Watts Bar Nuclear Plant (WBN) Unit 2

Pre-Submittal Meeting for License Amendment Request
Technical Specification 5.9.6
Add NRC-approved Neutron Fluence Calculational Methodology

May 14, 2020

Agenda

- Opening Remarks
- Background
- WBN Unit 2 Technical Specification (TS) 5.9.6
- Nuclear Regulatory Commission (NRC) Safety Evaluation (SE) for WCAP-18124-NP-A Revision 0
- Proposed TS Change
- Precedent
- Schedule Milestones
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Opening Remarks

- The purpose of this meeting is to discuss a proposed license amendment for WBN Unit 2.
- Tennessee Valley Authority (TVA) is requesting a license amendment to revise WBN Unit 2 TS 5.9.6, "*Reactor Coolant System (RCS) Pressure and Temperature Limits Report (PTLR)*," to add WCAP-18124-NP-A Revision 0 "*Fluence Determination with RAPTOR-M3G and FERRET*" as the neutron fluence calculational methodology for the evaluation of reactor vessel specimens, to support determination of RCS pressure and temperature limits.
- This presentation will discuss the basis for the proposed TS change as well as the June 2018 NRC SE that found this methodology acceptable for use in calculating reactor pressure vessel (RPV) neutron fluence.

Background

- 10 CFR 50, Appendix G, requires the establishment of P/T limits for specific material fracture toughness requirements of the reactor coolant pressure boundary (RCPB) materials. This includes a margin to brittle failure.
- Neutron embrittlement effect on material toughness is reflected by increasing nil ductility reference temperature (RT_{NDT}) as exposure to neutron fluence increases. The actual shift in the RT_{NDT} of the RPV material is established periodically by removing and evaluating irradiated reactor vessel material specimens, in accordance with 10 CFR 50, Appendix H.
- The neutron fluence received by these specimens is determined with a computational methodology. That neutron fluence information is then used to revise the PTLR, as necessary.

Background (continued)

- In addition, Regulatory Issue Summary (RIS) 2014-11, "*Information on Licensing Applications for Fracture Toughness Requirements for Ferritic Reactor Coolant Pressure Boundary Components*" clarifies that P/T limit calculations for ferritic RPV materials other than those materials with the highest reference temperature may result in more limiting P/T curves because of higher stresses due to structural discontinuities, such as those in RPV inlet and outlet nozzles.
- All ferritic components within the entire reactor vessel must be considered in the development of P-T limits, and the effects of neutron radiation must be considered for any locations that are predicted to experience a neutron fluence exposure greater than 1x1017 n/cm2 (E > 1 MeV) at the end of the licensed operating period.
- RIS 2014-11 has been considered in TVA's technical evaluation of this proposed change.

Background (continued)

- The previous generation of computer codes for determinaton of neutron fluence requires extensive computational resources, often requiring analysts to make overly conservative simplifying assumptions.
- To address the computational limitations, Westinghouse developed RAPTOR-M3G, a computer code with parallel-processing techniques allowing large problems to be solved more quickly, by distributing across the memory of multiple computers. This is described in WCAP-18124-NP-A Revision 0.
- NRC found this methodology acceptable for use in calculating RPV neutron fluence in a SE (ML18156A066), provided that the two limitations listed in Section 4.0 of the SE are met.

WBN Unit 2 TS 5.9.6

- WBN Unit 2 is a Pressure/Temperature Limits Report (PTLR) plant. As such, the methodology used for future changes to the PTLR must be listed in TS 5.9.6.

- The RAPTOR-M3G computer code was used to determine fluence values from the analysis of WBN Unit 2 Capsule U (ML20107F717). In accordance with 10 CFR 50 Appendix H Item IV.A, TVA's submittal letter for this report stated that a license amendment to incorporate this code into the WBN Unit 2 licensing basis was planned for submission later this year. Today we are discussing that planned amendment, which will revise WBN Unit 2 TS 5.9.6.

Safety Evaluation for WCAP-18124-NP-A Revision 0

- NRC SE issued June 15, 2018 (ML18156A066)

  "*The NRC staff has reviewed the calculational fluence methodology described in WCAP-18124-NP, Revision 0, and finds that the method adheres to the guidance in RG 1.190. Therefore, this methodology is acceptable for use in calculating RPV neutron fluence provided that the limitations and conditions listed in Section 4.0 of this safety evaluation report are met*."

- The NRC SE contains two limitations (see following slides for further information).

Safety Evaluation for WCAP-18124-NP-A Revision 0 (continued)

- Limitation 4.1
  - *Applicability of WCAP-18124-NP, Revision 0, is limited to the RPV region near the active height of the core based on the uncertainty analysis performed and the measurement data provided. Additional justification should be provided via additional benchmarking, fluence sensitivity analysis to response parameters of interest (e.g., pressure-temperature limits, material stress/strain), margin assessment, or a combination thereof, for applications of the method to components including, but not limited to, the RPV upper circumferential weld and reactor coolant system inlet and outlet nozzles and reactor vessel internal components.*

Safety Evaluation for WCAP-18124-NP-A Revision 0 (continued)

- Limitation 4.1 has been addressed with additional justification provided by benchmarking and margin assessment.
- Benchmarking has been performed by comparing RAPTOR-M3G calculated fluence values to ex-vessel neutron dosimetry (EVND) measurements at another Westinghouse 4-loop plant. The EVND capsules were placed in the vicinity of the RPV supports in a comparable geometry to the region of interest for WBN Unit 2.
- A margin assessment has been performed taking RAPTOR-M3G calculated fluences for WBN Unit 2, increasing these values by appropriate factors based on benchmarking, and validating that the appropriate extended beltline materials have been identified for evaluation of fracture toughness embrittlement effect.

Safety Evaluation for WCAP-18124-NP-A Revision 0 (continued)

- The benchmarking and margin assessment used for addressing Limitation 4.1 has been characterized in this license amendment request (LAR) for WBN Unit 2 with information related to:
  - fast neutron (E > 1.0 MeV) fluence determination uncertainty based on benchmarking measured-to-calculated (M/C) ratios, and best-estimate-to-calculation (BE/C) ratios for fast neutron (E > 1.0 MeV) fluence rate and iron atom displacement rate
  - comparison of fluence values to limiting thresholds for nozzles and outlying materials
- Sources of this information include:
  - WCAP-18518-NP Revision 0, "*Analysis of Capsule U from the Watts Bar Unit 2 Reactor Vessel Radiation Surveillance Program*," dated March 2020 (ML20107F717)
  - Pressurized Water Reactor Owner's Group (PWROG) Report, PWROG-15109-NP-A Revision 0, "*PWR Pressure Vessel Nozzle Appendix G Evaluation*," dated February 2018 (ML20024E573)

Safety Evaluation for WCAP-18124-NP-A Revision 0

- Limitation 4.2 (continued)
  - *Least squares adjustment is acceptable if the adjustments to the M/C ratios and to the calculated spectra values are within the assigned uncertainties of the calculated spectra, the dosimetry measured reaction rates, and the dosimetry reaction cross sections. Should this not be the case, the user should re-examine both measured and calculated values for possible errors. If errors cannot be found, the particular values causing the inconsistency should be disqualified.*
- This limitation applies in situations where the least squares analysis is used to adjust the calculated values of neutron exposure.
- This limitation does not apply. In the most recent analysis of a WBN Unit 2 surveillance capsule, the least squares analysis is used only as a supplemental check on the results of the dosimetry evaluation and not to modify the calculated surveillance capsule or reactor pressure vessel neutron exposure.

Proposed Technical Specification Change

Unit 2 – TS 5.9.6 Reactor Coolant System (RCS) PRESSURE AND TEMPERATURE LIMITS REPORT (PTLR)

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."

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).

Precedent

- NRC License Amendment for Catawba Nuclear Station, Units 1 and 2, dated April 29, 2016 (ML16081A333)
  - NRC approved a Measurement Uncertainty Recapture (MUR) Power Uprate based on use of RAPTOR-M3G for neutron fluence calculations under MUR power uprate conditions.
- NRC License Amendment for Waterford Steam Electric Station Unit 3, dated July 23, 2018 (ML18180A298)
  - NRC approved a license amendment request to incorporate the use of the RAPTOR-M3G code into the current licensing basis (CLB) for RPV neutron fluence evaluations.

Recent Submittals

- Catawba, Units 1 and 2, License Amendment Request Proposing to Revise Technical Specification 3.4.3, “RCS Pressure and Temperature (P/T) Limits,” dated July 2, 2019 (ML19183A038)
  - Duke Energy requested a revision to RCS Pressure and Temperature (P/T) Limits based on use of RAPTOR-M3G for neutron fluence calculations
- Joseph M. Farley Nuclear Plant, Units 1 and 2, License Amendment Request for MUR Power Uprate, dated October 30, 2019 (ML19308A763)
  - Southern Nuclear requested an MUR Power Uprate based on use of RAPTOR-M3G for neutron fluence calculations under MUR power uprate conditions.

Schedule Milestones

- May 14, 2020 – LAR Pre-Submittal Meeting with NRC
- June 2020 – LAR Submittal – Request NRC approval within 12 months of submittal with 30-day implementation
- July 2020 – Telecon or meeting to discuss any NRC questions
- June 2021 – NRC Approval of LAR (Requested)

Closing Remarks

TVA