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

March 20, 2019

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

SUBJECT: WATTS BAR NUCLEAR PLANT, UNIT 2 - ISSUANCE OF AMENDMENT REGARDING APPLICATION TO REVISE LICENSE CONDITION 2.C.(4) PAD4TCD (EPID L-2018-LLA-0051)

Dear Mr. Shea:

The U.S. Nuclear Regulatory Commission (NRC, the Commission) has issued the enclosed Amendment No. 26 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 March 5, 2018, as supplemented by your letters dated April 27 and October 11, 2018.

This amendment revises License Condition 2.C.(4), concerning the use of the PAD4TCD computer program. While the current License Condition permits the use of PAD4TCD for Watts Bar Unit 2, Cycles 1 and 2 only, the revision allows the use of PAD4TCD until the Watts Bar Unit 2 steam generators are replaced with steam generators equivalent to the existing steam generators at Watts Bar Unit 1.

Enclosure 2 transmitted herewith contains Sensitive Unclassified Non-Safeguards Information. When separated from Enclosure 2, this document is decontrolled.

The NRC staff has determined that its safety evaluation (SE) tor the subject amendment contains proprietary information pursuant to Title 10 of the *Code of Federal Regulations*, Section 2.390. Accordingly, the NRC staff has prepared a redacted, publicly available, non-proprietary version of the SE. Both versions of the SE are enclosed. Notice of issuance will be included in the Commission's biweekly *Federal Register* notice.

Sincerely,

/RA Farideh E. Saba for/

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. 26 to NPF-96
2. Safety Evaluation (Proprietary Information)
3. Safety Evaluation (Non-Proprietary Information)

cc w/o Enclosure 2: Listserv (**10 days after issuance of the amendment to the licensee)**

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. 26
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 March 5, 2018, as supplemented April 27 and October 11, 2018, 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, Facility Operating License No. NPF-96 is amended as indicated in the attachment to this license amendment, and paragraphs 2.C.(2) and 2.C.(4) are 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. 26 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.

   (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.

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

FOR THE NUCLEAR REGULATORY COMMISSION

Undine Shoop, 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: March 20, 2019

ATTACHMENT TO AMENDMENT NO. 26

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 vertical lines indicating the areas of change.

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. 26 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.

(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:

ENCLOSURE 3

NON PROPRIETARY SAFETY EVALUATION BY THE OFFICE OF

NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 26 TO FACILITY OPERATING LICENSE NO. NPF-96

TENNESSEE VALLEY AUTHORITY

WATTS BAR NUCLEAR PLANT, UNIT 2

DOCKET NO. 50-391

Proprietary information pursuant to Section 2.390 of Title 10
of the *Code of Federal Regulations* has been redacted from this document.
Redacted information is identified by blank space enclosed within **[[double brackets]]**.

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

SAFETY EVALUATION BY THE

OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 26 TO 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 March 5, 2018 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML18064A192), as supplemented by letters dated April 27 and October 11, 2018 (ADAMS Accession Nos. ML18137A193 and ML18284A450, respectively), the Tennessee Valley Authority (TVA, the licensee), submitted a request for changes to the Watts Bar Nuclear Plant (Watts Bar, WBN), Unit 2, Facility Operating License No. NPF-96. The requested changes would revise License Condition 2.C.(4), concerning the use of the PAD4TCD computer program. While the current License Condition permits the use of PAD4TCD for Watts Bar Unit 2, Cycles 1 and 2 only, the proposed revision would allow the use of PAD4TCD until the Watts Bar Unit 2 steam generators are replaced with steam generators equivalent to the existing steam generators at Watts Bar Unit 1.

The supplemental letters dated April 27 and October 11, 2018, provided additional information that clarified the application, did not expand the scope of the application as originally noticed, and did not change the staff's original proposed no significant hazards consideration determination as published in the *Federal Register* on December 4, 2018 (83 FR 62623).

2.0 REGULATORY EVALUATION

2.1 System Description

The subject of this license amendment request is the use of PAD4TCD, which is an interim computer analysis code used to evaluate fuel performance and design. As such, the system under consideration is the Watts Bar Unit 2 fuel system. For the purposes of this review, the fuel system is considered insofar as it is susceptible to the effects of nuclear fuel thermal conductivity degradation (TCD). The following paragraphs provide a brief summary of the fuel design, the TCD phenomenon, and the implications that not accounting for TCD can have on safety analyses.

2.1.1 Fuel System Design

The reactor core is comprised of an array of fuel assemblies that are similar in mechanical design, but different in fuel enrichment. Watts Bar Unit 2 uses 17 x 17 Westinghouse Electric Company (Westinghouse)-designed fuel assemblies. Within each assembly, 264 fuel rods are mechanically joined in a square array. The fuel rods consist of slightly enriched uranium dioxide ceramic cylindrical pellets contained in zirconium alloy tubing, which is plugged and seal welded at the ends to encapsulate the fuel.

2.1.2 Thermal Conductivity Degradation in Nuclear Fuel

As the uranium dioxide fuel is depleted through the fuel cycle, the thermal conductivity of the ceramic changes. Due to irradiation damage and the progressive buildup of fission products in the fuel pellets, the thermal conductivity is reduced as the fuel is exposed to higher burnup levels. This reduction in thermal conductivity as a function of burnup is commonly referred to as TCD.

The simulation of the fuel element is an integral part of plant safety analyses. Within the analysis, the fuel pellet thermal conductivity model determines the rate at which heat is transferred from the fuel pellet, first to the gas gap, then to the fuel cladding, and subsequently to the coolant. A lower fuel pellet thermal conductivity results in higher fuel temperatures at a given linear heat generation rate. Therefore, the analytical prediction of the fuel thermal conductivity will affect the results of several types of safety analyses. If a safety analysis models fuel rod performance, but does not take TCD into account, then the analysis may mischaracterize expected plant performance. More information on TCD and the potential effects if TCD is neglected in safety analyses is provided in U.S. Nuclear Regulatory Commission (NRC) Information Notice (IN) 2009-23, "Nuclear Fuel Thermal Conductivity Degradation."

2.2 Proposed Change

Watts Bar Unit 2 License Condition 2.C.(4) currently states:

> 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.

TVA proposes to revise this License Condition to state:

> 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.

2.3 Applicable Regulatory Requirements

As stated in the Watts Bar updated final safety analysis report (UFSAR) Section 3.1.1, "Introduction," Watts Bar was designed to meet the intent of the "Proposed General Design Criteria for Nuclear Power Plant Construction Permits" published in July 1967. The Watts Bar construction permit was issued in January 1973. The Watts Bar UFSAR, however, addresses the NRC General Design Criteria (GDC) published as Appendix A to 10 CFR Part 50 in July

1971. The Watts Bar UFSAR provides a discussion of the design features and procedures that meet the intent of the GDC, including a discussion of any exceptions to the GDC.

Because the simulation of the fuel element is an integral part of plant safety analyses, the NRC staff review of the proposed license condition revision is based on the GDC as described in the Watts Bar UFSAR. The regulatory requirements in aggregate generally require the reactor fuel, coolant, and protection systems to be designed and operated with sufficient margins to safety to limit the postulated consequences of anticipated operational occurrences and infrequent events. The GDC that are relevant to this license amendment request are described in the Watts Bar UFSAR as follows:

> Criterion 10 - Reactor Design
>
> The reactor core and associated coolant, control, and protection systems shall be designed with appropriate margin to assure that specified acceptable fuel design limits are not exceeded during any condition of normal operation, including the effects of anticipated operational occurrences.
>
> Criterion 28 - Reactivity Limits
>
> The reactivity control systems shall be designed with appropriate limits on the potential amount and rate of reactivity increase to assure that the effects of postulated reactivity accidents can neither (1) result in damage to the reactor coolant pressure boundary greater than limited local yielding nor (2) sufficiently disturb the core, its support structures or other reactor pressure vessel internals to impair significantly the capability to cool the core. These postulated reactivity accidents shall include consideration of rod ejection (unless prevented by positive means), rod dropout, steam line rupture, changes in reactor coolant temperature and pressure, and cold water addition.

The NRC staff review is based on guidance and acceptance criteria provided in specific sections of Chapters 4, "Reactor," and 15, "Transient and Accident Analysis," of NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, LWR [Light Water Reactor] Edition."

3.0 TECHNICAL EVALUATION

To perform this review, the NRC staff relied on prior review experience and information submitted by Westinghouse, which the licensee cited in its supplemental letter dated April 27, 2018. The referenced information was contained in Westinghouse letter LTR-NRC-12-18-P, "Westinghouse Response to December 16, 2011 NRC Letter Regarding Nuclear Fuel Thermal Conductivity Degradation" (ADAMS Accession Nos. ML12053A105 (publicly available) and ML12054A250 (not publicly available)).

The Watts Bar Unit 2 licensing basis accounts for TCD only in the large-break loss-of-coolant accident (LBLOCA) analysis. When the NRC staff initially approved the licensing and operation of Watts Bar Unit 2, it did so for a single cycle only, because TCD effects would not be realized until the fuel exceeded 30 gigawatt-days per metric ton uranium, a burnup more closely associated with late in the second cycle. The NRC staff subsequently extended its approval to a second cycle, in consideration of the facts that (1) the effect of TCD had been accounted for explicitly in LBLOCA, and (2) a detailed code-to-code comparison indicated that the means by

which the LBLOCA analysis accounted for the effects of TCD was technically sound, and therefore, acceptable. Meanwhile, because the licensee used an interim method to account for the effects of TCD, and because facility operation remained limited to two operating cycles, it was unnecessary to account for the effects of TCD in a more generic sense, within the Watts Bar Unit 2 licensing basis.

In light of the open-ended nature of the proposed revised license condition, the NRC staff determined that additional assurance was required to reach a conclusion that the facility would be operated in conformance with the NRC's regulations, when considering the effects of TCD. Information is available, in several forms, to assess the effects of TCD on Westinghouse-supported plants, including:

- A newer, NRC-approved method to perform fuel rod performance analysis,
- The qualitative evaluation submitted by Westinghouse via LTR-NRC-12-18-P, which the licensee referenced in its April 27, 2018, letter, and
- Prior, plant-specific analyses performed to support requests for licensing action at other, similar facilities.

The Westinghouse letter referenced by TVA dispositions many of the TCD effects by noting that nuclear fuel naturally tends to diminish its thermal power output as it reaches high burnup conditions, an effect that the vendor refers to as peaking factor burndown. Currently, peaking factor burndown is credited to offset the effects of TCD in the LBLOCA analysis. The peaking factor burndown curve is confirmed on a cycle-by-cycle basis, via the Reload Safety Analysis Checklist process.

Prior NRC staff review experience with plant-specific analyses corroborates many of the more general evaluations contained in LTR-NRC-12-18-P. However, these previous, plant-specific results also identified certain areas where licensing basis acceptance criteria for fuel rod design and accident and transient analyses have the potential to be exceeded when accounting for TCD, which required the application of a combination of new acceptance criteria and more restrictive initial conditions.[1]

The NRC staff considered the evaluations in LTR-NRC-12-18-P alongside the prior, plant-specific information and determined that additional information concerning the effects of TCD would be required in three specific areas, prior to allowing operation with the proposed license condition. The Westinghouse evaluation in LTR-NRC-12-18-P generally indicates that, in the other cases, substantial margin exists, or the particular analysis is not affected by TCD. Prior, plant-specific analyses have confirmed the information in the Westinghouse letter, with the exception of three areas. These areas are: (1) fuel rod cladding stress and strain; (2) the licensing basis main steamline break event; and (3) the control rod ejection accident.

Note that the NRC staff evaluated the information from Westinghouse, and from the prior NRC

[1] An example of applying more restrictive initial conditions exists in the Watts Bar Unit 2 licensing basis emergency core cooling system (ECCS) performance evaluation for LBLOCAs. In a letter dated August 6, 2013, TVA stated, "Burndown credit for the hot rod and hot assembly is taken for higher burnup fuel in the 2nd and 3rd cycle of operation" (ADAMS Accession No. ML13225A024). This margin offset applied in the ECCS performance evaluation is known as a peaking factor burndown credit.

staff review experience, to an extent necessary to identify the considerations essential to this review activity, but that the NRC staff did not review the information concerning other fuel design and safety analysis acceptance criteria in sufficient detail to make a regulatory decision concerning that information.

3.1 Fuel Rod Cladding Stress and Strain

Fuel rod design is addressed in Chapter 4.2 of the Watts Bar UFSAR. The design criteria are discussed in Section 4.2.1.1.1, and a design description is provided in Section 4.2.1.2.1. Notably, the design description concludes with the safety objectives for fuel rod design. Among other things, the fuel rods are designed such that the cladding stress-strain limits are not exceeded for Condition I and II events.

In Appendix B to Westinghouse Letter LTR-NRC-12-18, Westinghouse notes that [[

]]

Although the qualitative evaluation performed by Westinghouse suggests that margin is available to offset the effects of TCD, prior NRC staff review experience has indicated that accounting for TCD explicitly can result in challenging the cladding strain acceptance criterion. The NRC staff, therefore, determined that further evaluation was required to quantify available margins and ensure that appropriate constraints on fuel system operation ensure that the plant satisfies GDC 10 requirements.

In its October 11, 2018, supplemental letter, the licensee provided a more detailed evaluation of cladding stress and strain. Regarding cladding stress, the licensee stated that a new cladding stress criterion is used, which is unaffected by TCD. This new criterion is contained in WCAP-17642-NP-A and WCAP-17642-P-A, "Westinghouse Performance Analysis and Design Model (PAD5)," which has been approved for use by the NRC (ADAMS Accession No. ML17338A396 (publicly available) and ML17334A841 (not publicly available), respectively). Since the licensee explained that the new acceptance criterion is unaffected by TCD, and the new acceptance criterion is contained in an NRC-approved topical report, the NRC staff determined that the licensee acceptably addressed the effects of TCD with regard to cladding stress.

Also using methods contained in WCAP-17642-P-A, the licensee provided an updated cladding strain analysis, which demonstrated for Cycle 2 and for an equilibrium cycle that the cladding strain limits were satisfied when taking TCD into account. Since this analysis was performed using NRC-approved methods that account for TCD, and since the results met the applicable acceptance criteria, the NRC staff determined that the licensee acceptably addressed the effects of TCD with regard to cladding strain.

As the licensee provided a detailed evaluation of the effect of TCD on cladding stress and strain analyses, and that evaluation was performed in accordance with an NRC-approved methodology, the NRC staff determined that there is reasonable assurance that, with the

proposed revision to License Condition 2.C.(4), the Watts Bar Unit 2 fuel system would continue to operate consistent with the requirements of GDC 10. The licensee's evaluation demonstrates that the fuel system will not suffer mechanical damage due to excessive cladding stress or strain, as a result of normal operation or anticipated operational occurrences.

3.2 Main Steamline Break

This evaluation considers the immediate consequences following a pre-trip main steamline break (MSLB), and the analysis of the mass and energy release following a postulated MSLB.

3.2.1 Pre-Trip Main Steamline Break

The MSLB event is described in Section 15.4.2 of the Watts Bar UFSAR. The MSLB involves the rupture of a main steamline, followed by overcooling of the reactor coolant system (RCS). If the MSLB occurs at zero-power conditions, then the core can return to power conditions, and if the MSLB occurs at full power conditions, then the core can enter an overpower condition. The licensing basis analysis for Watts Bar Unit 2 assumes that the plant is initially in a no-load condition, and departure from nucleate boiling (DNB) is evaluated at the limiting statepoint associated with that condition. The analysis confirms that DNB ratio remains above the applicable limit and fuel integrity is maintained throughout the event. Page 15.4-35 of the UFSAR notes that:

> Both [analyzed MSLB cases] assume initial hot shutdown conditions at time zero since this represents the most limiting initial condition. Should the reactor be just critical or operating at power at the time of a steam line break, the reactor will be tripped by the normal overpower protection system when power level reaches a trip point. Following a trip at power the reactor coolant system contains more stored energy than at no load, the average coolant temperature is higher than at no load and there is appreciable energy stored in the fuel. Thus, the additional stored energy is removed via the cooldown caused by the steam line break before the no load conditions of RCS temperature and shutdown margin assumed in the analyses are reached.

The staff reviewed LTR-NRC-12-18-P. This letter provides additional detail concerning the effects of TCD on licensing basis accident and transient analyses that do not necessarily account for the phenomenon. As to the MSLB analyses, Westinghouse stated in Table B.1 of LTR-NRC-12-18-P that **[[**

]]

The Watts Bar Unit 2 licensing basis indicates that the results of a HFP MSLB would be bounded by the hot zero power event analyzed in the licensing bases. However, the rationale reflects consideration of thermal energy sources like core stored energy that would be increased when TCD is taken into account. The information that TVA referenced in the Westinghouse letter also indicates that **[[** **]]** In Supplement 24 to NUREG-0847, "Safety Evaluation Report Related to the Operation of Watts Bar Nuclear Plant, Unit 2," the NRC staff noted that the basis for not analyzing an HFP MSLB included the NRC-approved topical report WCAP-8745-P-A, "Design Bases for the Thermal Overpower ΔT and Overtemperature ΔT Trip Functions." This topical report includes

information indicating that the OPΔT trip provides adequate protection for an MSLB event from HFP conditions. Given the effect described in LTR-NRC-12-18-P, it is not clear that the Watts Bar Unit 2 licensing basis for the HFP SLB adequately accounts for the effects of TCD.

In its October 11, 2018, supplemental letter, the licensee provided a description of an updated analysis of a postulated MSLB coincident with a rod withdrawal at power[2] using the Westinghouse LOFTRAN computer code and fuel conditions that were modeled in accordance with methods described in WCAP-17642-P-A. The LOFTRAN computer code has been approved for use by the NRC staff and is described in WCAP-7907-P-A, "LOFTRAN Code Description." The results of the updated analyses demonstrated that, **[[**
]], taking the effects of TCD into account, the peak linear heat rate would not exceed that at which fuel melting would be anticipated.

The NRC staff determined that the licensee adequately addressed the effects of TCD relative to the MSLB, because the licensee used NRC-approved methods (i.e., LOFTRAN and PAD5) to model the event in a way that explicitly accounts for TCD effects, and showed that fuel melting would not occur. The NRC staff determined that the licensee provided reasonable assurance that, given the revised license condition, the capability to cool the core would be maintained because fuel melt would not be anticipated under postulated MSLB conditions. Therefore, the NRC staff concludes that the Watts Bar Unit 2 fuel system would continue to operate in compliance with GDC 28, taking TCD into account.

3.2.2 Mass and Energy Release

In reviewing the proposed revision to License Condition 2.C.(4) relative to the potential effects of TCD on the MSLB, the NRC staff also considered the potential for TCD to affect the post-MSLB containment pressure analysis. In LTR-NRC-12-18-P, Westinghouse stated that **[[**

]] Since the Westinghouse evaluation indicated that the TCD effect on the MSLB mass and energy release analyses would be negligible due to the modeling described above, the NRC staff determined that it was not necessary to review the post-MSLB containment response analyses in further detail. Note, also, that prior NRC review experience has not indicated that TCD would have a significant effect on this analysis.

3.3 Control Rod Ejection Accident

This accident is defined as the mechanical failure of a control rod mechanism pressure housing resulting in the ejection of a rod cluster control assembly and drive shaft. The consequence of this mechanical failure is a rapid positive reactivity insertion together with an adverse core power distribution, possibly leading to localized fuel rod damage.

The control rod ejection accident is described in Section 15.4.6 of the Watts Bar UFSAR. Section 15.4.6.1.2 provides the acceptance criteria for the event, which include the following:

[2] The licensee stated that this postulated event had been performed to address concerns identified in IN 1979-22, "Qualification of Control Systems." Because the analysis includes a coincident rod withdrawal, it is considered to be more severe than an uncomplicated, licensing basis MSLB at HFP conditions would be, and is hence more conservative.

- The average fuel pellet enthalpy at the hot spot must be below 225 calories per gram for unirradiated fuel, and below 200 calories per gram for irradiated fuel.

- The peak reactor coolant pressure must not exceed the faulted condition stress limits.

- Fuel melting must be less than the innermost 10-percent of the fuel pellet at the hot spot.

The event is analyzed for Watts Bar using the TWINKLE spatial kinetics code for the average core transient analysis, and the hot spot analysis is performed using FACTRAN. The hot spot analysis, in particular, has the potential to be affected by TCD. Specifically, [[ ]] affected by TCD, according to LTR-NRC-12-18-P. This is corroborated by prior NRC staff review experience, wherein accounting for the effects of TCD caused the predicted, end-of-cycle, centerline fuel melt to increase significantly.

In its October 11, 2018, supplemental letter, the licensee provided the results of updated [[ ]] control rod ejection analyses, using the existing licensing basis methods, but with fuel performance inputs developed using the methods described in WCAP-17642-P-A. These methods are described in WCAP-7588, Revision 1-A, "An Evaluation of the Rod Ejection Accident in Westinghouse Pressurized Water Reactors Using Spatial Kinetics Methods." The results showed that, [[ ]], it remained within the applicable acceptance criteria. There was a slight increase to the average fuel pellet enthalpy, but enthalpy also remained below the 200 calories per gram limit.

Because the licensee addressed the effects of TCD on the control rod ejection accident using NRC-approved methods, and showed that the acceptance criteria remained satisfied, the NRC staff determined that the licensee demonstrated that the Watts Bar Unit 2 fuel system design would continue to operate consistent with the requirements of GDC 28, insofar as it requires that the results of postulated reactivity accidents not be so severe as to impair the ability to cool the core. Therefore, the NRC staff concludes that the proposed license condition revision is acceptable with respect to the control rod ejection accident.

3.4 Summary of Technical Conclusions

The licensee's evaluation of the effect of TCD on cladding stress and strain, performed in accordance with an NRC-approved methodology, demonstrated that the fuel system will not suffer mechanical damage due to excessive cladding stress or strain as a result of normal operation or anticipated operational occurrences. Based on this analysis, the NRC staff determined that there is reasonable assurance that the Watts Bar Unit 2 fuel system will continue to operate consistent with the requirements of GDC 10.

Regarding the potential effects of TCD on the MSLB, the NRC staff determined that it was not necessary to review the post-MSLB containment response analyses in detail. Previous evaluation indicated that the TCD effect on the MSLB mass and energy release analyses would be negligible due to modeling, and prior NRC review experience has not indicated that TCD would have a significant effect on this analysis.

The NRC staff determined that the licensee provided reasonable assurance that the capability to cool the core would be maintained because fuel melt would not be anticipated under

postulated MSLB conditions. The licensee addressed the effects of TCD on the control rod ejection accident using NRC-approved methods and showed that the acceptance criteria remained satisfied. Therefore, the NRC staff concludes that the Watts Bar Unit 2 fuel system would continue to operate consistent with the requirements of GDC 28.

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 February 15, 2019. 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 previously issued a proposed finding that the amendment involves no significant hazards consideration, and there has been no public comment on such finding published in the *Federal Register* on December 4, 2018 (83 FR 62623). 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 Contributors: Benjamin Parks
Terrence Brimfield

Date: March 20, 2019

SUBJECT: WATTS BAR NUCLEAR PLANT, UNIT 2 - ISSUANCE OF AMENDMENT REGARDING APPLICATION TO REVISE LICENSE CONDITION 2.C.(4) PAD4TCD (EPID L-2018-LLA-0051) DATED MARCH 20, 2019

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