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

June 17, 2021

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

SUBJECT: WATTS BAR NUCLEAR PLANT, UNIT 2 - ISSUANCE OF AMENDMENT NO. 53 REGARDING NEUTRON FLUENCE CALCULATION METHODOLOGY (EPID L-2020-LLA-0167)

Dear Mr. Barstow:

The U.S. Nuclear Regulatory Commission (Commission) has issued the enclosed Amendment No. 53 to Facility Operating License No. NPF-96 for the Watts Bar Nuclear Plant (Watts Bar), Unit 2. This amendment is in response to your application dated July 27, 2020.

The amendment revises Watts Bar, Unit 2, Technical Specification 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 a neutron fluence calculational methodology for the evaluation of reactor vessel specimens to support the determination of reactor coolant system pressure and temperature limits.

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

Sincerely,

/RA/

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

Docket No. 50-391

Enclosures:
1. Amendment No. 53 to NPF-96
2. Safety Evaluation

cc: Listserv

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

TENNESSEE VALLEY AUTHORITY

DOCKET NO. 50-391

WATTS BAR NUCLEAR PLANT, UNIT 2

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 53
License No. NPF-96

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

   A. The application for amendment by Tennessee Valley Authority (TVA, the licensee) dated July 27, 2020, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I;

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

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

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

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

2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment, and paragraph 2.C.(2) of Facility Operating License No. NPF-96 is hereby amended to read as follows:

   (2) Technical Specifications and Environmental Protection Plan

   The Technical Specifications contained in Appendix A as revised through Amendment No. 53 and the Environmental Protection Plan contained in Appendix B, both of which are attached hereto, are hereby incorporated into this license. TVA shall operate the facility in accordance with the Technical Specifications and the Environmental Protection Plan.

3. This amendment is effective as of the date of its issuance, and shall be implemented within 30 days.

FOR THE NUCLEAR REGULATORY COMMISSION

David J. Wrona

Digitally signed by David J. Wrona
Date: 2021.06.17 09:36:43 -04'00'

David J. Wrona, Chief
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Attachment:
Changes to the Operating License
and Technical Specifications

Date of Issuance: June 17, 2021

ATTACHMENT TO AMENDMENT NO. 53

WATTS BAR NUCLEAR PLANT, UNIT 2

FACILITY OPERATING LICENSE NO. NPF-96

DOCKET NO. 50-391

Replace page 3 of Facility Operating License No. NPF-96 with the attached revised page 3. The revised page is identified by amendment number and contains a marginal line indicating the area of change.

Replace the following page of the Appendix A Technical Specifications with the attached revised page. The revised page is identified by amendment number and contains a marginal line indicating the area of change.

Remove Page	Insert Page
5.0-34	5.0-34

C. The license shall be deemed to contain and is subject to the conditions specified in the Commission's regulations set forth in 10 CFR Chapter I and is subject to all applicable provisions of the Act, and to the rules, regulations, and orders of the Commission now or hereafter in effect, and is subject to the additional conditions specified or incorporated below.

(1) Maximum Power Level

TVA is authorized to operate the facility at reactor core power levels not in excess of 3459 megawatts thermal.

(2) Technical Specifications and Environmental Protection Plan

The Technical Specifications contained in Appendix A as revised through Amendment No. 53 and the Environmental Protection Plan contained in Appendix B, both of which are attached hereto, are hereby incorporated into this license. TVA shall operate the facility in accordance with the Technical Specifications and the Environmental Protection Plan.

(3) TVA shall implement permanent modifications to prevent overtopping of the embankments of the Fort Loudon Dam due to the Probable Maximum Flood by June 30, 2018.

(4) PAD4TCD may be used to establish core operating limits until the WBN Unit 2 steam generators are replaced with steam generators equivalent to the existing steam generators at WBN Unit 1. FULL SPECTRUM LOCA Methodology shall be implemented when the WBN Unit 2 steam generators are replaced with steam generators equivalent to the existing steam generators at WBN Unit 1.

(5) By December 31, 2019, the licensee shall report to the NRC that the actions to resolve the issues identified in Bulletin 2012-01, "Design Vulnerability in Electrical Power System," have been implemented.

(6) The licensee shall maintain in effect the provisions of the physical security plan, security personnel training and qualification plan, and safeguards contingency plan, and all amendments made pursuant to the authority of 10 CFR 50.90 and 50.54(p).

(7) TVA shall fully implement and maintain in effect all provisions of the Commission approved cyber security plan (CSP), including changes made pursuant to the authority of 10 CFR 50.90 and 10 CFR 50.54(p). The TVA approved CSP was discussed in NUREG-0847, Supplement 28, as amended by changes approved in License Amendment No. 7.

(8) TVA shall implement and maintain in effect all provisions of the approved fire protection program as described in the Fire Protection Report for the facility, as described in NUREG-0847, Supplement 29, subject to the following provision:

5.9 Reporting Requirements (continued)

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” 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.

(continued)

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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 53 TO FACILITY OPERATING LICENSE NO. NPF-96

TENNESSEE VALLEY AUTHORITY

WATTS BAR NUCLEAR PLANT, UNIT 2

DOCKET NO. 50-391

1.0 INTRODUCTION

By application dated July 27, 2020 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML20209A071), the Tennessee Valley Authority (the licensee) submitted a license amendment request (LAR) to the U.S. Nuclear Regulatory Commission (NRC, the Commission) to change the Watts Bar Nuclear Plant (Watts Bar), Unit 2, Technical Specifications (TSs). The requested change would revise 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 a neutron fluence calculational methodology for the evaluation of reactor vessel specimens to support the determination of the RCS pressure and temperature (P/T) limits.

2.0 REGULATORY EVALUATION

2.1 Background

The methods described in WCAP-18124-NP-A provide reactor vessel fluence estimates as input to evaluation of reactor vessel pressure-temperature limits. These fluence estimates are generated using methods that are very similar to those described in WCAP-14040-A, Revision 4, Chapter 2.2, and, as such, are proposed as an alternative to that report, which is currently listed in TS 5.9.6.

2.2 Requested Changes

The licensee proposed to revise TS 5.9.6 by adding WCAP-18124-NP-A, Revision 0, "Fluence Determination with RAPTOR-M3G and FERRET," as new item b.2, and renumbering existing item b.2 as item b.3 as follows:

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” 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).

2.3 Regulatory Requirements and Guidance

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

Fundamental regulatory requirements with respect to the integrity of the reactor coolant pressure boundary are established in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, “Domestic Licensing of Production and Utilization Facilities,” Appendix A, “General Design Criteria for Nuclear Power Plants.” More specifically, General Design Criteria (GDCs) 14, “Reactor coolant pressure boundary,” 30, “Quality of reactor coolant pressure boundary,” and 31, “Fracture prevention of reactor coolant pressure boundary,” require, in part, the design, fabrication, and maintenance of the reactor coolant pressure boundary with adequate margin to assure that the probability of rapidly propagating failure of the boundary is minimized. In particular, GDC 31 explicitly requires consideration of the effects of irradiation on material properties.

Section 182.a of the Atomic Energy Act of 1954, as amended, requires nuclear power plant operating licenses to include TS as part of any license. In 10 CFR 50.36, “Technical specifications,” the NRC established its regulatory requirements related to the content of TSs. Pursuant to 10 CFR 50.36, TSs are required to include items in the following categories: (1) safety limits, limiting safety system settings, and limiting control settings; (2) limiting conditions for operation; (3) surveillance requirements; (4) design features; and (5) administrative controls. Administrative controls are the provisions relating to organization and management, procedures, recordkeeping, review and audit, and reporting necessary to assure operation of the facility in a safe manner. Each licensee shall submit any reports to the Commission pursuant to approved TSs as specified in 10 CFR 50.4.

The NRC staff’s guidance for the review of TSs is in NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR [Light-Water Reactor] Edition” (SRP), Chapter 16.0, “Technical Specifications,” Revision 3, dated March 2010 (ADAMS Accession No. ML100351425). As described therein, as part of the regulatory standardization effort, the NRC staff has prepared Standard Technical Specifications for each of the LWR nuclear designs. Accordingly, for Westinghouse Electric Company’s (Westinghouse) plant designs, the NRC staff’s review includes consideration of whether the proposed changes are consistent with NUREG-1431, “Standard Technical Specifications, Westinghouse Plants” (ADAMS Accession No. ML12100A222). NUREG-1431, Section 5.0, “Administrative Controls,” specifies reporting requirements, including an RCS PTLR. It also specifies that the analytical methods used to determine the RCS P/T limits and other setpoints shall be those previously reviewed and approved by the NRC and described in the reports listed in the TSs.

Regulatory Guide (RG) 1.190, Revision 0, “Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence” (ADAMS Accession No. ML010890301), describes methods and assumptions acceptable to the NRC staff for determining the reactor pressure vessel (RPV) neutron fluence with respect to GDCs 14, 30, and 31.

Regulatory Issue Summary (RIS) 2014-11, "Information on Licensing Applications for Fracture Toughness Requirements for Ferritic Reactor Coolant Pressure Boundary Components" (ADAMS Accession No. ML14149A165), clarifies that P/T limits for ferritic RPV components, such as RPV inlet and outlet nozzles, could be more limiting because higher stress levels from structural discontinuities could result in a lower allowable pressure. Regulatory Issue Summary 2014-11 also clarifies that the RPV beltline definition in Appendix G to 10 CFR Part 50 is applicable to all RPV ferritic materials with projected neutron fluence values greater than 1 x 10^{17} neutrons per square centimeter (n/cm^2) (E > 1 MeV), and that this fluence threshold remains applicable for the design life as well as throughout the licensed operating period of the reactor.

3.0 TECHNICAL EVALUATION

The license proposed to revise Watts Bar, Unit 2, TS 5.9.6 to allow WCAP-18124-NP-A, Revision 0 (ADAMS Accession No. ML18204A010), to be used as an alternative to Section 2.2 of WCAP-14040-A, Revision 4 (ADAMS Accession No. ML050120209), as the neutron fluence calculational methodology to support the determination of RCS P/T limits. The licensee would use RAPTOR-M3G to determine the RPV neutron fluence values in the reactor vessel beltline and extended beltline regions[1] for determining Watts Bar, Unit 2, P/T limits.

The NRC staff safety evaluation finding WCAP-18124-NP-A, Revision 0, acceptable for use in calculating RPV neutron fluence includes two limitations and conditions:

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.

2. Least squares adjustment is acceptable if the adjustments to the M/C [measured-to-calculated] 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.

The NRC staff's evaluation of the licensee's response to these limitations and conditions is provided in the sections below.

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[1] As noted in RIS 2014-11, the term "beltline" is applicable to all reactor vessel ferritic materials with projected neutron fluence values greater than 1 x 10^{17} n/cm^2. In this safety evaluation, the phrase "extended beltline" is intended to refer to those beltline regions that are further away from the active fuel region of the core.

3.1 Evaluation of Limitation and Condition 1 – Additional Benchmarking

The licensee has collected measurement benchmark data through use of ex-vessel neutron dosimetry (EVND). The EVND capsules were installed at the elevation of the reactor vessel support for a 4-loop Westinghouse plant, roughly the same axial height from the core midplane as some of the major extended beltline materials analyzed in the Watts Bar, Unit 2, neutron fluence evaluation. The EVND capsules contain a variety of radiometric monitor foils appropriate for use in benchmarking fluence calculations. Some of the most common reactions that occur in RPV materials include those with iron, copper, and nickel. All of these materials are included in the EVND capsules and account for the lowest reaction rate uncertainties of all reactions at a 1σ uncertainty of 5 percent. The NRC staff considers the use of EVND capsules for additional benchmarking acceptable because RG 1.190 indicates that EVND is an acceptable means of qualifying fluence estimates, and because the EVND under consideration had been installed in an upper elevation where the RG indicates that cavity streaming effects may have a more dominant influence on the total fluence, in comparison to a core mid-plane location.

The licensee provided M/C ratios of the calculated EVND capsule reaction rates and the measured data from counting laboratories. This comparison established that the average M/C ratio is 0.78 with a standard deviation of 25.5 percent. Additionally, the licensee provided best-estimate-to-calculated (BE/C) ratios for the fluence rate and iron atom displacement rate. This comparison determined that the BE/C ratio for the fluence rate is 0.84 with a standard deviation of 8.9 percent and a BE/C ratio for iron atom displacement rate of 0.94 with a standard deviation of 11 percent. These three comparisons demonstrate that the calculations consistently overpredict the neutron exposure. Additionally, both of the BE/C ratio uncertainties are within the ±20-percent uncertainty described in RG 1.190. RG 1.190 also describes an acceptable ±30-percent uncertainty for cavity dosimetry, which the NRC staff has considered in the justification for the 25.5-percent standard deviation of the M/C reaction rate ratio. All of the neutron transport calculations were carried out using RAPTOR-M3G and BUGLE-96 cross section library. The anisotropic scattering was treated with a P_3 Legendre expansion and the angular discretization modeled in an S_{20} order of angular quadrature. RG 1.190 states that a minimum of an S_8 order of angular quadrature is acceptable.

The most recent neutron fluence analysis for Watts Bar, Unit 2, uses an S_{12} order of angular quadrature (ADAMS Accession No. ML20107F717). The licensee stated that an S_{20} order of angular quadrature was used in the additional benchmarking analysis for neutron fluence evaluation in extended beltline materials in the submittal. The ±30-percent uncertainty proposed by the licensee is based on the benchmarking results using an S_{20} order of angular quadrature. The licensee stated that the maximum difference in agreement to measured data observed between S_{12} and S_{20} calculations is 5 percent, increasing the total uncertainty estimate to 35 percent for extended beltline materials. The NRC staff does not consider this increase in uncertainty to be significant as extended beltline materials are not limiting by a significant margin, as discussed in the remainder of this safety evaluation. The NRC staff concludes that the treatment of the order of angular quadrature for calculation of vessel fluence for beltline and extended beltline materials is acceptable since it adheres to the guidance provided in RG 1.190.

RG 1.190 describes an acceptable uncertainty in fast neutron fluence calculations of within ±20 percent. The analytic uncertainty described in WCAP-18124-NP-A is about 19–20 percent at the top and bottom of the active fuel. This is consistent with the guidance in RG 1.190. The licensee estimates the uncertainty of RAPTOR-M3G to be on the order of ±30 percent at the

RPV supports. This estimation is derived from the M/C and BE/C ratios described above and the analytic uncertainty associated with the cavity locations and the top and bottom of the core. The 20-percent uncertainty allowances recommended by RG 1.190 are based on associated margin terms provided in the calculation of the reference temperature for nil-ductility transition (RT_{NDT}). However, RG 1.190 suggests that more approximate methods for determining the fluence may be appropriate when there is a large margin to the RT_{NDT} limits. The licensee indicated that RAPTOR-M3G consistently over predicts the fast neutron fluence and that none of the extended beltline materials are limiting and have significant margin to become limiting.

The NRC staff reviewed the extended beltline materials that are not located within an axial distance of 8.5 feet above or below the core midplane. For the two materials in this category, the licensee calculated the end of life fluence to be 1.31×10^{16} n/cm^2. This is lower than the threshold of 1×10^{17} n/cm^2 defined in RIS 2014-11. Therefore, the NRC staff determined that the justification for application of the RAPTOR-M3G fluence methodology in extended beltline regions is acceptable, and that the first limitation and condition in the NRC staff's safety evaluation for WCAP-18124-NP-A is satisfied.

3.2 Evaluation of Limitation and Condition 2 – Least Squares Adjustment

The licensee stated in the most recent capsule analysis that utilized the methodology that the least squares analysis is provided only as a supplemental check on the results of the dosimetry evaluation, and that the least squares analysis was not used to modify the calculated surveillance capsule or reactor pressure vessel neutron exposure.

The NRC staff reviewed the licensee's justification and finds that this limitation and condition is not applicable because the least squares analysis was not used to modify the calculated capsule or reactor pressure vessel neutron exposure.

3.3 Evaluation of Proposed TS Change

As described in Section 2.2 of this safety evaluation, the licensee proposed to revise TS 5.9.6 to add WCAP-18124-NP-A, Revision 0, as a reference in the PTLR. As noted in Section 2.3 of this safety evaluation, Watts Bar, Unit 2, which has adopted the standard TSs, is required to list the analytical methods used to determine RCS P/T limits. Because Watts Bar, Unit 2, is adopting WCAP-18124-NP-A, Revision 0, as the neutron fluence calculational methodology for the evaluation of reactor vessel specimens to support the determination of the RCS P/T limits, it is appropriate for WCAP-18124-NP-A, Revision 0 to be added to TS 5.9.6b. The NRC staff reviewed the proposed TS changes for technical clarity and consistency with the requirements for customary terminology and formatting. The staff finds that the proposed TS changes are consistent with Chapter 16.0 of the SRP and NUREG-1431 and are, therefore, acceptable.

3.4 Technical Conclusion

Because the licensee has satisfactorily addressed the limitations and conditions established for use of WCAP-18124-NP-A, Revision 0, the NRC staff has determined that the licensee's use of WCAP-18124-NP-A, Revision 0, for determining neutron fluence is acceptable. The values were determined using NRC-approved methods consistent with RG 1.190 guidance and, as such, satisfy the criteria of GDCs 14, 30, and 31. Additionally, WCAP-18124-NP-A, Revision 0, will be added to the PTLR, as required. Therefore, the NRC staff concludes that, as amended, the Watts Bar, Unit 2, reporting requirements will continue to meet 10 CFR 50.36(c)(5).

4.0 STATE CONSULTATION

In accordance with the Commission's regulations, the Tennessee State official was notified of the proposed issuance of the amendment on March 3, 2021. The State official had no comments.

5.0 ENVIRONMENTAL CONSIDERATION

The amendment changes a requirement with respect to the installation or use of facility components located within the restricted area as defined in 10 CFR Part 20. The NRC staff has determined that the amendment involves no significant increase in the amounts, and no significant change in the types, of any effluents that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission previously issued a proposed finding that the amendment involves no significant hazards consideration in the *Federal Register* on September 8, 2020 (85 FR 55508), and there has been no public comment on such finding. Accordingly, the amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendment.

6.0 CONCLUSION

The Commission has concluded, based on the considerations discussed above, that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) there is reasonable assurance that such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

Principal Contributor: A. Smith, NRR

Date: June 17, 2021

SUBJECT: WATTS BAR NUCLEAR PLANT, UNIT 2 - ISSUANCE OF AMENDMENT NO. 53 REGARDING NEUTRON FLUENCE CALCULATION METHODOLOGY (EPID L-2020-LLA-0167) DATED JUNE 17, 2021

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