of Energy (DOE) National Nuclear Security Administration (NNSA), TVA is developing a LAR to increase the licensed limit to 2,496 TPBARs for each WBN unit.
- The proposed LAR is based on efficiencies gained during the development and Nuclear Regulatory Commission (NRC) review of the previous WBN TPBAR LARs.
- Key differences between the proposed LAR and previous WBN Units 1 and 2 TPBAR LARs are addressed.
- Identify key schedule milestones to support DOE NNSA production requirements.

Background

- Tritium Production Program
  - Watts Bar Unit 1 tritium production began in October 2003
  - Watts Bar Unit 2 tritium production began in October 2020
- WBN Unit 1 License Amendment 107 (ML16159A057) and WBN Unit 2 License Amendment 27 (ML18347B330) authorized up to 1,792 TPBARs for each unit.
- WBN Unit 1 License Amendment 143 and WBN Unit 2 License Amendment 50 (ML21034A169) approved the use of the loss-of-coolant accident (LOCA) specific TPBAR stress analysis methodology to evaluate the integrity of the TPBARs for the conditions expected during a large break LOCA and provide a recovery of margin in the post-LOCA criticality evaluation.

Project Scope

- No plant physical modifications to support radioactive effluent source term changes
  - Radioactive effluent concentration and dose assessment calculation updates similar to recent TPBAR LARs
- Fluence-related calculations
  - Similar to recent TPBAR LARs
- No control room operator actions associated with radioactive effluent management
  - No human factors evaluations required
- Environmental assessment information based on updated radioactive effluence calculations
  - Similar to recent TPBAR LARs

Proposed TS Changes

- The LAR revises WBN Units 1 and 2 TS 4.2.1, "Fuel Assemblies," to authorize the irradiation of up to 2,496 TPBARs in WBN Units 1 and 2.
- The LAR also proposes a supporting change to WBN Units 1 and 2 TS 5.9.6, “Reactor Coolant System (RCS) PRESSURE AND TEMPERATURE LIMITS REPORT (PTLR).” The proposed change makes WBN Unit 1 TS 5.9.6 consistent with WBN Unit 2 TS 5.9.6 and adds WCAP-18124-NP-A Rev. 0 Supplement 1-NP-A, Rev. 0, "Fluence Determination with RAPTOR-M3G and FERRET – Supplement for Extended Beltline Materials." Corresponding changes being made to the WBN Units 1 and 2 TS Bases 3.4.3, “RCS P/T Limits.”

Proposed TS Changes

Units 1 and 2 TS 4.2.1

4.2.1 Fuel Assemblies

The reactor shall contain 193 fuel assemblies. Each assembly shall consist of a matrix of ZIRLO® or Optimized ZIRLO™ clad fuel rods with an initial composition of natural or slightly enriched uranium dioxide (UO_2) as fuel material. Limited substitutions of zirconium alloy or stainless steel filler rods for fuel rods, in accordance with approved applications of fuel rod configurations, may be used. Fuel assemblies shall be limited to those fuel designs that have been analyzed with applicable NRC staff approved codes and methods and shown by tests or analyses to comply with all fuel safety design bases. A limited number of lead test assemblies that have not completed representative testing may be placed in nonlimiting core regions. For Unit 1, Watts Bar is authorized to place a maximum of 24961~~792~~ Tritium Producing Burnable Absorber Rods into the reactor in an operating cycle.

Proposed TS Changes Unit 2 TS 5.9.6 (marked-up)

5.9.6 Reactor Coolant System (RCS) PRESSURE AND TEMPERATURE LIMITS REPORT (PTLR)

a. RCS pressure and temperature limits for heatup, cooldown, low temperature operation (power operated relief valve lift settings required to support the Cold Overpressure Mitigation System (COMS) and the COMS arming temperature), criticality, and hydrostatic testing as well as heatup and cooldown rates shall be established and documented in the PTLR for the following:

LCO 3.4.3 RCS Pressure and Temperature (P/T) Limits
LCO 3.4.12 Cold Overpressure Mitigation System (COMS)

b. The analytical methods used to determine the RCS pressure and temperature limits and COMS setpoints shall be those previously reviewed and approved by the NRC, specifically those described in the following documents:

1. WCAP-14040-A, Rev. 4 "Methodology Used to Develop Cold Overpressure Mitigating System Setpoints and RCS Heatup and Cooldown Limit Curves."

2. WCAP-18124-NP-A, Rev. 0, "Fluence Determination with RAPTOR-M3G and FERRET," and WCAP-18124-NP-A Rev. 0 Supplement 1-NP-A, Rev. 0, "Fluence Determination with RAPTOR-M3G and FERRET – Supplement for Extended Beltline Materials," may be used as an alternative to Section 2.2 of WCAP-14040-A Rev. 4.

3. The PTLR will contain the complete identification for each of the TS reference Topical Reports used to prepare the PTLR (i.e., report number, title, revision, date, and any supplements).

c. The PTLR shall be provided to the NRC upon issuance for each reactor vessel fluence period and for any revision or supplement thereto.

Proposed TS Changes Unit 1 TS 5.9.6 (marked-up)

Reactor Coolant System (RCS) PRESSURE AND TEMPERATURE LIMITS REPORT (PTLR)

a. RCS pressure and temperature limits for heatup, cooldown, low temperature operation (power operated relief valve lift settings required to support the Cold Overpressure Mitigation System (COMS) and the COMS arming temperature), criticality, and hydrostatic testing as well as heatup and cooldown rates shall be established and documented in the PTLR for the following:

LCO 3.4.3 RCS Pressure and Temperature (P/T) Limits
LCO 3.4.12 Cold Overpressure Mitigation System (COMS)

b. The analytical methods used to determine the RCS pressure and temperature limits and COMS setpoints shall be those previously reviewed and approved by the NRC. ~~The acceptability of the analytical methods is documented in NRC letter, "WATTS BAR UNIT 1 - ACCEPTANCE FOR REFERENCING OF PRESSURE TEMPERATURE LIMITS METHODOLOGY AND PRESSURE TEMPERATURE LIMITS REPORT (TAC M89048)", September 22, 1995 and "EXEMPTION FROM THE REQUIREMENTS OF 10 CFR Part 50.60, ACCEPTANCE CRITERIA FOR FRACTURE PREVENTION MEASURES FOR LIGHTWATER NUCLEAR POWER REACTORS FOR NORMAL OPERATION - WATTS BAR NUCLEAR PLANT (TAC NO. M99063)," September 29, 1997. S~~, specifically, the analytical methods are described in the following references:

1. WCAP-14040-A, Rev. 4 "Methodology Used to Develop Cold Overpressure Mitigating System Setpoints and RCS Heatup and Cooldown Limit Curves." ~~Letter, W. J. Museler to NRC, regarding request for exemption from 10 CFR 50.60, March 10, 1994.~~

2. WCAP-18124-NP-A, Rev. 0, "Fluence Determination with RAPTOR-M3G and FERRET," and WCAP-18124-NP-A Rev. 0 Supplement 1-NP-A, Rev. 0, "Fluence Determination with RAPTOR-M3G and FERRET – Supplement for Extended Beltline Materials," may be used as an alternative to Section 2.2 of WCAP-14040-A Rev. 4. ~~Letter, D. E. Nunn to NRC, regarding heatup and cooldown curves for normal operation (submitting WCAP-14176 and WCAP-14040, Rev. 1), December 23, 1994.~~

3. The PTLR will contain the complete identification for each of the TS reference Topical Reports used to prepare the PTLR (i.e., report number, title, revision, date, and any supplements) ~~Letter, R. R. Baron to NRC, responding to NRC July 11, 1995, request for additional information, July 31, 1995.~~

~~4. Letter, R. R. Baron to NRC providing more information regarding cold overpressure mitigating system setpoints, September 8, 1995.~~

~~5 Letter, L.A. Sealice to NRC, regarding request for exemption from 10~~

Reporting Requirements
5.9

~~CFR 50.60, concerning use of Code Case N-514 to determine LTOP setpoints, dated June 20, 1997.~~

c. The PTLR shall be provided to the NRC upon issuance for each reactor vessel fluency period and for any revision or supplement thereto.

TENNESSEE VALLEY AUTHORITY

Proposed TS Changes Unit 1 TS 5.9.6 (final typed)

5.9.6 Reactor Coolant System (RCS) PRESSURE AND TEMPERATURE LIMITS REPORT (PTLR)

a. RCS pressure and temperature limits for heatup, cooldown, low temperature operation (power operated relief valve lift settings required to support the Cold Overpressure Mitigation System (COMS) and the COMS arming temperature), criticality, and hydrostatic testing as well as heatup and cooldown rates shall be established and documented in the PTLR for the following:

LCO 3.4.3 RCS Pressure and Temperature (P/T) Limits
LCO 3.4.12 Cold Overpressure Mitigation System (COMS)

b. The analytical methods used to determine the RCS pressure and temperature limits and COMS setpoints shall be those previously reviewed and approved by the NRC, specifically, the analytical methods are described in the following references:

1. WCAP-14040-A, Rev. 4 "Methodology Used to Develop Cold Overpressure Mitigating System Setpoints and RCS Heatup and Cooldown Limit Curves."

2. WCAP-18124-NP-A, Rev. 0, "Fluence Determination with RAPTOR-M3G and FERRET," and WCAP-18124-NP-A Rev. 0 Supplement 1-NP-A, Rev. 0, "Fluence Determination with RAPTOR-M3G and FERRET – Supplement for Extended Beltline Materials," may be used as an alternative to Section 2.2 of WCAP-14040-A Rev. 4.

3. The PTLR will contain the complete identification for each of the TS reference Topical Reports used to prepare the PTLR (i.e., report number, title, revision, date, and any supplements).

c. The PTLR shall be provided to the NRC upon issuance for each reactor vessel fluency period and for any revision or supplement thereto.

License Amendment Request Content

- The LAR for increased tritium production is based on the previous WBN Units 1 and 2 TPBAR LAR precedents.
- Addresses 17 plant-specific interface items from NUREG-1672 Safety Evaluation Report for DOE Tritium Production Core Topical Report (see following slide).
- Addresses key differences between the past TPBAR precedents for increasing the number of TPBARs from 1,792 to 2,496.
- Updates information for increased two-unit tritium production for NRC environmental assessment.

License Amendment Request Content (cont'd)

- The following is a listing of the NUREG-1672 interface items along with the section number in the LAR where these items are addressed:

  - 1. Handling of TPBARs (4.1)
  - 3. Compliance with DNB Criterion (4.2)
  - 4. Reactor Vessel Integrity Analysis (4.3)
  - 5. Control Room Habitability Systems (4.4)
  - 7. Light-Load Handling System (4.5)
  - 8. Station Service Water System (4.6)
  - 9. Ultimate Heat Sink (4.7)
  - 11. Spent Fuel Pool Cooling and Cleanup System (4.8)
  - 12. Component Cooling Water System (4.9)
  - 13. Demineralized Water Makeup System (4.10)
  - 14. Liquid Waste Management System (4.11)
  - 15. Process and Effluent Radiological Monitoring and Sampling System (4.12)
  - 16. Use of LOCTA_JR Code for LOCA Analyses (4.13)
  - 17. ATWS Analysis (4.14)

License Amendment Request Content (cont'd)

- There are no substantive changes to Interface Issues 2, "Procurement and Fabrication Issues," 6, "Specific Assessment of Hydrogen Source and Timing or Recombiner Operation," and 10, "New and Spent Fuel Storage," as described in the previous WBN Unit 2 TPBAR LAR [TVA letter to NRC, CNL-17-144, dated December 20, 2017 (ML17354B282)] and they remain applicable to this LAR.
- Therefore, Interface Issues 2, 6, and 10 are not discussed in the LAR.

Interface Issue 1: Handling of TPBARs

- The information regarding Interface Issue 1 provided in the previous TPBAR LAR (ML17354B282) applies to this LAR except as provided below.
- TVA has determined that 2,496 TPBARs per unit can be harvested and shipped by utilizing two crews for those evolutions to improve these durations from previous estimates.
- The durations to consolidate two units of maximum load TPBARs (i.e., 4,992 TPBARs) into canisters stored in the spent fuel pool (SFP) and shipped off-site as part of ongoing initiatives to manage competition for resources (e.g., refuel floor space, spent fuel pool, auxiliary building crane) associated with other activities.

Interface Issue 3: Compliance with DNB Criterion

- The information regarding Interface Issue 3 provided in the previous TPBAR LAR (ML17354B282) applies to this LAR except as provided below.
- For the WBN 2,496 TPBAR core, the normal thermal-hydraulic departure from nucleate boiling (DNB) related reload analyses were performed using VIPRE-01 (ML993160096) and are described in the previous TPBAR LAR.
- Therefore, the presence of TPBARs in the reload core design did not challenge the DNB criterion. An explicit check of the DNB criterion is included in the cycle-specific reload safety evaluation performed for each WBN reload core. Continued performance of this check validates the acceptability of each reload core for operation within the DNB design limits.

Interface Issue 4: Reactor Vessel Integrity

- The TPBAR Interface Issue 4 is addressed in WCAP-18769-NP, Revision 1, “Watts Bar Units 1 & 2 Reactor Vessel Integrity Evaluations for the 2,496 TPBAR Implementation Project,” (Enclosure 2 to the LAR).
- The summary of results provided also includes changes to the surveillance capsule removal schedule for eventual inclusion into the WBN Units 1 and 2 PTLR (discussed later in this presentation).
- The basis for these updates continues to satisfy the requirements of ASTM E-185-82. Specifically, the changes to the schedule are required due to the plant-specific neutron fluence that was addressed as part of this interface item. Changes to the lead factors, effective full power years (EFPY) removal times and expected capsule fluence reflect the recently addressed plant-specific neutron fluence as part of this interface issue.

Interface Issue 5: Control Room Habitability Systems

- The TPBAR Interface Issue 5 information provided for the WBN Unit 1 and WBN Unit 2 tritium production program increase to 2,496 TPBAR is based on the applicable WBN Unit 1 and WBN Unit 2 license amendments.
- The established site-specific design basis analyses for control room (CR) dose have been updated to reflect the TPBAR increase to 2,496.
- The current accident source term (i.e., fission product inventory) for the tritium production core (TPC) for WBN Units 1 and 2 was calculated using ORIGEN2.1. The core radionuclide activity inventory for the TPC with 2,496 TPBARs was calculated using ORIGEN-ARP/ORIGEN-S in SCALE 6.0 (see proposed UFSAR change later in the presentation).
- Updates to the TPC and core inventory tables provided to reflect the 2,496 TPBAR equilibrium fuel cycle. Core inventory was updated to reflect increase in reload batch sizes.

Interface Issue 5 (cont'd)

- Primary and Secondary Coolant Concentrations updated
  - The concentration of tritium for a TPC was calculated using the same methodology as used for the existing TPC, except with 2,496 instead of 1,792 TPBARs and 80 Ci/year for integral fuel burnable absorber (IFBA) releases, up from 40 Ci/year.
  - The total annual tritium expected from TPBARs is 13,430 Ci/year (i.e., 2,496 TPBARs with a permeation rate of 5 Ci/TPBAR/year, an IFBA release rate of 80 Ci/year, and a non-TPC source of 870 Ci/year). ANSI/ANS-18.1-1984 states that the average tritium concentration should be assumed to be 1.0 µCi/gm in the primary coolant. This results in an average tritium concentration of the RCS to be 15.5 µCi/gm [(13,430 Ci/year*1.0 µCi/gm)/870 Ci/year] rounded up for conservatism.
- Large break loss of cooling accident (LBLOCA) analyses of record were revised to account for the increase in TPBARs by utilizing the core inventory calculated for the 2,496 TPBAR TPC.
  - The WBN LBLOCA radiological dose consequences for the CR and offsite [two-hour exclusion area boundary (EAB), and 30-day low population zone (LPZ)] analysis results are below the 10 CFR Part 100, 10 CFR Part 50 Appendix A General Design Criterion (GDC) 19 regulatory criteria.

Interface Issue 5 (cont'd)

- The WBN loss of offsite power (LOOP), waste gas decay tank (WGDT) rupture, and main steam line break (MSLB) analysis of records were also revised to account for increasing the maximum number of TPBARs from 1,792 to 2,496 in the TPC.
  - The calculated radiological consequences for the LOOP, WGDT rupture, and MSLB are below the 10 CFR Part 100, 10 CFR Part 50, and NUREG-0800 SRP regulatory criteria.
- The WBN fuel handling accident (FHA) analysis of record was also revised to account for increasing the maximum number of TPBARs from 1,792 to 2,496 in the TPC. The WBN FHA radiological dose consequences analysis results are below the 10 CFR 50.67 and RG 1.183 limits.

Interface Issue 5 (cont'd)

- Steam generator (SG) tube rupture analysis also updated to account for increasing the maximum number of TPBARs from 1,792 to 2,496 in the TPC
  - Includes the WBN Units 1 and 2 replacement steam generators (RSGs).
  - The parameters remain the same except for the mass releases, which were revised due to PAD5 implementation.
  - Dose results remain well within 10 CFR Part 100 and 10 CFR Part 50 Appendix A GDC 19 dose limits.

Interface Issue 7: Light Load Handling System

- The information regarding Interface Issue 7 provided in the previous TPBAR LAR (ML17354B282) is applicable to this LAR except as provided below.
- The spent fuel pit crane has been replaced and has a reduced capacity of 2,500 pounds as opposed to the original crane's capacity of 4,000 pounds. This is acceptable because the capacity is above the maximum load to be handled by the crane, and the previous LAR write-up remains valid with the decreased capacity.

Interface Issues 8: Station Service Water System and 9: Ultimate Heat Sink (UHS)

- The information regarding Interface Issues 8 and 9 provided in the previous TPBAR LAR (ML17354B282) is applicable to this LAR except as provided below.
- TVA updated the quantitative analysis of expected impact of decay heat on the SFP cooling and cleanup system (SFPCCS). The updates to these analyses have shown that the heat loads from these systems to the component cooling system (CCS) are bounded by what was analyzed for the previous increase to 1,792 TPBARs. Interface Issue 12 provides a more detailed discussion of these changes.
- The essential raw cooling water (ERCW) system and the ultimate heat sink (UHS) have adequate capacity and cooling margin to perform its safety and non-safety functions with the changes in decay heat loads imposed by the increase to 2,496 TPBARs.

Interface Issue 11: Spent Fuel Pool Cooling and Cleanup System

- The information regarding Interface Issue 11 provided in the previous TPBAR LAR (ML17354B282) is applicable to this LAR except as provided below.
- For the most limiting scenario of a full-core offload, the previously analyzed heat load is bounding of the 2,496 TPBARs case after approximately 4.5 days.
- TVA calculations, procedures, and other station documentation provide specific heat load requirements for offloading into the SFP. These documents provide the station with a rigorous, controlled mechanism for which the SFP heat load is managed to ensure all station commitments are met.
- The station design basis conservatively assumes a completely full SFP. TVA completes regular dry cask campaigns to minimize the spent fuel in the pool, resulting in heat loads which are less then what are conservatively assumed.

Interface Issue 12: Component Cooling Water System

- Tritium impact on RHR system heat loads - the expected core decay heat load for 2,496 TPBARs is bounded by the current analysis of record, no adverse impacts to RHR cooldown and CCS are anticipated during cooldown.
- For the 2,496 TPBAR increase, the established site-specific methodology for analysis of the SFP heat load, which rejects heat to the CCS is maintained, but is updated to reflect the TPBAR increase.
- The increase from 1,792 TPBARs to 2,496 TPBARs does not result in any change in the net SFP decay heat impact due to tritium production activities and the value analyzed in in the previous TPBAR LAR (ML17354B282) remains bounding.
- The CCS has adequate capacity and cooling margin to perform its safety and non-safety related functions with the additional heat loads imposed by the increase to 2,496 TPBARs. Tritium production activities do not have an adverse impact on the CCS heat removal capabilities.

Interface Issue 13: Demineralized Water Makeup System

- The makeup water treatment plant (MWTP) is designed to supply the filtered and demineralized water required for both units. The demineralized water, storage, and distribution system (DMWS) receives demineralized water from the MWTP, stores it, and distributes high purity demineralized water.
- The MWTP has sufficient capacity to supply the filtered and demineralized water required for both operating units (including a TPC with up to 2,496 TPBARs) to the DWMS.
- Interface Issue 14 provides further evaluation of radioactive waste management and design dose rates relative to regulatory criteria.

Interface Issue 14: Liquid Waste Management Systems

- Revised analysis of liquid and gaseous radioactive effluents performed:
  - Includes effects of tritium production in WBN Units 1 and 2.
  - Updated primary and secondary radionuclide concentrations.
  - The same permeation rate of 5/Ci/TPBAR/year is considered.
  - Based on latest land use census.
- As noted in Interface Issue 5, the average tritium concentration of the RCS, without any TPBAR failures, is 15.5 µCi/gm for 2,496 TPBARs.
- The tritium release concentrations for operation with 2,496 TPBARs remain below 10 CFR 20 release concentration limits given a CTB dilution flow rate greater than or equal to 30,000 gpm.
- Results demonstrate that both 10 CFR Part 20 effluent concentration limit values and 10 CFR Part 50 Appendix I dose limits are met.

Interface Issue 14 (cont'd)

Category	Non-TPC Dose	TPC Dose	Incremental Increase from TPC	NRC Annual Effluent Exposure Guideline
Annual Radioactive Gaseous Emissions				
Maximally Exposed Individual (mrem) Total Body	0.60	0.60	0	5.00 Total Body
Maximally Exposed Individual (mrem) Organ	8.85 (Bone)	11.3 (Bone)	2.45	15.00 Any Organ
50-mile Population Dose (person-rem)	11.3 (Thyroid)	19.1 (Thyroid)	7.8	NA

Interface Issue 14 (cont'd)

Category	Non-TPC Dose	TPC Dose	Incremental Increase from TPC	NRC Annual Effluent Exposure Guideline
Annual Radioactive Liquid Emissions				
Maximally Exposed Individual (mrem) Total Body	0.34	0.39	0.05	3.00 Total Body
Maximally Exposed Individual (mrem) Organ	0.47 (Liver)	0.50 (Liver)	0.03	10.00 Any Organ
50-mile Population Dose (person-rem)	6.9 (Thyroid)	13.0 (Thyroid)	6.1	NA

Interface Issue 14 (cont'd)

- 40 CFR 190.10, "Standards for normal operations," in part (a), sets annual dose equivalent limits for the normal operation at WBN. Using the revised realistic TPC source terms for 2,496 TPBARs, the offsite doses calculated for releases of radionuclides in liquid and gaseous effluents from the site operating with two TPC cores during normal operation plus direct radiation [including contributions from the independent spent fuel storage installation (ISFSI)] are summarized in the following table, which also lists the regulatory established dose limits.

Interface Issue 14 (cont'd)

Annual Projected Impact of Two TPCs (2,496 TPBARs) on 40 CFR Part 190 Compliance		
Organ	Site Dose from Two TPCs (mrem/yr)	**40 CFR 190 Limit (mrem/yr)**
Whole Body	12.24	25
Thyroid	16.52	75
Critical Organ (Bone)	23.44	25

The above table demonstrates that the resultant environmental releases from tritium production at the site meet the Environmental Protection Agency limits.

Interface Issue 15: Process and Effluent Radiological Monitoring and Sampling System

- The information regarding Interface Issue 15 provided in the previous TPBAR LAR (ML17354B282) is applicable to this LAR.
- TVA previously performed an evaluation of the production of tritium for both WBN units and determined that no additional sampling points were needed beyond those presently required by the WBN TS during normal plant operations and refueling operations with a TPC (ML16159A057 and ML17354B282).

Interface Issue 16: Use of LOCTA_JR Code for LOCA Analyses

- The current analysis of record for the Small-Break LOCA (SBLOCA) and LBLOCA events for WBN Bar Units 1 and 2 utilizes the 2016 Westinghouse FULL SPECTRUM LOCA (FSLOCA) evaluation model (EM) and is supported by a TPBAR structural integrity analysis based on the FSLOCA EM.
- These analyses have been approved by the NRC (ML21034A166 and ML21034A169). Neither the analysis for nuclear fuel using the FSLOCA EM nor the TPBAR structural integrity analysis explicitly uses the LOCTA_JR code. Therefore, Interface Issue 16 is not applicable to these analyses.

Post-LOCA Subcriticality Evaluation

- In WBN Unit 1 License Amendment 143 and WBN Unit 2 License Amendment 50 (ML21034A166 and ML21034A169), NRC approved the use of the Westinghouse FSLOCA methodology for WBN Units 1 and 2, which is used to evaluate TPBAR structural integrity during a LBLOCA.
- The use of the FSLOCA EM yields a reduction in the peak cladding temperature in analyses of LBLOCA and SBLOCA for WBN Units 1 and 2. The application of the new TPBAR stress analysis methodology demonstrates that TPBAR integrity will be maintained following a LBLOCA. As a result, the presence of intact TPBARs is credited in the post-LOCA criticality evaluation as a negative reactivity contribution. Consequently, post-LOCA subcriticality margin is increased.
- The standard reload methodology for a core containing 2,496 TPBARs confirms post-LOCA subcriticality is maintained.

Interface Issue 17: ATWS Analysis

- The information regarding Interface Issue 17 provided in the previous TPBAR LAR (ML17354B282) is applicable to this LAR except as provided below.
- The one discernable trend that was noted in TVA Letter to NRC, “Watts Bar Nuclear Plant - Tritium Production Program Anticipated Transients Without Scram (ATWS)” dated September 29, 2000 (ML003759282), was that at the beginning of the cycle the TPC would exhibit a more negative moderator temperature coefficient (MTC). The reason is that fixed burnable absorbers, like TPBARs, serve as a source of negative reactivity which limits the amount of soluble boron required to be in the RCS to maintain criticality.
- Because a lower soluble boron concentration leads to a more negative moderator feedback, the use of additional TPBARs will further decrease the core MTC and will add additional safety margin to the ATWS overpressurization event.

License Amendment Request Content (cont'd)

- The LAR also contains a revision to the WBN dual-unit UFSAR that TVA has determined requires prior NRC approval. Specifically, the proposed UFSAR change modifies the source term for design basis accident analyses to allow the core fission product inventory to be calculated using an updated version of the ORIGEN code.
- TVA is also requesting NRC approval of a revision to the reactor vessel (RV) surveillance capsule removal schedule for WBN Units 1 and 2, pursuant to 10 CFR 50, Appendix H, "Reactor Vessel Material Surveillance Program Requirements," Paragraph III.B.3.

Proposed UFSAR Change

15.1.7 Fission Product Inventories

15.1.7.1 Radioactivity in the Core

ORIGEN-S/ORIGEN-ARP modules within the SCALE 6.0[2]

~~Unit 1~~

The core fission product-inventory is calculated by the ~~ORIGEN~~[2] computer code. The inventories of fission products important from a health hazard point of view are given in Table 15.1-4. The isotopes included in Table 15.1-4 are the isotopes controlling from considerations of inhalation dose (iodines) and from direct dose due to immersion (noble gases).

~~Unit 2~~

~~The average core fission product inventory is calculated by the ORIGEN-S Subcode within the SCALE 4.2 [2] computer code. The inventories of fission products important from a health hazard point of view are given in Table 15.1-4. The isotopes included in Table 15.1-4 are the isotopes controlling from considerations of inhalation dose (iodines) and from direct dose due to immersion (noble gases).~~

15.1.7.2 Radioactivity in the Fuel Pellet Clad Gap

based on the core fission product inventories calculated by the ORIGEN-S/ORIGEN-ARP modules within the SCALE 6.0[2]

~~Unit 1~~

The ~~calculation of the~~ maximum core fission product-inventories are also calculated ~~by the ORIGEN~~ computer code and are the basis for determining the gap activities used in single fuel assembly accident analyses. The gap activities are consistent with the guidance of Regulatory Guide 1.25[3]. ~~10% of the total noble gases other than Kr-85 and 30% of Kr-85. For an accident analysis involving a fuel assembly, 10% of the total radioactive iodine in the rods at the time of the accident is also in the gap~~.

1.183

The radioactivity in the reactor coolant as well as in the volume control tank, pressurizer, and waste gas decay tanks are given in Chapter 11 along with the data on which these computations are based.

TENNESSEE VALLEY AUTHORITY

Proposed Revision to the RV Surveillance Capsule Removal Schedule

- As previously noted, in support of Interface Issue 4, WCAP-18769-NP, Revision 1 (Enclosure 2 to the LAR) includes changes to the surveillance capsule removal schedule for eventual inclusion into the WBN Units 1 and 2 PTLR.
- The changes to the schedule are required due to the plant-specific neutron fluence that was addressed in Interface item 4. Changes to the lead factors, EFPY removal times and expected capsule fluence are seen in the revised schedule to reflect the recently addressed plant-specific neutron fluence as part of this interface issue.
- Therefore, TVA is requesting NRC approval of a revision to the reactor vessel surveillance capsule removal schedule for WBN Units 1 and 2, pursuant to 10 CFR 50, Appendix H, "Reactor Vessel Material Surveillance Program Requirements," Paragraph III.B.3.
- In accordance with the guidance of Administrative Letter (AL) 97-04, “NRC Staff Approval for Changes to 10 CFR Part 50, Appendix H, Reactor Vessel Surveillance Specimen Withdrawal Schedules,” TVA has determined that a license amendment is not required for the proposed change to the reactor vessel surveillance capsule removal schedule for WBN Units 1 and 2.

Current WBN Unit 1 Surveillance Capsule Removal Schedule

Table 4-1
Surveillance Capsule Removal Schedule

Capsule	Capsule Location	Lead Factor[a]	Withdrawal EFPY[b]	Fluence (n/cm^2)[a]
U	56°	5.00	1.20	4.47×10^{18} (c)
W	124°	5.05	3.88	1.08×10^{19} (c)
X	236°	5.03	6.63	1.71×10^{19} (c)
Z	304°	5.06	9.37	2.40×10^{19} (c)
V	58.5°	4.31	(d)	6.02×10^{19}
Y	238.5°	4.31	(e)	Standby

(Notes):

(a) Updated from Capsule Z dosimetry analysis.

(b) Effective Full Power Years (EFPY) from plant startup.

(c) Plant specific evaluation.

(d) Capsule V will be removed during the last scheduled outage before estimated capsule exposure to a neutron fluence equal to two times the peak RPV neutron fluence at 60 years of operation (i.e. 54 EFPY).

(e) Capsule Y shall remain inserted in the reactor vessel on standby until needed to fulfill future 10 CFR 50, Appendix H or license renewal requirements.

Proposed Revision to the WBN Unit 1 Surveillance Capsule Removal Schedule

Table 4-1
Surveillance Capsule Removal Schedule

Capsule	Capsule Location	Capsule Lead Factor[a]	Removal Time (EFPY)[b]	Capsule Fluence (n/cm^2)[a]
U	56°	4.87	1.20	4.6×10^{18}
W	124°	4.78	3.88	1.08×10^{19}
X	236°	4.83	6.62	1.75×10^{19}
Z	304°	4.76	9.29	2.40×10^{19}
V	58.5°	4.11[c]	24.1[d]	5.44×10^{19}
Y	238.5°	4.06[c]	[e]	Standby

NOTES:

(a) Capsule lead factors and fluence values are taken from Section 2.2.1 of WCAP-18769-NP, Revision 1

(b) Effective Full Power Years (EFPY) from plant startup.

(c) Capsule V lead factor is that projected at the end-of-cycle (EOC) 18, the anticipated withdrawal date. Capsule Y lead factor is calculated at 48 EFPY.

(d) Projected EFPY at the EOC 18, the anticipated withdrawal date of Capsule V. This removal ensures the capsule exposure remains before two times the peak reactor pressure vessel (RPV) neutron fluence (2.73×10^{19}) at 60 years of operation (48 EFPY).

(e) Capsule Y shall remain inserted in the reactor vessel on standby until needed to fulfill future 10 CFR 50, Appendix H or license renewal requirements.

Current WBN Unit 2 Surveillance Capsule Removal Schedule

TABLE 4.0-1 Watts Bar Unit 2 Surveillance Capsule Removal Schedule [a]				
Capsule	**Orientation of Capsule**	**Lead Factor**	**Removal Time**	**Expected Capsule Fluence (n/cm^2,E > 1.0 MeV)**
U	Dual 34°	4.70	2.0 EFPY (EOC 2)	0.604×10^{19}
W	Single 34°	4.66	7.0 EFPY	1.94×10^{19} [b]
X	Dual 34°	4.69	7.0 EFPY to 13.7 EFPY	1.94×10^{19} [b] to 3.88×10^{19} [c]
Z	Single 34°	4.69	Note (d)	Note (d)
V	Dual 31.5°	4.04	Note (d)	Note (d)
Y	Dual 31.5°	4.04	Note (d)	Note (d)

Notes:

(a) This information is taken from the withdrawal schedule contained in WCAP-18518-NP (Ref. 12). EOC = End-of-Cycle

(b) Approximate Fluence at vessel inner wall at End-of-Life (32 EFPY). This capsule should be withdrawn at the outage nearest to but following 7.0 EFPY of operation.

(c) Capsule X should be removed between 11.7 EFPY and 13.7 EFPY if possible. Capsule X must be removed between 7.0 EFPY and 13.7 EFPY in order to satisfy the recommendations of the third capsule end-of-license per ASTM E185-82 (Ref. 7). This removal EFPY should be re-visited at a later date, such as after Capsule W is removed.

(d) Capsules Z, V, and Y should remain in the reactor. If additional metallurgical data is needed, withdrawal and testing of these capsules should be considered. In the event that Capsule W cannot be removed, then Capsule Z may serve as a backup and be removed instead during the same outage.

Proposed Revision to the WBN Unit 2 Surveillance Capsule Removal Schedule

TABLE 4.0-1
Watts Bar Unit 2 Surveillance Capsule Removal Schedule

Capsule	Capsule Location	Capsule Lead Factor[a]	Removal Time (EFPY)[b]	Capsule Fluence (n/cm^2, E > 1.0 MeV)[a]
U	Dual 34°	4.80	2.00 EFPY (EOC 2)	0.614×10^{19}
W	Single 34°	4.87	6.8 EFPY[c]	1.93×10^{19}
X	Dual 34°	~4.8	6.8 EFPY to 13.8 EFPY[d]	1.93×10^{19} to 3.86×10^{19} [d]
Z	Single 34°	4.55	Standby[e]	Standby[e]
V	Dual 31.5°	3.94	Standby[e]	Standby[e]
Y	Dual 31.5°	3.94	Standby[e]	Standby[e]

Notes:

(a) Capsule lead factors and fluence values are taken from Section 2.2.2 of WCAP-18769-NP, Revision 1

(b) Effective full power years (EFPY) from plant startup.

(c) Capsule W should be withdrawn at the outage nearest to but following 6.8 EFPY of operation.

(d) Capsule X should be removed between 10.4 EFPY and 13.8 EFPY if possible. Capsule X must be withdrawn between 6.8 EFPY and 13.8 EFPY in order satisfy the recommendations of the third capsule for EOL per ASTM E185-82. The removal EFPY of the third capsule should be revisited at a later date, such as after Capsule W is removed.

(e) Capsules Z, V, and Y should remain in the reactor. If additional metallurgical data is needed, withdrawal and testing of these capsules should be considered. Per ASTM E185-82 and NUREG 1801, Revision 2, it is recommended that the capsules be removed prior to reaching a fluence of two times the peak fluence at EOL. In the event that Capsule W cannot be withdrawn, Capsule Z may be removed instead, during the same outage, to satisfy the ASTM E185-82 requirements for the second withdrawn capsule

Basis for Changes to WBN Units 1 and 2 TS 5.9.6

- NRC approved a license amendment for WBN Unit 2 to revise WBN Unit 2 TS 5.9.6.b to add WCAP-18124-NP-A Revision 0, “Fluence Determination with RAPTOR-M3G and FERRET,” as a neutron fluence calculational methodology for the evaluation of reactor vessel specimens to support the determination of reactor coolant system pressure and temperature limits (ML20209A071 and ML21148A100).
- Similarly, WBN Unit 1 TS 5.9.6.b is being revised to add WCAP-18124-NP-A Revision 0. The same justification for use of WCAP-18124-NP-A Revision 0, including conformance to the NRC limitations and conditions is applicable to the proposed change to WBN Unit 1 TS 5.9.6.b.
- The applicability of Limitation #1 of WCAP-18124-NP-A Revision 0 limiting the applicability of the methodology to the region of the RPV near the active core is adjusted via implementation of WCAP 18124-NP-A Rev. 0 Supplement 1-NP-A, Revision 0. Limitation #2 of WCAP 18124-NP-A Revision 0 will be applied if least squares adjustment is employed.

Basis for Changes to WBN Units 1 and 2 TS 5.9.6 (cont'd)

- WBN Units 1 and 2 TS 5.9.6.b are also revised to add WCAP-18124-NP-A Rev. 0 Supplement 1-NP-A, Revision 0, which provides the justification for the proposed changes. Supplement 1 NP-A provides additional methodology requirements and qualification data to justify the application of the RAPTOR-M3G and FERRET fluence methods to the extended beltline. (ML22153A136)
- The NRC reviewed WCAP-18124-NP-A, Revision 0, Supplement 1 NP-A, Revision 0, and determined that appropriate modeling techniques and adequate qualification were provided to apply RAPTOR-M3G to determine neutron fluence in the reactor vessel extended beltline and that the modeling techniques adhere to the guidance in Regulatory Guide (RG) 1.190, as appropriate, and exceed it when necessary.
- WBN Unit 1 TS 5.9.6.b.1 is also being revised to add WCAP-14040-A, Revision 4, "Methodology Used to Develop Cold Overpressure Mitigating System Setpoints and RCS Heatup and Cooldown Limit Curves," consistent with WBN Unit 2 TS 5.9.6.b.1 and revising the references to be consistent with WBN Unit 2 TS 5.9.6.b (ML040620297 and ML050120209).
- The NRC previously evaluated the use of WCAP-14040-A, Revision 4 for WBN (ML110390197 and ML17354B282).

Precedents

- The LAR is similar to the previous LARs for WBN Unit 1 (ML16159A057) and Unit 2 (ML18347B330) which authorized the increase in TPBARs.
- Regarding the proposed change to the UFSAR, the NRC routinely approves license amendments which make changes to dose consequence analyses of records. For example, the NRC issued an amendment to Susquehanna Steam Electric Station which utilized new analysis codes, a new source term, new assumptions, and made other changes (ML20199G749). The source term was calculated using TRITON/ORIGEN-ARP in SCALE 6.2.3. The use of ORIGEN-ARP to calculate the core fission product inventory is also discussed in Regulatory Guide (RG) 1.183 and RG 1.195. As another example, the NRC approved Certificate of Compliance No. 1042 for TN Americas which utilized a source term calculated using ORIGEN-ARP in SCALE 6.0 (ML17116A277).
  - While these amendments are not directly applicable to the proposed WBN UFSAR revision, they do demonstrate the acceptability of updating the source term for accident analyses using newer versions of ORIGEN, including the use of ORIGEN-ARP.

Schedule Milestones

- TVA to submit LAR to NRC by March 31, 2023.
- Request NRC approval within one year of submittal with a 60-day implementation period.
- Previous WBN TPBAR LARs have taken up to 18 months for NRC approval, but because there are no substantial changes in plant configuration for the proposed TPBAR increase, TVA requests NRC approval within the normal one-year review metric.
- The proposed schedule supports a planned increase of TPBAR inventory in the WBN Unit 1 Cycle 19 refueling outage (U1R19) in fall 2024 and WBN Unit 2 U2R6 in spring 2025 to support DOE requests.

Closing Remarks

- TVA appreciates the opportunity to meet with NRC regarding the schedule for development of the increased tritium production LAR.
- TVA welcomes NRC feedback on the NRC review schedule of the LAR and future opportunities to discuss the status of the LAR.
- Proposed LAR is needed to support the DOE NNSA production requirements.


TVA
TENNESSEE
VALLEY
AUTHORITY