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

CNL-19-115

March 2, 2020

10 CFR 50.90

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

Watts Bar Nuclear Plant, Units 1 and 2
Facility Operating License Nos. NPF-90 and NPF-96
NRC Docket Nos. 50-390 and 50-391

Subject: **Non-Voluntary License Amendment Request to Modify Watts Bar Nuclear Plant Units 1 and 2 Technical Specifications 3.2.1, $F_Q(Z)$, to Implement Methodology from WCAP-17661, Revision 1, "Improved RAOC and CAOC FQ Surveillance Technical Specifications," (WBN-TS-19-08)**

References:

1. NRC Letter to PWROG, "Verification Letter of the Approval Version of the Pressurized Water Reactor Owners Group Topical Report WCAP-17661, Revision 1, 'Improved RAOC and CAOC FQ Surveillance Technical Specifications'," dated August 23, 2019 (ML19225D179)
2. WCAP-17661-P-A, Revision 1, "Improved RAOC and CAOC F_Q Surveillance Technical Specifications," dated February 2019 (ML19225C079)
3. NUREG-1431, Revision 4, Volume 1, "Standard Technical Specifications Westinghouse Plants, Revision 4.0 Volume 1, Specifications," dated April 2012
4. NUREG-0847 Supplement 29, Safety Evaluation Report: "Related to the Operation of Watts Bar Nuclear Plant, Unit 2," dated October 2015 (ML15282A051)
5. Westinghouse Nuclear Safety Advisory Letter (NSAL-09-05), Revision 1, "Relaxed Axial Offset Control F_Q Technical Specification Actions," dated September 23, 2009
6. Westinghouse Nuclear Safety Advisory Letter (NSAL-15-1), "Heat Flux Hot Channel Factor Technical Specification Surveillance," dated February 3, 2015

In accordance with the provisions of Title 10 of the *Code of Federal Regulations* (10 CFR) 50.90, "Application for amendment of license, construction permit, or early site permit," Tennessee Valley Authority (TVA) is submitting a request for an amendment to the Facility Operating License Nos. NPF-90 and NPF-96 for the Watts Bar Nuclear Plant (WBN) Units 1 and 2, respectively.

The proposed amendment revises the WBN Units 1 and 2 Technical Specification (TS) 3.2.1, "Heat Flux Hot Channel Factor ($F_Q(Z)$)," to implement the methodology in WCAP-17661-P-A, Revision 1, "Improved RAOC and CAOC F_Q Surveillance Technical Specifications," (References 1 and 2). The proposed revised WBN Units 1 and 2 TS 3.2.1 are also consistent with NUREG-1431, Revision 4, "Standard Technical Specifications Westinghouse Plants," (Reference 3). Additionally, this license amendment request (LAR) modifies the WBN Unit 1 and Unit 2 TS 5.9.5 to include Reference 2 in the list of the Nuclear Regulatory Commission (NRC) approved methodologies used to develop the cycle specific Core Operating Limits Report (COLR). The proposed change also deletes WBN Unit 2 Operating License (OL) Condition 2.C.10, which is documented in Section 1.9.6 of NUREG-0847 Supplement 29 (Reference 4).

Nuclear Safety Advisory Letter (NSAL) 09-05, Revision 1, (Reference 5) and NSAL-15-1, (Reference 6) noted there are non-conservatisms in the methodology in Westinghouse Standard TS (STS) 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. Therefore, in accordance with the guidance in NRC Administrative Letter 98-10, "Dispositioning of Technical Specifications That Are Insufficient to Assure Plant Safety," this LAR is required to resolve non-conservative TS and is not a voluntary request from a licensee to change its licensing basis. Therefore, this request is not subject to "forward fit" considerations as described in the letter from S. Burns (NRC) to E. Ginsberg (NEI), dated July 14, 2010 (ML101960180). TVA has implemented compensatory measures in accordance with References 5 and 6.

The enclosure to this submittal provides a description and assessment of the proposed change, including technical analyses, regulatory analyses, and environmental considerations. Attachments 1 and 2 to the enclosure provide the existing WBN Units 1 and 2 TS pages marked-up to show the proposed changes. Attachment 3 to the enclosure provides the existing WBN Unit 2 OL Condition 2.C.10 marked-up to show the proposed change. Attachments 4 and 5 to the enclosure provide the existing WBN Units 1 and 2 TS pages retyped to show the proposed changes. Attachment 6 to the enclosure provides the existing WBN Unit 2 OL Condition 2.C.10 retyped to show the proposed change. Attachments 7 and 8 to the enclosure provide the existing WBN Units 1 and 2 TS Bases pages marked-up to show the proposed changes. Changes to the existing TS Bases are provided for information only and will be implemented under the Technical Specification Bases Control Program.

TVA determined that there are no significant hazard considerations associated with the proposed change and that the TS change qualifies for a categorical exclusion from environmental review pursuant to the provisions of 10 CFR 51.22(c)(9). In accordance with 10 CFR 50.91, "Notice for Public Comment; State Consultation," TVA is sending a copy of this letter and the enclosure to the Tennessee Department of Environment and Conservation.

TVA requests approval of the proposed non-voluntary license amendment within one year from the date of this submittal. Due to the core design and safety analysis evaluation needed to support each core design using the methodology in WCAP-17661-P-A, Revision 1, implementation of this amendment for each unit will coincide with the start of the

fuel cycles for WBN Unit 1 Cycle 18 (Fall 2021) and WBN Unit 2 Cycle 5 (Spring 2022), but no later than November 30, 2021 for WBN Unit 1 and May 15, 2022 for WBN Unit 2.

There are no new regulatory commitments associated with this submittal. Please address any questions regarding this request to Kimberly D. Hulvey, Fleet Licensing Manager, at 423-751-3275.

I declare under penalty of perjury that the foregoing is true and correct. Executed on this 2nd day of March 2020.

Respectfully,

James T. Polickoski
Director, Nuclear Regulatory Affairs

Enclosure:

Evaluation of Proposed Change

cc (Enclosure):

NRC Regional Administrator - Region II
NRC Senior Resident Inspector - Watts Bar Nuclear Plant
NRC Project Manager – Watts Bar Nuclear Plant
Director, Division of Radiological Health - Tennessee State Department of Environment and Conservation

Enclosure

Evaluation of Proposed Change

Subject: **Non-Voluntary License Amendment Request to Modify Watts Bar Nuclear Plant Units 1 and 2 Technical Specifications 3.2.1, $F_Q(Z)$, to Implement Methodology from WCAP-17661, Revision 1, Improved RAOC and CAOC FQ Surveillance Technical Specifications (WBN-TS-19-08)**

TABLE OF CONTENTS

ATTACHMENTS

1. Proposed TS Changes (Mark-Ups) for WBN Unit 1
2. Proposed TS Changes (Mark-Ups) for WBN Unit 2
3. Proposed WBN Unit 2 OL Condition 2.C.10 (Mark-Ups)
4. Proposed TS Changes (Final Typed) for WBN Unit 1
5. Proposed TS Changes (Final Typed) for WBN Unit 2
6. Proposed WBN Unit 2 OL Condition 2.C.10 (Final Typed)
7. Proposed TS Bases Page Changes (Mark-Ups) for WBN Unit 1 (For Information Only)
8. Proposed TS Bases Page Changes (Mark-Ups) for WBN Unit 2 (For Information Only)

1.0 SUMMARY DESCRIPTION

In accordance with the provisions of Title 10 of the *Code of Federal Regulations* (10 CFR) 50.90, "Application for amendment of license, construction permit, or early site permit," Tennessee Valley Authority (TVA) is requesting a non-voluntary license amendment to the Watts Bar Nuclear Plant (WBN) Unit 1 and Unit 2 Technical Specifications (TS) 3.2.1, "Heat Flux Hot Channel Factor ($F_Q(Z)$)," to implement the improved F_Q Surveillance TS methodology. This non-voluntary license amendment request (LAR) proposes to revise WBN Units 1 and 2 TS 3.2.1, "Heat Flux Hot Channel Factor ($F_Q(Z)$)," to implement the methodology in WCAP-17661-P-A, Revision 1, "Improved RAOC and CAOC F_Q Surveillance Technical Specifications," (References 1 and 2), without deviation. The proposed revised WBN Units 1 and 2 TS 3.2.1 are also consistent with NUREG-1431, Revision 4, "Standard Technical Specifications Westinghouse Plants," (Reference 3). Additionally, this LAR modifies the WBN Unit 1 and Unit 2 TS 5.9.5 to include Reference 2 in the list of Nuclear Regulatory Commission (NRC)-approved methodologies used to develop the cycle specific Core Operating Limits Report (COLR). The proposed change also deletes WBN Unit 2 Operating License (OL) Condition 2.C.10, which is documented in Section 1.9.6 of NUREG-0847, Supplement 29 (Reference 4).

2.0 DETAILED DESCRIPTION

2.1 BACKGROUND

The purpose of the F_Q Surveillance TS is to provide assurance that the heat flux hot channel factor $F_Q(Z)$, will remain within the limits assumed in the plant safety analyses when the core is operated within its allowed operating space. Key operating space limits include the Rated Thermal Power (RTP), the control bank Rod Insertion Limits (RILs), and the Axial Flux Difference (AFD) limits. Together, these operating space limits restrict the range of potential non-equilibrium core power shapes during normal operation, thereby limiting the maximum non-equilibrium $F_Q(Z)$.

The current F_Q Surveillance formulation relies on a combination of analytical factors and periodic measurements to provide assurance that core operation within the allowed operating space will be acceptable. When an F_Q surveillance is performed, the equilibrium $F_Q(Z)$ is measured at or near steady-state conditions. $F_Q(Z)$ is then multiplied by an analytical factor, W(Z), which characterizes the increase in $F_Q(Z)$ for non-equilibrium operation. The result, when uncertainties are included, is the maximum postulated transient $F_Q(Z)$, which is then compared to the $F_Q(Z)$ limit.

The above formulation has been shown to be problematic for Relaxed Axial Offset Control (RAOC) plants. The accuracy of the analytically derived W(Z) values is sensitive to how well the surveillance axial power shape is predicted. While the predicted axial power shape can be inaccurate under nominal full power conditions, the accuracy of predicting the axial power shape for part-power surveillances is even more problematic. Additionally, the current Required Action of WBN Units 1 and 2 TS 3.2.1, to reduce the AFD limits if the transient F_Q limit is not met, may be insufficient to ensure that the peaking factor basis assumed in the licensing basis analysis is maintained under all conditions.

Nuclear Safety Advisory Letter (NSAL) 09-5 and NSAL-15-1 (References 5 and 6, respectively) document specific issues with regards to these general problems with the

current TS. Reference 5 notified Westinghouse customers of an issue associated with the Required Actions for Condition B of Standard TS (STS) 3.2.1B, "Heat Flux Hot Channel Factor ($F_Q(Z)$ (RAOC-W(Z) Methodology)," for plants that have implemented the RAOC methodology. In certain situations where transient $F_Q^W(Z)$ is not within its limit, the existing Required Actions may be insufficient to restore $F_Q^W(Z)$ to within its limit. Reference 5 provided clarification regarding the applicability of the recommended interim actions to address this issue in accordance with NRC Administrative Letter (AL) 98-10, "Dispositioning of Technical Specifications That Are Insufficient to Assure Plant Safety."

Reference 6 notified Westinghouse customers of an issue associated with STS 3.2.1B and 3.2.1C (Heat Flux Hot Channel Factor (FQ(Z)). Specifically, STS Surveillance Requirement (SR) 3.2.1.2 in STS 3.2.1B and 3.2.1C may not ensure that the transient F_Q meets the limiting condition for operation (LCO) limit between the performance of the 31 effective full power days (EFPD) flux map measurements, under some conditions, for those plants that use the W(Z) F_Q surveillance methodology.

Therefore, because of the issues identified in References 5 and 6, TVA determined that WBN Units 1 and 2 TS 3.2.1 constitute a non-conservative TS and entered this into the corrective action program. TVA implemented the References 5 and 6 recommended actions procedurally for WBN Unit 1. The WBN Unit 2 TS also incorporated these recommended actions with the restriction that WBN Unit 2 OL Condition 2.C.10 was adopted to verify that the Reference 5 recommended actions are sufficient for each WBN Unit 2 operating cycle.

The improved F_Q surveillance methodology in Reference 2 resolves the above issues. The new surveillance methodology requires the measurement of $F_{XY}(Z)$, which is then multiplied by factors that characterize the maximum transient P(Z) values postulated to occur during non-equilibrium operation. This formulation essentially eliminates the sensitivity of the surveillance to the surveillance axial power shape. Additionally, the improved F_Q surveillance methodology incorporates various RAOC operating spaces, consisting of combinations of control bank rod insertion, AFD, and thermal power limits that provides sufficient F_Q margin for future operation.

2.2 Description of the Proposed Change

The LAR proposes changes to WBN Unit 1 and Unit 2 TS 3.2.1 and TS 5.9.5 that implement the methodology and TS changes in Reference 2 without deviation. Additionally, the LAR deletes WBN Unit 2 OL Condition 2.C.10, which is documented in Section 1.9.6 of Reference 4. Further description of the proposed changes is provided in Section 3.2 to this enclosure.

Attachments 1 and 2 to this enclosure provide the existing WBN Units 1 and 2 TS pages marked-up to show the proposed changes. Attachment 3 to this enclosure provides the existing WBN Unit 2 OL Condition 2.C.10 marked-up to show the proposed change. Attachments 4 and 5 to this enclosure provide the existing WBN Units 1 and 2 TS pages retyped to show the proposed changes. Attachment 6 to this enclosure provides the existing WBN Unit 2 OL Condition 2.C.10 retyped to show the proposed change. Attachments 7 and 8 to this enclosure provide the existing WBN Units 1 and 2 TS Bases pages marked-up to show the proposed changes. Changes to the existing TS Bases

are provided for information only and will be implemented under the Technical Specification Bases Control Program

2.3 REASON FOR THE PROPOSED CHANGE

In accordance with the guidance in NRC AL 98-10, this LAR is required to resolve a non-conservative TS and is not a voluntary request from a licensee to change its licensing basis. The proposed LAR is needed to resolve the issues discussed in References 5 and 6 and align the WBN Units 1 and 2 TS with the STS changes in Reference 2. Additionally, the requested change is needed for Unit 2 because OL Condition 2.C.10 requires special cycle specific evaluations to be performed that are beyond the routine evaluations performed for a fuel cycle. The new F_Q formulation will remove the surveillance sensitivity to the predicted axial power shapes and remove the potential non-conservatism in TS 3.2.1.

3.0 TECHNICAL EVALUATION

3.1 PROCESS PARAMETER LIMITATIONS

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

$F_Q(Z)$ is defined as the maximum local fuel rod linear power density divided by the average fuel rod linear power density and is a measure of the peak fuel pellet power within the reactor core. The values of F_Q vary along the axial height (Z) of the core. $F_Q(Z)$ also varies with 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 either the movable incore detector system (MIDS) or the power distribution monitoring system (PDMS). Because these measurements are generally taken with the core at or near equilibrium conditions, the measured $F_Q(Z)$ does not include the variations which would be present during non-equilibrium situations, such as load following or power ascension.

To account for these possible variations, the equilibrium values of $F_Q(Z)$ are adjusted by elevation dependent factors that account for the expected maximum values postulated to occur during RAOC operation.

The proposed changes to TS 3.2.1 involve a re-formulation of these elevation dependent factors, designated as $[T(Z)]^{COLR}$. The proposed TS 3.2.1 incorporates various RAOC Operation Spaces (ROS) that define the corresponding elevation dependent factors, $[T(Z)]^{COLR}$. Each ROS is composed of corresponding COLR limits associated with TS 3.2.3, “AXIAL FLUX DIFFERENCE (AFD),” and TS 3.1.7, “CONTROL BANK Insertion Limits,” assumed in the calculation of each particular $[T(Z)]^{COLR}$ function.

3.1.2 AFD

The purpose of TS 3.2.3 is to establish limits on the values of AFD in order to limit the amount of axial power distribution skewing to either the top or bottom of the core. By limiting the amount of power distribution skewing, core peaking factors are consistent with the assumption used in the safety analyses. Limiting power distribution skewing over time also minimizes the xenon distribution skewing, which is a significant factor in axial power distribution control.

AFD is the difference in normalized flux signals between the top and bottom halves of a two-section excore neutron detector. AFD is a measure of the axial power distribution skewing to either the top or bottom half of the core. AFD is sensitive to many core related parameters such as control bank positions, core power level, axial burnup, axial xenon distribution, and, to a lesser extent, reactor coolant temperature and boron concentration.

The allowed range of AFD is used in the nuclear design process to confirm that operation within these limits produces core peaking factors and axial power distributions that meet safety analysis requirements. The limits on AFD ensure that $F_Q(Z)$ is not exceeded during either normal operation or in the event of xenon redistribution following power changes. The limits on AFD also restrict the range of power distributions that are used as initial conditions in the analyses of Condition II, III, or IV events as described in Chapter 15 of the WBN dual-unit Updated Final Safety Analysis Report.

RAOC, as described in WCAP-10216-P-A, Revision 1A, “Relaxation of Constant Axial Offset Control/FQ Surveillance Technical Specification,” (Reference 7), is a calculational procedure that defines the allowed operational space of the AFD versus THERMAL POWER. AFD limits are selected by considering a range of axial xenon distributions that may occur as a result of large variations of AFD. Subsequently, power peaking factors and power distributions are examined to ensure that the loss of coolant accident (LOCA), loss of flow accident, and anticipated transient limits are met. Violation of the AFD limits invalidates the conclusions of the accident and transient analyses with regard to fuel cladding integrity.

The RAOC methodology establishes a xenon distribution library with tentatively wide AFD limits. One-dimensional axial power distribution calculations are then performed to demonstrate that normal operation power shapes are acceptable for LOCA and loss of flow accident and for initial conditions of anticipated transients. The tentative limits are adjusted as necessary to meet the safety analysis requirements.

3.1.3 Control Bank Insertion Limits

The insertion of the control rods directly affect core power and fuel burnup distributions and assumptions of available ejected rod worth, shutdown margin (SDM), and initial reactivity insertion rate. RILs are established and rod positions are monitored against the RILs and controlled during power operation to ensure that the power distribution and reactivity limits defined by the design power peaking and SDM limits are preserved.

The rod cluster control assemblies (RCCAs) are divided among control banks and shutdown banks. Each bank may be further subdivided into two groups to provide for precise reactivity control (shutdown banks C and D have only one group each). A group consists of two or more RCCAs that are electrically paralleled to step simultaneously. Except for shutdown banks C and D, a bank of RCCAs consists of two groups that are moved in a staggered fashion, but always within one-step of each other. There are four control banks and four shutdown banks.

TS 3.1.6 requires each shutdown bank to be within the insertion limits as specified in the COLR. TS 3.1.7 requires the control banks to be within the insertion, sequence, and overlap limits as specified in the COLR. The control banks are operated in sequence by

withdrawal of Bank A, Bank B, Bank C, and then Bank D. The control banks are sequenced in reverse order upon insertion.

Overlap is the distance travelled together by two control banks. Upon initiation of control bank withdrawal, control bank A is withdrawn by itself. At a predetermined position, control bank B begins withdrawing, resulting in both banks withdrawing simultaneously until control bank A is fully withdrawn. Control bank B will continue withdrawing until, at a subsequent predetermined position, control bank C begins withdrawing. This process continues until control bank D is fully withdrawn or the demand for rod withdrawal ceases. As such, each bank's overlap is the number of steps that each bank travelled from the following bank's predetermined position to the fully withdrawn position.

The power density at any point in the core must be limited so that the fuel design criteria are maintained. Together, TS 3.1.5, "Rod Group Alignment Limits," TS 3.1.6, TS 3.1.7, TS 3.2.3, and TS 3.2.4, "QUADRANT POWER TILT RATIO (QPTR)," provide limits on control component operation and on monitored process variables, which ensure that the core operates within the fuel design criteria. The shutdown and control bank insertion and alignment limits, AFD, and QPTR are process variables that together characterize and control the three dimensional power distribution of the reactor core.

3.2 EVALUATION OF PROPOSED TS CHANGES

The current WBN Unit 1 and Unit 2 TS 3.2.1 differ due to the extended period of time between the approval of each unit's OL (i.e., February 7, 1996 for Unit 1 and October 22, 2015 for Unit 2). The WBN Unit 1 TS 3.2.1 reflects the original RAOC methodology contained in Reference 7. The WBN Unit 1 TS 3.2.1 reflects the recommended action from References 5 and 6, which supplement the original Reference 7 methodology The WBN Unit 2 OL Condition 2.C.10 was imposed because the recommended actions from Reference 6 were largely based on engineering judgement. The cycle specific evaluation required by WBN Unit 2 OL Condition 2.C.10 ensure these actions are bounded for the given fuel cycle.

Furthermore, the formulations for $F_Q^W(Z)$ differ between WBN Units 1 and 2 due to the systems available to obtain an incore power measurement system between each unit. WBN Unit 1 utilizes the movable incore detector system (MIDS) and a power distribution monitoring system (PDMS) using core exit thermocouples. Whereas, WBN Unit 2 utilizes a PDMS with fixed self-powered incore detectors. The measurement uncertainty factor [i.e., F_Q^{MU} or $(1+U_Q/100)$] is dependent on the method used to measure either $F_Q^M(Z)$ or $F_{XY}^M(Z)$.

Further description of the proposed TS changes in this LAR is provided below.

3.2.1 TS 3.2.1

A. LCO

While the LCO remains unchanged, the underlying formulation of the approximation, $F_Q^W(Z)$, is changed. The current formulations for $F_Q^W(Z)$ are:

<u>Unit 1</u>

$F_Q^W(Z) = 1.03\ F_Q^M(Z)\ F_Q^{MU}\ W(Z)/P$ [MIDS]

or

$F_Q^W(Z) = 1.03\ F_Q^M(Z)\ (1+U_Q/100)\ W(Z)/P$ [PDMS]

Unit 2

$F_Q^W(Z) = 1.03\ F_Q^M(Z)\ (1+U_Q/100)\ W(Z)/P$

The new formulations for $F_Q^W(Z)$ are:

Unit 1

$F_Q^W(Z) = 1.03\ F_{XY}^M(Z)\ F_Q^{MU}\ A_{XY}(Z)\ R_j\ [T(Z)]^{COLR}/P$ [MIDS]

or

$F_Q^W(Z) = 1.03\ F_{XY}^M(Z)\ (1+U_Q/100)\ A_{XY}(Z)\ R_j\ [T(Z)]^{COLR}/P$ [PDMS]

Unit 2

$F_Q^W(Z) = 1.03\ F_{XY}^M(Z)\ (1+U_Q/100)\ A_{XY}(Z)\ R_j\ [T(Z)]^{COLR}/P$

In the new formulations, the measured parameter is $F_{XY}(Z)$, which is the planar peaking factor. The new factor, $A_{XY}(Z)$, accounts for differences between the reference and surveillance conditions. The newly defined factor, R_j, is used to account for the expected decrease in margin due to operation over the allowed period of time before the next performance of SR 3.2.1.2. This factor exists in the current TS as the “appropriate factor specified in the COLR” in the Note to SR 3.2.1.2. The factor, W(Z), is replaced by the new factor, $[T(Z)]^{COLR}$. This new formulation reduces the sensitivity of the $F_Q^W(Z)$ evaluation to the prediction of the axial power shape at the time of the surveillance.

B. Condition A

The proposed Condition A is modified by a note in accordance with Reference 2, which requires the performance of SR 3.2.1.1 and SR 3.2.1.2 (Required Action A.4) whenever Condition A is entered prior to increasing thermal power above the thermal power limit imposed by Required Action A.1. This new requirement ensures $F_Q(Z)$ is properly evaluated even if plant conditions change such that Condition A may be exited. The note clarifies further that SR 3.2.1.2 is not required to be performed if Condition A is entered prior to thermal power exceeding 75% RTP after a refueling. This latter clarification makes the note consistent with the changes in the other Required Actions and Surveillance Requirements.

The Completion Time for Required Action A.1 is modified by a statement to ensure Required Action A.1 is re-performed after each $F_Q^C(Z)$ determination. Otherwise, Required Action A.1 would only have to be performed within 15 minutes of Condition A initial entry.

Required Action A.2 is revised to change the NIS setpoint reductions when $F_Q^C(Z)$ is not within limits. Instead of reducing the setpoints $\geq$ 1% for each 1% "$F_Q^C(Z)$ exceeds limit," the setpoints are reduced $\geq$ 1% for each 1% "that THERMAL POWER is limited below RATED THERMAL POWER by Required Action A.1." The change will require a greater setpoint reduction if the surveillance was performed at reduced power.

The Completion Time for Required Action A.2 is modified in two ways. The Completion Time is relaxed from eight to 72 hours. This relaxation is necessary in light of the activities needing to be performed on all four power range channels. This relaxation is reasonable considering the small likelihood of a severe transient in this time period and the preceding prompt reduction in thermal power in accordance with Required Action A.1. The second change ensures Required Action A.2 is re-performed after each $F_Q^C(Z)$ determination. Otherwise, Required Action A.2 would only have to be performed within 72 hours of Condition A initial entry.

Required Action A.3 is revised to change the Overpower (OP)ΔT setpoint reductions when $F_Q^C(Z)$ is not within limits. Instead of reducing the "setpoints $\geq$ 1% for each 1% $F_Q^C(Z)$ exceeds limit," the setpoints are reduced "$\geq$ 1% for each 1% that THERMAL POWER is limited below RATED THERMAL POWER by Required Action A.1." The change will require a greater setpoint reduction if the surveillance was performed at reduced power.

The Completion Time for Required Action A.3 is modified by a statement that ensures Required Action A.3 is re-performed after each $F_Q^C(Z)$ determination. Otherwise, Required Action A.3 would only have to be performed within 72 hours of Condition A initial entry.

Required Action A.4 is revised to require performance of SR 3.2.1.2 in addition to SR 3.2.1.1. This ensures that future operation is evaluated prior to increasing thermal power above the limit of Required Action A.1.

C. Condition B

Unit 1

The current Unit 1 TS 3.2.1 only contains Required Action B.1 to "reduce AFD limits $\geq$ 1% for each 1% $F_Q^W(Z)$ exceeds limit," which contains the non-conservatisms documented in Reference 5. The current Required Action B.1 is being replaced with a number of new Required Actions, in accordance with Reference 2, as described below.

The proposed Required Action B.1.1 requires another ROS, as specified in the COLR, be implemented that restores $F_Q^W(Z)$ to within limits. Implicit in this action to implement a ROS "that restores $F_Q^W(Z)$ to within limits" is the verification that the previously obtained measurement has sufficient $F_Q^W(Z)$ margin using the $[T(Z)]^{COLR}$ factors associated with the new ROS being implemented. This action is better than the current Required Action B.1, because Reference 5 documents that the $\geq$ 1% AFD limit reduction for each 1% $F_Q^W(Z)$ exceeded its limit and may not provide sufficient $F_Q^W(Z)$ margin in all situations.

Proposed Required Action B.1.2 requires SR 3.2.1.1 and SR 3.2.1.2 be performed if control rod motion is required to comply with the new ROS. Because changed control rod positions affect peaking factors, this ensures $F_Q(Z)$ is evaluated under the new operating conditions.

The proposed Required Action B.2.1 is modified by a Note, which requires the performance of Required Action B.2.4 (i.e., perform SR 3.2.1.1 and SR 3.2.1.2) whenever Required Action B.2.1 is performed prior to increasing thermal power above the thermal power limit imposed by Required Action B.2.1. Proposed Required Action B.2.1 requires thermal power to be limited to less than RTP and to reduce AFD limits as specified in the COLR. This proposed Required Action is equivalent to implementing an alternate ROS that restricts thermal power as opposed to the RILs in addition to the reduction of the AFD Limits.

Proposed Required Action B.2.2 requires the Power Range Neutron Flux-High trip setpoints to be reduced $\geq$ 1% for each 1% that thermal power is limited below RTP by Required Action B.2.1. This action retains the same margin between the highest level of allowed thermal power and the power level at which the Power Range trip would be initiated.

Proposed Required Action B.2.3 requires the OPΔT trip setpoints to be reduced $\geq$ 1% for each 1% that thermal power is limited below RTP by Required Action B.2.1. This action retains the same margin between the highest level of allowed thermal power and the power level at which the OPΔT trip would be initiated.

Proposed Required Action B.2.4 requires SR 3.2.1.1 and SR 3.2.1.2 be performed prior to increasing thermal power above the limit of Required Action B.2.1. This ensures that $F_Q(Z)$ is properly evaluated prior to increasing thermal power above the limit of Required Action B.2.1.

Unit 2

The current Required Action B.1 to reduce AFD limits $\geq$ 1% for each 1% $F_Q^W(Z)$ exceeds limit is replaced by proposed Required Action B.1.1, which requires another ROS be implemented that restores $F_Q^W(Z)$ to within limits. Implicit in this proposed action to implement a ROS "that restores $F_Q^W(Z)$ to within limits" is the verification that the previously determined measurement has sufficient $F_Q^W(Z)$ margin using the $[T(Z)]^{COLR}$ factors associated with the new ROS being implemented. This action is superior to the current Required Action B.1, because Reference 5 documents that the $\geq$ 1% AFD limit reduction for each 1% $F_Q^W(Z)$ exceeded its limit and may not provide sufficient $F_Q^W(Z)$ margin in all situations.

Proposed Required Action B.1.2 requires SR 3.2.1.1 and SR 3.2.1.2 be performed if control rod motion is required to comply with the new ROS. Because changed control rod positions affect peaking factors, this ensures $F_Q(Z)$ is evaluated under the new operating conditions.

The current note modifying Required Action B.2.1 is replaced by a new note. The current note allows for Required Actions B.2.1, B.2.2, B.2.3, and B.2.4 to not be performed if SR 3.2.1.2 was performed at < 75% RTP. The proposed note requires the performance of Required Action B.2.4 (i.e., SR 3.2.1.1 and SR 3.2.1.2) whenever Required Action B.2.1 is performed prior to increasing thermal power above the

thermal power limit imposed by Required Action B.2.1. This new requirement ensures $F_Q(Z)$ is properly evaluated even if plant conditions change such that Condition B may be exited or Required Action B.1 is subsequently performed.

The current Required Action B.2.1 to reduce the maximum allowable power $\geq$ 3% RTP for each 1% $F_Q^W(Z)$ exceeds the limit is replaced by the requirement to limit thermal power to less than RTP and to reduce AFD limits as specified in the COLR. This proposed Required Action is equivalent to implementing an alternate ROS that restricts thermal power as opposed to the RILs in addition to the reduction of the AFD Limits.

Required Action B.2.2 is revised to change the Power Range Neutron Flux-High trip setpoints reductions when $F_Q^W(Z)$ is not within limits. Instead of reducing the setpoint 1% for each 1% “the maximum allowable power is reduced,” the setpoint is reduced 1% for each 1% that thermal power limited below RTP by Required Action B.2.1. The proposed action retains the same margin between the highest level of allowed thermal power and the power level at which the Power Range trip would be initiated if the surveillance was performed at a part power condition.

Required Action B.2.3 is revised to change the OPΔT setpoint reductions when $F_Q^W(Z)$ is not within limits. Instead of reducing the setpoint 1% for each 1% “the maximum allowable power is reduced,” the setpoint is reduced 1% for each 1% that thermal power limited below RTP by Required Action B.2.1. The proposed action retains the same margin between the highest level of allowed thermal power and the power level at which the OPΔT trip would be initiated if the surveillance was performed at a part power condition.

Required Action B.2.4 requires SR 3.2.1.1 and SR 3.2.1.2 be performed prior to increasing thermal power above the limit of Required Action B.2.1. This ensures that $F_Q(Z)$ is properly evaluated prior to increasing thermal power above the limit of Required Action B.2.1.

D. Surveillance Requirements

The Note modifying all surveillance requirements is deleted. The Note stated, “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.” This Note has been the source of confusion within the industry. The new surveillance Frequency requirements are unambiguous and the Bases have been enhanced with the explanation of the equilibrium conditions necessary for surveillance performance.

The first surveillance Frequency for SR 3.2.1.1 is modified by the removal of “initial fuel loading and”. The initial fuel loading was completed a number of fuel cycles ago and this wording is now moot.

The second surveillance Frequency for SR 3.2.1.1 is changed from “12” hours to “24” hours after achieving equilibrium conditions after exceeding, by $\geq$ 10% RTP, the thermal power at which $F_Q^C(Z)$ was last verified.

The Note modifying SR 3.2.1.2 is deleted. Reference 6 documents potential non-conservatisms with the application of this note. Removal of this Note allows for the

application of the appropriate factor accounting for expected decreases in $F_Q^W(Z)$ margin in future surveillances regardless of the trend of $F_Q^W(Z)$ margin in the past. Additionally, this change removes the option to perform SR 3.2.1.2 at an increased frequency of 7 EFPD without the factor applied. The formulation of $F_Q^W(Z)$ will include the appropriate factor whenever margin is expected to decrease.

The first surveillance Frequency for SR 3.2.1.2 is modified in two ways. The requirement to perform the surveillance after "initial fuel loading and" is removed. The initial fuel loading was completed a number of fuel cycles ago and this wording is now moot. Additionally, the requirement to perform the surveillance "prior to thermal power exceeding 75% RTP" is replaced with the requirement to perform the surveillance "within 24 hours after thermal power exceeds 75% RTP." Power levels of $\leq$ 75% RTP are non-limiting for minimum transient $F_Q^W(Z)$ margin. Performing this initial verification after exceeding 75% RTP ensures that the surveillance will be performed with more appropriate steady state peaking factors measured at or near the power level where future non-equilibrium operation could be limiting.

The second surveillance Frequency for SR 3.2.1.2 is changed from "12" hours to "24" hours after achieving equilibrium conditions after exceeding, by $\geq$ 10% RTP, the thermal power at which $F_Q^W(Z)$ was last verified.

The value of 24 hours in SRs 3.2.1.1 and 3.2.1.2 is bracketed in Reference 2, meaning it is a site-specific value. As noted in Reference 2, the 24-hour time frame is a reasonable time period in which to perform this verification given the extremely small likelihood of limiting power shapes or limiting design basis events occurring prior to completion of the surveillance. The change from 12 to 24 hours will provide a more accurate measurement of $F_Q^C(Z)$ and $F_Q^W(Z)$ by allowing sufficient time to achieve equilibrium conditions and obtain the power distribution measurement.

E. TS 5.9.5 - COLR

The reference to TS 3.2.1 is removed from TS 5.9.5 Reference b.3 with respect to WCAP-10216-P-A, Revision 1A, because the new $F_Q^W(Z)$ formulation is no longer applicable to the methodology in WCAP-10216-P-A, Revision 1A, but rather to WCAP-17661-P-A. The AFD limits associated with TS 3.2.3, however, remain applicable to the WCAP-10216-P-A methodology.

TS 5.9.5 Reference b.11 was added to include a reference to WCAP-17661-P-A. The new $F_Q^W(Z)$ formulation and surveillance requirements are directly related to this newly approved topical.

F. Deletion of Unit 2 OL Condition 2.C.10

Unit 2 OL Condition 2.C.10 states, "TVA will verify for each core reload that the actions taken if $F_Q^W(Z)$ is not within limits will assure that the limits on core power peaking $F_Q(Z)$ remain below the initial total peaking factor assumed in the accident analyses." The basis for this OL condition was Section 1.9.6 of Reference 4, which states:

> "The NRC staff proposed a license condition discussed in Section 15.3.1, of SSER 29. The operating license for WBN, Unit 2 will include a license condition similar to the following.

Core Reload License Condition:

> TVA will verify for each core reload that the actions taken if FQ W(Z) is not within limits will assure that the limits on core power peaking FQ(Z) remain below the initial total peaking factor assumed in the accident analyses."

Section 15.3.1 of Reference 4 addresses the issues in References 5 and 6 and states:

> *"On October 9, 2015, in response to the NRC staff's questions associated with how TVA addressed the issues identified in the NSALs, TVA (1) provided a license condition where the margins provided in TS 3.2.1 will be evaluated each fuel cycle to assure that the related assumptions in the accident analyses are maintained, and (2) submitted a summary of a Westinghouse margin assessment report for Cycle 1 providing additional information related to the proposed TS 3.2.1.*
>
> *The proposed license condition requires TVA to perform cycle-specific evaluations of the margins of the Required Actions in TS 3.2.1 Condition B, and states:*
>
> > *TVA will verify for each core reload that the actions taken if $F_Q^W(Z)$ is not within limits will assure that the limits on core power peaking $F_Q(Z)$ remain below the initial total peaking factor assumed in the accident analyses.*
>
> *The results of this verification are documented in the final Reload Safety Evaluation that the vendor provides WBN, Unit 2 for each core reload, which will be reviewed by TVA, and is a quality assurance record as defined in 10 CFR 50, Appendix B, and available for NRC inspection.*
>
> *While the NRC staff has not come to a final decision on any actions required for already-licensed plants using different versions of TS 3.2.1 that are impacted by the NSALs, the NRC staff has reached a decision for WBN, Unit 2. Specifically, as detailed in Section 16 of this SSER, the proposed TS, which include provisions to address the NSALs, are acceptable. Further, the additional analyses imposed though the new license condition will provide additional assurances that the actions taken under TS 3.2.1 are appropriate."*

TVA has complied with the above license condition. However, based on the proposed TS changes in this LAR and based on Reference 2, WBN Unit 2 OL Condition 2.C.10 is no longer needed because the implementation of the methodology in Reference 2 renders this license condition moot. The current WBN Unit 2 TS 3.2.1 is based on the Reference 7 methodology. References 5 and 6 documented non-conservatisms in the Reference 7 methodology, which was the basis for the WBN Unit 2 OL Condition 2.C.10. Because the Reference 2 methodology replaces the Reference 7 methodology and eliminates the non-conservatisms, the compensatory actions of WBN Unit 2 OL Condition 2.C.10 are no longer needed.

3.2.2 Approval Limitations

In Reference 2, the NRC stipulated two limitations for the implementation of the proposed Technical Specifications.

Limitation 1: Use of A_{XY} and A_Q

Methods 1 and 2 are acceptable for calculating A_{XY} and A_Q when performing RAOC and CAOC W(Z) surveillances, subject to the following limitations:

1. *The NRC-approved methods provided in the response to RAI 15.b must be used to perform the surveillance-specific A_{XY} or A_Q calculations. Newer methods with similar capabilities may be considered acceptable provided the NRC staff specifically approves them for calculating A_{XY} and A_Q factors.*
2. *The depletion calculation used to determine the numerator and denominator of the A_{XY} or A_Q factor must be performed similarly to the original design calculation, as described in the response to RAI 15.c.*
3. *The use of Method 1 for calculating A_Q is only acceptable subject to the constraints discussed in the response to RAI 15.a. The surveillance Axial Offset must be within 1.5-percent of the target AO, and there must be assurance that the limiting $F_Q^W(Z)$ location does not lie within a rodded elevation at the time of surveillance. Note that the use of Method 1 remains acceptable when surveillance-specific W(Z) functions are used.*

TVA Response

WCAP-17661-P-A and the Technical Specification Bases were revised to limit the methods to calculate A_{XY} to Methods 1 and 2. Method 1 sets $A_{XY}(Z)$ to 1.0. Method 2 calculates $A_{XY}(Z)$ for the conditions existing at the time of the surveillance. The NRC approved methods provided in the response to RAI 15.b are ANC and BEACON, which uses the same neutronic methodology as the design ANC model that was used as the base model for calculating the F_Q surveillance factors. There are no plans at this time to add an additional method to calculate the $A_{XY}(Z)$ values, but doing so would require a revision to the TS, which would require NRC approval.

When BEACON is used to calculate surveillance condition specific $A_{XY}(Z)$ values, the calculation will be performed without using nodal calibration factors and the core depletion assumptions will be the same as used in the original core model to generate the T(Z) factors.

When ANC is used to calculate the surveillance condition specific $A_{XY}(Z)$ values, the calculation will use the same nuclear model and depletion basis that was used to generate the original T(Z) factors.

Item 3 of the limitation is not applicable because A_Q is applicable to the CAOC methodology, whereas WBN used the used the RAOC methodology.

Limitation 2: Power Level Reduction to 50 Percent RTP

As noted in Section 4.3.2 of this SE, the use of 50 percent as the final power level reduction in the event of failed F_Q surveillance is not included in the TS, but rather in the BASES and in the COLR. As such, this final power level, 50 percent, must be

implemented on a plant-specific basis and included in COLR input generated, using this methodology, in order to use this TR.

TVA Response

WCAP-17661-P-A provides sample COLR input, which specifies 50% RTP as the final power level reduction in the event of a failed F_Q surveillance. All COLR input for WBN Units 1 and 2 fuel cycles will also specify 50% RTP as the final power level reduction in the event of a failed F_Q surveillance.

3.3 CONCLUSION

This evaluation concludes that the changes to the $F_Q(Z)$ surveillance methodology in TS 3.2.1, to implement the methodology in Reference 2, are acceptable. The changes provide a more robust means of performing the $F_Q^W(Z)$ surveillance. A bounding ROS, selected from a set of previously evaluated ROSs, is implemented if $F_Q^W(Z)$ does not meet the $F_Q(Z)$ limit. The SRs and Required Actions are more clearly defined. The changes also provide reasonable assurance that a core operated in accordance with the new requirements will remain within the power distribution limits assumed in the safety analyses.

4.0 REGULATORY ANALYSIS

4.1 APPLICABLE REGULATORY REQUIREMENT CRITERIA

General Design Criteria

WBN Units 1 and 2 were 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 dual-unit UFSAR, however, addresses the NRC General Design Criteria (GDC) published as Appendix A to 10 CFR 50 in July 1971, including Criterion 4 as amended October 27, 1987.

Each criterion listed below is followed by a discussion of the design features and procedures that meet the intent of the criteria.

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 conditions of normal operation, including the effects of anticipated operational occurrences.

Conformance with GDC 10 is described in Section 3.1.2.2 of the WBN dual-unit UFSAR. The reactor core with its related coolant, control, and protection systems is designed to function throughout its design lifetime without exceeding acceptable fuel damage limits. The reactor trip system is designed to actuate a reactor trip for any anticipated combination of plant conditions when necessary to ensure that fuel design limits are not exceeded. The core design, together with reliable process and decay heat removal systems, provides for this capability under all expected conditions of normal operation with appropriate margins for uncertainties and anticipated transient situations, including

the effects of loss of reactor coolant flow, trip of the turbine-generator, loss of normal feedwater and loss of both normal and preferred power sources.

Criterion 13 - Instrumentation and control

Instrumentation shall be provided to monitor variables and systems over their anticipated ranges for normal operation, for anticipated operational occurrences, and for accident conditions as appropriate to assure adequate safety, including those variables and systems that can affect the fission process, the integrity of the reactor core, the reactor coolant pressure boundary, and the containment and its associated systems.

Conformance with GDC 13 is described in Section 3.1.2.2 of the WBN dual-unit UFSAR.

Instrumentation and controls are provided to monitor and control neutron flux, control rod position, temperatures, pressures, flows, and levels as necessary to assure that adequate plant safety can be maintained. Instrumentation is provided in the reactor coolant system, steam and power conversion system, the containment, engineered safety features systems, radiological waste systems, and other auxiliaries. Parameters that must be provided for operator use under normal operating and accident conditions are indicated in the control room in proximity with the controls for maintaining the indicated parameter in the proper range. The quantity and types of process instrumentation provided measures safe and orderly operation of all systems over the full design range of the plant.

Criterion 20 - Protection System Functions

The protection system shall be designed (1) to initiate automatically the operation of appropriate systems including the reactivity control systems, to assure that specified acceptable fuel design limits are not exceeded as a result of anticipated operational occurrences and (2) to sense accident conditions and to initiate the operation of systems and components important to safety.

Conformance with GDC 20 is described in Section 3.1.2.3 of the WBN dual-unit UFSAR.

A fully automatic protection system (with appropriate redundant channels) is provided to cope with transients where insufficient time is available for manual corrective action. The design basis for all protection systems is in accord with IEEE Standard 279-1971. The reactor trip system automatically initiates a reactor trip when any appropriate monitored variable or combination of variables exceed the normal operating range. Setpoints are chosen to provide an envelope of safe operating conditions with adequate margin for uncertainties to ensure that fuel design limits are not exceeded.

Reactor trip is initiated by removing power to the rod drive mechanisms of all the full-length rod cluster control assemblies. This will allow the assemblies to free fall into the core, rapidly reducing reactor power output.

The engineered safety features actuation system automatically initiates emergency core cooling, and other safeguards functions, by sensing accident conditions using redundant process protection system channels measuring diverse parameters. Manual actuation of safeguards is relied upon where ample time is available for operator action. The ESF actuation system also provides a reactor trip on manual or automatic safety injection (S) signal generation.

Criterion 26 - Reactivity Control System Redundancy and Capability

Two independent reactivity control systems of different design principles shall be provided. One of the systems shall use control rods, preferably including a positive means for inserting the rods, and shall be capable of reliably controlling reactivity changes to assure that under conditions of normal operation, including anticipated operational occurrences, and with appropriate margin for malfunctions such as stuck rods, specified acceptable fuel design limits are not exceeded. The second reactivity control system shall be capable of reliably controlling the rate of reactivity changes resulting from planned, normal power changes (including xenon burnout) to assure acceptable fuel design limits are not exceeded. One of the systems shall be capable of holding the reactor core subcritical under cold conditions.

Conformance with GDC 20 is described in Section 3.1.2.3 of the WBN dual-unit UFSAR.

Two reactivity control systems are provided. These are rod cluster control assemblies (RCCAs) and chemical shim (boric acid). The RCCAs are inserted into the core by the force of gravity. During operation, the shutdown rod banks are fully withdrawn. The full-length control rod system automatically maintains a programmed average reactor temperature compensating for reactivity effects associated with scheduled and transient load changes. The shutdown rod banks along with the full-length control banks are designed to shutdown the reactor with adequate margin under conditions of normal operation and anticipated operational occurrences thereby ensuring that specified fuel design limits are not exceeded. The most restrictive period in core life is assumed in all analyses and the most reactive rod cluster is assumed to be in the fully withdrawn position.

The boron system will maintain the reactor in the cold shutdown state independent of the position of the control rods and can compensate for xenon burnout transients.

4.2 PRECEDENT

There are no applicable regulatory precedents regarding the changes proposed in this LAR.

4.3 NO SIGNIFICANT HAZARDS CONSIDERATION DETERMINATION

The proposed change revises the TS 3.2.1, “Heat Flux Hot Channel Factor ($F_Q(Z)$),” and associated references in TS 5.9.5, “Core Operating Limits Report (COLR),” to implement the new $F_Q(Z)$ surveillance methodology of WCAP-17661-P-A, Revision 1. The proposed changes will re-formulate the $F_Q^W(Z)$ approximation for $F_Q(Z)$, revise the surveillance requirements, and revise the required actions when $F_Q(Z)$ is not within limits. These changes remove the potential non-conservatisms documented in Westinghouse Nuclear Safety Advisory Letter (NSAL-15-1), "Heat Flux Hot Channel Factor Technical Specification Surveillance," and NSAL-09-05, Revision 1, "Relaxed Axial Offset Control FQ Technical Specification Actions."

Tennessee Valley Authority (TVA) has evaluated the proposed changes to the TS using the criteria in Section 50.92 to Title 10 of the Code of Federal Regulations (10 CFR) and has determined that the proposed changes do not involve a significant hazards

consideration. As required by 10 CFR 50.91(a), the TVA analysis of the issue of no significant hazards consideration is presented below:

1. Does the proposed change involve a significant increase in the probability or consequences of any accident previously evaluated?

   Response: No

   The proposed change will re-formulate the $F_Q^W(Z)$ approximation for $F_Q(Z)$, revise the surveillance requirements, and revise the required actions when $F_Q(Z)$ is not within limits. This change does not result in any physical changes to plant safety-related structures, systems, or components (SSC).

   As such, the proposed change does not involve an increase in the probability of any accident previously evaluated.

   The proposed changes affect the Surveillance Requirements performed to ensure the Heat Flux Hot Channel Factor, $F_Q(Z)$, is within the limits assumed in the safety analyses for previously evaluated accidents. The new surveillance activity involves a reformulation of the transient hot channel factor approximation, $F_Q^W(Z)$, and a more conservative application of applied factors to ensure $F_Q^W(Z)$ remains within limit during subsequent operation up until the next surveillance performance. Both of these changes to the surveillance activity provide assurance that the $F_Q^W(Z)$ remains within the accident analyses assumptions.

   The proposed changes also affect the Required Actions and Completion Times should $F_Q(Z)$ be found to not be within limit. The new Required Actions and Completion Times ensure the plant is placed in a condition whereby $F_Q(Z)$ is restored to within limit in a timely manner. Should $F_Q^C(Z)$ be found not within limit, thermal power is reduced and the NIS and OPΔT reactor trip setpoints are reduced a conservative amount that retains the margin between the nominal thermal power and reactor trip setpoints. Should $F_Q^W(Z)$ be found not within limit, the core power distribution is constrained by reduced AFD limits, more limiting Rod Insertion Limits, and/or thermal power reductions. These changes to the Required Actions and Completion Times restore $F_Q(Z)$ to within the safety analyses assumptions in a timely manner.

   Therefore, the proposed change does not involve a significant increase in the consequences of an accident previously evaluated.

2. Does the proposed change create the possibility of a new or different kind of accident from any previously evaluated?

   Response: No

   The proposed change will re-formulate the $F_Q^W(Z)$ approximation for $F_Q(Z)$, revise the surveillance requirements, and revise the required actions when $F_Q(Z)$ is not within limits. This change does not result in any physical changes to plant safety-related structures, systems, or components (SSCs). Neither does this change alter the modes of plant operation in a manner that is outside the bounds of those previously evaluated.

Therefore, the proposed change does not create the possibility of a new or different kind of accident from any accident previously evaluated.

3. Does the proposed change involve a significant reduction in the margin of safety?

   Response: No

   The proposed change will re-formulate the $F_Q^W(Z)$ approximation for $F_Q(Z)$, revise the surveillance requirements, and revise the required actions when $F_Q(Z)$ is not within limits. This change does not result in any physical changes to plant safety-related structures, systems, or components (SSCs)

   The proposed changes affect the Surveillance Requirements performed to ensure the Heat Flux Hot Channel Factor, $F_Q(Z)$, is within the limits assumed in the safety analyses for previously evaluated accidents. The new surveillance activity involves a reformulation of the transient hot channel factor approximation, $F_Q^W(Z)$, and a more conservative application of applied factors to ensure $F_Q^W(Z)$ remains within limit during subsequent operation up until the next surveillance performance. Both of these changes to the surveillance activity provide assurance that the $F_Q^W(Z)$ remains within the accident analyses assumptions.

   The proposed changes also affect the Required Actions and Completion Times should $F_Q(Z)$ be found to not be within limit. The new Required Actions and Completion Times ensure the plant is placed in a condition whereby $F_Q(Z)$ is restored to within limit in a timely manner. Should $F_Q^C(Z)$ be found not within limit, thermal power is reduced and the NIS and OPΔT reactor trip setpoints are reduced a conservative amount that retains the margin between the nominal thermal power and reactor trip setpoints. Should $F_Q^W(Z)$ be found not within limit, the core power distribution is constrained by reduced AFD limits, more limiting Rod Insertion Limits, and/or thermal power reductions. These changes to the Required Actions and Completion Times restore $F_Q(Z)$ to within the safety analyses assumptions in a timely manner.

   The proposed changes do not affect the $F_Q(Z)$ limit to which the $F_Q^C(Z)$ and $F_Q^W(Z)$ approximations are compared. Therefore, the proposed changes do not involve a significant reduction in a margin of safety.

Based on the above, TVA concludes that the proposed amendment does not involve a significant hazards consideration under the standards set forth in 10 CFR 50.92 (c), and accordingly, a finding of “no significant hazards consideration” is justified.

Conclusions

In conclusion, based on the considerations discussed above, (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) 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.

4.0 ENVIRONMENTAL CONSIDERATION

The proposed TS change would change a requirement with respect to installation or use of a facility component located within the restricted area, as defined in 10 CFR Part 20, and would change an inspection or surveillance requirement. However, the proposed change does not involve (i) a significant hazards consideration, (ii) a significant change in the types or significant increase in the amounts of any effluent that may be released offsite, or (iii) a significant increase in individual or cumulative occupational radiation exposure. Accordingly, the proposed TS change meets the eligibility criterion for categorical exclusion set forth in 10 CFR 51.22(c)(9). Therefore, pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the proposed TS change.

5.0 REFERENCES

1. NRC Letter to PWROG, “Verification Letter of the Approval Version of the Pressurized Water Reactor Owners Group Topical Report WCAP-17661, Revision 1, ‘Improved RAOC and CAOC FQ Surveillance Technical Specifications’,” dated August 23, 2019 (ML19225D179)
2. WCAP-17661-P-A, Revision 1, “Improved RAOC and CAOC F_Q Surveillance Technical Specifications,” dated February 2019 (ML19225C079)
3. NUREG-1431, Revision 4, Volume 1, “Standard Technical Specifications Westinghouse Plants, Revision 4.0 Volume 1, Specifications,” dated April 2012
4. NUREG-0847 Supplement 29, Safety Evaluation Report: “Related to the Operation of Watts Bar Nuclear Plant, Unit 2,” dated October 2015 (ML15282A051)
5. Westinghouse Nuclear Safety Advisory Letter (NSAL-09-05), Revision 1, “Relaxed Axial Offset Control F_Q Technical Specification Actions,” dated September 23, 2009
6. Westinghouse Nuclear Safety Advisory Letter (NSAL-15-1), “Heat Flux Hot Channel Factor Technical Specification Surveillance,” dated February 3, 2015
7. WCAP-10216-P-A, Revision 1A, “Relaxation of Constant Axial Offset Control/FQ Surveillance Technical Specification,” dated February 1994

Enclosure

Attachment 1

Proposed TS Changes (Mark-Ups) for WBN Unit 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. ----------NOTE------------------- Required Action A.4 shall be completed whenever this Condition is entered prior to increasing THERMAL POWER above the limit of Required Action A.1. SR 3.2.1.2 is not required to be performed if this Condition is entered prior to THERMAL POWER exceeding 75% RTP after a refueling. ------------------------------------		
F_Q^C~~Q~~(Z) not within limit.	A.1 Reduce THERMAL POWER ≥ 1% RTP for each 1% $F_Q^C(Z)$ exceeds limit.	15 minutes after each $F_Q^C(Z)$ determination
	<u>AND</u>	
	A.2 Reduce Power Range Neutron Flux—High trip setpoints ≥ 1% for each 1% ~~F^C^Q(Z) exceeds limit~~. that THERMAL POWER is limited below RATED THERMAL POWER by Required Action A.1.	~~8~~72 hours after each $F_Q^C(Z)$ determination
	<u>AND</u>	
	A.3 Reduce Overpower ΔT trip setpoints ≥ 1% for each 1% ~~F^C^Q(Z) exceeds limit.~~ that THERMAL POWER is limited below RATED THERMAL POWER by Required Action A.1.	72 hours after each $F_Q^C(Z)$ determination
	<u>AND</u>	

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. (continued)	A.4 Perform SR 3.2.1.1 and SR 3.2.1.2.	Prior to increasing THERMAL POWER above the limit of Required Action A.1
B. $F_Q^W(Z)$ not within limits.	~~B.1 Reduce AFD limits ≥ 1% for each 1% $F^W_Q(Z)$ exceeds limit.~~	~~2 hours~~
	B.1.1 Implement a RAOC operating space specified in the COLR that restores $F_Q^W(Z)$ to within limits. <u>AND</u>	4 hours
	B.1.2 Perform SR 3.2.1.1 and SR 3.2.1.2 if control rod motion is required to comply with the new operating space. <u>OR</u>	72 hours
	B.2.1 -----------NOTE-------------------- Required Action B.2.4 shall be completed whenever Required Action B.2.1 is performed prior to increasing THERMAL POWER above the limit of Required Action B.2.1. -- Limit THERMAL POWER to less than RATED THERMAL POWER and reduce AFD limits as specified in the COLR. <u>AND</u>	4 hours
	B.2.2 Reduce Power Range Neutron Flux - High trip setpoints ≥ 1% for each 1% that THERMAL POWER is limited below RATED THERMAL POWER by Required Action B.2.1. <u>AND</u>	72 hours

CONDITION	REQUIRED ACTION	COMPLETION TIME

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
B. (continued)	B.2.3 Reduce Overpower ΔT trip setpoints $\geq$ 1 % for each 1% that THERMAL POWER is limited below RATED THERMAL POWER by Required Action B.2.1. <u>AND</u>	72 hours
	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
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 24 ~~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 $F^W_Q(Z)$ is within limits and measurements indicate Maximum over z $\left[\frac{F^C_Q(Z)}{K(Z)}\right]$ has increased since the previous evaluation of $F^C_Q(Z)$: a. Increase $F^W_Q(Z)$ by the appropriate factor specified in the COLR and reverify $F^W_Q(Z)$ is within limits; or b. Repeat SR 3.2.1.2 once per 7 EFPD using either the movable incore detectors or the PDMS until two successive power distribution measurements indicate Maximum over z $\left[\frac{F^C_Q(Z)}{K(Z)}\right]$ has not increased. -- Verify $F_Q^W(Z)$ is within limit.	Once after initial fuel loading and each refueling prior to within 24 hours after THERMAL POWER exceeding exceeds 75% RTP AND (continued)

SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY
SR 3.2.1.2 (continued)	Once within ~~12~~ 24 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

5.9 Reporting Requirements

5.9.5 CORE OPERATING LIMITS REPORT (COLR) (continued)

3. WCAP-10216-P-A, Revision 1A, "RELAXATION OF CONSTANT AXIAL OFFSET CONTROL F(Q) SURVEILLANCE TECHNICAL SPECIFICATION," February 1994 (W Proprietary). (Methodology for Specification~~s 3.2.1 - Heat Flux Hot Channel Factor (W(Z) Surveillance Requirements For F(Q) Methodology) and~~ 3.2.3 - Axial Flux Difference (Relaxed Axial Offset Control).)

4. WCAP-12610-P-A, "VANTAGE + FUEL ASSEMBLY REFERENCE CORE REPORT," April 1995. (W Proprietary). (Methodology for Specification 3.2.1 - Heat Flux Hot Channel Factor).

5. WCAP-15088-P, Rev. 1, "Safety Evaluation Supporting A More Negative EOL Moderator Temperature Coefficient Technical Specification for the Watts Bar Nuclear Plant," July 1999, (W Proprietary), as approved by the NRC staff's Safety Evaluation accompanying the issuance of Amendment No. 20 (Methodology for Specification 3.1.4 - Moderator Temperature Coefficient.).

6. Caldon, Inc. Engineering Report-80P, "Improving Thermal Accuracy and Plant Safety While Increasing Operating Power Level Using the LEFM✓™ System," Revision 0, March 1997; and Caldon, Inc. Engineering Report-160P, "Supplement to Topical Report ER-80P: Basis for a Power Uprate With the LEFM✓™," Revision 0, May 2000; as approved by the NRC staff's Safety Evaluation accompanying the issuance of Amendment No. 31.

7. WCAP-11397-P-A, "Revised Thermal Design Procedure," April 1989. (Methodology for Specification 3.2.2 - Nuclear Enthalpy Rise Hot Channel Factor).

8. WCAP-15025-P-A, "Modified WRB-2 Correlation, WRB-2M, for Predicting Critical Heat Flux in 17 x 17 Rod Bundles with Modified LPD Mixing Vane Grids," April 1999. (Methodology for Specification 3.2.2 - Nuclear Enthalpy Rise Hot Channel Factor).

9. WCAP-14565-P-A, "VIPRE-01 Modeling and Qualification for Pressurized Water Reactor Non-LOCA Thermal-Hydraulic Safety Analysis," October 1999. (Methodology for Specification 3.2.2 - Nuclear Enthalpy Rise Hot Channel Factor).

10. WCAP-12610-P-A and CENPD-404-P-A, Addendum 1-A, "Optimized ZIRLO™."

11. WCAP-17661-P-A, Revision 1, "Improved RAOC and CAOC F_Q Surveillance Technical Specifications," February 2019 (Methodology for Specification 3.2.1 - Heat Flux Hot Channel Factor (T(Z) Surveillance Requirements for F_Q Methodology).)

(continued)

5.9 Reporting Requirements (continued)

5.9.5 CORE OPERATING LIMITS REPORT (COLR) (continued)

c. The core operating limits shall be determined such that all applicable limits (e.g., fuel thermal mechanical limits, core thermal hydraulic limits, Emergency Core Cooling Systems (ECCS) limits, nuclear limits such as SDM, transient analysis limits, and accident analysis limits) of the safety analysis are met.

d. The COLR, including any midcycle revisions or supplements, shall be provided upon issuance for each reload cycle to the NRC.

(continued)

Enclosure

Attachment 2

Proposed TS Changes (Mark-Ups) for WBN Unit 2

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. ------------NOTE---------------- Required Action A.4 shall be completed whenever this Condition is entered prior to increasing THERMAL POWER above the limit of Required Action A.1. SR 3.2.1.2 is not required to be performed if this Condition is entered prior to THERMAL POWER exceeding 75% RTP after a refueling. -------------------------------------			
$F_Q^C(Z)$ not within limit.	A.1	Reduce THERMAL POWER ≥ 1% RTP for each 1% $F_Q^C(Z)$ exceeds limit.	15 minutes after each F_Q^C~~Q~~(Z) determination
	AND		
	A.2	Reduce Power Range Neutron Flux – High trip setpoints ≥ 1% for each 1% ~~$F_Q^C(Z)$ exceeds limit.~~ that THERMAL POWER is limited below RATED THERMAL POWER by Required Action A.1.	~~8~~72 hours after each $F_Q^C(Z)$ determination
	AND		

ACTIONS (continued)

A. (continued)	A.3	Reduce Overpower ΔT trip setpoints ≥ 1% for each 1% ~~F_Q^C (Z) exceeds limit.~~ that THERMAL POWER is limited below RATED THERMAL POWER by Required Action A.1.	72 hours after each F_Q^C (Z) determination
	AND		
	A.4	Perform SR 3.2.1.1 and SR 3.2.1.2.	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~~
	B.1.1	Implement a RAOC operating space specified in the COLR that restores $F_Q^W(Z)$ to within limits. AND	4 hours
	B.1.2	Perform SR 3.2.1.1 and SR 3.2.1.2 if control rod motion is required to comply with the new operating space.	72 hours
	~~AND~~ OR		

CONDITION	REQUIRED ACTION		COMPLETION TIME
	B.2.1	-----------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. Required Action B.2.4 shall be completed whenever Required Action B.2.1 is performed prior to increasing THERMAL POWER above the limit of Required Action B.2.1. ---------------------------------- Reduce maximum allowable power ≥ 3% RTP for each 1% $F_Q^W(Z)$ exceeds limit. Limit THERMAL POWER to less than RATED THERMAL POWER and reduce AFD limits as specified in the COLR. AND	4 hours
	B.2.2	Reduce Power Range Neutron Flux – High trip setpoints ≥ 1% for each 1% the maximum allowable power is reduced that THERMAL POWER is limited below RATED THERMAL POWER by Required Action B.2.1. AND	72 hours

CONDITION	REQUIRED ACTION		COMPLETION TIME
B. (continued)	B.2.3	Reduce Overpower ΔT trip setpoints ≥ 1% for each 1% ~~the maximum allowable power is reduced~~ that THERMAL POWER is limited below RATED THERMAL POWER by Required Action B.2.1.	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 AND Once within 24 12 hours after achieving equilibrium conditions after exceeding, by ≥ 10% RTP, the THERMAL POWER at which $F_Q^C(Z)$ was last verified AND 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 $\left[\frac{F_Q^C(Z)}{K(Z)}\right]$ AND 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 within 24 hours after THERMAL POWER exceeding exceeds 75% RTP AND (continued)

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.2.1.2	(continued)	Once within 24 ~~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

5.9 Reporting Requirements

5.9.5 CORE OPERATING LIMITS REPORT (COLR) (continued)

1. WCAP-9272-P-A, WESTINGHOUSE RELOAD SAFETY EVALUATION METHODOLOGY," July 1985 (W Proprietary). (Methodology for Specifications 3.1.4 - Moderator Temperature Coefficient, 3.1.6 - Shutdown Bank Insertion Limit, 3.1.7 - Control Bank Insertion Limits, 3.2.1 - Heat Flux Hot Channel Factor, 3.2.2 - Nuclear Enthalpy Rise Hot Channel Factor, 3.2.3 - Axial Flux Difference, and 3.9.1 - Boron Concentration).

2a. WCAP-16009-P-A, "Realistic Large-Break LOCA Evaluation Methodology Using the Automated Statistical Treatment of Uncertainty Method (ASTRUM)," January 2005 (W Proprietary).(Methodology for Specification 3.2.1 - Heat Flux Hot Channel Factor, and 3.2.2 - Nuclear Enthalpy Rise Hot Channel Factor).

2b. WCAP-10054-P-A, "Small Break ECCS Evaluation Model Using NOTRUMP Code," August 1985. Addendum 2, Rev. 1: "Addendum to the Westinghouse Small Break ECCS Evaluation Model using the NOTRUMP Code: Safety Injection into the Broken Loop and COSI Condensation Model," July 1997. (W Proprietary). (Methodology for Specifications 3.2.1 - Heat Flux Hot Channel Factor, and 3.2.2 - Nuclear Enthalpy Rise Hot Channel Factor).

3. WCAP-10216-P-A, Revision 1A, "RELAXATION OF CONSTANT AXIAL OFFSET CONTROL F(Q) SURVEILLANCE TECHNICAL SPECIFICATION," February 1994 (W Proprietary). (Methodology for Specification~~s 3.2.1 - Heat Flux Hot Channel Factor (W(Z) Surveillance Requirements For F(Q) Methodology) and~~ 3.2.3 - Axial Flux Difference (Relaxed Axial Offset Control).)

4. WCAP-12610-P-A, "VANTAGE + FUEL ASSEMBLY REFERENCE CORE REPORT," April 1995. (W Proprietary). (Methodology for Specification 3.2.1 - Heat Flux Hot Channel Factor).

(continued)

5.9 Reporting Requirements

5.9.5 CORE OPERATING LIMTS REPORT (COLR) (continued)

11. WCAP-17661-P-A, Revision 1, “Improved RAOC and CAOC F_Q Surveillance Technical Specifications,” February 2019 (Methodology for Specification 3.2.1 - Heat Flux Hot Channel Factor (T(Z) Surveillance Requirements for F_Q Methodology).)

c. The core operating limits shall be determined such that all applicable limits (e.g., fuel thermal mechanical limits, core thermal hydraulic limits, Emergency Core Cooling Systems (ECCS) limits, nuclear limits such as SDM, transient analysis limits, and accident analysis limits) of the safety analysis are met.

d. The COLR, including any midcycle revisions or supplements, shall be provided upon issuance for each reload cycle to the NRC.

(continued)

Enclosure

Attachment 3

Proposed WBN Unit 2 OL Condition 2.C.10 (Mark-Ups)

TVA may make changes to the approved fire protection program without prior approval of the Commission, only if those changes would not adversely affect the ability to achieve and maintain safe shutdown in the event of a fire.

(9) By May 31, 2018, TVA shall report that a listing organization acceptable to the NRC (as the Authority Having Jurisdiction) has determined that the fire detection monitoring panel in the main control room either meets the appropriate designated standards or has been tested and found suitable for the specified purpose.

(10) ~~TVA will verify for each core reload that the actions taken if $F_Q^W(Z)$ is not within limits will assure that the limits on core power peaking $F_Q(Z)$ remain below the initial total peaking factor assumed in the accident analyses.~~Deleted

(11) TVA will implement the compensatory measures described in Section 3.4, “Additional Compensatory Measures,” of TVA Letter CNL-18-012, dated January 17, 2018, during the timeframe the temperature indicator for RCS hot let 3 is not required to be operable for the remainder of Cycle 2. If the RCS hot leg 3 temperature indicator is returned to operable status prior to the end of Cycle 2, then these compensatory measures are no longer required.

D. The licensee shall have and maintain financial protection of such types and in such amounts as the Commission shall require in accordance with Section 170 of the Atomic Energy Act of 1954, as amended, to cover public liability claims.

E. This license is effective as of the date of issuance and shall expire at midnight on October 21, 2055.

FOR THE NUCLEAR REGULATORY COMMISSION

William M. Dean, Director
Office of Nuclear Reactor Regulation

Appendices: 1. Appendix A –
Technical Specifications
2. Appendix B –
Environmental Protection Plan

Date of Issuance: October 22, 2015

Enclosure

Attachment 4

Proposed TS Changes (Final Typed) for WBN Unit 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. ----------NOTE------------------- Required Action A.4 shall be completed whenever this Condition is entered prior to increasing THERMAL POWER above the limit of Required Action A.1. SR 3.2.1.2 is not required to be performed if this Condition is entered prior to THERMAL POWER exceeding 75% RTP after a refueling. ------------------------------------		
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 after each F_Q^C (Z) determination
	AND	
	A.2 Reduce Power Range Neutron Flux—High trip setpoints ≥ 1% for each 1% that THERMAL POWER is limited below RATED THERMAL POWER by Required Action A.1.	72 hours after each F_Q^C (Z) determination
	AND	
	A.3 Reduce Overpower ΔT trip setpoints ≥ 1% for each 1% that THERMAL POWER is limited below RATED THERMAL POWER by Required Action A.1.	72 hours after each F_Q^C (Z) determination
	AND	

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. (continued)	A.4 Perform SR 3.2.1.1 and SR 3.2.1.2.	Prior to increasing THERMAL POWER above the limit of Required Action A.1
B. $F_Q^W(Z)$ not within limits.	B.1.1 Implement a RAOC operating space specified in the COLR that restores $F_Q^W(Z)$ to within limits. AND	4 hours
	B.1.2 Perform SR 3.2.1.1 and SR 3.2.1.2 if control rod motion is required to comply with the new operating space.	72 hours
	OR	
	B.2.1 -----------NOTE--------------------- Required Action B.2.4 shall be completed whenever Required Action B.2.1 is performed prior to increasing THERMAL POWER above the limit of Required Action B.2.1. --------------------------------------- Limit THERMAL POWER to less than RATED THERMAL POWER and reduce AFD limits as specified in the COLR. AND	4 hours
	B.2.2 Reduce Power Range Neutron Flux - High trip setpoints $\geq$ 1% for each 1% that THERMAL POWER is limited below RATED THERMAL POWER by Required Action B.2.1. AND	72 hours

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
B. (continued)	B.2.3 Reduce Overpower ΔT trip setpoints $\geq$ 1 % for each 1% that THERMAL POWER is limited below RATED THERMAL POWER by Required Action B.2.1. AND	72 hours
	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
C. Required Action and associated Completion Time not met.	C.1 Be in MODE 2.	6 hours

(continued)

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.2.1.1	Verify $F_Q^C(Z)$ is within limit.	Once after each refueling prior to THERMAL POWER exceeding 75% RTP <u>AND</u> Once within 24 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	Verify $F_Q^W(Z)$ is within limit.	Once after each refueling within 24 hours after THERMAL POWER exceeds 75% RTP <u>AND</u> Once within 24 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

5.9 Reporting Requirements

5.9.5 CORE OPERATING LIMITS REPORT (COLR) (continued)

3. WCAP-10216-P-A, Revision 1A, “RELAXATION OF CONSTANT AXIAL OFFSET CONTROL F(Q) SURVEILLANCE TECHNICAL SPECIFICATION,” February 1994 (W Proprietary). (Methodology for Specification 3.2.3 - Axial Flux Difference (Relaxed Axial Offset Control).)

4. WCAP-12610-P-A, “VANTAGE + FUEL ASSEMBLY REFERENCE CORE REPORT,” April 1995. (W Proprietary). (Methodology for Specification 3.2.1 - Heat Flux Hot Channel Factor).

5. WCAP-15088-P, Rev. 1, “Safety Evaluation Supporting A More Negative EOL Moderator Temperature Coefficient Technical Specification for the Watts Bar Nuclear Plant,” July 1999, (W Proprietary), as approved by the NRC staff’s Safety Evaluation accompanying the issuance of Amendment No. 20 (Methodology for Specification 3.1.4 - Moderator Temperature Coefficient.).

6. Caldon, Inc. Engineering Report-80P, “Improving Thermal Accuracy and Plant Safety While Increasing Operating Power Level Using the LEFM✓™ System,” Revision 0, March 1997; and Caldon, Inc. Engineering Report-160P, “Supplement to Topical Report ER-80P: Basis for a Power Uprate With the LEFM✓™,” Revision 0, May 2000; as approved by the NRC staff’s Safety Evaluation accompanying the issuance of Amendment No. 31.

7. WCAP-11397-P-A, “Revised Thermal Design Procedure,” April 1989. (Methodology for Specification 3.2.2 - Nuclear Enthalpy Rise Hot Channel Factor).

8. WCAP-15025-P-A, “Modified WRB-2 Correlation, WRB-2M, for Predicting Critical Heat Flux in 17 x 17 Rod Bundles with Modified LPD Mixing Vane Grids,” April 1999. (Methodology for Specification 3.2.2 - Nuclear Enthalpy Rise Hot Channel Factor).

9. WCAP-14565-P-A, “VIPRE-01 Modeling and Qualification for Pressurized Water Reactor Non-LOCA Thermal-Hydraulic Safety Analysis,” October 1999. (Methodology for Specification 3.2.2 - Nuclear Enthalpy Rise Hot Channel Factor).

10. WCAP-12610-P-A and CENPD-404-P-A, Addendum 1-A, “Optimized ZIRLO™.”

11. WCAP-17661-P-A, Revision 1, “Improved RAOC and CAOC F_Q Surveillance Technical Specifications,” February 2019 (Methodology for Specification 3.2.1 - Heat Flux Hot Channel Factor (T(Z) Surveillance Requirements for F_Q Methodology).)

(continued)

5.9 Reporting Requirements (continued)

5.9.5 CORE OPERATING LIMITS REPORT (COLR) (continued)

c. The core operating limits shall be determined such that all applicable limits (e.g., fuel thermal mechanical limits, core thermal hydraulic limits, Emergency Core Cooling Systems (ECCS) limits, nuclear limits such as SDM, transient analysis limits, and accident analysis limits) of the safety analysis are met.

d. The COLR, including any midcycle revisions or supplements, shall be provided upon issuance for each reload cycle to the NRC.

(continued)

Enclosure

Attachment 5

Proposed TS Changes (Final Typed) for WBN Unit 2

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. ------------NOTE---------------- Required Action A.4 shall be completed whenever this Condition is entered prior to increasing THERMAL POWER above the limit of Required Action A.1. SR 3.2.1.2 is not required to be performed if this Condition is entered prior to THERMAL POWER exceeding 75% RTP after a refueling. -------------------------------------			
$F_Q^C(Z)$ not within limit.	A.1	Reduce THERMAL POWER ≥ 1% RTP for each 1% $F_Q^C(Z)$ exceeds limit.	15 minutes after each $F^C(Z)$ determination
	<u>AND</u>		
	A.2	Reduce Power Range Neutron Flux – High trip setpoints ≥ 1% for each 1% that THERMAL POWER is limited below RATED THERMAL POWER by Required Action A.1.	72 hours after each $F_Q^C(Z)$ determination
	<u>AND</u>		

(continued)

ACTIONS (continued)

A. (continued)	A.3	Reduce Overpower ΔT trip setpoints $\geq$ 1% for each 1% that THERMAL POWER is limited below RATED THERMAL POWER by Required Action A.1.	72 hours after each $F_Q^C(Z)$ determination
	AND		
	A.4	Perform SR 3.2.1.1 and SR 3.2.1.2.	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.1.1	Implement a RAOC operating space specified in the COLR that restores $F_Q^W(Z)$ to within limits. <u>AND</u>	4 hours
	B.1.2	Perform SR 3.2.1.1 and SR 3.2.1.2 if control rod motion is required to comply with the new operating space.	72 hours
	<u>OR</u>		
	B.2.1	-----------NOTE-------------- Required Action B.2.4 shall be completed whenever Required Action B.2.1 is performed prior to increasing THERMAL POWER above the limit of Required Action B.2.1. ---------------------------------- Limit THERMAL POWER to less than RATED THERMAL POWER and reduce AFD limits as specified in the COLR. <u>AND</u>	4 hours
	B.2.2	Reduce Power Range Neutron Flux – High trip setpoints ≥ 1% for each 1% that THERMAL POWER is limited below RATED THERMAL POWER by Required Action B.2.1. <u>AND</u>	72 hours

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION		COMPLETION TIME
B. (continued)	B.2.3	Reduce Overpower ΔT trip setpoints ≥ 1% for each 1% that THERMAL POWER is limited below RATED THERMAL POWER by Required Action B.2.1.	72 hours
	<u>AND</u>		
	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
C. Required Action and associated Completion Time not met.	C.1	Be in MODE 2.	6 hours

(continued)

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.2.1.1	Verify $F_Q^C(Z)$ is within limit.	Once after each refueling prior to THERMAL POWER exceeding 75% RTP <u>AND</u> Once within 24 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	Verify $F_Q^W(Z)$ is within limit.	Once after each refueling within 24 hours after THERMAL POWER exceeds 75% RTP <u>AND</u> Once within 24 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

5.9 Reporting Requirements

5.9.5 CORE OPERATING LIMITS REPORT (COLR) (continued)

1. WCAP-9272-P-A, WESTINGHOUSE RELOAD SAFETY EVALUATION METHODOLOGY," July 1985 (W Proprietary). (Methodology for Specifications 3.1.4 - Moderator Temperature Coefficient, 3.1.6 - Shutdown Bank Insertion Limit, 3.1.7 - Control Bank Insertion Limits, 3.2.1 - Heat Flux Hot Channel Factor, 3.2.2 - Nuclear Enthalpy Rise Hot Channel Factor, 3.2.3 - Axial Flux Difference, and 3.9.1 - Boron Concentration).

2a. WCAP-16009-P-A, "Realistic Large-Break LOCA Evaluation Methodology Using the Automated Statistical Treatment of Uncertainty Method (ASTRUM)," January 2005 (W Proprietary).(Methodology for Specification 3.2.1 - Heat Flux Hot Channel Factor, and 3.2.2 - Nuclear Enthalpy Rise Hot Channel Factor).

2b. WCAP-10054-P-A, "Small Break ECCS Evaluation Model Using NOTRUMP Code," August 1985. Addendum 2, Rev. 1: "Addendum to the Westinghouse Small Break ECCS Evaluation Model using the NOTRUMP Code: Safety Injection into the Broken Loop and COSI Condensation Model," July 1997. (W Proprietary). (Methodology for Specifications 3.2.1 - Heat Flux Hot Channel Factor, and 3.2.2 - Nuclear Enthalpy Rise Hot Channel Factor).

3. WCAP-10216-P-A, Revision 1A, "RELAXATION OF CONSTANT AXIAL OFFSET CONTROL F(Q) SURVEILLANCE TECHNICAL SPECIFICATION," February 1994 (W Proprietary). (Methodology for Specification 3.2.3 - Axial Flux Difference (Relaxed Axial Offset Control).)

4. WCAP-12610-P-A, "VANTAGE + FUEL ASSEMBLY REFERENCE CORE REPORT," April 1995. (W Proprietary). (Methodology for Specification 3.2.1 - Heat Flux Hot Channel Factor).

(continued)

5.9 Reporting Requirements

5.9.5 CORE OPERATING LIMTS REPORT (COLR) (continued)

11. WCAP-17661-P-A, Revision 1, “Improved RAOC and CAOC F_Q Surveillance Technical Specifications,” February 2019 (Methodology for Specification 3.2.1 - Heat Flux Hot Channel Factor (T(Z) Surveillance Requirements for F_Q Methodology).)

c. The core operating limits shall be determined such that all applicable limits (e.g., fuel thermal mechanical limits, core thermal hydraulic limits, Emergency Core Cooling Systems (ECCS) limits, nuclear limits such as SDM, transient analysis limits, and accident analysis limits) of the safety analysis are met.

d. The COLR, including any midcycle revisions or supplements, shall be provided upon issuance for each reload cycle to the NRC.

(continued)

Enclosure

Attachment 6

Proposed WBN Unit 2 OL Condition 2.C.10 (Final Typed)

TVA may make changes to the approved fire protection program without prior approval of the Commission, only if those changes would not adversely affect the ability to achieve and maintain safe shutdown in the event of a fire.

(9) By May 31, 2018, TVA shall report that a listing organization acceptable to the NRC (as the Authority Having Jurisdiction) has determined that the fire detection monitoring panel in the main control room either meets the appropriate designated standards or has been tested and found suitable for the specified purpose.

(10) Deleted

(11) TVA will implement the compensatory measures described in Section 3.4, "Additional Compensatory Measures," of TVA Letter CNL-18-012, dated January 17, 2018, during the timeframe the temperature indicator for RCS hot let 3 is not required to be operable for the remainder of Cycle 2. If the RCS hot leg 3 temperature indicator is returned to operable status prior to the end of Cycle 2, then these compensatory measures are no longer required.

D. The licensee shall have and maintain financial protection of such types and in such amounts as the Commission shall require in accordance with Section 170 of the Atomic Energy Act of 1954, as amended, to cover public liability claims.

E. This license is effective as of the date of issuance and shall expire at midnight on October 21, 2055.

FOR THE NUCLEAR REGULATORY COMMISSION

William M. Dean, Director
Office of Nuclear Reactor Regulation

Appendices:
1. Appendix A – Technical Specifications
2. Appendix B – Environmental Protection Plan

Date of Issuance: October 22, 2015

Enclosure

Attachment 7

Proposed TS Bases Page Changes (Mark-Ups) for WBN Unit 1 (For Information Only)

BASES

B 3.2 POWER DISTRIBUTION LIMITS

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

BASES

BACKGROUND

The purpose of the limits on the values of $F_Q(Z)$ is to limit the local (i.e., pellet) peak power density. The value of $F_Q(Z)$ varies along the axial height (Z) of the core.

$F_Q(Z)$ 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~~. Therefore, $F_Q(Z)$ is a measure of the peak fuel pellet power within the reactor core.

During power operation, the global power distribution is limited by LCO 3.2.3, "AXIAL FLUX DIFFERENCE (AFD)," and LCO 3.2.4, "QUADRANT POWER TILT RATIO (QPTR)," which are directly and continuously measured process variables. These LCOs, along with LCO 3.1.7, "Control Bank Insertion Limits," maintain the core limits on power distributions on a continuous basis.

$F_Q(Z)$ varies with fuel loading patterns, control bank insertion, fuel burnup, and changes in axial power distribution.

$F_Q(Z)$ is measured periodically using either the Movable Incore Detector System or the Power Distribution Monitoring System (PDMS) (Ref.6). These measurements are generally taken with the core at or near ~~steady state~~ equilibrium 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~~ an equilibrium condition, it does not include the variations in the value of $F_Q(Z)$ ~~that~~ which are present during non-equilibrium situations, such as load following or power ascension.

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.~~ the elevation dependent measured planar radial peaking factors, $F_{XY}(Z)$, are increased by an elevation dependent factor, $[T(Z)]^{COLR}$, that accounts for the expected maximum values of the transient axial power shapes postulated to occur during RAOC operation. Thus, $[T(Z))]^{COLR}$ accounts for the worst case non-equilibrium power shapes that are expected for the assumed RAOC operating space.

The RAOC operating space is defined as the combination of AFD and Control Bank Insertion Limits assumed in the calculation of a particular $[T(Z)]^{COLR}$ function. The $[T(Z)]^{COLR}$ factors are directly dependent on the AFD and Control Bank Insertion Limit assumptions. The COLR may contain different $[T(Z)]^{COLR}$ functions that reflect different operating space assumptions. If the limit on $F_Q(Z)$

(continued)

BACKGROUND (continued)

is exceeded, a more restrictive operating space may be implemented to gain margin for future non-equilibrium operation.

Core monitoring and control under ~~nonsteady state~~ non-equilibrium conditions are accomplished by operating the core within the limits of the appropriate LCOs, including the limits on AFD, QPTR, and control rod insertion.

APPLICABLE SAFETY ANALYSES

This LCO precludes core power distributions that violate the following fuel design criteria:

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 (Ref. 1);

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 (Ref. 2); and

d. The control rods must be capable of shutting down the reactor with a minimum required SDM with the highest worth control rod stuck fully withdrawn (Ref. 3).

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

$F_Q(Z)$ limits assumed in the LOCA analysis are typically limiting relative to (i.e., lower than) the $F_Q(Z)$ limit assumed in safety analyses for other postulated accidents. Therefore, this LCO provides conservative limits for other postulated accidents.

$F_Q(Z)$ satisfies Criterion 2 of ~~the NRC Policy Statement~~ 10 CFR 50.36(c)(2)(ii).

(continued)

BASES (continued)

LCO

The Heat Flux Hot Channel Factor, $F_Q(Z)$, shall be limited by the following relationships:

$$F_Q(Z) \leq \frac{CFQ}{P} K(Z) \quad \text{for} \quad P > 0.5$$

$$F_Q(Z) \leq \frac{CFQ}{0.5} K(Z) \quad \text{for} \quad P \leq 0.5$$

where: CFQ is the $F_Q(Z)$ limit at RTP provided in the COLR,

K(Z) is the normalized $F_Q(Z)$ limit as a function of core height provided in the COLR, and

$$P = \frac{\text{THERMAL POWER}}{\text{RTP}}$$

The actual values of CFQ and K(Z) are given in the COLR; however, CFQ is normally a number on the order of ~~2.4~~ 2.5, and K(Z) is a function that looks like the one provided in Figure B 3.2.1-1.

For Relaxed Axial Offset Control operation, $F_Q(Z)$ is approximated by $F_Q^C(Z)$ and $F_Q^W(Z)$. Thus, both $F_Q^C(Z)$ and $F_Q^W(Z)$ must meet the preceding limits on $F_Q(Z)$ (Ref 6).

An $F_Q^C(Z)$ evaluation requires obtaining an incore power distribution measurement in MODE 1.

The measured value, $F^M{}_Q(Z)$, of $F_Q(Z)$ is obtained from the incore power distribution measurement and then corrected for fuel manufacturing tolerances and measurement uncertainty. If the Moveable Incore Detector System (MIDS) is used to obtain the incore power distribution measurement, then:

$$F_Q{}^C{}_Q(Z) = 1.03\ F_Q{}^M{}_Q(Z)\ F_Q{}^{MU}{}_Q$$

where 1.03 is the factor that accounts for the fuel manufacturing tolerances and $F_Q{}^{MU}{}_Q$, which accounts for flux map measurement uncertainty, is 1.05 (Ref. 4).

When the PDMS is used to obtain the incore power distribution measurement, then:

$$F^{\not{C}}{}_Q{}^C(Z) = 1.03\ F^{\not{M}}{}_Q{}^M(Z)\ (1+U_Q/100)$$

(continued)

BASES (continued)

LCO
(continued)

where 1.03 is the factor that accounts for the fuel manufacturing tolerances and the factor $(1+U_Q/100)$, which accounts for PDMS measurement uncertainty, is calculated and applied automatically by the BEACON™ software (Ref. ~~6~~5). In order to be consistent with the LOCA analysis and the uncertainty inputs utilized, a minimum uncertainty of 5 should be used for U_Q.

F_Q^C~~Q~~(Z) is an excellent approximation ~~of the steady state~~ for $F_Q(Z)$ when the reactor is at the steady state power at which the incore power distribution measurement was obtained.

The expression for $F_Q^W(Z)$ ~~is~~ for a MIDS measurement is:

$$F_Q^W(Z) = 1.03\ F_{QXY}^{CM}(Z)\ W(Z)\ ([T(Z)]^{COLR} / P)\ A_{XY}(Z)\ R_j\ F_Q^{MU}$$

The expression for $F_Q^W(Z)$ for a PDMS measurement is:

$$F_Q^W(Z) = 1.03\ F_{XY}^M(Z)\ ([T(Z)]^{COLR} / P)\ A_{XY}(Z)\ R_j\ (1 + U_Q / 100)$$

~~where W(Z) is a cycle dependent function that accounts for power distribution transients encountered during normal operation. W(Z) is included in the COLR.~~

The various factors in these expressions are defined below:

$F_{XY}^M(Z)$ is the measured radial peaking factor at axial location Z and is equal to the value of $F_Q^M(Z)/P^M(Z)$, where $P^M(Z)$ is the measured core average axial power shape.

$[T(Z)]^{COLR}$ is the cycle and burnup dependent function, specified in the COLR, which accounts for power distribution transients encountered during non-equilibrium normal operation. $[T(Z)]^{COLR}$ functions are specified for each analyzed RAOC operating space (i.e. each unique combination of AFD limits and Control Bank Insertion Limits). The $[T(Z)]^{COLR}$ functions account for the limiting non-equilibrium axial power shapes postulated to occur during normal operation for each RAOC operating space. Limiting power shapes at both full and reduced power operation are considered in determining the maximum values of $[T(Z)]^{COLR}$. The $[T(Z)]^{COLR}$ functions also account for the following effects: (1) the presence of spacer grids in the fuel assembly, (2) the increase in radial peaking in rodded core planes due to the presence of control rods during non-equilibrium normal operation, (3) the increase in radial peaking that occurs during part-power operation due to reduced fuel and moderator temperatures. and (4) the increase in radial peaking due to non-equilibrium xenon effects. The $[T(Z)]^{COLR}$ functions are normally calculated assuming that the Surveillance is performed at nominal RTP conditions with all shutdown and control rods fully withdrawn, i.e., all rods out (ARO). Surveillance specific $[T(Z)]^{COLR}$ values may be generated for a given surveillance core condition.

P is the THERMAL POWER / RTP.

$A_{XY}(Z)$ is a function that adjusts the $F_Q^W(Z)$ Surveillance for differences between the reference core condition assumed in generating the $[T(Z)]^{COLR}$ function and

BASES (continued)

LCO (continued)

the actual core condition that exists when the Surveillance is performed. Normally, this reference core condition is 100% RTP, all rods out, and equilibrium xenon. For simplicity, $A_{XY}(Z)$ may be assumed to be 1.0 as this will typically result in an accurate $F_Q^W(Z)$ Surveillance result for a Surveillance that is performed at or near the reference core condition, and an underestimation of the available margin to the F_Q limit for Surveillances that are performed at core conditions different from the reference condition. Alternatively, the $A_{XY}(Z)$ function may be calculated using the NRC approved methodology in Reference 7.

F_Q^{MU} and $(1 + U_Q/100)$ are factors that account for measurement uncertainty and 1.03 is a factor that accounts for fuel manufacturing tolerances.

R_j is a cycle and burnup dependent analytical factor specified in the COLR that accounts for potential increases in $F_Q^W(Z)$ between Surveillances. R_j values are provided for each RAOC operating space.

The $F_Q(Z)$ limits define limiting values for core power peaking that ensure that the 10 CFR 50.46 acceptance criteria are met during a LOCA (Ref. 1).

This LCO requires operation within the bounds assumed in the safety analyses. Violating the LCO limits for $F_Q(Z)$ could result in unacceptable consequences if a design basis event were to occur while $F_Q(Z)$ exceeds its specified limits. Calculations are performed in the core design process to confirm that the core can be controlled in such a manner during operation that it can stay within the LOCA $F_Q(Z)$ limits. If $F_Q(Z)$ cannot be maintained within the LCO limits, reduction of the core power is required, a more restrictive RAOC operating space must be implemented, or core power limits and AFD limits must be reduced.

Violating the LCO limits for $F_Q(Z)$ produces unacceptable consequences if a design basis event occurs while $F_Q(Z)$ is outside its specified limits.

APPLICABILITY

The $F_Q(Z)$ limits must be maintained in MODE 1 to prevent core power distributions from exceeding the limits assumed in the safety analyses. Applicability in other MODES is not required because there is either insufficient stored energy in the fuel or insufficient energy being transferred to the reactor coolant to require a limit on the distribution of core power.

ACTIONS

A.1

Reducing THERMAL POWER by ≥ 1% RTP for each 1% by which $F_Q^C(Z)$ exceeds its limit, maintains an acceptable absolute power density. $F_Q^C(Z)$ is $F_Q^M(Z)$ multiplied by a factor accounting for manufacturing tolerances and measurement uncertainties. $F_Q^M(Z)$ is the measured value of $F_Q(Z)$. The Completion Time of 15 minutes provides an acceptable time to reduce power in an orderly manner and without allowing the plant to remain in an unacceptable

BASES (continued)

ACTIONS (continued)

condition for an extended period of time.

The maximum allowable power level initially determined by Required Action A.1 may be affected by subsequent determinations of $F_Q(Z)$ and would require power reductions within 15 minutes of the $F_Q^C(Z)$ determination, if necessary, to comply with the decreased maximum allowable power level. Decreases in $F_Q^C(Z)$ would allow increasing the maximum allowable power level and increasing power up to this revised limit. If an F_Q Surveillance is performed at 100% RTP conditions, and both $F_Q^C(Z)$ and $F_Q^W(Z)$ exceed their limits, the option to reduce the THERMAL POWER limit in accordance with Required Action B.2.1 instead of implementing a new operating space in accordance with Required Action B.1 will result in a further power reduction after Required Action A.1 has been completed. However, this further power reduction would be permitted to occur over the next 4 hours. In the event the evaluated THERMAL POWER reduction in the COLR for Required Action B.2.1 did not result in a further power reduction (for example, if both Condition A and Condition B were entered at less than 100% RTP conditions), then the THERMAL POWER level established as a result of completing Required Action A.1 will take precedence, and will establish the effective operating power level limit for the unit until both Conditions A and B are exited.

A.2

A reduction of the Power Range Neutron Flux - High trip setpoints by ≥ 1% for each 1% by which $F_Q^C(Z)$ exceeds its limit that THERMAL POWER is limited below RATED THERMAL POWER by Required Action A.1, is a conservative action for protection against the consequences of severe transients with unanalyzed power distributions. The Completion Time of 8 72 hours is sufficient considering the small likelihood of a severe transient in this time period and the preceding prompt reduction in THERMAL POWER in accordance with Required Action A.1. The maximum allowable Power Range Neutron Flux - High trip setpoints initially determined by Required Action A.2 may be affected by subsequent determinations of $F_Q^C(Z)$ and would require Power Range Neutron Flux - High trip setpoint reductions within 72 hours of the $F_Q^C(Z)$ determination, if necessary, to comply with the decreased maximum allowable Power Range Neutron Flux - High trip setpoints. Decreases in $F_Q^C(Z)$ would allow increasing the maximum allowable Power Range Neutron Flux - High trip setpoints.

A.3

Reduction in the Overpower ΔT trip setpoints (value of K_4) by ≥ 1% for each 1% by which $F_Q^C(Z)$ exceeds its limit, that THERMAL POWER is limited below RATED THERMAL POWER by Required Action A.1 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 severe transient in this time period, and the preceding prompt reduction in THERMAL POWER in accordance with Required Action A.1. The maximum allowable Overpower ΔT trip setpoints initially determined by Required Action A.3 may be affected by subsequent determinations of $F_Q^C(Z)$ and would require Overpower ΔT trip setpoint reductions within 72 hours of the $F_Q^C(Z)$ determination, if necessary, to comply with the decreased maximum allowable Overpower ΔT trip setpoints. Decreases in $F_Q^C(Z)$ would allow increasing the

ACTIONS (continued)

maximum allowable Overpower ΔT trip setpoints.

A.4

Verification that $F_Q^C(Z)$ has been restored to within its limit, by performing SR 3.2.1.1 and SR 3.2.1.2 prior to increasing THERMAL POWER above the limit imposed by Required Action A.1, ensures that core conditions during operation at higher power levels and future operation are consistent with safety analyses assumptions.

Condition A is modified by a NOTE that requires Required Action A.4 to be performed whenever the Condition is entered prior to increasing THERMAL POWER above the limit of Required Action A.1. The Note also states that SR 3.2.1.2 is not required to be performed if this Condition is entered prior to THERMAL POWER exceeding 75% RTP after a refueling. This ensures that SR 3.2.1.1 and SR 3.2.1.2 (if required) will be performed prior to increasing THERMAL POWER above the limit of Required Action A.1, even when Condition A is exited prior to performing Required Action A.4. Performance of SR 3.2.1.1 and SR 3.2.1.2 are necessary to ensure $F_Q(Z)$ is properly evaluated prior to increasing THERMAL POWER.

B.1.1

If it is found that the maximum calculated value of $F_Q(Z)$ that can occur during normal maneuvers, $F_Q^W(Z)$, exceeds its specified limits, there exists a potential for $F_Q^C(Z)$ to become excessively high if a normal operational transient occurs. ~~Reducing the AFD limits by ≥ 1% for each 1% by which $F_Q^W(Z)$ exceeds its limit within the allowed Completion Time of 2 hours, restricts the axial flux distribution such that even if a transient occurred, core peaking factors are not exceeded.~~ Implementing a more restrictive RAOC operating space, as specified in the COLR, within the allowed Completion Time of 4 hours will restrict the AFD such that peaking factor limits will not be exceeded during non-equilibrium normal operation. Several RAOC operating spaces, representing successively smaller AFD envelopes and, optionally shallower Control Bank Insertion Limits, may be specified in the COLR. The corresponding T(Z) functions for these operating spaces can be used to determine which RAOC operating space will result in acceptable non-equilibrium operation within the $F_Q^W(Z)$ limits.

B.1.2

If it is found that the maximum calculated value of $F_Q(Z)$ that can occur during normal maneuvers, $F_Q^W(Z)$, exceeds its specified limits, there exists a potential for $F_Q^C(Z)$ to become excessively high if a normal operational transient occurs. As discussed above, Required Action B.1.1 requires that a new RAOC operating space be implemented to restore $F_Q^W(Z)$ to within its limits. Required Action B.1.2 requires that SR 3.2.1.1 and SR 3.2.1.2 be performed if control rod motion occurs as a result of implementing the new RAOC operating space in accordance with Required Action B.1.1. The performance of SR 3.2.1.1 and SR 3.2.1.2 is necessary to ensure $F_Q(Z)$ is properly evaluated after any rod motion resulting from the implementation of a new RAOC operating space in

BASES (continued)

ACTIONS (continued)

accordance with Required Action B.1.1.

B.2.1

When $F_Q^W(Z)$ exceeds it limit, Required Action B.2 may be implemented instead of Required Action B.1. Required Action B.2.1 limits THERMAL POWER to less than RATED THERMAL POWER by the amount specified in the COLR. It also requires reductions in the AFD limits by the amount specified in the COLR. This maintains an acceptable absolute power density relative to the maximum power density value assumed in the safety analyses.

If the required $F_Q^W(Z)$ margin improvement exceeds the margin improvement available from the pre-analyzed THERMAL POWER and AFD reductions provided in the COLR, then THERMAL POWER must be further reduced to less than or equal to 50% RTP. In this case, reducing THERMAL POWER to less than or equal to 50% RTP will provide additional margin in the transient F_Q by the required change in THERMAL POWER and the increase in the F_Q limit. This will ensure that the F_Q limit is met during transient operation that may occur at or below 50% RTP.

The Completion Time of 4 hours provides an acceptable time to reduce the THERMAL POWER and AFD limits in an orderly manner to preclude entering an unacceptable condition during future non-equilibrium operation. The limit on THERMAL POWER initially determined by Required Action B.2.1 may be affected by subsequent determinations of $F_Q^W(Z)$ and would require power reductions within 4 hours of the $F_Q^W(Z)$ determination, if necessary, to comply with the decreased THERMAL POWER limit. Decreases in $F_Q^W(Z)$ would allow increasing the THERMAL POWER limit and increasing THERMAL POWER up to this revised limit.

Required Action B.2.1 is modified by a NOTE that states Required Action B.2.4 shall be completed whenever Required Action B.2.1 is performed prior to increasing THERMAL POWER above the limit of Required Action B.2.1. Required Action B.2.4 requires the performance of SR 3.2.1.1 and SR 3.2.1.2 prior to increasing THERMAL POWER above the limit established by Required Action B.2.1. The Note ensures that the SRs will be performed even if Condition B may be exited prior to performing Required Action B.2.4. The performance of SR 3.2.1.1 and SR 3.2.1.2 is necessary to ensure $F_Q(Z)$ is properly evaluated prior to increasing THERMAL POWER.

If an F_Q surveillance is performed at 100% RTP conditions, and both $F_Q^C(Z)$ and $F_Q^W(Z)$ exceed their limits, the option to reduce the THERMAL POWER limit in accordance with proposed Required Action B.2.1 instead of implementing a new operating space in accordance with proposed Required Action B.1, will result in a further power reduction after Required Action A.1 has been completed. However, this further power reduction would be permitted to occur over the next 4 hours. In the event the evaluated THERMAL POWER reduction in the COLR for proposed Required Action B.2.1 did not result in a further power reduction (for example, if both Condition A and Condition B were entered at less than 100% RTP conditions), then the THERMAL POWER level established as a result of completing Required Action A.1 will take precedence, and will establish the

BASES (continued)

ACTIONS (continued)

effective operating power level limit for the unit until both Conditions A and B are exited.

B.2.2

A reduction of the Power Range Neutron Flux - High trip setpoints by $\geq$ 1% for each 1% by which the maximum allowable power is reduced 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 severe transient in this time period and the preceding prompt reduction in the THERMAL POWER limit and AFD limits in accordance with Required Action B.2.1.

B.2.3

Reduction in the Overpower ΔT trip setpoints value of K_4 by $\geq$ 1% for each 1% by which the maximum allowable power is reduced 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 severe transient in this time period, and the preceding prompt reduction in the THERMAL POWER limit and AFD limits in accordance with the Required Action B.2.1.

B.2.4

Verification that $F_Q^C(Z)$ and $F_Q^W(Z)$ have been restored to within limit, by performing SR 3.2.1.1 and SR 3.2.1.2 prior to increasing THERMAL POWER above the maximum allowable power limit imposed by Required Action B.2.1, ensures that core conditions during operation at higher power levels and future operation are consistent with safety analyses assumptions.

C.1

If Required Actions A.1 through A.4 or B.1.1 through B.2.4 are not met within their associated Completion Times, the plant must be placed in a mode or condition in which the LCO requirements are not applicable. This is done by placing the plant in at least MODE 2 within 6 hours.

This allowed Completion Time is reasonable based on operating experience regarding the amount of time it takes to reach MODE 2 from full power operation in an orderly manner and without challenging plant systems.

BASES (continued)

SURVEILLANCE REQUIREMENTS

~~SR 3.2.1.1 and SR 3.2.1.2 are modified by a Note. The Note applies during the first power ascension after initial fuel loading and a refueling. It states that THERMAL POWER may be increased until an equilibrium power level has been achieved at which a power distribution map can be obtained. This allowance is modified, however, by one of the Frequency conditions that requires verification that $F_Q^C(Z)$ and $F_Q^W(Z)$ are within their specified limits after a power rise of more than 10% RTP over the THERMAL POWER at which they were last verified to be within specified limits. Because $F_Q^C(Z)$ and $F_Q^W(Z)$ could not have previously been measured in this core, there is a second Frequency condition that requires determination of these parameters before exceeding 75% RTP. This ensures that some determination of $F_Q^C(Z)$ and $F_Q^W(Z)$ is made at a lower power level at which adequate margin is available before going to 100% RTP. Also, this Frequency condition, together with the Frequency condition requiring verification of $F_Q^C(Z)$ and $F_Q^W(Z)$ following a power increase of more than 10%, ensures that they are verified as soon as RTP (or any other level for extended operation) is achieved.~~

~~In the absence of these Frequency conditions, it is possible to increase power to RTP and operate for 31 days without verification of $F_Q^C(Z)$ and $F_Q^W(Z)$. The Frequency condition is not intended to require verification of these parameters after every 10% increase in power level above the last verification. It only requires verification after a power level is achieved for extended operation that is 10% higher than that power at which F_Q was last measured.~~

SR 3.2.1.1

Verification that $F_Q^C(Z)$ is within its specified limits involves increasing $F_Q^M(Z)$ to allow for manufacturing tolerance and measurement uncertainties in order to obtain $F_Q^C(Z)$. Specifically, $F_Q^M(Z)$ is the measured value of $F_Q(Z)$ obtained from an incore power distribution measurement.

If the Movable Incore Detector System is used to obtain the incore power distribution measurement, then:

$$F_Q^C(Z) = 1.03\ F_Q^M(Z)\ F_Q^{MU}$$

where 1.03 is the factor that accounts for the fuel manufacturing tolerances and F_Q^{MU}, which accounts for flux map measurement uncertainty, is 1.05 (Ref. 4).

When the PDMS is used to obtain the incore power distribution measurement, then:

$$F_Q^C(Z) = 1.03\ F_Q^M(Z)\ (1+U_Q/100)$$

where 1.03 is the factor that accounts for the fuel manufacturing tolerances and the factor $(1+U_Q/100)$, which accounts for PDMS measurement uncertainty, is calculated and applied automatically by the BEACON software (Ref. ~~6~~5). In order to be consistent with the LOCA analysis and the uncertainty inputs utilized, a minimum uncertainty of 5 should be used for U_Q.

BASES (continued)

SURVEILLANCE REQUIREMENTS (continued)

$F_Q^C(Z)$ is then compared to its specified limits. The limit with which $F_Q^C(Z)$ is compared varies inversely with power above 50% RTP and directly with a function called K(Z) provided in the COLR.

Performing this Surveillance in MODE 1 prior to exceeding 75% RTP following a refueling ensures that ~~the $F_Q^C(Z)$ limit is met when RTP is achieved, because peaking factors generally decrease as power level is increased~~ some determination of $F_Q^C(Z)$ is made prior to achieving a significant power level where peak linear heat rate could approach the limits assumed in the safety analyses.

If THERMAL POWER has been increased by ≥ 10% RTP since the ~~last~~ initial or most recent determination of $F_Q^C(Z)$, another evaluation of this factor is required ~~12~~ 24 hours after achieving equilibrium conditions at this higher power level (to ensure that $F_Q^C(Z)$ values are being reduced sufficiently with power increase to stay within the LCO limits). Equilibrium conditions are achieved when the core is sufficiently stable at the intended operating conditions required to perform the surveillance.

The allowance of up to 24 hours after achieving equilibrium conditions at the increased THERMAL POWER level to complete the next $F_Q^C(Z)$ surveillance applies to situations where the $F_Q^C(Z)$ has already been measured at least once at a reduced THERMAL POWER level. The observed margin in the previous surveillance will provide assurance that increasing power up to the next plateau will not exceed the F_Q limit, and that the core is behaving as designed.

This Frequency condition is not intended to require verification of these parameters after every 10% increase in RTP above the THERMAL POWER at which the last verification was performed. It only requires verification after a THERMAL POWER is achieved for extended operation that is 10% higher than the THERMAL POWER at which $F_Q^C(Z)$ was last measured.

The Surveillance Frequency is controlled under the Surveillance Frequency Control Program

SR 3.2.1.2

The nuclear design process includes calculations performed to determine that the core can be operated within the $F_Q(Z)$ limits. Because incore power distribution measurements are taken ~~at or near~~ in steady state conditions, the variations in power distribution resulting from normal operational maneuvers are not present in the measured data. These variations are, however, conservatively calculated by considering a wide range of unit maneuvers in normal operation. ~~The maximum peaking factor increase over steady state values, calculated as a function of core elevation, Z, is called W(Z). Multiplying the measured total peaking factor, $F_Q^C(Z)$, by W(Z) and dividing by P gives the maximum $F_Q(Z)$ calculated to occur in normal operation, $F_Q^W(Z)$. Scaling the W(Z) factors by "I/P" accounts for the possibility that reactor power may be increased prior to the next F_Q surveillance.~~

SURVEILLANCE REQUIREMENTS (continued)

The measured $F_Q(Z)$ can be determined through a synthesis of the measured planar radial peaking factors, $F_{XY}^M(Z)$, and the measured core average axial power shape, $P^M(Z)$. Thus, $F_Q^C(Z)$ is given by the following expressions:

$F_Q^C(Z) = 1.03\ F_{XY}^M(Z)\ P^M(Z)\ F_Q^{MU} = 1.03\ F_Q^M(Z)\ F_Q^{MU}$ [MIDS]

or

$F_Q^C(Z) = 1.03\ F_{XY}^M(Z)\ P^M(Z)\ (1 + U_Q/100) = 1.03\ F_Q^M(Z)\ (1 + U_Q/100)$ [PDMS]

For RAOC operation, the analytical $[T(Z)]^{COLR}$ functions, specified in the COLR for each RAOC operating space, are used together with the measured $F_{XY}(Z)$ values to estimate $F_Q(Z)$ for non-equilibrium operation within the RAOC operating space. When the $F_{XY}(Z)$ values are measured at HFP ARO conditions ($A_{XY}(Z)$ equals 1.0), $F_Q^W(Z)$ is given by the following expressions:

$F_Q^W(Z) = 1.03\ F_{XY}^M(Z)\ [T(Z)]^{COLR}\ R_j\ F_Q^{MU}$ [MIDS]

or

$F_Q^W(Z) = 1.03\ F_{XY}^M(Z)\ [T(Z)]^{COLR}\ R_j\ (1 + U_Q/100)$ [PDMS]

Non-equilibrium operation can result in significant changes to the axial power shape. To a lesser extent, non-equilibrium operation can increase the radial peaking factors, $F_{XY}(Z)$, through control rod insertion and through reduced Doppler and moderator feedback at part-power conditions.

The $[T(Z)]^{COLR}$ functions quantify these effects for the range of power shapes, control rod insertion, and power levels characteristic of the operating space. Multiplying $[T(Z)]^{COLR}$ by the measured full power, un-rodded $F_{XY}^M(Z)$ value, and the factors that account for manufacturing and measurement uncertainties gives $F_Q^W(Z)$, the maximum total peaking factor postulated for non-equilibrium RAOC operation.

The limit with which $F_Q^W(Z)$ is compared varies inversely with power above 50% RTP and directly with the function K(Z) provided in the COLR.

The ~~W(Z) curve is provided~~ $[T(Z)]^{COLR}$ functions are specified in the COLR for discrete core elevations. Flux map data are typically taken for 30 to 75 core elevations. $F_Q^W(Z)$ evaluations are not applicable for ~~the following~~ axial core regions, measured in percent of core height:

a. Lower core region, from 0 to 10% inclusive~~; and~~ ,

b. Upper core region, from 90 to 100% inclusive~~.~~ ,

c. Grid plane regions, $\pm$2% inclusive, and

d. Core plane regions, within 2% of the bank demand positions of the control banks.

BASES (continued)

SURVEILLANCE REQUIREMENTS (continued)

~~The top and bottom 10%~~ These regions of the core are excluded from the evaluation because of the low probability that they would be more limiting in the safety analysis and because of the difficulty of making a precise measurement in these regions. The excluded regions at the top and bottom of the core are specified in the COLR and are defined to ensure that the minimum margin location is adequately surveilled. A slightly smaller exclusion zone may be specified, if necessary, to include the limiting margin location in the surveilled region of the core.

~~This Surveillance has been modified by a Note that may require that more frequent surveillances be performed. If $F_Q^W(Z)$ is evaluated and found to be within its limit, an evaluation of the expression below is required to account for any increase to $F_Q^M(Z)$ that may occur and cause the $F_Q(Z)$ limit to be exceeded before the next required $F_Q(Z)$ evaluation.~~

~~If the two most recent $F_Q(Z)$ evaluations show an increase in the expression~~

~~maximum over z~~ $\left[\frac{F_Q^C(Z)}{K(Z)}\right]$,

~~it is required to meet the $F_Q(Z)$ limit with the last $F_Q^W(Z)$ increased by the appropriate factor specified in the COLR, or to evaluate $F_Q(Z)$ more frequently, each 7 EFPD. These alternative requirements prevent $F_Q(Z)$ from exceeding its limit for any significant period of time without detection.~~

~~Performing the Surveillance in MODE 1 prior to exceeding 75% RTP ensures that the $F_Q(Z)$ limit is met when RTP is achieved, because peaking factors are generally decreased as power level is increased.~~

~~$F_Q(Z)$ is verified at power levels $\geq$ 10% RTP above the THERMAL POWER of its last verification, 12 hours after achieving equilibrium conditions to ensure that $F_Q(Z)$ is within its limit at higher power levels.~~

SR 3.2.1.2 requires a Surveillance of $F_Q^W(Z)$ during the initial startup following each refueling within 24 hours after exceeding 75% RTP. THERMAL POWER levels below 75% are typically non-limiting with respect to the limit for $F_Q^W(Z)$. Furthermore, startup physics testing and flux symmetry measurements, also performed at low power, provide confirmation that the core is operating as expected. This Frequency ensures that verification of $F_Q^W(Z)$ is performed prior to extended operation at power levels where the maximum permitted peak LHR could be challenged and that the first verified performance of SR 3.2.1.2 after a refueling is performed at a power level high enough to provide a high level of confidence in the accuracy of the Surveillance result.

Equilibrium conditions are achieved when the core is sufficiently stable at the intended operating conditions required to perform the Surveillance.

If a previous Surveillance of $F_Q^W(Z)$ was performed at part power conditions, SR 3.2.1.2 also requires that $F_Q^W(Z)$ be verified at power levels $\geq$ 10% RTP above the THERMAL POWER of its last verification within 24 hours after achieving

BASES (continued)

equilibrium conditions. This ensures that $F_Q^W(Z)$ is within its limit using radial peaking factors measured at the higher power level.

The allowance of up to 24 hours after achieving equilibrium conditions will provide a more accurate measurement of $F_Q^W(Z)$ by allowing sufficient time to achieve equilibrium conditions and obtain the power distribution measurement.

The Surveillance Frequency is controlled under the Surveillance Frequency Control Program

REFERENCES

1. Title 10, Code of Federal Regulations, Part 50.46, "Acceptance Criteria for Emergency Core Cooling Systems for Light Water Nuclear Power Reactors."

2. Regulatory Guide 1.77, Rev. 0, "Assumptions Used for Evaluating a Control Rod Ejection Accident for Pressurized water Reactors," May 1974.

3. Title 10, Code of Federal Regulations, Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants," GDC 26, "Reactivity Control System Redundancy and Capability."

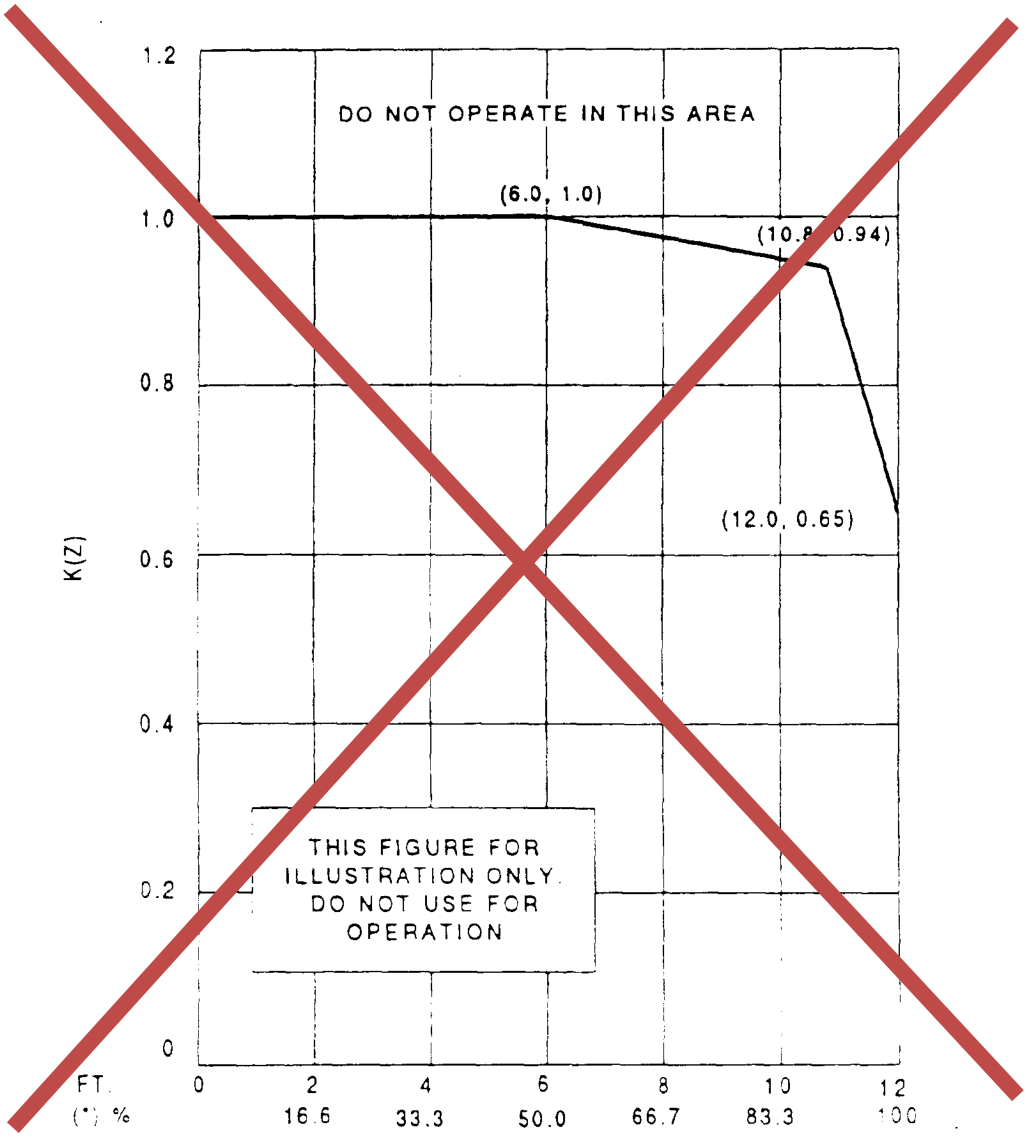
4. WCAP-7308-L-P-A, "Evaluation of Nuclear Hot Channel Factor Uncertainties," June 1988.

~~5. Westinghouse Technical Bulletin (TB) 08-4, "F_Q Surveillance at Part Powers," July 15, 2008.~~

~~6~~5. WCAP-12472-P-A, "BEACON Core Monitoring and Operations Support System," August 1994.

6. WCAP-10216-P-A, Rev. 1A, "Relaxation of Constant Axial Offset Control (and) F_Q Surveillance Technical Specification," February 1994.

7. WCAP-17661-P-A, "Improved RAOC and CAOC F_Q Surveillance Technical Specifications," February 2019.



~~CORE HEIGHT~~

~~*For core height of 12 feet~~

BASES (continued)

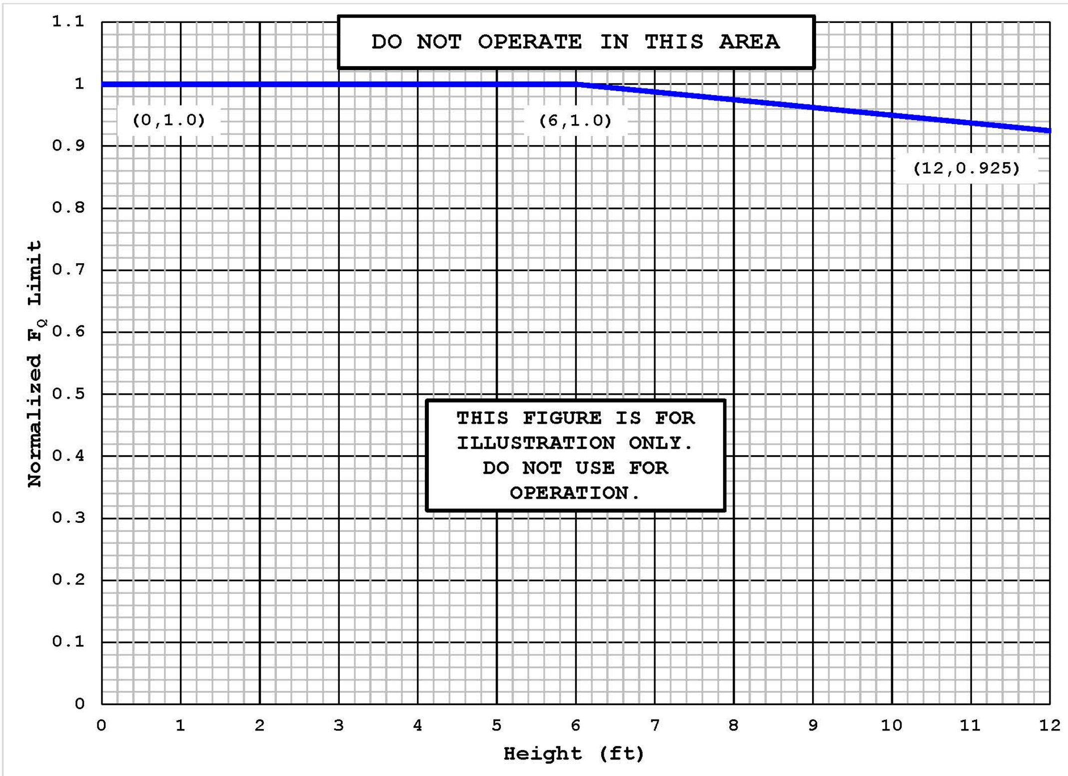


Figure B 3.2.1-1 (page 1 of 1)
K(Z) - Normalized $F_Q(Z)$ as a Function of Core Height

Enclosure

Attachment 8

Proposed TS Bases Page Changes (Mark-Ups) for WBN Unit 2 (For Information Only)

B 3.2 POWER DISTRIBUTION LIMITS

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

BASES

BACKGROUND

The purpose of the limits on the values of $F_Q(Z)$ is to limit the local (i.e., pellet) peak power density. The value of $F_Q(Z)$ varies along the axial height (Z) of the core.

$F_Q(Z)$ 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~~. Therefore, $F_Q(Z)$ is a measure of the peak fuel pellet power within the reactor core.

During power operation, the global power distribution is limited by LCO 3.2.3, "AXIAL FLUX DIFFERENCE (AFD)," and LCO 3.2.4, "QUADRANT POWER TILT RATIO (QPTR)," which are directly and continuously measured process variables. These LCOs, along with LCO 3.1.7, "Control Bank Insertion Limits," maintain the core limits on power distributions on a continuous basis.

$F_Q(Z)$ varies with fuel loading patterns, control bank insertion, fuel burnup, and changes in axial power distribution.

$F_Q(Z)$ is measured periodically using the Power Distribution Monitoring System (PDMS). These measurements are generally taken with the core at or near ~~steady state~~ equilibrium 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~~ an equilibrium condition, it does not include the variations in the value of $F_Q(Z)$ ~~that~~ which are present during non-equilibrium situations, such as load following or power ascension.

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~~ the elevation dependent measured planar radial peaking factors, $F_{XY}(Z)$, are increased by an elevation dependent factor, $[T(Z)]^{COLR}$, that accounts for the expected maximum values of the transient axial power shapes postulated to occur during RAOC operation. Thus, $[T(Z)]^{COLR}$ accounts for the worst case non-equilibrium power shapes that are expected for the assumed RAOC operating space.

The RAOC operating space is defined as the combination of AFD and Control Bank Insertion Limits assumed in the calculation of a particular $[T(Z)]^{COLR}$ function. The $[T(Z)]^{COLR}$ factors are directly dependent on the AFD and Control Bank Insertion Limit assumptions. The COLR may

(continued)

BASES (continued)

BACKGROUND (continued)

contain different $[T(Z)]^{COLR}$ functions that reflect different operating space limitations. If the limit on $F_Q(Z)$ is exceeded, a more restrictive operating space may be implemented to gain margin for future non-equilibrium operation.

Core monitoring and control under ~~nonsteady state~~ non-equilibrium conditions are accomplished by operating the core within the limits of the appropriate LCOs, including the limits on AFD, QPTR, and control rod insertion.

APPLICABLE SAFETY ANALYSES

This LCO precludes core power distributions that violate the following fuel design criteria:

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 (Ref. 1);

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 (Ref. 2); and

d. The control rods must be capable of shutting down the reactor with a minimum required SDM with the highest worth control rod stuck fully withdrawn (Ref. 3).

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

$F_Q(Z)$ limits assumed in the LOCA analysis are typically limiting relative to (i.e., lower than) the $F_Q(Z)$ limit assumed in safety analyses for other postulated accidents. Therefore, this LCO provides conservative limits for other postulated accidents.

$F_Q(Z)$ satisfies Criterion 2 of 10 CFR 50.36(c)(2)(ii).

(continued)

BASES (continued)

LCO

The Heat Flux Hot Channel Factor, $F_Q(Z)$, shall be limited by the following relationships:

$$F_Q(Z) \leq \frac{CFQ}{P} K(Z) \quad \text{for } P > 0.5$$

$$F_Q(Z) \leq \frac{CFQ}{0.5} K(Z) \quad \text{for } P \leq 0.5$$

where: CFQ is the $F_Q(Z)$ limit at RTP provided in the COLR,

K(Z) is the normalized $F_Q(Z)$ limit as a function of core height provided in the COLR, and

$$P = \frac{\text{THERMAL POWER}}{\text{RTP}}$$

The actual values of CFQ and K(Z) are given in the COLR; however, CFQ is normally a number on the order of 2.5, and K(Z) is a function that looks like the one provided in Figure B 3.2.1-1.

For Relaxed Axial Offset Control operation, $F_Q(Z)$ is approximated by $F_Q^C(Z)$ and $F_Q^W(Z)$. Thus, both $F_Q^C(Z)$ and $F_Q^W(Z)$ must meet the preceding limits on $F_Q(Z)$ (Ref 5).

An $F_Q^C(Z)$ evaluation requires obtaining an incore power distribution measurement in MODE 1. The measured value, $F_Q^M(Z)$, of $F_Q(Z)$ is obtained from the incore power distribution measurement and then corrected for fuel manufacturing tolerances and measurement uncertainty.

(continued)

LCO (continued)

Using the PDMS to obtain the incore power distribution measurement:

$$F_Q^C = 1.03\, F_Q^M(Z)\left(1+\frac{U_Q}{100}\right)$$

where 1.03 is the factor that accounts for the fuel manufacturing tolerances and the factor $(1+U_Q/100)$, which accounts for measurement uncertainty, is calculated and applied automatically by the BEACON™ software (Ref. 4). In order to be consistent with the LOCA analysis and the uncertainty inputs utilized, a minimum uncertainty of 5 should be used for U_Q.

$F_Q^C(Z)$ is an excellent approximation ~~of the steady state~~ for $F_Q(Z)$ when the reactor is at the steady state power at which the incore power distribution measurement was obtained.

The expression for $F_Q^W(Z)$ is:

~~$F_Q^W(Z) = F_Q^C(Z)\, W(Z)/P$ for $P > 0.5$~~

$F_Q^W(Z) = 1.03\, F_{XY}^M(Z)\, ([T(Z)]^{COLR} / P)\, A_{XY}(Z)\, R_j\, (1 + U_Q / 100)$

~~$F_Q^W(Z) = F_Q^C(Z)\, W(Z)/0.5$ for $P \leq 0.5$~~

~~where W(Z) is a cycle dependent function that accounts for power distribution transients encountered during normal operation. W(Z) is included in the COLR.~~

The various factors in these expressions are defined below:

$F_{XY}^M(Z)$ is the measured radial peaking factor at axial location Z and is equal to the value of $F_Q^M(Z)/P^M(Z)$, where $P^M(Z)$ is the measured core average axial power shape.

$[T(Z)]^{COLR}$ is the cycle and burnup dependent function, specified in the COLR, which accounts for power distribution transients encountered during non-equilibrium normal operation. $[T(Z)]^{COLR}$ functions are specified for each analyzed RAOC operating space (i.e. each unique combination of AFD limits and Control Bank Insertion Limits). The $[T(Z)]^{COLR}$ functions account for the limiting non-equilibrium axial power shapes postulated to occur during normal operation for each RAOC operating space. Limiting power shapes at both full and reduced power operation are considered in determining the maximum values of $[T(Z)]^{COLR}$. The $[T(Z)]^{COLR}$ functions also account for the following effects: (1) the presence of spacer grids in the fuel assembly, (2) the increase in radial peaking in rodded core planes due to the presence of control rods during non-equilibrium normal operation, (3) the increase in radial peaking that occurs during part-power operation due to reduced fuel and

(continued)

BASES (continued)

LCO (continued)

moderator temperatures, and (4) the increase in radial peaking due to non-equilibrium xenon effects. The $[T(Z)]^{COLR}$ functions are normally calculated assuming that the Surveillance is performed at nominal RTP conditions with all shutdown and control rods fully withdrawn, i.e., all rods out (ARO). Surveillance specific $[T(Z)]^{COLR}$ values may be generated for a given surveillance core condition.

P is the THERMAL POWER / RTP.

$A_{XY}(Z)$ is a function that adjusts the $F_Q^W(Z)$ Surveillance for differences between the reference core condition assumed in generating the $[T(Z)]^{COLR}$ function and the actual core condition that exists when the Surveillance is performed. Normally, this reference core condition is 100% RTP, all rods out, and equilibrium xenon. For simplicity, $A_{XY}(Z)$ may be assumed to be 1.0 as this will typically result in an accurate $F_Q^W(Z)$ Surveillance result for a Surveillance that is performed at or near the reference core condition, and an underestimation of the available margin to the F_Q limit for Surveillances that are performed at core conditions different from the reference condition. Alternatively, the $A_{XY}(Z)$ function may be calculated using the NRC approved methodology in Reference 6.

$(1 + U_Q/100)$ is a factor that accounts for measurement uncertainty and 1.03 is a factor that accounts for fuel manufacturing tolerances.

R_j is a cycle and burnup dependent analytical factor specified in the COLR that accounts for potential increases in $F_Q^W(Z)$ between Surveillances. R_j values are provided for each RAOC operating space.

The $F_Q(Z)$ limits define limiting values for core power peaking and ensure that the 10 CFR 50.46 acceptance criteria are met during a LOCA (Ref. 1).

This LCO requires operation within the bounds assumed in the safety analyses. Violating the LCO limits for $F_Q(Z)$ could result in unacceptable consequences if a design basis event were to occur while $F_Q(Z)$ exceeds its specified limits. Calculations are performed in the core design process to confirm that the core can be controlled in such a manner during operation that it can stay within the LOCA $F_Q(Z)$ limits. If $F_Q(Z)$ cannot be maintained within the LCO limits, reduction of the core power is required, a more restrictive RAOC operating space must be implemented, or core power limits and AFD limits must be reduced.

~~Violating the LCO limits for $F_Q(Z)$ produces unacceptable consequences if a design basis event occurs while $F_Q(Z)$ is outside its specified limits.~~

(continued)

BASES (continued)

APPLICABILITY

The $F_Q(Z)$ limits must be maintained in MODE 1 to prevent core power distributions from exceeding the limits assumed in the safety analyses. Applicability in other MODES is not required because there is either insufficient stored energy in the fuel or insufficient energy being transferred to the reactor coolant to require a limit on the distribution of core power.

(continued)

BASES (continued)

ACTIONS

A.1

Reducing THERMAL POWER by ≥ 1% RTP for each 1% by which $F_Q^C(Z)$ exceeds its limit, maintains an acceptable absolute power density. $F_Q^C(Z)$ is $F_Q^M(Z)$ multiplied by a factor accounting for manufacturing tolerances and measurement uncertainties. $F_Q^M(Z)$ is the measured value of $F_Q(Z)$. The Completion Time of 15 minutes provides an acceptable time to reduce power in an orderly manner and without allowing the plant to remain in an unacceptable condition for an extended period of time.

The maximum allowable power level initially determined by Required Action A.1 may be affected by subsequent determinations of $F_Q^C(Z)$ and would require power reductions within 15 minutes of the $F_Q^C(Z)$ determination, if necessary, to comply with the decreased maximum allowable power level. Decreases in $F_Q^C(Z)$ would allow increasing the maximum allowable power level and increasing power up to the revised limit.

If an F_Q surveillance is performed at 100% RTP conditions and both $F_Q^C(Z)$ and $F_Q^W(Z)$ exceed their limits, the option to reduce the THERMAL POWER limit in accordance with Required Action B.2.1, instead of implementing a new operating space in accordance with Required Action B.1, will result in a further power reduction after Required Action A.1 has been completed. However, this further power reduction would be permitted to occur over the next 4 hours. In the event the evaluated THERMAL POWER reduction in the COLR for Required Action B.2.1 did not result in a further power reduction (for example, if both Condition A and Condition B were entered at less than 100% RTP conditions), then the THERMAL POWER level established as a result of completing Required Action A.1 will take precedence, and will establish the effective operating power level limit for the unit until both Conditions A and B are exited.

A.2

A reduction of the Power Range Neutron Flux - High trip setpoints by ≥ 1% for each 1% ~~by which $F_Q^C(Z)$ exceeds its limit~~ that THERMAL POWER is limited below RATED THERMAL POWER by Required Action A.1, is a conservative action for protection against the consequences of severe transients with unanalyzed power distributions. The Completion Time of ~~8~~ 72 hours is sufficient considering the small likelihood of a severe transient in this time period and the preceding prompt reduction in THERMAL POWER in accordance with Required Action A.1. The maximum allowable Power Range Neutron Flux - High trip setpoints initially determined by Required Action A.2 may be affected by subsequent determinations of $F_Q^C(Z)$ and would require Power Range Neutron Flux - High trip setpoint reductions within 72 hours of the $F_Q^C(Z)$ determination, if necessary, to comply with the decreased maximum

(continued)

BASES (continued)

allowable Power Range Neutron Flux - High trip setpoints. Decreases in $F_Q^C(Z)$ would allow increasing the maximum allowable Power Range Neutron Flux - High trip setpoints.

A.3

Reduction in the Overpower ΔT trip setpoints (value of K_4) by ≥ 1% for each 1% ~~by which $F_Q^C(Z)$ exceeds its limit~~ that THERMAL POWER is limited below RATED THERMAL POWER by Required Action A.1, 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 severe transient in this time period, and the preceding prompt reduction in THERMAL POWER in accordance with Required Action A.1. The maximum allowable Overpower ΔT trip setpoint initially determined by Required Action A.3 may be affected by subsequent determinations of $F_Q^C(Z)$ and would require Overpower ΔT trip setpoint reductions within 72 hours of the $F_Q^C(Z)$ determination, if necessary, to comply with the decreased maximum allowable Overpower ΔT trip setpoints. Decreases in $F_Q^C(Z)$ would allow increasing the maximum allowable Overpower ΔT trip setpoints.

A.4

Verification that $F_Q^C(Z)$ has been restored to within its limit, by performing SR 3.2.1.1 and SR 3.2.1.2 prior to increasing THERMAL POWER above the limit imposed by Required Action A.1, ensures that core conditions during operation at higher power levels and future operation are consistent with safety analyses assumptions.

Condition A is modified by a NOTE that requires Required Action A.4 to be performed whenever the Condition is entered prior to increasing THERMAL POWER above the limit of Required Action A.1. The Note also states that SR 3.2.1.2 is not required to be performed if this Condition is entered prior to THERMAL POWER exceeding 75% RTP after a refueling. This ensures that SR 3.2.1.1 and SR 3.2.1.2 (if required) will be performed prior to increasing THERMAL POWER above the limit of Required Action A.1 even when Condition A is exited prior to performing Required Action A.4. Performance of SR 3.2.1.1 and SR 3.2.1.2 are necessary to ensure $F_Q(Z)$ is properly evaluated prior to increasing THERMAL POWER.

(continued)

BASES (continued)

ACTIONS (continued)

B.1.1

If it is found that the maximum calculated value of $F_Q(Z)$ that can occur during normal maneuvers, $F_Q^W(Z)$, exceeds its specified limits, there exists a potential for $F_Q^C(Z)$ to become excessively high if a normal operational transient occurs. ~~Reducing the AFD limits by ≥ 1% for each 1% by which $F_Q^W(Z)$ exceeds its limit within the allowed Completion Time of 2 hours, restricts the axial flux distribution such that even if a transient occurred, core peaking factors would be similarly restricted.~~ Implementing a more restrictive RAOC operating space, as specified in the COLR, within the allowed Completion Time of 4 hours will restrict the AFD such that peaking factor limits will not be exceeded during non-equilibrium normal operation. Several RAOC operating spaces, representing successively smaller AFD envelopes and, optionally shallower Control Bank Insertion Limits, may be specified in the COLR. The corresponding T(Z) functions for these operating spaces can be used to determine which RAOC operating space will result in acceptable non-equilibrium operation within the $F_Q^W(Z)$ limit.

B.1.2

If it is found that the maximum calculated value of $F_Q(Z)$ that can occur during normal maneuvers, $F_Q^W(Z)$, exceeds its specified limits, there exists a potential for $F_Q^C(Z)$ to become excessively high if a normal operational transient occurs. As discussed above, Required Action B.1.1 requires that a new RAOC operating space be implemented to restore $F_Q^W(Z)$ to within its limits. Required Action B.1.2 requires that SR 3.2.1.1 and SR 3.2.1.2 be performed if control rod motion occurs as a result of implementing the new RAOC operating space in accordance with Required Action B.1.1. The performance of SR 3.2.1.1 and SR 3.2.1.2 is necessary to ensure $F_Q(Z)$ is properly evaluated after any rod motion resulting from the implementation of a new RAOC operating space in accordance with Required Action B.1.1.

B.2.1

When $F_Q^W(Z)$ exceeds it limit, Required Action B.2 may be implemented instead of Required Action B.1. Required Action B.2.1 limits THERMAL POWER to less than RATED THERMAL POWER by the amount specified in the COLR. It also requires reductions in the AFD limits by the amount specified in the COLR. This maintains an acceptable absolute power density relative to the maximum power density value assumed in the safety analyses.

If the required $F_Q^W(Z)$ margin improvement exceeds the margin improvement available from the pre-analyzed THERMAL POWER and AFD reductions provided in the COLR, then THERMAL POWER must be further reduced to less than or equal to 50% RTP. In this case, reducing THERMAL POWER to less than or equal to 50% RTP will provide

(continued)

BASES (continued)

ACTIONS (continued)

additional margin in the transient F_Q by the required change in THERMAL POWER and the increase in the F_Q limit. This will ensure that the F_Q limit is met during transient operation that may occur at or below 50% RTP.

The Completion Time of 4 hours provides an acceptable time to reduce the THERMAL POWER and AFD limits in an orderly manner to preclude entering an unacceptable condition during future non-equilibrium operation. The limit on THERMAL POWER initially determined by Required Action B.2.1 may be affected by subsequent determinations of $F_Q^W(Z)$ and would require power reductions within 4 hours of the $F_Q^W(Z)$ determination, if necessary, to comply with the decreased THERMAL POWER limit. Decreases in $F_Q^W(Z)$ would allow increasing the THERMAL POWER limit and increasing THERMAL POWER up to this revised limit.

Required Action B.2.1 is modified by a NOTE that states Required Action B.2.4 shall be completed whenever Required Action B.2.1 is performed prior to increasing THERMAL POWER above the limit of Required Action B.2.1. Required Action B.2.4 requires the performance of SR 3.2.1.1 and SR 3.2.1.2 prior to increasing THERMAL POWER above the limit established by Required Action B.2.1. The Note ensures that the SRs will be performed even if Condition B may be exited prior to performing Required Action B.2.4. The performance of SR 3.2.1.1 and SR 3.2.1.2 is necessary to ensure $F_Q(Z)$ is properly evaluated prior to increasing THERMAL POWER.

If an F_Q surveillance is performed at 100% RTP conditions, and both $F_Q^C(Z)$ and $F_Q^W(Z)$ exceed their limits, the option to reduce the THERMAL POWER limit in accordance with proposed Required Action B.2.1 instead of implementing a new operating space in accordance with proposed Required Action B.1, will result in a further power reduction after Required Action A.1 has been completed. However, this further power reduction would be permitted to occur over the next 4 hours. In the event the evaluated THERMAL POWER reduction in the COLR for proposed Required Action B.2.1 did not result in a further power reduction (for example, if both Condition A and Condition B were entered at less than 100% RTP conditions), then the THERMAL POWER level established as a result of completing Required Action A.1 will take precedence, and will establish the effective operating power level limit for the unit until both Conditions A and B are exited.

~~B.2.1, B.2.2, B.2.3, and B.2.4~~

~~Required Actions B.2.1 through B.2.4 are modified by a Note. The Note clarifies that Required Actions B.2.1, B.2.2, B.2.3, and B.2.4 only apply to measurements performed at greater than or equal to 75% RTP that resulted in $F_Q^W(Z)$ not within limits. In the central core regions, $F_Q^W(Z)$ is limiting at full power. Consequently, operation below 75% RTP will not challenge the LCO limit. SR 3.2.1.2 is required to be performed after achieving equilibrium conditions after exceeding, by 10% RTP, the~~

(continued)

BASES (continued)

ACTIONS (continued)

THERMAL POWER at which $F_Q^W(Z)$ was last verified. This ensures that an appropriate margin assessment will be performed at full power equilibrium conditions. The results of this full power surveillance will be sufficient to determine whether subsequent non-equilibrium operation could challenge the LCO limit.

B.2.1

Reducing the maximum allowable power by ≥ 3% RTP for each 1% by which $F_Q^W(Z)$ exceeds its limit, maintains an 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 of AFD limits in accordance with Required Action B.1.

B.2.2

A reduction of 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 by which the maximum allowable power is reduced 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 prompt reduction in maximum allowable power the THERMAL POWER limit and AFD limits in accordance with Required Action B.2.1.

BASES (continued)

ACTIONS (continued)

B.2.3

Reduction in the Overpower ΔT trip setpoints value of K_4 by ≥ 1% for each 1%, by which the maximum allowable power is reduced in accordance with Required Action B.2.1 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 prompt reduction in maximum allowable power the THERMAL POWER limit and AFD limits in accordance with Required Action B.2.1.

B.2.4

Verification that $F_Q^C(Z)$ and $F_Q^W(Z)$ have been restored to within limit, by performing SR 3.2.1.1 and SR 3.2.1.2 prior to increasing THERMAL POWER above the maximum allowable power limit imposed by Required Action B.2.1, ensures that core conditions during operation at higher power levels and future operation are consistent with safety analyses assumptions.

C.1

If Required Actions A.1 through A.4, or B.1.1 and B.2.1 through B.2.4, are not met within their associated Completion Times, the plant must be placed in a mode or condition in which the LCO requirements are not applicable. This is done by placing the plant in at least MODE 2 within 6 hours.

This allowed Completion Time is reasonable based on operating experience regarding the amount of time it takes to reach MODE 2 from full power operation in an orderly manner and without challenging plant systems.

BASES (continued)

SURVEILLANCE REQUIREMENTS

~~SR 3.2.1.1 and SR 3.2.1.2 are modified by a Note. The Note applies during the first power ascension after initial fuel loading and a refueling. It states that THERMAL POWER may be increased until an equilibrium power level has been achieved at which a power distribution map can be obtained. This allowance is modified, however, by one of the Frequency conditions that requires verification that $F_Q^C(Z)$ and $F_Q^W(Z)$ are within their specified limits after a power rise of more than 10% RTP over the THERMAL POWER at which they were last verified to be within specified limits. Because $F_Q^C(Z)$ and $F_Q^W(Z)$ could not have previously been measured in this core, there is a second Frequency condition that requires determination of these parameters before exceeding 75% RTP. This ensures that some determination of $F_Q^C(Z)$ and $F_Q^W(Z)$ is made at a lower power level at which adequate margin is available before going to 100% RTP. Also, this Frequency condition, together with the Frequency condition requiring verification of $F_Q^C(Z)$ and $F_Q^W(Z)$ following a power increase of more than 10%, ensures that they are verified as soon as RTP (or any other level for extended operation) is achieved.~~

(continued)

SURVEILLANCE REQUIREMENTS (continued)

~~In the absence of these Frequency conditions, it is possible to increase power to RTP and operate for 31 days without verification of $F_Q^C(Z)$ and $F_Q^W(Z)$. The Frequency condition is not intended to require verification of these parameters after every 10% increase in power level above the last verification. It only requires verification after a power level is achieved for extended operation that is 10% higher than that power at which F_Q was last measured.~~

SR 3.2.1.1

Verification that $F_Q^C(Z)$ is within its specified limits involves increasing $F_Q^M(Z)$ to allow for manufacturing tolerance and measurement uncertainties in order to obtain $F_Q^C(Z)$. Specifically, $F_Q^M(Z)$ is the measured value of $F_Q(Z)$ obtained from the incore power distribution measurement.

Using the PDMS to obtain the incore power distribution measurement:

$$F_Q^C\ (Z) = \ 1.03\ F_Q^M(Z)\left(1 + \frac{U_Q}{100}\right)$$

where 1.03 is the factor that accounts for the fuel manufacturing tolerances and the factor $(1+U_Q/100)$, which accounts for measurement uncertainty, is calculated and applied automatically by the BEACON™ software (Ref. 4). In order to be consistent with the LOCA analysis and the uncertainty inputs utilized, a minimum uncertainty of 5 should be used for U_Q.

$F_Q^C(Z)$ is then compared to its specified limits. The limit with which $F_Q^C(Z)$ is compared varies inversely with power above 50% RTP and directly with a function called K(Z) provided in the COLR.

Performing this Surveillance in MODE 1 prior to exceeding 75% RTP following a refueling ensures that ~~the $F_Q^C(Z)$ limit is met when RTP is achieved, because peaking factors generally decrease as power level is increased~~ some determination of $F_Q^C(Z)$ is made prior to achieving a significant power level where peak linear heat rate could approach the limits assumed in the safety analysis.

If THERMAL POWER has been increased by ≥ 10% RTP since the ~~last~~ initial or most recent determination of $F_Q^C(Z)$, another evaluation of this factor is required ~~12~~ 24 hours after achieving equilibrium conditions at this higher power level (to ensure that $F_Q^C(Z)$ values are being reduced sufficiently with power increase to stay within the LCO limits). Equilibrium conditions are achieved when the core is sufficiently stable at the intended operating conditions required to perform the surveillance.

The allowance of up to 24 hours after achieving equilibrium conditions at

(continued)

BASES (continued)

SURVEILLANCE REQUIREMENTS (continued)

SR 3.2.1.1 (continued)

the increased THERMAL POWER level to complete the next $F_Q^C(Z)$ surveillance applies to situations where the $F_Q^C(Z)$ has already been measured at least once at a reduced THERMAL POWER level. The observed margin in the previous surveillance will provide assurance that increasing power up to the next plateau will not exceed the F_Q limit, and that the core is behaving as designed.

This Frequency condition is not intended to require verification of these parameters after every 10% increase in RTP above the THERMAL POWER at which the last verification was performed. It only requires verification after a THERMAL POWER is achieved for extended operation that is 10% higher than the THERMAL POWER at which $F_Q^C(Z)$ was last measured.

The Surveillance Frequency is controlled under the Surveillance Frequency Control Program

(continued)

BASES (continued)

SURVEILLANCE REQUIREMENTS (continued)

SR 3.2.1.2

The nuclear design process includes calculations performed to determine that the core can be operated within the $F_Q(Z)$ limits. Because incore power distribution measurements are taken at or near in steady state conditions, the variations in power distribution resulting from normal operational maneuvers are not present in the incore power distribution measurement data. These variations are, however, conservatively calculated by considering a wide range of unit maneuvers in normal operation. The maximum peaking factor increase over steady state values, calculated as a function of core elevation, Z, is called W(Z). Multiplying the measured total peaking factor, $F_Q^C(Z)$, by W(Z) and by dividing by P gives the maximum $F_Q(Z)$ calculated to occur in normal operation, $F_Q^W(Z)$. Scaling the W(Z) factors by "1/P" accounts for the possibility that reactor power may be increased prior to the next F_Q surveillance (Ref. 5).

The measured $F_Q(Z)$ can be determined through a synthesis of the measured planar radial peaking factors, $F_{XY}^M(Z)$, and the measured core average axial power shape, $P^M(Z)$. Thus, $F_Q^C(Z)$ is given by the following expression:

$$F_Q^C(Z) = 1.03\ F_{XY}^M(Z)\ P^M(Z)\ (1 + U_Q/100) = 1.03\ F_Q^M(Z)\ (1 + U_Q/100)$$

For RAOC operation, the analytical $[T(Z)]^{COLR}$ functions, specified in the COLR for each RAOC operating space, are used together with the measured $F_{XY}(Z)$ values to estimate $F_Q(Z)$ for non-equilibrium operation within the RAOC operating space. When the $F_{XY}(Z)$ values are measured at HFP ARO conditions ($A_{XY}(Z)$ equals 1.0), $F_Q^W(Z)$ is given by the following expression:

$$F_Q^W(Z) = 1.03\ F_{XY}^M(Z)\ [T(Z)]^{COLR}\ R_j\ (1 + U_Q/100)$$

Non-equilibrium operation can result in significant changes to the axial power shape. To a lesser extent, non-equilibrium operation can increase the radial peaking factors, $F_{XY}(Z)$, through control rod insertion and through reduced Doppler and moderator feedback at part-power conditions.

The $[T(Z)]^{COLR}$ functions quantify these effects for the range of power shapes, control rod insertion, and power levels characteristic of the operating space. Multiplying $[T(Z)]^{COLR}$ by the measured full power, un-rodded $F_{XY}^M(Z)$ value, and the factor that accounts for manufacturing and measurement uncertainties gives $F_Q^W(Z)$, the maximum total peaking factor postulated for non-equilibrium RAOC operation.

The limit with which $F_Q^W(Z)$ is compared varies inversely with power above 50% RTP and directly with the function K(Z) provided in the COLR.

(continued)

BASES (continued)

SURVEILLANCE REQUIREMENTS (continued)

SR 3.2.1.2 (continued)

The W(Z) curve is provided $[T(Z)]^{COLR}$ functions are specified in the COLR for discrete core elevations. Incore power distribution measurement results are typically calculated at 30 to 75 core elevations. $F_Q^W(Z)$ evaluations are not applicable for the following axial core regions, measured in percent of core height:

a. Lower core region, from 0 to 10% inclusive; and,

b. Upper core region, from 90 to 100% inclusive.,

c. Grid plane regions, +2% inclusive, and

d. Core Plane regions, within 2% of the bank demand positions of the control banks.

The top and bottom 10% These regions of the core are excluded from the evaluation because of the low probability that they would be more limiting in the safety analysis and because of the difficulty of making a precise measurement in these regions. The excluded regions are specified in the COLR and are defined to ensure that the minimum margin location is adequately surveilled. A slightly smaller exclusion zone may be specified, if necessary, to include the limiting margin location in the surveilled region of the core.

This Surveillance has been modified by a Note that may require that more frequent surveillances be performed. If $F_Q^W(Z)$ increased by the appropriate factor specified in the COLR is not within limit, then $F_Q(Z)$ is required to be evaluated more frequently, each 7 EFPD. The appropriate factor specified in the COLR bounds the amount $F_Q(Z)$ is expected to increase within the normal surveillance frequency of 31 EFPD. The increased surveillance frequency, 7 EFPD, may be discontinued when two successive F_Q evaluations indicate increasing margin to the limit.

(continued)

BASES (continued)

SURVEILLANCE REQUIREMENTS (continued)

SR 3.2.1.2 (continued)

~~These alternative requirements prevent $F_Q(Z)$ from exceeding its limit for any significant period of time without detection.~~

~~Performing the Surveillance in MODE 1 prior to exceeding 75% RTP ensures that the $F_Q(Z)$ limit is met when RTP is achieved, because peaking factors are generally decreased as power level is increased.~~

~~$F_Q(Z)$ is verified at power levels ≥ 10% RTP above the THERMAL POWER of its last verification, 12 hours after achieving equilibrium conditions to ensure that $F_Q(Z)$ is within its limit at higher power levels.~~

SR 3.2.1.2 requires a Surveillance of $F_Q^W(Z)$ during the initial startup following each refueling within 24 hours after exceeding 75% RTP. THERMAL POWER levels below 75% are typically non-limiting with respect to the limit for $F_Q^W(Z)$. Furthermore, startup physics testing and flux symmetry measurements, also performed at low power, provide confirmation that the core is operating as expected. This Frequency ensures that verification of $F_Q^W(Z)$ is performed prior to extended operation at power levels where the maximum permitted peak LHR could be challenged and that the first required performance of SR 3.2.1.2 after a refueling is performed at a power level high enough to provide a high level of confidence in the accuracy of the Surveillance result.

Equilibrium conditions are achieved when the core is sufficiently stable at the intended operating conditions required to perform the Surveillance.

If a previous Surveillance of $F_Q^W(Z)$ was performed at part power conditions, SR 3.2.1.2 also requires that $F_Q^W(Z)$ be verified at power levels ≥ 10% RTP above the THERMAL POWER of its last verification within 24 hours after achieving equilibrium conditions. This ensures that $F_Q^W(Z)$ is within its limit using radial peaking factors measured at the higher power level.

The allowance of up to 24 hours after achieving equilibrium conditions will provide a more accurate measurement of $F_Q^W(Z)$ by allowing sufficient time to achieve equilibrium conditions and obtain the power distribution measurement.

The Surveillance Frequency is controlled under the Surveillance Frequency Control Program.

(continued)

BASES (continued)

REFERENCES

1. Title 10, Code of Federal Regulations, Part 50.46, "Acceptance Criteria for Emergency Core Cooling Systems for Light Water Nuclear Power Reactors."

2. Regulatory Guide 1.77, Rev. 0, "Assumptions Used for Evaluating a Control Rod Ejection Accident for Pressurized water Reactors," May 1974.

3. Title 10, Code of Federal Regulations, Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants," GDC 26, "Reactivity Control System Redundancy and Capability."

4. WCAP-12472-P-A, "BEACON™ Core Monitoring and Operations Support System," August 1994, (Addendum 2, April 2002).

~~5. Westinghouse Technical Bulletin (TB) 08-4, "F_Q Surveillance at Part Powers," July 15, 2008.~~

~~6~~5. WCAP-10216-P-A, Rev. 1A, "Relaxation of Constant Axial Offset Control (and) F_Q Surveillance Technical Specification," February 1994.~~Not used.~~

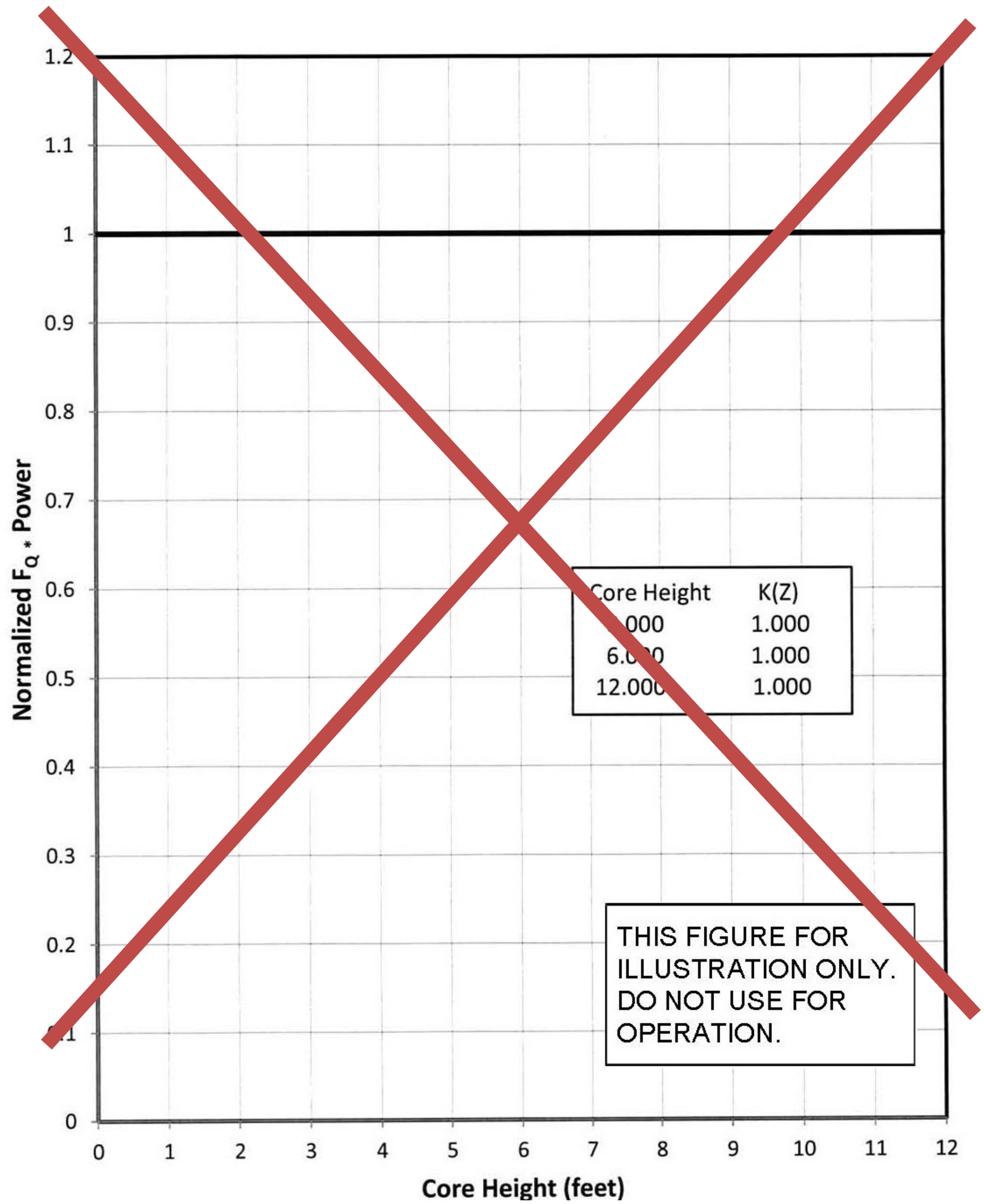
~~7. Westinghouse Nuclear Safety Advisory Letter, NSAL-09-5, Revision 1, "Relaxed Axial Offset Control F_Q Technical Specification Actions," September 23, 2009.~~

~~8. Westinghouse Nuclear Safety Advisory Letter, NSAL-15-1, "Heat Flux Channel Factor Technical Specification Surveillance," February 3, 2015.~~

6. WCAP-17661-P-A, "Improved RAOC and CAOC F_Q Surveillance Technical Specifications," February 2019.

(continued)

BASES (continued)



(continued)

BASES (continued)

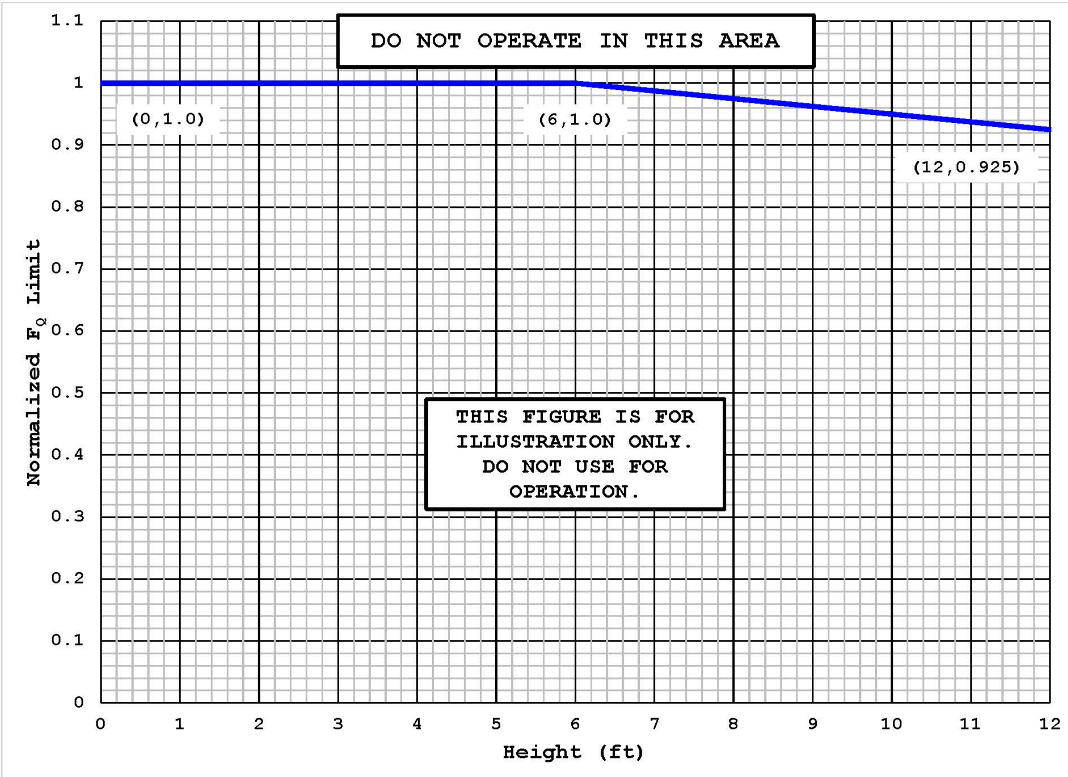


Figure B 3.2.1-1 (page 1 of 1)
K(Z) - Normalized $F_Q(Z)$ as a Function of Core Height

(continued)