Tennessee Valley Authority, 1101 Market Street, Chattanooga, Tennessee 37402

CNL-15-208

September 30, 2015

10 CFR 50.36

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555-0001

Watts Bar Nuclear Plant, Unit 2
Construction Permit No. CPPR-92
NRC Docket No. 50-391

Subject: **Watts Bar Nuclear Plant Unit 2 – Technical and Regulatory Basis for Technical Specification 3.2.1, Heat Flux Hot Channel Factor (FQ (Z)), Revision 0**

Reference.

1. Letter from TVA to NRC, CNL-15-190, "Watts Bar Nuclear Plant Unit 2 – Submittal of Final Revision 0 of the Technical Specifications & Technical Specification Bases, and Final Revision 0 of the Technical Requirements Manual & Technical Requirements Manual Bases," dated September 23, 2015 [ADAMS Accession No. ML15267A183]

2. Letter from TVA to NRC, "Watts Bar Nuclear Plant Unit 2 – Submittal of Developmental Revision I of the Technical Specifications & Technical Specification Bases, and Developmental Revision D of the Technical Requirements Manual & Technical Requirements Manual Bases," dated June 16, 2014 [ADAMS Accession No. ML14170A054]

By letter dated September 23, 2015 (Reference 1), Tennessee Valley Authority (TVA) submitted Final Revision 0 of the Watts Bar Nuclear Plant (WBN) Unit 2 Technical Specifications (TS) and TS Bases as well as Final Revision 0 of the WBN Unit 2 Technical Requirements Manual (TRM) and TRM Bases. During a pre-submittal teleconference between the NRC staff and TVA personnel, it was determined that the NRC needed additional information to approve changes proposed in WBN Unit 2 Technical Specification 3.2.1, "Heat Flux Hot Channel Factor (F_Q (Z))." The purpose of this letter is to provide the additional information.

The enclosure to this letter provides the regulatory and technical basis for the TS Limiting Condition for Operation Actions and the associated Surveillance Requirements. The discussion establishes that the Actions and Surveillance Requirements support the Final Safety Analysis Report accident analyses provided in the WBN Unit 2 Final Safety Analysis Report Chapter 15. The enclosure also shows the changes in TS 3.2.1 from Developmental Revision I of the WBN Unit 2 TS (Reference 2) to TS 3.2.1 as submitted in Revision 0 (Reference 1).

There are no new regulatory commitments included in this submittal. Please direct any questions concerning this matter to Gordon Arent at (423) 365-2004.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 30th day of September 2015.

Respectfully,

J. W. Shea

Digitally signed by J. W. Shea
DN: cn=J. W. Shea, o=Tennessee Valley Authority, ou=Nuclear Licensing, email=jwshea@tva.gov, c=US
Date: 2015.09.30 20:45:36 -04'00'

J. W. Shea
Vice President, Nuclear Licensing

Enclosure:

Watts Bar Nuclear Plant Unit 2 – Technical and Regulatory Basis for Technical Specification 3.2.1, Heat Flux Hot Channel Factor (FQ (Z)), Revision 0

cc (Enclosure):

U.S. Nuclear Regulatory Commission, Region II
NRC Senior Resident Inspector - Watts Bar Nuclear Plant, Unit 2
NRC Project Manager - Watts Bar Nuclear Plant, Unit 2

ENCLOSURE

Watts Bar Nuclear Plant Unit 2 – Technical and Regulatory Basis for Technical Specification 3.2.1, Heat Flux Hot Channel Factor ($F_Q(Z)$), Revision 0

Enclosure

Watts Bar Unit 2 Technical and Regulatory Basis for Technical Specification 3.2.1, Heat Flux Hot Channel Factor (F_Q (Z)), Revision 0

CONTENTS

Attachments

1. Clean TS 3.2.1

Watts Bar Unit 2 Technical and Regulatory Basis for Technical Specification 3.2.1, Heat Flux Hot Channel Factor (F_Q (Z)), Revision 0

1.0 SUMMARY DESCRIPTION

Tennessee Valley Authority (TVA) submitted Revision 0 of the Watts Bar Nuclear Plant (WBN) Unit 2 Technical Specifications (TS) and TS Bases to the Nuclear Regulatory Commission (NRC) on September 23, 2015 (Reference 1). Reference 1 included a commitment to provide a technical and regulatory evaluation for WBN Unit 2 TS 3.2.1, "Heat Flux Hot Channel Factor (F_Q(Z))." This enclosure provides the technical and regulatory evaluation for TS 3.2.1 for WBN Unit 2 fulfilling the commitment made in Reference 1.

In developing the WBN Unit 2 TS, TVA concluded that TS 3.2.1 was potentially non-conservative based on industry information and actions that WBN Unit 1 had established for this specification. Consequently, TVA evaluated the situation and developed additional actions and surveillance requirements to assure that TS 3.2.1 was conservative and supported the accident analyses described in the WBN Unit 2 Final Safety Analysis Report (FSAR). The updated WBN Unit 2 TS 3.2.1 was submitted to the NRC in Reference 1.

Westinghouse Electric Corporation (Westinghouse) had identified that this specification was potentially non-conservative for a number of operating nuclear units using a standard Westinghouse nuclear design methodology. That methodology was used for WBN Unit 2. Westinghouse prepared an engineering evaluation that provided administrative actions for utilities to take in accordance with NRC Administrative Letter (AL) 98-10, “Dispositioning of Technical Specifications that are Insufficient to Assure Plant Safety,” (Reference 2). This provided an acceptable basis for allowing continued operation of plants with an operating license until a final resolution was established that addressed the issue generically for the impacted plants. Because WBN Unit 2 does not have an operating license, TVA concluded that Technical Specification (TS) 3.2.1 should support the Final Safety Analysis Report (FSAR) Chapter 15 accident and transient analyses. Thus, TS 3.2.1 was modified from earlier revisions of the TS to the wording that was provided in Reference 1.

In Westinghouse Nuclear Safety Advisory Letter (NSAL)-09-5 (Reference 3), Relaxed Constant Axial Offset Control (RAOC) calculations using the standard Westinghouse nuclear design methodology were performed for recent cycles of typical plants to calculate the impact on F_Q^W(Z) associated with various reductions in the RAOC axial flux difference (AFD) envelope. The results of these calculations indicate that the AFD reduction required by Required Action B.1 of TS 3.2.1 may not restore the transient F_Q^W(Z) to within its limits, if the limit is exceeded in the middle elevations of the core. Additional calculations determined that F_Q^W(Z) can be restored to within its limits with additional reductions in the core power level and/or control rod insertion limits. TVA concluded that the reductions in core power and in setpoints were applicable and appropriate for WBN Unit 2. TS 3.2.1 provided in Reference 1 incorporated these additional reductions in core power level assuring that the peaking factor assumed in the loss of coolant accident (LOCA) analyses remained bounding.

In Westinghouse NSAL-15-1, "Heat Flux Hot Channel Factor Technical Specification Surveillance," (Reference 4), the potential for exceeding the Limiting Condition for Operation (LCO) associated with TS 3.2.1 could occur when the core axial power shape transitions to a flattened saddle-type shape. Associated with this transition is a decreasing nominal F_Q^C value, but potentially increasing F_Q^W, because the saddle-type shapes are more sensitive to changes in the AFD. For this condition, the current TS Surveillance Requirements

(SR) given in SR 3.2.1.2 may not be sufficient to assure that the F_Q^W assumed in the safety analysis is conservative between the 31 effective full power day (EFPD) intervals when the F_Q surveillance is performed. This NSAL recommended changes to SR 3.2.1.2 to perform additional surveillances if the last surveillance that was performed indicates that the margin to the F_Q^W LCO limit is not sufficient to accommodate the F_Q^W penalty factor specified in the Core Operating Limits Report (COLR). Based on TVA's review of the recommended changes to the surveillance, TVA chose to incorporate the intent of the SR change recommendations but simplifies the SR format and instructions while increasing the restrictions.

2.0 DETAIL DESCRIPTION OF CHANGES

TVA made two changes to address the issues identified in NSAL-09-5 and NSAL-15-1 for use in the WBN Unit 2 Revision 0 TS.

The first change was to add the following Required Actions to TS 3.2.1 Condition B as recommended in NSAL-09-5. Note the italicized and bolded verbiage to identify the change (Required Actions B.2.1, B.2.2, B.2.3, and B.2.4 and associated Note).

CONDITION	REQUIRED ACTION		COMPLETION TIME
B. F_Q^W (Z) not within limits	B.1	Reduce AFD limits ≥ 1% for each 1% F_Q^W (Z) exceeds limit.	2 hours
	AND		
		-------------NOTE------------ Required Actions B.2.1, B.2.2, B.2.3, and B.2.4 not required if SR 3.2.1.2 was performed at < 75% RTP. ---------------------------------	
	B.2.1	***Reduce maximum allowable power ≥ 3% RTP for each 1% F_Q^W (Z) exceeds limit.***	***4 hours***
	AND		
	B.2.2	***Reduce Power Range Neutron Flux – High trip setpoints ≥ 1% for each 1% the maximum allowable power is reduced.***	***72 hours***
	AND		
	B.2.3	***Reduce Overpower ΔT trip setpoints ≥ 1% for each 1% the maximum allowable power is reduced.***	***72 hours***
	AND		
	B.2.4	***Perform SR 3.2.1.1 and SR 3.2.1.2.***	***Prior to increasing THERMAL POWER above the limit of Required Action B.2.1***

The second change affected the NOTE associated with SR 3.2.1.2, to verify F_Q^W (Z) is within the limit. This change addressed the issue raised in NSAL-15-1. Note the italicized and bolded verbiage to identify the change in SR 3.2.1.2, however, in the formula "F_Q^C(Z) * W(Z)", the factor "W(Z)" was added but is not shown italicized or bolded.

SURVEILLANCE		FREQUENCY
SR 3.2.1.2	-------------------------------NOTE------------------------------ If F_Q^W (Z)***,*** ~~is within limits and measurements indicate~~ ~~maximum over z~~ $\cancel{\left[\frac{F_Q^C(Z)}{K(Z)}\right]}$ ~~has increase since the previous evaluation of F_Q^C (Z):~~ ~~a.~~ ~~I~~***i***ncrease***d*** ~~F_Q^W(Z)~~ by the appropriate factor specified in the COLR***,*** ~~and reverify F_Q^W (Z)~~ is ***not*** within limits~~; or~~ ~~b.~~ Repeat SR 3.2.1.2 once per 7 EFPD using the Power Distribution Monitoring System (PDMS) until two successive incore power distribution measurements indicate maximum over z $\left[\frac{F_Q^C(Z)}{K(Z)}\right]$ ***AND*** ***maximum over z*** $\left[\frac{F_Q^C(Z) * W(Z)}{K(Z)}\right]$ ~~has~~***have*** not increased. ---	
	Verify F_Q^W(Z) is within limit.	Once after initial fuel loading and each refueling prior to THERMAL POWER exceeding 75% RTP AND Once within 12 hours after achieving equilibrium conditions after exceeding, by ≥ 10% RTP, the THERMAL POWER at which F_Q^W (Z) was last verified AND 31 EFPD thereafter

Enclosure

Watts Bar Unit 2 Technical and Regulatory Basis for Technical Specification 3.2.1, Heat Flux Hot Channel Factor (F_Q (Z)), Revision 0

The change to SR 3.2.1.2 reads as follows.

	SURVEILLANCE	FREQUENCY
SR 3.2.1.2	-------------------------------NOTE------------------------------ If F_Q^W (Z), increased by the appropriate factor specified in the COLR, is not within limits: Repeat SR 3.2.1.2 once per 7 EFPD using the Power Distribution Monitoring System (PDMS) until two successive incore power distribution measurements indicate maximum over z $\left[\frac{F_Q^C(Z)}{K(Z)}\right]$ <u>AND</u> maximum over z $\left[\frac{F_Q^C(Z) * W(Z)}{K(Z)}\right]$ have not increased. ---	
	Verify F_Q^W (Z) is within limit.	Once after initial fuel loading and each refueling prior to THERMAL POWER exceeding 75% RTP <u>AND</u> Once within 12 hours after achieving equilibrium conditions after exceeding, by ≥ 10% RTP, the THERMAL POWER at which F_Q^W (Z) was last verified <u>AND</u> 31 EFPD thereafter

3.0 TECHNICAL EVALUATION

3.1 Background - Issue

In August 2007, TVA informed the NRC of plans to restart the construction of WBN Unit 2 and request an operating license (Reference 5). In January 2008, TVA submitted the regulatory framework for completing WBN Unit 2 (Reference 6). TVA proposed that the "current licensing basis for Unit 1 will be used as the reference basis for the review and licensing of Unit 2." The NRC Commissioners supported the approach of using the current WBN Unit 1 licensing basis as the reference basis for the review and licensing of WBN Unit 2 (Reference 7). As such, developmental revision A of the WBN Unit 2 TS and TS Bases were based on NUREG-1431, "Standard Technical Specifications, Westinghouse Plants, Revision 0" and the WBN Unit 1 TS and TS Bases including Amendments 70 through 91 (Reference 8).

In September of 2009, Westinghouse issued NSAL-09-5 R1 (Reference 3) associated with relaxed axial offset control F_Q Technical Specification Required Actions. This NSAL stated that the Required Actions for Condition B of Improved Standard Technical Specifications (NUREG-1431) TS 3.2.1B, "Heat Flux Hot Channel Factor (F_Q(Z) (RAOC-W(Z) Methodology)," may not be sufficient to assure that the peaking factor basis assumed in the licensing basis analysis is maintained under all conditions if the transient F_Q limit is not met. This NSAL recommended four actions be administratively implemented in accordance with NRC AL 98-10, which are listed in Section 3.3. The WBN Unit 2 TS 3.2.1 are based on NUREG-1431, TS 3.2.1B and WBN Unit 2 uses the RAOC methodology, therefore NSAL-09-5, R1, is applicable to WBN Unit 2.

To resolve this issue generically, Westinghouse submitted a topical report to the NRC (Reference 9) to support a TS change for the industry. Because these interim actions are very conservative in order to bound all plants, NSAL-09-5 R1 recommended that licensees not submit license amendment requests that include these interim actions until a generic industry resolution was prepared and approved by the NRC. WBN Unit 1 is following the recommendation for implementation in accordance with AL 98-10.

In February of 2015, Westinghouse issued NSAL-15-1, "Heat Flux Hot Channel Factor Technical Specification Surveillance (Reference 4)." This NSAL stated that one aspect of TS SR 3.2.1.2 of TS 3.2.1B, "Heat Flux Hot Channel Factor (FQ(Z) (RAOC-W(Z) Methodology)," and TS 3.2.1C, "Heat Flux Hot Channel Factor (FQ(Z) (CAOC [constant axial offset control]-W(Z) Methodology)," in NUREG-1431 may not be sufficient to assure that the peaking factor that is assumed in the licensing basis analysis is maintained under all conditions between the frequency of performance of TS SR 3.2.1.2. Westinghouse recommended interim changes to TS SR 3.2.1.2, that should be implemented in accordance with NRC AL 98-10. Again WBN Unit 2 uses the RAOC methodology and TS 3.2.1 is based on NUREG-1431, TS 3.2.1B, therefore NSAL-15-1, is applicable to WBN Unit 2. WBN Unit 1 is following the recommendation for implementation in accordance with AL 98-10.

3.2 Background - Heat Flux Hot Channel Factor F_Q(Z) Limits

F_Q (Z) is defined as the maximum local fuel rod linear power density divided by the average fuel rod linear power density, assuming nominal fuel pellet and fuel rod dimensions, adjusted for uncertainty. The value of F_Q (Z) varies along the axial height (Z) of the core, fuel loading patterns, control bank insertion, fuel burnup, and changes in axial power distribution. The purpose of the limits on the values of F_Q (Z) is to limit the local (i.e., pellet) peak power density.

F_Q (Z) is measured periodically using the Power Distribution Monitoring System (PDMS), that are generally taken with the core at or near steady state conditions. Using the measured three dimensional power distributions, it is possible to derive a measured value for F_Q (Z). However, because this value represents a steady state condition, it does not include the variations in the value of F_Q (Z) that are present during non-equilibrium situations, such as load following.

To account for these possible variations, the steady state value of F_Q (Z) is adjusted by an elevation dependent factor that accounts for the calculated worst case transient conditions. This factor, K(Z), is contained in the WBN Unit 1 and 2 specific Core Operating Limits Report (COLR).

3.3 WBN Unit 2 Actions to Address NSAL-09-5, Relaxed Axial Offset Control F_Q Technical Specification

Required Actions for Condition B of TS 3.2.1B, “Heat Flux Hot Channel Factor F_Q(Z) (RAOC-W(Z) Methodology),” for plants that have implemented the relaxed axial offset control (RAOC) methodology may not be sufficient to ensure that the peaking factor basis assumed in the licensing basis analysis is maintained under all conditions if the transient F_Q does not meet the LCO limit.

TS 3.2.1 ensures that F_Q(Z) is maintained within the limits assumed as initial conditions in the large break loss-of-coolant accident (LBLOCA) analysis. Currently, if the height dependent Transient F_Q, (F_Q^W(Z)), does not meet the LCO limit, Required Action B.1 requires the relaxed axial offset control (RAOC) axial flux difference (AFD) limits to be reduced (on both the positive and negative side) in proportion to the amount that F_Q^W(Z) exceeds the limit. However, if the limiting F_Q^W(Z) is in the middle of the core, then reducing the AFD limits has less impact on reducing the F_Q^W(Z) values. Evaluations performed for some plants indicate that the benefit of reducing the AFD is dependent on the axial position where F_Q^W(Z) exceeds the LCO limit. The current required action may not be sufficient to bring F_Q^W(Z) within the LCO limit if the limit is exceeded near the middle of the core.

For the operating nuclear power plants, Westinghouse recommended that conservative interim actions be administratively implemented in accordance with NRC AL 98-10. The recommended actions were administratively implemented on WBN Unit 1. Although Westinghouse recommended that plant-specific license amendments not be submitted until the issue was resolved generically, WBN Unit 2 is submitting this unit-specific TS for the above stated reasons, in support of obtaining an operating license.

Revision 1 of the NSAL was issued to clarify when the recommended interim actions are applicable and how they should be implemented, to provide additional clarification as to why these interim actions should not be included in plant specific TS changes, to provide a summary of the discussion with the PWROG Licensing Subcommittee (LSC) August 2009 meeting, and to provide additional information on the long-term TS changes and schedule for those changes.

RAOC calculations using the standard Westinghouse nuclear design methodology have been performed for recent cycles of typical plants to calculate the impact on $F_Q^W(Z)$ associated with various reductions in the RAOC AFD band. These results indicate that when the peak $F_Q^W(Z)$ occurs in the middle elevations of the core, the benefit of the AFD reduction on $F_Q^W(Z)$ is less than 1% $F_Q^W(Z)$ per %AFD reduction. The results of these calculations indicate that the AFD reduction required by Required Action B.1 of Technical Specification 3.2.1 in Reference 1 may not restore the transient $F_Q^W(Z)$ to within its limits if the limit is exceeded in the middle elevations of the core.

Additional calculations have determined that $F_Q^W(Z)$ can be restored to within its limits with additional reductions in the core power level and/or control rod insertion limits. These calculations have determined that one conservative approach is to require at least a 3% reduction in core power, instead of the currently required 1% reduction in the AFD envelope, for every 1% that $F_Q^W(Z)$ exceeds the limit when the unit is at or above 75% RTP. This is the approach outlined in the recommended actions described below from the NSAL. The additional power reduction requirement would only be applicable to surveillances performed at ≥ 75% rated thermal power (RTP). For example, if the $F_Q^W(Z)$ limit is not met following a refueling outage when the surveillance is performed at 50% RTP, the actions are not applicable. Nor would they be applicable during the subsequent power ascension above 75% RTP. The actions are only applicable when the surveillance power level is ≥ 75% RTP and the $F_Q^W(Z)$ limit is exceeded. The intent of limiting the applicability of these actions is to ensure that they are not implemented unnecessarily following the performance of a surveillance at < 75% RTP. In the central core regions, $F_Q^W(Z)$ is limiting at full power. Consequently, operation < 75% RTP will not challenge the LCO limit. Furthermore, the Heat Flux Hot Channel Factor TS requires a surveillance to be performed after achieving equilibrium conditions when exceeding by a significant amount (typically 10% or 20% in most plant specific TS) the thermal power at which $F_Q^W(Z)$ was last verified. This surveillance ensures that an appropriate margin assessment will be performed at full power equilibrium conditions (or any near full power condition for extended operation). The results of this full power surveillance will be sufficient to determine whether subsequent non-equilibrium operation could challenge the LCO limit such that appropriate compensatory actions are necessary.

The NSAL recommended that four actions be taken if it is determined that $F_Q^W(Z)$ is not within the LCO limit following a surveillance performed at ≥ 75% RTP. These additional actions are:

1. Reduce the maximum allowable power by ≥ 3% for each 1% $F_Q^W(Z)$ exceeds the limit within 4 hours;
2. Reduce the power range neutron flux - high trip setpoints ≥ 1% for each 1% that the maximum allowable power level is reduced within 72 hours;
3. Reduce the Overpower ∆T trip setpoints by ≥ 1% for each 1% that the maximum allowable power level is reduced within 72 hours; and
4. Perform SR 3.2.1.1 and SR 3.2.1.2 prior to increasing THERMAL POWER above the limit of action 1. As clarified by the Note, these actions are not required if SR 3.2.1.2 was performed at power < 75% RTP. Conversely, the actions must be performed whenever the $F_Q^W(Z)$ limit is not met following a surveillance performed at ≥ 75% RTP.

TVA evaluated these recommendation and concluded that they provided conservative actions for WBN Unit 2 to support the accident analyses. Based on this evaluation the actions were incorporated as Required Actions B.2.1, B.2.2, B.2.3, and B.2.4 of the Revision 0 TS (Reference 1).

3.4 WBN Unit 2 Actions to Address NSAL-15-1, Heat Flux Hot Channel Factor Surveillance Requirements

TS 3.2.1 ensures that the height dependent heat flux hot channel factor, $F_Q(Z)$, is maintained within the limits assumed in the plant safety analysis. Compliance with the TS LCO is demonstrated by measuring the steady state peak power density at each axial elevation and verifying that both the Steady State F_Q, $F_Q^C(Z)$, and the Transient F_Q, $F_Q^W(Z)$, are within the F_Q limits. The $F_Q^W(Z)$ values are derived by applying a pre-calculated allowance factor, W(Z)/P to the $F_Q^C(Z)$ values. The W(Z)/P factor adjusts for the maximum F_Q increase at each axial location expected during normal plant operation to the $F_Q^C(Z)$ values, where P is the fractional reactor power during the measurement. (When P is $\leq$ 0.5, then the pre-calculated allowance factor is W(Z)/0.5).

The NSAL identified that the NUREG-1431, TS SR 3.2.1.2 may not ensure that $F_Q^W(Z)$ will meet the LCO limit between the performance of the 31 EFPD incore power distribution measurements under some conditions. The potential consequence is that the total heat flux hot channel factor limit assumed in the safety analysis could be exceeded between the 31 EFPD incore power distribution measurements without being identified.

In order to maintain the intent of TS SR 3.2.1.2 to ensure that $F_Q^W(Z)$ meets the LCO limit, Westinghouse recommended that a Note to SR 3.2.1.2 be administratively implemented in accordance with NRC AL 98-10. The interim note would ensure that $F_Q^W(Z)$ would be measured sufficiently frequent to ensure the LCO limit is always met.

TVA evaluated the recommendations in NSAL-15-1 and determined that SR 3.2.1.2 should be revised to address the issue identified to ensure that $F_Q^W(Z)$ will meet the LCO limit. The SR 3.2.1.2 requirements provided in WBN Unit 2 TS Revision 0 address the issue raised in NSAL-15-1, but revise the approach. The proposed Note to SR 3.2.1.2 greatly simplifies the requirements from the NSAL-15-1 Note, and places slightly greater restrictions on the WBN Unit 2 SRs.

There are two technical differences between the WBN Unit 2 submittal and the NSAL-15-1 Note, which are summarized below:

1. WBN Unit 2 SR 3.2.1.2 requires the increased $F_Q^W(Z)$ surveillance frequency of 7 EFPD be implemented if $F_Q^W(Z)$, increased by the appropriate factor specified in the COLR, does not meet the F_Q limits. The NSAL-15-1 interim Note provides an additional allowance to **not** increase the $F_Q^W(Z)$ surveillance frequency to 7 EFPD if a variety of measured and predicted trends of F_Q as a function of core burnup are not increasing.

   The WBN Unit 2 TS do not include this allowance, and as such, require the increased surveillance frequency of 7 EFPD regardless of the measured and predicted trends.

2. The NSAL interim Note allows relaxation of the increased $F_Q^W(Z)$ surveillance frequency from 7 EFPD to 31 EFPD if:

   - $F_Q^W(Z)$, increased by the appropriate factor specified in the COLR, meets the F_Q limits, or
   - The measured trends of F_Q as a function of core burnup, as indicated by two successive incore power distribution measurements, have not increased.

   The WBN Unit 2 TS do not include the first bullet. The $F_Q^W(Z)$ surveillance frequency may be relaxed from 7 EFPD to 31 EFPD **only** if the measured trends of F_Q as a function of core burnup, as indicated by two successive incore power distribution measurements, have not increased.

WBN Unit 2 Differences from WBN Unit 1

TS 3.2.1 Condition B Required Actions

The WBN Unit 2 Condition B contains the additional Required Actions B.2.1, B.2.2, B.2.3, and B.2.4 discussed in Section 2.1 and 3.3 above.

Required Actions B.2.1 through B.2.4 only apply to incore power distribution measurements obtained at ≥ 75% RTP that result in $F_Q^W(Z)$ not within limits, as stated in the NOTE preceding Required Action B.2.1. Typically, SR 3.2.1.2 is performed at full power conditions. In the central core regions, $F_Q^W(Z)$ is limiting at full power. Consequently, operation < 75% RTP will not challenge the LCO limit. During power ascension after a refueling, however, SR 3.2.1.2 is required to be performed prior to thermal power exceeding 75% RTP. To ensure operation near full power conditions is minimized before an appropriate margin assessment is performed, SR 3.2.1.2 is required to be performed once equilibrium conditions are established after RTP exceeds the thermal power at which $F_Q^W(Z)$ was last verified by 10%.

Required Action B.2.1 requires reducing the maximum allowable power by ≥ 3% RTP for each 1% by which $F_Q^W(Z)$ exceeds the limits. The reduction in thermal power maintains acceptable absolute power density. The Completion Time of 4 hours is sufficient considering the small likelihood of a power distribution transient followed by a severe transient in this time period and the preceding reduction in AFD limits in accordance with Required Action B.1.

Required Action B.2.2 requires reducing the Power Range Neutron Flux - High trip setpoints by ≥ 1% for each 1% the maximum allowable power is reduced in accordance with Required Action B.2.1. This is a conservative action for protection against the consequences of severe transients with unanalyzed power distributions. The Completion Time of 72 hours is sufficient considering the small likelihood of a power distribution transient followed by a severe transient in this time period and the preceding reduction in maximum allowable power level in accordance with Required Action B.2.1.

Required Action B.2.3 requires reducing the Overpower ΔT trip setpoints by > 1% for each 1% the maximum allowable power is reduced in accordance with Required Action B.2.1. This is a conservative action for protection against the consequences of severe transients with unanalyzed power distributions. The Completion Time of 72 hours is sufficient considering the small likelihood of a power distribution transient followed by a severe transient in this period and the preceding reduction in maximum allowable power level in accordance with Required Action B.2.1.

Required Action B.2.4 requires that $F_Q^C(Z)$ and $F_Q^W(Z)$ be restored to within limits by performing SR 3.2.1.1 and SR 3.2.1.2 prior to increasing thermal power above the limits imposed by Required Action B.2.1. This ensures that core conditions during operation at higher power levels are consistent with safety analyses assumptions.

SR 3.2.1.2 Note

The WBN Unit 2 SR 3.2.1.2 Note has been modified from the Note in NUREG-1431 and WBN Unit 1 SR 3.2.1.2 as discussed in Section 2.1 above.

The current WBN Unit 1 SR 3.2.1.2 Note states that it applies if $F_Q^W(Z)$ is within limits, whereas the WBN Unit 2 SR 3.2.1.2 Note does not include this statement. The inclusion of the phrase, "If $F_Q^W(Z)$ is within limits" is not necessary. If $F_Q^W(Z)$ were not within limits, Condition B would apply and SR 3.2.1.2 would not have to be performed in accordance with SR 3.0.1, which states, in part, that surveillances do not have to be performed on inoperable equipment or variables outside specified limits. This change, therefore, is considered editorial and a simplification of the format.

The WBN Unit 1 SR 3.2.1.2 Note requires SR 3.2.1.2 to be repeated once per 7 EFPD until relaxation criteria are satisfied if the following conditions exist:

1. $F_Q^W(Z)$, increased by the appropriate factor specified in the COLR, is not within limits, and

2. Measurements indicate Maximum over Z [$F_Q^C(Z)/K(Z)$] has increased since the previous evaluation of $F_Q^C(Z)$

The WBN Unit 2 SR does not include the first condition above. If $F_Q^W(Z)$, increased by the appropriate factor specified in the COLR, is not within limits, SR 3.2.1.2 is required to be repeated once per 7 EFPD until relaxation criteria are satisfied. The removal of the first condition is conservative because it will result in the increased surveillance frequency under a greater set of circumstances. The removal of the first condition is prudent. Even if the trend in Maximum over z[$F_Q^C(Z)/K(Z)$] has decreased, the past behavior of the incore power distribution measurement may not be a reliable indication of future performance. If the $F_Q^W(Z)$ is close to exceeding the limits, then more frequent performance of SR 3.2.1.2 is prudent.

The WBN Unit 1 SR 3.2.1.2 Note relaxation criteria for the 7 EFPD surveillance frequency is two successive power distribution measurements indicate Maximum over z [$F_Q^C(Z)/K(Z)$] has not increased. The WBN Unit 2 SR 3.2.1.2 Note includes this same relaxation criteria, but also requires two successive power distribution measurements indicate maximum over z [$F_Q^C(Z)$ * $W(Z)/K(Z)$] has not increased. Requiring an evaluation of $F_Q(Z)$ that involves the W(Z) factor is a conservative measure because the limiting values for $F_Q(Z)$ may be shifting in the core height, Z, as a function of core depletion and the function that accounts for power distribution transients encountered during normal operation, W(Z), should be included in the assessment. W(Z) is a function of both core height and core depletion. This enhanced $F_Q(Z)$ assessment prevents burnup or height dependent factors from causing $F_Q^W(Z)$ to exceed the limits without being identified, even though Maximum over z [$F_Q^C(Z)/K(Z)$] has not increased.

Other formatting changes made in the WBN Unit 2 SR 3.2.1.2 Note compared to the WBN Unit 1 SR 3.2.1.2 Note do not change the applicable requirements.

3.5 Conclusion

Westinghouse has issued two NSALs associated with WBN TS 3.2.1, Heat Flux Hot Channel Factor (F_Q (Z)). The first NSAL discussed an issue associated with the Required Actions for Condition B of TS 3.2.1. The second NSAL discussed an issue with SR 3.2.1.2 of TS 3.2.1. TVA evaluated the conditions described in the two NSALs and developed additional actions and surveillance requirements to assure that the TS 3.2.1 is conservative and supports the accident analyses described in the WBN Unit 2 Final Safety Analysis Report (FSAR). The WBN Unit 2 TS 3.2.1 submitted in TS Revision 0 (Reference 1) completely addresses both of these NSALs as discussed above.

4.0 REGULATORY EVALUATION

4.1 Applicable Regulatory Requirements and Criteria

10 CFR 50.36, Technical Specifications, paragraphs (c)(2), (c)(3), and (c)(5) states that technical specifications will include limiting conditions for operations, surveillance requirements, and administrative controls. Limiting conditions for operations are the lowest functional capability or performance levels of equipment required for safe operation of the facility. Surveillance requirements are requirements relating to test, calibration, or inspection to assure that the necessary quality of systems and components is maintained, that facility operation will be within safety limits, and that the limiting conditions for operation will be met. 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.

10 CFR 50.46, “Acceptance criteria for emergency core cooling systems for light-water nuclear power reactors,” requires that emergency core cooling systems (ECCS) be designed such that analyses show that acceptance criteria such as peak clad temperature, cladding oxidation, hydrogen generation, maintenance of a coolable core geometry, and long-term cooling are met for a range of loss-of-coolant accidents (LOCAs), including the most severe LOCA.

10 CFR 50, Appendix K, “ECCS Evaluation Models,” provides both high level criteria that must be considered in an ECCS Evaluation Model, or may be used specifically in an Appendix K ECCS Evaluation Model for determining that 10 CFR 50.46 acceptance criteria are met. Appendix K requires, among other considerations, that the initial stored energy in the fuel must be appropriately accounted for. The limits discussed in TS 3.2.1 assure that the initial stored energy in the fuel is less than the values assumed in the LOCA analyses.

4.2 Safety Evaluation

WBN Unit 2 Technical Specification 3.2.1, Heat Flux Hot Channel Factor (F_Q(Z)), Condition B Required Actions and Surveillance Requirement (SR) 3.2.1.2, verify F_Q^W(Z) is within the limit, are provided in TS and TS Bases Revision 0 (Reference 1) and include items to address the technical issues identified in Westinghouse NSAL 09-5 and NSAL-15-1. TVA has evaluated whether or not the WBN Unit 2 TS Revision 0 Specification 3.2.1 meets regulatory requirements by answering the following questions.

Watts Bar Unit 2 Technical and Regulatory Basis for Technical Specification 3.2.1, Heat Flux Hot Channel Factor (F_Q (Z)), Revision 0

1. Does TS 3.2.1, change the FSAR Chapter 15, Safety Analysis, or change the offsite dose analyses provided in FSAR Section 15.5, Environmental Consequences of Accidents, for LOCAs?

   Response: No.

   The WBN Unit 2 TS 3.2.1, "Heat Flux Hot Channel Factor(F_Q(Z))," limits the local fuel peak power density to prevent core power distributions that would violate fuel design criteria. The values provided in the specification assure the following specific fuel design criteria are not violated:

   a. During a loss of coolant accident (LOCA), the peak cladding temperature must not exceed 2200°F for small breaks, and there must be a high level of probability that the peak cladding temperature does not exceed 2200°F for large breaks;

   b. During a loss of forced reactor coolant flow accident, there must be at least 95% probability at the 95% confidence level (the 95/95 DNB criterion) that the hot fuel rod in the core does not experience a departure from nucleate boiling (DNB) condition;

   c. During an ejected rod accident, the energy deposition to the fuel must not exceed 280 cal/gm; and

   d. The control rods must be capable of shutting down the reactor with a minimum required shutdown margin with the highest worth control rod stuck fully withdrawn.

   Limits on F_Q (Z) ensure that the value of the initial total peaking factor assumed in the accident analyses remains valid. Other criteria are also met (e.g., maximum cladding oxidation, maximum hydrogen generation, coolable geometry, and long term cooling). However, the peak cladding temperature is typically most limiting.

   Because the local fuel peak power density is maintained less than the limit specified, the accident fuel response is bounded by the analyses presented in Chapter 15 of the FSAR. Because there is no change to these accidents, the off-site dose analyses provided in FSAR Section 15.5 remain unchanged and bounding for WBN Unit 2 operation.

2. Does TS 3.2.1, as provided in WBN Unit 2 TS and TS Bases Revision 0, require a physical modification to the WBN Unit 2 that has not been evaluated by the NRC in Supplemental Safety Evaluation (SSER) 22 through 28?

   Response: No.

   TVA's development of actions in TS 3.2.1 in response to Westinghouse NSAL-09-5 and NSAL-15-1 in TS 3.2.1 for WBN Unit 2 did not require a change to plant equipment. The changes made added steps in procedures that require the plant operators to either reduce power, move control rods, or perform additional core monitoring during normal power operation. These actions are standard actions that are already performed by the main control room staff. The procedure changes and operator actions for WBN Unit 2 align with the procedure changes and operator actions in place for WBN Unit 1 to address the Westinghouse NSALs using NRC AL 98-10. TVA did not identify conclusions made by the NRC in SSERs 22 through 28 that would need to be amended because of this TS.

3. Does TS 3.2.1 involve a significant reduction in a margin of safety compared to previous developmental revisions of the WBN Unit 2 TS and TS Bases?

   Response: No.

   The additional restrictions and monitoring in TS 3.2.1 with the associated Actions and Surveillance Requirements assure that margins of safety are maintained such that the accident analyses presented for WBN Unit 2 in Chapter 15 of the FSAR remain valid and bounding for the expected actual plant response should such a design basis event occur. The changes also assure that the regulatory requirements of 10 CFR Part 50 will be met when WBN Unit 2 begins power operation.

5.0 CONCLUSIONS

Tennessee Valley Authority evaluated the WBN Unit 2 TS for the issues identified by Westinghouse concerning potential non-conservatisms in TS 3.2.1 Heat Flux Hot Channel Factor (F_Q (Z)) as documented in NSAL-09-5 and NSAL-15-1. TVA has evaluated these NSALs and their recommended actions and developed actions that assure that the potential non-conservatisms in TS 3.2.1 are addressed and are no longer present in the WBN Unit 2 TS.

In TVA's submittal of the WBN Unit 2 TS and TS Bases Revision 0, an updated TS 3.2.1 was provided incorporating the required actions. The Revision 0 TS 3.2.1 assures that the WBN Unit 2 Chapter 15 accident analyses remain bounding as previously reviewed by the NRC, that regulatory requirements with respect to fuel design and accident response are met, and that operational fidelity with WBN Unit 1 is maintained with respect to this TS.

6.0 REFERENCES

1. Letter from TVA to NRC, "Watts Bar Nuclear Plant Unit 2 Submittal of Final Revision 0 of the Technical Specifications & Technical Specification Bases, and Final Revision 0 of the Technical Requirements Manual & Technical Requirements Manual Bases," dated September 23, 2015 [ADAMS Accession No. ML15267A183]

2. Letter from NRC to All holders of Operating Licenses, "NRC Administrative Letter 98-10: Dispositioning of Technical Specifications that are Insufficient to Assure Plant Safety," dated December 29, 1998 [NUDOCS Accession No. 9812280273]

3. Nuclear Safety Advisory Letter, NSAL-09-5 Revision 1, "Relaxed Axial Offset Control F_Q Technical Specification Actions," dated September 24, 2009

4. Nuclear Safety Advisory Letter, NSAL-15-1, "Heat Flux Hot Channel Factor Technical Specification Surveillance," dated February 3, 2015

5. Letter from TVA to NRC, "Watts Bar Nuclear Plant (WBN) - Unit 2 - Reactivation of Construction Activities," dated August 3, 2007 [ADAMS Accession No. ML072190047]

6. Letter from TVA to NRC, "Watts Bar Nuclear Plant (WBN) - Unit 2 - Regulatory Framework for the Completion of Construction and Licensing Activities for Unit 2," dated January 29. 2008 [ADAMS Accession No. ML080320443]

7. Staff Requirements Memorandum, "Staff Requirement - SECY-07-0096 - Possible Reactivation of Construction and Licensing Activities for the Watts Bar Nuclear Plant Unit 2," dated July 25, 2007

8. Letter from TVA to NRC, "Watts Bar Nuclear Plant (WBN) Unit 2 - Operating License Application Update," dated March 4, 2009 [ADAMS Accession No. ML090700378]

9. Letter from Westinghouse to NRC, Submittal of WCAP-17661-P/NP, Revision 1, "Improved RAOC and CAOC For Surveillance Technical Specifications," PA-LSC-0795, dated January 2, 2014 [ADAMS Accession Nos. ML14009A092, ML14009A093, and ML14009A094]

ENCLOSURE

ATTACHMENT 1

Watts Bar Nuclear Plant - Unit 2

Clean TS 3.2.1

3.2 POWER DISTRIBUTION LIMITS

3.2.1 Heat Flux Hot Channel Factor ($F_Q(Z)$)

LCO 3.2.1 $F_Q(Z)$, as approximated by $F_Q^C(Z)$ and $F_Q^W(Z)$, shall be within the limits specified in the COLR.

APPLICABILITY: MODE 1.

ACTIONS

CONDITION	REQUIRED ACTION		COMPLETION TIME
A. $F_Q^C(Z)$ not within limit.	A.1	Reduce THERMAL POWER ≥ 1% RTP for each 1% $F_Q^C(Z)$ exceeds limit.	15 minutes
	<u>AND</u>		
	A.2	Reduce Power Range Neutron Flux – High trip setpoints ≥ 1% for each 1% $F_Q^C(Z)$ exceeds limit.	8 hours
	<u>AND</u>		
	A.3	Reduce Overpower ΔT trip setpoints ≥ 1% for each 1% $F_Q^C(Z)$ exceeds limit.	72 hours
	<u>AND</u>		
	A.4	Perform SR 3.2.1.1.	Prior to increasing THERMAL POWER above the limit of Required Action A.1

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION		COMPLETION TIME
B. $F_Q^W(Z)$ not within limits.	B.1	Reduce AFD limits ≥ 1% for each 1% $F_Q^W(Z)$ exceeds limit.	2 hours
	AND		
		------------NOTE-------------- Required Actions B.2.1, B.2.2, B.2.3, and B.2.4 not required if SR 3.2.1.2 was performed at < 75% RTP. ----------------------------------	
	B.2.1	Reduce maximum allowable power ≥ 3% RTP for each 1% $F_Q^W(Z)$ exceeds limit.	4 hours
	AND		
	B.2.2	Reduce Power Range Neutron Flux – High trip setpoints ≥ 1% for each 1% the maximum allowable power is reduced.	72 hours
	AND		
	B.2.3	Reduce Overpower ΔT trip setpoints ≥ 1% for each 1% the maximum allowable power is reduced.	72 hours
	AND		
	B.2.4	Perform SR 3.2.1.1 and SR 3.2.1.2.	Prior to increasing THERMAL POWER above the limit of Required Action B.2.1

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
C. Required Action and associated Completion Time not met.	C.1 Be in MODE 2.	6 hours

SURVEILLANCE REQUIREMENTS

---NOTE---
During power escalation at the beginning of each cycle, THERMAL POWER may be increased until an equilibrium power level has been achieved, at which a power distribution map is obtained.

SURVEILLANCE	FREQUENCY
SR 3.2.1.1 Verify $F_Q^C(Z)$ is within limit.	Once after initial fuel loading and each refueling prior to THERMAL POWER exceeding 75% RTP <u>AND</u> Once within 12 hours after achieving equilibrium conditions after exceeding, by ≥ 10% RTP, the THERMAL POWER at which $F_Q^C(Z)$ was last verified <u>AND</u> 31 EFPD thereafter

(continued)

SURVEILLANCE REQUIREMENTS (continued)

	SURVEILLANCE	FREQUENCY
SR 3.2.1.2	-------------------------------NOTE------------------------------ If $F_Q^W(Z)$, increased by the appropriate factor specified in the COLR, is not within limits: Repeat SR 3.2.1.2 once per 7 EFPD using the Power Distribution Monitoring System (PDMS) until two successive incore power distribution measurements indicate Maximum over z $\left[\frac{F_Q^C(Z)}{K(Z)}\right]$ <u>AND</u> Maximum over z $\left[\frac{F_Q^C(Z)*W(Z)}{K(Z)}\right]$ have not increased. ---	
	Verify $F_Q^W(Z)$ is within limit.	Once after initial fuel loading and each refueling prior to THERMAL POWER exceeding 75% RTP <u>AND</u> (continued)

SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY
SR 3.2.1.2 (continued)	Once within 12 hours after achieving equilibrium conditions after exceeding, by ≥ 10% RTP, the THERMAL POWER at which $F_Q^W(Z)$ was last verified <u>AND</u> 31 EFPD thereafter