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PG&E Letter DCL-20-063

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
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10 CFR 50.90

Diablo Canyon Units 1 and 2
Docket No. 50-275, OL-DPR-80
Docket No. 50-323, OL-DPR-82
License Amendment Request 20-02,
Non-Voluntary License Amendment Request to Revise Technical Specifications 3.2.1, $F_Q(Z)$, to Implement Methodology from WCAP-17661, Revision 1, "Improved RAOC and CAOC F_Q Surveillance Technical Specifications"

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 FQ 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. Westinghouse Nuclear Safety Advisory Letter (NSAL-09-05), Revision 1, "Relaxed Axial Offset Control F_Q Technical Specification Actions," dated September 23, 2009
5. Westinghouse Nuclear Safety Advisory Letter (NSAL-15-1), "Heat Flux Hot Channel Factor Technical Specification Surveillance" dated February 3, 2015

Dear Commissioners and Staff:

Pursuant to 10 CFR 50.90, Pacific Gas and Electric Company (PG&E) hereby requests approval of the enclosed proposed amendment to the Diablo Canyon

Power Plant (DCPP) Facility Operating License Nos. DPR-80 and DPR-82 for Units 1 and 2, respectively. The enclosed license amendment request (LAR) proposes to modify 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) with deviations to the Condition B Required Action Completion Times. The proposed revised TS 3.2.1 are also consistent with NUREG-1431, Revision 4, "Standard Technical Specifications Westinghouse Plants," (Reference 3). Additionally, this LAR modifies TS 5.6.5b 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).

Nuclear Safety Advisory Letter (NSAL) 09-05, Revision 1, (Reference 4) and NSAL-15-1, (Reference 5) 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). PG&E 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, environmental considerations, and PG&E's determination that the proposed changes involve no significant hazards. Attachment 1 to the Enclosure provides markup pages of TS to show the proposed change. Attachment 2 to the Enclosure provides retyped TS pages. Attachment 3 to the Enclosure provides the TS Bases markups. Changes to the TS Bases are provided for information only and will be implemented under the Technical Specification Bases Control Program.

The changes in this LAR are not required to address an immediate safety concern. PG&E requests approval of this non-voluntary LAR 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 be prior to Mode 4 entry for DCPP Unit 1 Cycle 24 (Spring 2022) and DCPP Unit 2 Cycle 24 (Fall 2022). The DCPP Unit 1 and 2 Cycles 24 are currently planned to begin in April and November, 2022, respectively.

PG&E makes no new or revised regulatory commitments (as defined by NEI 99-04) in this letter.

In accordance with DCPP administrative procedures and the Quality Assurance Program, the proposed amendment has been reviewed by the Plant Staff Review Committee.

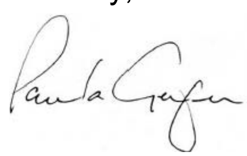
Pursuant to 10 CFR 50.91, PG&E is sending a copy of this proposed amendment to the California Department of Public Health.

If you have any questions or require additional information, please contact Mr. James Morris, Acting Regulatory Services Manager, at (805) 545-4720.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on August 31, 2020.

Sincerely,



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Enclosure
cc: Diablo Distribution
cc/enc: Samson S. Lee, NRR Senior Project Manager
Scott A. Morris, NRC Region IV Administrator
Christopher W. Newport, NRC Senior Resident Inspector
Gonzalo L. Perez, Branch Chief, California Department of Public Health

Evaluation of the Proposed Change

License Amendment Request 20-02, Non-Voluntary License Amendment Request to Revise Technical Specifications 3.2.1, $F_Q(Z)$, to Implement Methodology from WCAP-17661, Revision 1, "Improved RAOC and CAOC F_Q Surveillance Technical Specifications"

ATTACHMENTS:

EVALUATION

1. SUMMARY DESCRIPTION

This letter is a non-voluntary request to amend the Diablo Canyon Power Plant (DCPP) Facility Operating Licenses DPR-80 and DPR-82 for Units 1 and 2, respectively. The proposed license amendment request (LAR) requests approval to revise Technical Specification (TS) 3.2.1, “Heat Flux Hot Channel Factor ($F_Q(Z)$),” to implement the improved F_Q Surveillance TS methodology in WCAP-17661-P-A, Revision 1, “Improved RAOC and CAOC F_Q Surveillance Technical Specifications,” (References 1 and 2), with deviations to the Condition B Required Action Completion Times. The proposed revised DCPP 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 DCPP Unit 1 and Unit 2 TS 5.6.5b 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).

2. 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 DCPP 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_QW(Z) is not within its limit, the existing Required Actions may be insufficient to restore F_QW(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 (F_Q (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, PG&E determined that DCPP Units 1 and 2 TS 3.2.1 constitute a non-conservative TS and entered this into the corrective action program. PG&E implemented the References 5 and 6 recommended actions procedurally for DCPP Unit 1 and 2.

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 reduces 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 DCPP Unit 1 and Unit 2 TS 3.2.1 and TS 5.6.5b that implement the methodology and TS changes in Reference 2 with deviations to the Condition B Required Action Completion Times. Further description of the proposed changes is provided in Section 3.2 to this enclosure.

Attachment 1 to this enclosure provides the DCPP Units 1 and 2 TS pages marked-up to show the proposed changes. Attachment 2 to this enclosure provides the DCPP Units 1 and 2 TS pages retyped to show the proposed changes. Attachment 3 to this enclosure provide the DCPP Units 1 and 2 TS Bases pages marked-up to show the proposed changes to Bases 3.2.1 for the changes associated with Appendix A of Reference 2 for a Relaxed Axial Offset Control plant. Changes to the TS Bases are provided for information only and will be implemented under the Technical Specification Bases Control Program.

2.3 Reason for Proposed the 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 DCPP Units 1 and 2 TS with the STS changes in Reference 2. The new F_Q formulation reduces the surveillance sensitivity to the predicted axial power shapes and remove the potential non-conservatism in TS 3.2.1.

3. 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 3.1.6, “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 DCPP Updated Final Safety Analysis Report (UFSAR).

RAOC, as described in WCAP-10216-P-A, Revision 1A, “Relaxation of Constant Axial Offset Control/F_Q 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 3.1.5 requires each shutdown bank to be within the insertion limits as specified in the COLR. TS 3.1.6 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 3.1.4, "Rod Group Alignment Limits," TS 3.1.5, TS 3.1.6, 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 DCPP TS 3.2.1 reflects the original RAOC methodology contained in Reference 7. The TS 3.2.1 changes based on References 1 and 2 reflect the recommended action from References 5 and 6, which supplement the original Reference 7 methodology. The new F_Q formulation reduces the surveillance sensitivity to the predicted axial power shapes and remove the potential non-conservatism in TS 3.2.1.

DCPP Units 1 and 2 utilize the MIDS and a PDMS using core exit thermocouples. For DCPP, the fuel manufacturing tolerances and measurement uncertainty factor, U_{FQ}, used to determine if the F_Q limit is met is dependent on the method used to measure either $F_Q^M(Z)$ or $F_{XY}^M(Z)$. The formulation of the uncertainty factor used for each method is specified in the COLR based on the specific detections systems in use at DCPP. Therefore, in this section and the TS Bases, the existing DCPP measurement uncertainty term U_{FQ} has been used in place of the bracketed uncertainty value of [1.0815] used in Reference 2.

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

3.2.1 TS 3.2.1 LCO

While the TS 3.2.1 LCO remains unchanged, the underlying formulation of the approximation, $F_Q^W(Z)$, is changed. The current formulation for $F_Q^W(Z)$ is:

$$F_Q^W(Z) = F_Q^C(Z)\ W(Z)$$

The new formulations for $F_Q^W(Z)$ using the methodology of Reference 2 is:

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

In the new formulations, the measured parameter is $F_{XY}^M(Z)$, 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, $[T(Z)]^{COLR}$. U_{FQ} is a factor that accounts for consideration of fuel manufacturing tolerances and measurement uncertainty and is currently utilized at DCPP for determination of $F_Q^C(Z)$ as described in the TS 3.2.1 SR 3.2.1.1 Bases. 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, compared to the current formulation that is used.

3.2.2 TS 3.2.1 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.

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.

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.

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.

3.2.3 TS 3.2.1 Condition B

The current DCPP 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% $F_Q^W(Z)$ exceeds its limit 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 limited (reduced) to $\geq$ 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 limited (reduced) to $\geq$ 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.

The Completion Times for Required Actions B.2.1, B.2.2, and B.2.3 contain a deviation from those contained in Reference 2. They include the phrase "after each $F_Q^W(Z)$ determination." This additional phrase has been included to these Completion Times since the THERMAL POWER initially determined by Required Action B.2.1 may be affected by subsequent determinations of $F_Q^W(Z)$ that are not within limit when Required Action B.2.4 is performed and could require additional power reductions within 4 hours of the of the subsequent $F_Q^W(Z)$ determination, if necessary to comply with the decreased THERMAL POWER limit. The additionof the phrase "after each $F_Q^W(Z)$ determination" to the Completion Times for Required Action B.2.1, B.2.2, and B.2.3 ensures they apply after each subsequent determination $F_Q^W(Z)$ during performance of Required Action B.2.4, similar to the phrase "after each $F_Q^C(Z)$ determination" that is contained in the Completion Times for Required Actions A.1, A.2, and A.3 associated with $F_Q^C(Z)$ in Reference 2. The TS Bases for Required Actions B.2.1, B.2.2, and B.2.3 have been updated to include the reason for the inclusion of the phrase "after each $F_Q^W(Z)$ determination."

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.

3.2.4 TS 3.2.1 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." The new surveillance Frequency requirements are unambiguous and the Bases have been enhanced with the explanation of the equilibrium conditions necessary for surveillance performance. Therefore, this Note is no longer required as approved by the staff in Section 4.4 of the final safety evaluation for WCAP-17661-P-A, Revision 1, contained in Reference 2.

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. 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.

It is noted in the TS in Reference 2 the second surveillance Frequency for SR 3.2.1.1 and 3.2.1.2 contain a value of "$\geq$10"RTP" for the RTP change for which after achieving equilibrium conditions, the SR must be performed. The DCPP TS SRs 3.2.1.1 and 3.2.1.2 contain a plant specific value of "$\geq$20"RTP" as approved by the NRC as part of conversion to STS in Reference 8. The

"$\geq$10"RTP" value in the SRs 3.2.1.1 and 3.2.1.2 Frequency was not part of the scope of changes made to TS 3.2.1 in Reference 2 to address the non-conservative aspects of TS 3.2.1. Therefore, the DCPP plant specific value of "$\geq$20"RTP" in the SRs 3.2.1.1 and 3.2.1.2 Frequency has not been changed.

3.2.5 TS 3.6.5 COLR

TS 5.6.5b Reference 5 was added to include a reference to WCAP-17661-P-A Revision 1. The new $F_Q^W(Z)$ formulation and surveillance requirements are directly related to this newly approved topical report (TR).

3.3 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 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.*

PG&E Response

WCAP-17661-P-A and the TS 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 Request for Additional Information 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 DCPP uses the RAOC methodology.

Limitation 2: Power Level Reduction to 50% RTP

As noted in Section 4.3.2 of this SE, the use of 50% 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%, must be implemented on a plant-specific basis and included in COLR input generated, using this methodology, in order to use this TR.

PG&E Response

WCAP-17661-P-A Revision 1 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 DCPP 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 as part of implementation of the WCAP-17661-P-A Revision 1 methodology.

3.4. Conclusions

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. REGULATORY EVALUATION

4.1 Applicable Regulatory Requirements/Criteria

General Design Criteria

DCPP Units 1 and 2 were designed to comply with the Atomic Energy Commission (AEC) (now the Nuclear Regulatory Commission, or NRC) General Design Criteria (GDC) for Nuclear Power Plant Construction Permits, published in July 1967. PG&E has made subsequent commitments to GDCs issued later (e.g., 1971 GDC 10 for reactor design) that are discussed in Section 3.1 of the DCPP UFSAR. The applicable criterion listed below related to this change are individually addressed.

Criterion 10 (1971 GDC), Reactor Design

The reactor core and associated coolant, control, and protection systems shall be designed with appropriate margin to assure that specified acceptable fuel design limits are not exceeded during any condition of normal operation, including the effects of anticipated operational occurrences.

Conformance with GDC 10 is described in Section 3.1.3.1.1 of the DCPP UFSAR. GDC 10, 1971 supersedes GDC 6, 1967 with respect to the design of the reactor core.

Each reactor core with its related control and protection systems is designed to function throughout its design lifetime without exceeding acceptable fuel damage limits. 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 the loss of reactor coolant flow, trip of the turbine-generator, loss of normal feedwater, and loss of offsite power.

Criterion 13 (1967 GDC) - Fission Process Monitors and Controls

Means shall be provided for monitoring and maintaining control over the fission process throughout core life and for all conditions that can reasonably be anticipated to cause variations in reactivity of the core, such as indication of position of control rods and concentration of soluble reactivity control poisons.

Conformance with GDC 13 is described in Section 3.1.4.3 of the DCPP UFSAR.

Control over the fission process for each reactor will be maintained throughout the core life by the combination of control rods and chemical shim (boration). Adequate indication of the core reactivity status is provided by the nuclear instrumentation system (NIS). Periodic samples of boron concentration and continuous indication of RCS temperature and control rod position provide additional fission process information.

During operation, the shutdown rod banks are fully withdrawn. The 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 control banks are designed to shut down the reactor under conditions of normal operation and anticipated operational occurrences.

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

Criterion 20 (1967 GDC) - Protection Systems Redundancy and Independence

Redundancy and independence designed into protection systems shall be sufficient to assure that no single failure or removal from service of any component or channel of a system will result in loss of the protection function. The redundancy provided shall include, as a minimum, two channels of protection for each protection function to be served. Different principles shall be used where necessary to achieve true independence of redundant instrumentation components.

Conformance with GDC 20 is described in Section 3.1.5.2 of the DCPP UFSAR.

Sufficient redundancy and independence is designed into the protection systems to ensure that no single failure nor removal from service of any component or channel of a system will result in loss of the protection function. The minimum redundancy is exceeded in each protection function that is active with the reactor at power.

Functional diversity and consequential location diversity are designed into the systems. DCPP uses the Westinghouse Eagle 21 Process Protection System to provide the protection functions.

Criterion 26 (1971 GDC) - 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 margins 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 3.1.6.1.1 of the DCPP UFSAR. Criterion 27, 1967 is no longer part of the DCPP license basis and has been replaced by GDC 26, 1971.

Two independent reactivity control systems of different design principles are provided for each reactor. These are RCCAs and chemical shim (boration). The boron system is capable of maintaining the reactor in a subcritical status under cold shutdown conditions and is capable of controlling the rate of reactivity change resulting from planned normal power changes including xenon burnout. The rod control system maintains a programmed average reactor temperature with scheduled and transient load changes. The RCCAs are inserted into the core by the force of gravity.

The RCCA system is capable of making and holding the core subcritical from all operating and hot shutdown conditions sufficiently fast to prevent exceeding acceptable fuel damage limits. The chemical shim control is also capable of making and holding the core subcritical, but at a slower rate, and is not employed as a means of compensating for rapid reactivity transients. The RCCA system is, therefore, used in protecting each core from fast transients.

4.2 Precedent

A similar LAR has been requested for TS changes for WCAP-17661-P-A Revision 1 for Watts Bar Units 1 and 2 by Tennessee Valley Authority in Reference 9. Watts Bar Unit 1 utilizes PDMS and MIDs instrumentation to meet the TS 3.2.1 requirements.

4.3 Significant Hazards Consideration

PG&E has evaluated whether or not a significant hazards consideration is involved with the proposed amendment by focusing on the three standards set forth in 10 CFR 50.92, “Issuance of amendment,” as discussed below.

1. Does the proposed change involve a significant increase in the probability or consequences of an 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 Nuclear Instrumentation System (NIS) and over-power delta temperature (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 axial flux difference (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 probability or consequences of an accident previously evaluated.

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

   Response: No.

   The proposed change will reformulate 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 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 accident from any accident previously evaluated.

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

   Response: No.

   The proposed change will reformulate 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 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.

   Therefore, the proposed change does not involve a significant reduction in a margin of safety.

   Based on the above evaluation, PG&E concludes that the proposed change 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.

4.4 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.

5. ENVIRONMENTAL CONSIDERATION

PG&E has evaluated the proposed amendment and has determined that the proposed amendment does not involve (i) a significant hazards consideration, (ii) a significant change in the types or significant increase in the amounts of any effluents that may be released offsite, or (iii) a significant increase in individual or cumulative occupational radiation exposure. Accordingly, the proposed amendment 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 amendment.

6. 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/F_Q Surveillance Technical Specification," dated February 1994
8. NRC Letter, "Conversion to Improved Technical Specifications for Diablo Canyon Power Plant, Units I and 2 – Amendment No. 135 to Facility Operating License Nos. DPR-80 and DPR-82 (TAC Nos. M98984 and M98985)," dated May 28, 1999.
9. Tennessee Valley Authority Letter CNL-19-115 , "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 F_Q Surveillance Technical Specifications, (WBN-TS-19-08)," dated March 2, 2020.

Technical Specification Markup Pages

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
[Insert 1] A. $F_Q^C(Z)$ not within limit.	A.1 Reduce THERMAL POWER ≥ 1% RTP for each 1% $F_Q^C(Z)$ exceeds limit. AND A.2 Reduce Power Range Neutron Flux—High trip setpoints ≥ 1% for each 1% ~~$F_Q^C(Z)$ exceeds limit.~~ [Insert 2] AND A.3 Reduce Overpower ΔT trip setpoints ≥ 1% for each 1% ~~$F_Q^C(Z)$ exceeds limit.~~ [Insert 2] AND A.4 Perform SR 3.2.1.1. [Delete Period] [and SR 3.2.1.2.]	15 minutes after each $F_Q^C(Z)$ determination 72 hours after each $F_Q^C(Z)$ determination 72 hours after each $F_Q^C(Z)$ determination Prior to increasing THERMAL POWER above the limit of Required Action A.1
B. $F_Q^W(Z)$ not within limits.	B.1 [.1] ~~Reduce AFD limits ≥ 1% for each 1% $F_Q^W(Z)$ exceeds limit.~~	~~4 hours~~ [Insert 3]
C. Required Action and associated Completion Time not met.	C.1 Be in MODE 2.	6 hours

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SURVEILLANCE REQUIREMENTS

---NOTE---
During power escalation following shutdown, 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 each refueling prior to THERMAL POWER exceeding 75% RTP <u>AND</u> Once within 24 hours after achieving equilibrium conditions after exceeding, by ≥ 20% RTP, the THERMAL POWER at which $F_Q^C(Z)$ was last verified <u>AND</u> In accordance with the Surveillance Frequency Control Program

(continued)

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SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.2.1.2	~~-----NOTE-----~~ ~~If $F^C_Q(Z)$ 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 until two successive power distribution measurements indicate~~ ~~maximum over z $\left[\frac{F^C_Q(Z)}{K(Z)}\right]$~~ ~~has not increased.~~ ~~----------~~ Verify $F^W_Q(Z)$ is within limit.	Once after each refueling ~~prior to~~ within 24 hours after THERMAL POWER ~~exceeding~~ exceeds 75% RTP <u>AND</u> (continued)

SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY
SR 3.2.1.2 (continued)	Once within 24 hours after achieving equilibrium conditions after exceeding, by ≥ 20% RTP, the THERMAL POWER at which $F_Q^W(Z)$ was last verified AND In accordance with the Surveillance Frequency Control Program

5.6 Reporting Requirements

5.6.5 CORE OPERATING LIMITS REPORT (COLR) (continued)

b. The analytical methods used to determine the core operating limits shall be those previously reviewed and approved by the NRC, specifically those described in the following documents:

1. WCAP-10216-P-A, Relaxation of Constant Axial Offset Control F_Q Surveillance Technical Specification, (Westinghouse Proprietary),
2. WCAP-9272-P-A, Westinghouse Reload Safety Evaluation Methodology, (Westinghouse Proprietary),
3. WCAP-8385, Power Distribution Control and Load Following Procedures, (Westinghouse Proprietary),
4. WCAP-16996-P-A, Revision 1, "Realistic LOCA Evaluation Methodology Applied to the Full Spectrum of Break Sizes (FULL SPECTRUM LOCA Methodology),"
5. ~~Not used.~~ WCAP-17661-P-A, Revision 1, "Improved RAOC and CAOC F_Q Surveillance Technical Specifications,"
6. Not used.
7. Not used.
8. Not used.
9. WCAP-8567-P-A, "Improved Thermal Design Procedure,"
10. WCAP-16045-P-A, "Qualification of the Two Dimensional Transport Code PARAGON," and
11. WCAP-16045-P-A, Addendum 1-A, "Qualification of the NEXUS Nuclear Data Methodology."

(continued)

TS Inserts (page 1/3)

Insert 1

----------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.

Insert 2

that THERMAL POWER is limited below RATED THERMAL POWER by Required Action A.1.

TS Inserts (continued) (page 2/3)

Insert 3

REQUIRED ACTION		COMPLETION TIME
B.1.1	Implement a RAOC operating space specified in the COLR that restores F_Q^W (Z) to within limits.	4 hours
<u>AND</u>		
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 allowable THERMAL POWER and AFD limits as specified in the COLR.	4 hours after each F_Q^W (Z) determination
<u>AND</u>		
B.2.2	Limit 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.	72 hours after each F_Q^W (Z) determination
<u>AND</u>		

TS Inserts (continued) (page 3/3)

Insert 3 (continued)

REQUIRED ACTION		COMPLETION TIME
B.2.3	Limit Overpower ΔT trip setpoints $\geq$ 1 % for each 1% that THERMAL POWER is limited below RATED THERMAL POWER by Required Action B.2.1.	72 hours after each F_Q^W (Z) determination
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

Technical Specification Retyped Pages

Remove Page	Insert Page
3.2-1	**3.2-1**
	3.2-1a
3.2-2	**3.2-2**
3.2-3	**3.2-3**
3.2-4	**3.2-4**
5.0-20	**5.0-20**

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
	<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

CONDITION	REQUIRED ACTION		COMPLETION TIME
A. (continued)	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
	<u>AND</u>		
	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.	4 hours
	<u>AND</u>		
	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. --------------------------------	

(continued)

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
B. (continued)	B.2.1 Limit allowable THERMAL POWER and AFD limits as specified in the COLR.	4 hours after each $F_Q^W(Z)$ determination
	AND	
	B.2.2 Limit 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.	72 hours after each $F_Q^W(Z)$ determination
	AND	
	B.2.3 Limit 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 after each $F_Q^W(Z)$ determination
	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
C. Required Action and associated Completion Time not met.	C.1 Be in MODE 2.	6 hours

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 AND Once within 24 hours after achieving equilibrium conditions after exceeding, by ≥ 20% RTP, the THERMAL POWER at which $F_Q^C(Z)$ was last verified AND In accordance with the Surveillance Frequency Control Program

(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 AND Once within 24 hours after achieving equilibrium conditions after exceeding, by ≥ 20% RTP, the THERMAL POWER at which $F_Q^w(Z)$ was last verified AND In accordance with the Surveillance Frequency Control Program

5.6 Reporting Requirements

5.6.5 CORE OPERATING LIMITS REPORT (COLR) (continued)

b. The analytical methods used to determine the core operating limits shall be those previously reviewed and approved by the NRC, specifically those described in the following documents:

1. WCAP-10216-P-A, Relaxation of Constant Axial Offset Control F_Q Surveillance Technical Specification, (Westinghouse Proprietary),
2. WCAP-9272-P-A, Westinghouse Reload Safety Evaluation Methodology, (Westinghouse Proprietary),
3. WCAP-8385, Power Distribution Control and Load Following Procedures, (Westinghouse Proprietary),
4. WCAP-16996-P-A, Revision 1, "Realistic LOCA Evaluation Methodology Applied to the Full Spectrum of Break Sizes (FULL SPECTRUM LOCA Methodology),"
5. WCAP-17661-P-A, Revision 1, “Improved RAOC and CAOC F_Q Surveillance Technical Specifications,”
6. Not used.
7. Not used.
8. Not used.
9. WCAP-8567-P-A, "Improved Thermal Design Procedure,"
10. WCAP-16045-P-A, "Qualification of the Two Dimensional Transport Code PARAGON," and
11. WCAP-16045-P-A, Addendum 1-A, "Qualification of the NEXUS Nuclear Data Methodology."

(continued)

Technical Specification Bases Markups

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. 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. 6, "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 not directly measurable but is inferred from a power distribution measurement obtained with either the movable incore detector system or from an OPERABLE Power Distribution Monitoring System (PDMS) (References 3 & 4). The results of the power distribution measurement are analyzed to derive a measured value for $F_Q(Z)$. These measurements are generally taken with the core at or near equilibrium conditions.

However, because this value represents an equilibrium condition, it does not include the variations in the value of $F_Q(Z)$ that are present during nonequilibrium situations, such as load following.

Insert 1

To account for these possible variations, ~~a transient $F_Q(Z)$ is also calculated based on the steady state value of $F_Q(Z)$. In this case, the steady state $F_Q(Z)$ is adjusted by an elevation dependent factor, W(Z), that accounts for the calculated transient conditions.~~

Core monitoring and control under nonsteady state 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's principal effect is to preclude core power distributions that could lead to violation of the following fuel design criterion:

During a large break loss of coolant accident (LOCA), there is a high level of probability that the peak cladding temperature will not exceed 2200° F (Ref. 1).

(continued)

BASES

APPLICABLE SAFETY ANALYSES (continued)

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 LOCA 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).

LCO

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

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

$$F_Q(Z) \leq \frac{F_Q^{RTP}}{0.5} K(Z) \text{ for } P \leq 0.5$$

where: F_Q^{RTP} is the $F_Q(Z)$ limit at RATED THERMAL POWER (RTP) provided in the COLR,

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

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

The actual values of F_Q^{RTP} and K(Z) are given in the COLR.

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 $F_Q(Z)$.

(continued)

BASES

LCO (continued)

An $F^C_Q(Z)$ evaluation requires obtaining a power distribution measurement in MODE 1. From the incore flux map results we obtain the measured value ($F^M_Q(Z)$) of $F_Q(Z)$. The computed heat flux hot channel factor, $F^C_Q(Z)$ is obtained by the equation:

$$F^C_Q(Z) = F^M_Q(Z)\ U_{FQ}$$

where U_{FQ} is a factor that accounts for fuel manufacturing tolerances and measurement uncertainty.

The expression for $F^W_Q(Z)$ is:

$= ~~F^C_Q(Z)\ W(Z)~~$ ← Insert 2

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.

Calculate the percent $F_Q(Z)$ exceeds its limit by the following expression:

$$\left\{\left(\underset{\text{over } z}{\text{maximum}}\left[\frac{F^C_Q(z) \times W(z)}{\frac{F^{RTP}_Q}{P} \times K(z)}\right]\right) - 1\right\} \times 100 \quad \text{for } P \geq 0.5$$

$$\left\{\left(\underset{\text{over } z}{\text{maximum}}\left[\frac{F^C_Q(z) \times W(z)}{\frac{F^{RTP}_Q}{0.5} \times K(z)}\right]\right) - 1\right\} \times 100 \quad \text{for } P < 0.5$$

The $F_Q(Z)$ limits define limiting values for core power peaking that, with a high level of probability, preclude peak cladding temperatures above 2200° F during either a large or small break LOCA

This LCO requires operation within the bounds assumed in the safety analyses. [Insert 3] If $F_Q(Z)$ cannot be maintained within the LCO limits, reduction of the core power is required, ← Insert 4
~~Violating the LCO limits for $F_Q(Z)$ may produce unacceptable~~

(continued)

BASES

LCO (continued)

~~consequences if a design basis event occurs while $F_Q(Z)$ is outside its specified limits.~~

If the power distribution measurements are performed at a power level less than 100% RTP, then the $F_Q^C(Z)$ and $F_Q^W(Z)$ values that would result from measurements if the core was at 100% RTP should be inferred from the available information. A comparison of these inferred values with F_Q^{RTP} assures compliance with the LCO at all power levels.

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 factors which account 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 the 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.

Insert 5

A.2

Insert 6

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,~~ 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

(continued)

BASES

ACTIONS

A.2 (continued)

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.3 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.

Insert 6

A.3

Reduction in the Overpower ΔT trip setpoints by ≥ 1% for each 1% ~~by which $F_Q^c(Z)$ exceeds its limit,~~ 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 setpoints initially determined by Required Action A.4 may be affected by subsequent determinations of $F_Q^c(Z)$ and would require Overpower ΔT 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. Inherent in this action is identification of the cause of the out of limit condition, and the correction of the cause, to the extent necessary to allow safe operation at the higher power level. The allowable power level is determined by extrapolating $F_Q^c(Z)$. SR 3.2.1.1 must be satisfied prior to increasing power above the extrapolated allowable power level or restoration of any reduced Reactor Trip System setpoints.

Insent 7

(continued)

.1

BASES

ACTION (continued)

B.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 both the positive and negative AFD limits by ≥ 1% for each 1% by which $F_Q^W(Z)$ exceeds its limit within the allowed Completion Time of 4 hours, restricts the axial flux distribution such that even if a transient occurred, core peaking factor limits are not exceeded.~~

Insert 8

C.1

through B.2.4

If Required Actions A.1 through A.4 or B.1 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.

SURVEILLANCE REQUIREMENTS

SR 3.2.1.1 and SR 3.2.1.2 are modified by a Note. The Note applies during power ascensions following a plant shutdown (leaving MODE 1). The note allows for power ascensions if the surveillances are not current. 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 20% 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 for a reload core, there is a second Frequency condition, applicable only for reload cores, that requires determination of these parameters before exceeding 75% RTP. This ensures that some determination of $F_Q^C(Z)$ and $F_Q^W(Z)$ are 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 20%, ensures that they are verified within 24 hours from when equilibrium conditions are achieved

e

(continued)

BASES

SURVEILLANCE REQUIREMENTS (continued)

at RTP (or any other level for extended operation). Equilibrium conditions are achieved when the core is sufficiently stable such that the uncertainties associated with the measurement are valid. 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 20% increase in power level above the last verification. It only requires verification after a power level is achieved for extended operation that is 20% higher than that power at which $F_Q(Z)$ 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 core power distribution measurement results and $F_Q^C(Z) = F_Q^M(Z)\ U_{FQ}$ (Ref. 2). The value of U_{FQ} is determined using the formulation provided in the COLR. $F_Q^C(Z)$ 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. following a refueling Insert 9

Performing this Surveillance in MODE 1 prior to exceeding 75% RTP (and meeting the 100% RTP $F_Q(Z)$ limit) provides assurance that ~~the $F_Q^C(Z)$ limit is met when RTP is achieved, because peaking factors generally decrease as power level is increased.~~

If THERMAL POWER has been increased by ≥ 20% RTP since the ~~last~~ initial or most recent determination of $F_Q^C(Z)$, another evaluation of this factor is required 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. Insert 10

The Surveillance Frequency is based on operating experience, equipment reliability, and plant risk and is controlled under the Surveillance Frequency Control Program.

(continued)

BASES

SURVEILLANCE REQUIREMENTS (continued)

SR 3.2.1.2

Because power distribution measurements are taken either at, or near equilibrium conditions, the variations in power distribution resulting from normal operational maneuvers are not typically present in the flux map 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, $F^C_Q(Z)$, by W(Z) gives the maximum $F_Q(Z)$ calculated to occur in normal operation, $F^W_Q(Z)$.~~ Insert 11

The limit with which $F^W_Q(Z)$ is compared varies inversely with power and directly with the function K(Z) provided in the COLR.

The ~~W(Z) curve is provided~~ Insert 12 in the COLR for discrete core elevations. Flux map data are typically taken for 61 axial core elevations. $F^W_Q(Z)$ evaluations are not applicable for ~~the following~~ axial core regions, measured in percent of core height:

a. Lower core region, from 0 to 8% inclusive~~, and~~ J

b. Upper core region, from 92 to 100% inclusive J

Insert 13

~~The top and bottom 8%~~ These regions of the core are excluded they from the evaluation because of the low probability that ~~these regions~~ would be more limiting in the safety analyses and because of the difficulty of making a precise measurement in these regions. Insert 14

~~This Surveillance has been modified by a Note that may require that~~ more frequent surveillances be performed. When $F^W_Q(Z)$ is determined, an evaluation of the expression below is required to account for any increase to $F^C_Q(Z)$ 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

$$\text{maximum over z} \left[\frac{F^C_Q(Z)}{K(Z)}\right]$$

it is required to meet the $F_Q(Z)$ limit with the last $F^W_Q(Z)$ increased by a factor ≥ 2 percent which is specified in the COLR, or to evaluate $F_Q(Z)$ more frequently, each 7 EFPD. These alternative requirements

(continued)

BASES

SURVEILLANCE REQUIREMENTS

SR 3.2.1.2 (continued)

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 or at a reduced power at any other time, and meeting the 100% RTP $F_Q(Z)$ limit, provides assurance that the $F_Q(Z)$ limit will be met when RTP is achieved, because peaking factors are generally decreased as power level is increased.

$F_Q(Z)$ is verified at power levels ≥ 20% RTP above the THERMAL POWER of its last verification, 24 hours after achieving equilibrium conditions to ensure that $F_Q(Z)$ is within its limit at higher power levels.

Insert 15

The Surveillance Frequency is based on operating experience, equipment reliability, and plant risk and is controlled under the Surveillance Frequency Control Program.

REFERENCES

1. 10 CFR 50.46, 1974.
2. WCAP-7308-L-P-A, "Evaluation of Nuclear Hot Channel Factor Uncertainties," June 1988.
3. WCAP-12472-P-A, "BEACON Core Monitoring and Operations Support System," August 1994.
4. WCAP-12472-P-A, Addendum 4, Revision 0, "BEACON Core Monitoring and Operations Support System," September 2012

Insert 16

TS Bases Inserts (page 1/9)

Insert 1

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

Insert 2

$F_{XY}^M(Z)$ $([T(Z)]^{COLR} / P)$ $A_{XY}(Z)$ R_j U_{FQ}

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 nonequilibrium 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

TS Bases Inserts (continued) (page 2/9)

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 percent 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.

U_{FQ} is a factor that accounts for measurement uncertainty and 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.

Insert 3

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.

Insert 4

a more restrictive RAOC operating space must be implemented, or core power limits and AFD limits must be reduced.

Insert 5

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

TS Bases Inserts (continued) (page 3/9)

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.

Insert 6

that THERMAL POWER is limited below RATED THERMAL POWER by Required Action A.1

Insert 7

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.

Insert 8

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.

TS Bases Inserts (continued) (page 4/9)

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 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 $F_Q^W(Z)$ that are not within limit and could require power reductions within 4 hours of the of the subsequent $F_Q^W(Z)$ determination, if necessary to comply with the decreased THERMAL POWER limit. In short, the 4-hour Completion Time for Required Action B.2.1 applies after each $F_Q^W(Z)$ determination.

TS Bases Inserts (continued) (page 5/9)

Decreases in subsequent $F_Q^W(Z)$ measurements while in Conditon B 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.

<u>B.2.2</u>

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. bThe 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.

The maximum allowable Power Range Neutron Flux - High trip setpoints initially determined by Required Action B.2.2 may be affected by subsequent determinations of $F_Q^W(Z)$ that are not within limit and could require Power Range Neutron Flux - High trip setpoint reductions within 72 hours of the subsequent $F_Q^W(Z)$ determination, if necessary to comply with the decreased maximum allowable Power Range Neutron.

TS Bases Inserts (continued) (page 6/9)

Flux - High trip setpoints. In short, the 72-hour Completion Time for Required Action B.2.2 applies after each $F_Q^W(Z)$ determination. Decreases in subsequent $F_Q^W(Z)$ measurements while in Condition B would allow increasing the maximum allowable Power Range Neutron Flux - High trip setpoints.

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.

The maximum allowable Overpower ΔT trip setpoints initially determined by Required Action B.2.3 may be affected by subsequent determinations of $F_Q^W(Z)$ that are not within limit and could require Overpower ΔT trip setpoint reductions within 72 hours of the subsequent $F_Q^W(Z)$ determination, if necessary to comply with the decreased maximum allowable Overpower ΔT trip setpoints. In short, the 72-hour Completion Time for Required Action B.2.3 applies after each $F_Q^W(Z)$ determination. Decreases in subsequent $F_Q^W(Z)$ measurements while in Condition B would allow increasing the maximum allowable Overpower ΔT trip setpoints.

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.

Insert 9

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.

Insert 10

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

TS Bases Inserts (continued) (page 7/9)

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 20% 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 20% higher than the THERMAL POWER at which $F_Q^C(Z)$ was last measured.

In the absence of these Frequency conditions (discussed above) it is possible to operate for the number of EFPD allowed by the Frequency without verification of $F_Q^C(Z)$.

<u>Insert 11</u>

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:
$F_Q^C(Z) = F_{XY}^M(Z)\ P_M(Z)\ U_{FQ}$

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:
$F_Q^W(Z) = F_{XY}^M(Z)\ [T(Z)]^{COLR}\ R_j\ U_{FQ}$

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.

TS Bases Inserts (continued) (page 8/9)

Insert 12

$[T(Z)]^{COLR}$ functions are specified

Insert 13

c. Grid plane regions, +2% inclusive, and
d. Core plane regions, within 2% of the bank demand positions of the control banks.

Insert 14

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.

Insert 15

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 > 20% 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.

TS Bases Inserts (continued) (page 9/9)

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.

In the absence of these Frequency conditions (discussed above) it is possible to operate for the number of EFPD allowed by the Frequency without verification of $F_Q^w(Z)$.

Insert 16

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

6. WCAP-17661-P-A, Revision 1, "Improved RAOC and CAOC F_Q Surveillance Technical Specifications," February 2019