



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

July 25, 2016

Mr. Joseph W. Shea  
Vice President, Nuclear Licensing  
Tennessee Valley Authority  
1101 Market Street, LP 3R-C  
Chattanooga, TN 37402-2801

SUBJECT: WATTS BAR NUCLEAR PLANT, UNIT 2 – ISSUANCE OF AMENDMENT  
REGARDING USE OF PAD4TCD FOR THE SECOND OPERATING CYCLE  
(CAC NO. MF7219)

Dear Mr. Shea:

The U.S. Nuclear Regulatory Commission has issued the enclosed Amendment No. 1 to Facility Operating License No. NPF-96 for the Watts Bar Nuclear Plant, Unit 2. This amendment consists of changes to the license in response to your application dated December 31, 2015.

The amendment modifies a license condition related to use of the Fuel Rod Performance and Design 4 Thermal Conductivity Degradation (PAD4TCD) computer program for the second cycle of plant operation.

A copy of the related Safety Evaluation is also enclosed. The Notice of Issuance will be included in the Commission's biweekly *Federal Register* notice. If you have any questions regarding this letter, please contact me at (301) 415-6020.

Sincerely,

A handwritten signature in black ink, appearing to read "Robert G. Schaaf".

Robert G. Schaaf, 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. 1 to NPF-96
2. Safety Evaluation

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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. 1  
License No. NPF-96

1. The Nuclear Regulatory Commission (the Commission) has found that:
  - A. The application for amendment by the Tennessee Valley Authority (TVA or the licensee) dated December 31, 2015, 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 Facility Operating License NPF-96 is amended as indicated in the attachment to this license amendment.

Paragraph 2.C.(2) 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. 1 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.

Paragraph 2.C.(4) of is hereby amended to read as follows:

- (4) PAD4TCD may be used to establish core operating limits for Cycles 1 and 2 only. PAD4TCD may not be used to establish core operating limits for subsequent reload cycles.
3. This license amendment is effective as of the date of its issuance, and shall be implemented within 14 days of issuance.

FOR THE NUCLEAR REGULATORY COMMISSION



Tracy J. Orf, Acting Chief  
Plant Licensing Branch II-2  
Division of Operating Reactor Licensing  
Office of Nuclear Reactor Regulation

Attachment:  
Changes to the Operating License

Date of Issuance: July 25, 2016

ATTACHMENT TO LICENSE AMENDMENT NO. 1

FACILITY OPERATING LICENSE NO. NPF-96

WATTS BAR NUCLEAR PLANT, UNIT 2

DOCKET NO. 50-391

Replace Page 3 of Facility Operating License NPF-96 with the attached Page 3.

The revised page is identified by amendment number and contains vertical lines indicating the areas of change.

Remove  
3

Insert  
3

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 3411 megawatts thermal.

(2) Technical Specifications and Environmental Protection Plan

The Technical Specifications contained in Appendix A as revised through Amendment No. 1 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 February 1, 2017.

(4) PAD4TCD may be used to establish core operating limits for Cycles 1 and 2 only. PAD4TCD may not be used to establish core operating limits for subsequent reload cycles.

(5) By December 31, 2017, 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.

(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:



UNITED STATES  
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 1 FACILITY OPERATING LICENSE NO. NPF-96

TENNESSEE VALLEY AUTHORITY

WATTS BAR NUCLEAR PLANT, UNIT 2

DOCKET NO. 50-391

1.0 INTRODUCTION

By letter dated December 31, 2015 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML15365A595), the Tennessee Valley Authority (TVA, the licensee) submitted a license amendment request (LAR) for Watts Bar Nuclear Plant (WBN), Unit 2. The proposed amendment would amend license condition 2.C.(4) of Facility Operating License NPF-96. Specifically, license condition 2.C.(4) would be modified to permit the use of the Fuel Rod Performance and Design 4 Thermal Conductivity Degradation (PAD4TCD) computer program for the second cycle of plant operation.

2.0 REGULATORY EVALUATION

Loss-of-coolant accidents (LOCAs) are postulated design-basis accidents that would result in the loss of reactor coolant from piping breaks in the reactor coolant pressure boundary at a rate in excess of the capability of the normal reactor coolant makeup system to replenish it. Loss of significant quantities of reactor coolant would prevent heat removal from the reactor core. The reactor protection system and the emergency core cooling system (ECCS) are provided to mitigate these accidents.

Applicants for and holders of operating licenses are required to demonstrate the capability of the ECCS to transfer heat from the reactor core following a LOCA such that acceptable fuel design limits will be maintained. Applicants and licensees perform calculations using U.S. Nuclear Regulatory Commission (NRC)-approved computer codes to provide reasonable assurance that these criteria will be met. Fuel thermal conductivity degradation (TCD) with increased burnup effects these LOCA calculations by changing the initial stored energy in the fuel.

Fuel performance codes are used to perform fuel thermal-mechanical design analyses and generate input to downstream safety analyses. The currently approved Westinghouse PAD 4.0 fuel performance code does not account for TCD due to neutron irradiation exposure (also referred to as burnup). The formal replacement for PAD 4.0, which will include consideration of TCD, has not yet been approved by the NRC. A revised version of PAD 4.0, named PAD4TCD, has been developed as an interim solution. PAD4TCD contains an updated thermal

conductivity model that accounts for TCD with increased burnup. The NRC has previously approved the use of PAD4TCD on an interim basis, including for the Extended Power Uprate (EPU) of Turkey Point, Units 3 and 4 (ADAMS Accession No. ML11293A365), and for the initial operating cycle of WBN, Unit 2.

TVA proposed to revise license condition 2.C.(4) of the WBN, Unit 2, Operating License, which currently permits use of PAD4TCD for the first operating cycle, to permit the continued use of PAD4TCD for the second operating cycle. Specifically, TVA proposed to revise the license condition to read:

PAD4TCD may be used to establish core operating limits for Cycles 1 and 2 only. PAD4TCD may not be used to establish core operating limits for subsequent reload cycles.

The NRC's acceptance criteria are based on:

- (1) Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.46, insofar as it establishes standards for the calculation of ECCS performance and acceptance criteria for that calculated performance;
- (2) 10 CFR Part 50, Appendix K, insofar as it establishes required and acceptable features of evaluation models for heat removal by the ECCS after the blowdown phase of a LOCA, and specifically requires that initial stored energy in the fuel be appropriately accounted for, and;
- (3) GDC 35, insofar as it requires a system to provide abundant emergency core cooling be provided to transfer heat from the reactor core following any LOCA at a rate so that fuel clad damage that could interfere with continued effective core cooling will be prevented.

Specific review criteria are contained in Standard Review Plan Sections 6.3 and 15.6.5.

### 3.0 TECHNICAL EVALUATION

#### 3.1 Background

As part of the initial licensing of WBN, Unit 2, the NRC reviewed the WBN, Unit 2, fuel design, as documented in NUREG-0847, "Safety Evaluation Report for Operation of the Watts Bar Nuclear Plant, Unit 2," Supplement 23 (SSER 23). In SSER 23, the NRC staff concluded that, due to the lack of a fuel thermal conductivity degradation model, additional information was needed to demonstrate that PAD 4.0 can conservatively calculate the fuel temperature and other impacted variables, such as stored energy. This issue was identified as SSER Open Item 61.

By letter dated August 6, 2013 (ADAMS Accession No. ML13225A024), TVA submitted new fuel performance data generated for WBN, Unit 2, with PAD4TCD. On May 22, 2014, TVA provided detailed information on the WBN, Unit 2, fuel as well as specific computer code input data the NRC requested (ADAMS Accession No. ML14143A252) to allow the staff to perform a

confirmatory calculation using the FRAPCON-3.4 fuel performance computer code. The results of the NRC review of the analyses performed by TVA and the confirmatory analyses performed by the NRC were documented in WBN Unit 2 SSER 27. The NRC staff's review concluded:

*Based upon (1) comparison of the PAD4TCD model predictions against Halden high burnup fuel temperature measurements and (2) good agreement of the temperature dependent and exposure dependent coefficients between PAD4TCD and FRAPCON-3.4 thermal conductivity models, the NRC staff has previously found the PAD4TCD thermal conductivity model acceptable during the review of the Turkey Point Units 3 and 4 Extended Power Uprate (EPU) (ADAMS Accession No. ML11293A365). Using the information supplied in the May 22, 2014, letter, the NRC staff performed a confirmatory analysis similar to that performed in the Turkey Point Units 3 and 4 EPU, which demonstrated that there is good agreement between PAD4TCD and FRAPCON-3.5 [sic] for the fuel design planned for WBN Unit 2. Based upon the previous review of PAD4TCD done for the Turkey Point 3 and 4 EPU and the confirmatory analysis performed by the NRC staff on the Watts Bar fuel, the NRC staff finds that this open item has been satisfied and considers Open Item 61 to be closed.*

Open Item 61 was closed through the addition of the following license condition to the WBN Unit 2 operating license:

*PAD4TCD may be used to establish core operating limits for Cycle 1 only. PAD4TCD may not be used to establish core operating limits for subsequent reload cycles.*

### 3.2 Summary of Licensee Analysis

In its amendment request dated December 31, 2015, TVA provided details of its analysis using the Westinghouse realistic ECCS evaluation model ASTRUM and PAD4TCD that considers the effect of TCD and peaking factor burndown on Cycle 2. All other inputs remained the same as the Best Estimate LOCA (analysis included in the plant's Final Safety Analysis Report (FSAR)). This allows the licensee to isolate the impact of TCD and burndown on predicted peak clad temperature (PCT) during a Large Break LOCA analysis.

TVA stated that for both the first cycle study performed previously in support of the resolution of Open Item 61 described above and the second cycle study performed in support of this amendment request, the ASTRUM-required 124 runs were executed using the same random seed. TVA stated that this constraint maintained the integrity of the TCD analysis, by ensuring that any difference between the new 95/95 estimate and the previous pre-TCD estimate in FSAR Section 15.4.1.1 is due only to the effect of TCD and peaking factor burndown. The analysis concluded that, in Cycle 2, considerable margin will remain to the applicable regulatory limits in 10 CFR 50.46 for PCT, maximum local oxidation, and core-wide oxidation.

TVA concluded that its analysis demonstrated with a high level of probability that the regulatory limits in 10 CFR 50.46 will continue to be met and that the results of this analysis remain consistent with the conclusions reached by the NRC staff in SSER 27.



### 3.3 Staff Evaluation

The NRC staff has reviewed TVA's updated ASTRUM analysis described above. The licensee's analysis considered fuel performance inputs that explicitly model TCD and the inherently associated peaking factors burndown credit for second cycle operation. Peaking factor burndown and TCD are both influenced directly by burnup; thus NRC staff have assessed burndown to be acceptable to include in the analysis. Other assumptions and input parameters are consistent with analysis previously reviewed by the NRC. Additional circumstances supporting the approval of this amendment include the large margin to the PCT and cladding oxidation limits, and the precedent set both by the WBN, Unit 2, SSER 27 and the Turkey Point, Units 3 and 4, EPU (ML11293A365), which used PAD4TCD.

Therefore, NRC staff finds that TVA's analysis demonstrates compliance with the 10 CFR 50.46 acceptance criteria while maintaining a significant margin of safety to the prescribed limits.

### 3.4 Conclusion

Based on the results of the licensee's ASTRUM analysis and consistent with past NRC findings on the issue, the NRC staff concludes that the requirements of 50.46 will continue to be met; therefore, the proposed use of PAD4TCD for Cycle 2 at WBN, Unit 2, is acceptable. Therefore, the NRC staff approves the proposed amendment to license condition 2.C.(4).

### 4.0 STATE CONSULTATION

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

### 5.0 ENVIRONMENTAL CONSIDERATION

The amendment changes a requirement with respect to installation or use of a facility component 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 has previously issued a proposed finding that the amendment involves no significant hazards consideration, and there has been no public comment on such finding (81 FR 10682, March 1, 2016). 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 amendments will not be inimical to the common defense and security or to the health and safety of the public.

Contributors: Joshua Whitman

Date: July 25, 2016

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Mr. Joseph W. Shea  
Vice President, Nuclear Licensing  
Tennessee Valley Authority  
1101 Market Street, LP 3R-C  
Chattanooga, TN 37402-2801

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Sincerely,  
**/RA/**  
Robert G. Schaaf, Senior Project Manager  
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**ADAMS Accession No.: ML16174A354**

OFFICE	NRR/DORL/LPL2-2/PM	NRR/DORL/LPL2-2/LA	NRR/DSS/SNPB*	OGC
NAME	RSchaaf (FSaba for)	BClayton	JDean	VHoang
DATE	6/30/2016	6/30/2016	7/19/2016	7/13/2016
OFFICE	NRR/DORL/LPL2-2/BC(A)	NRR/DORL/LPL2-2/PM		
NAME	TOrf	RSchaaf		
DATE	7/25/2016	7/25/2016		

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