REQUEST FOR ADDITIONAL INFORMATION QUESTIONS

PRESSURIZED WATER REACTOR OWNERS GROUP

TOPICAL REPORT WCAP-17661-P/NP, REVISION 1, "IMPROVED RAOC AND CAOC $F_Q$ SURVEILLANCE TECHNICAL SPECIFICATION"

**RAI No. 1: Required Actions when both $F_Q^C(z)$ and $F_Q^W(z)$ exceed limits**

Background

Under the proposed change for both relaxed axial offset control (RAOC) heat flux hot channel factor ($F_Q(Z)$) Surveillance (TS 3.2.1B) and constant axial offset control (CAOC) $F_Q(Z)$ Surveillance (TS 3.2.1C), Required Actions are now different for Condition A and B. When $F_Q^C(Z)$ is not within limits, reduction of THERMAL POWER is required along with reduction of setpoints and performance of Surveillance Requirement (SR) 3.2.1.1 and SR 3.2.1.2. Whereas, when $F_Q^W(Z)$ is not within limits, two alternative actions may be applicable. Required Action B.1 requires implementation of a different operating space and if an appropriate operating space cannot be implemented, reduction of THERMAL POWER and setpoints and performance of SR 3.2.1.1 and SR 3.2.1.1 are required. The proposed change in Required Action when $F_Q^W(Z)$ exceeds limits is intended to avoid THERMAL POWER reduction through implementation of a different operating space (Required Action B.1).

Issue and Request

Under the proposed change, when $F_Q^C(Z)$ is within limits and $F_Q^W(z)$ is not within limits, a different operating space may be implemented and a THERMAL POWER reduction will not be required. However, when both $F_Q^C(Z)$ and $F_Q^W(Z)$ are not within limits, Required Action for $F_Q^C(Z)$ will require reduction of THERMAL POWER. The corresponding evaluation and action for $F_Q^W(Z)$ require clarification. For example, Condition A ($F_Q^C(Z)$ not within limit) requires reduction of THERMAL POWER greater than or equal to (≥) 1 percent (%) for each 1% $F_Q^C(Z)$ exceeds the limit, but Condition B ($F_Q^W(Z)$ not within limit) may require reduction of THERMAL POWER which may be evaluated for 5% decrements in the core operating limit report (COLR). Also, implementation of Required Action B.1 is unclear since the action does not involve reduction of THERMAL POWER.

a. Provide a complete explanation and justification for the THERMAL POWER actions that will be taken when *both* $F_Q^C(Z)$ and $F_Q^W(Z)$ exceed their limits including how the COLR evaluations will be used. Discuss the compatibility of actions for $F_Q^C(Z)$ and $F_Q^W(Z)$ and the supporting evaluations in the COLR.

b. Based on the discussion and the need for clarity of the Required Actions when both $F_Q^C(Z)$ and $F_Q^W(Z)$ exceed limits, discuss the need for a NOTE in the Required Action column that may be useful for the operators in abiding by these specifications.

**RAI No. 2: Need to perform SR 3.2.1.2 when $F_Q^C(Z)$ not within limit following refueling prior to THERMAL POWER exceeding 75% rated thermal power (RTP)**

Background

Under the proposed change for SR 3.2.1.2, "Verify $F_Q^W(Z)$ is within limit," the first frequency is revised whereby instead of conducting the surveillance "Once after each refueling prior to THERMAL POWER exceeding 75% RTP [rated thermal power]" the requirement will be "Once after each refueling within [24] hours after achieving equilibrium conditions *after* [emphasis added] THERMAL POWER exceeds 75% RTP." This change makes the SR for $F_Q^C(Z)$ and $F_Q^W(Z)$ different, i.e., following refueling, $F_Q^C(Z)$ is checked prior to exceeding 75% RTP whereas $F_Q^W(Z)$ is checked after exceeding 75% RTP. The primary justification for not conducting the surveillance for $F_Q^W(Z)$ below 75% RTP is that, during power ascension, $F_Q^W(Z)$ calculations are not reliable at such power levels.

Issue and Request

The justification for not conducting the $F_Q^W(Z)$ surveillance following refueling prior to exceeding the 75% RTP seems valid and appropriate. However, because of the change, an apparent contradiction is noted. Condition A, $F_Q^C(Z)$ not within limit, may occur prior to THERMAL POWER exceeding 75% RTP. Required Action A.4, "Perform SR 3.2.1.1 and SR 3.2.1.2," will involve unnecessary performance of SR 3.2.1.2.

Provide either an explanation or correction for this situation.

**RAI No. 3: Changes to SR 3.2.1.2**

Background

Section 3.2.5 states (Page 3-16):

> The first Frequency for SR 3.2.1.2 [currently requiring performance of $F_Q^W(Z)$ surveillance "Once after each refueling prior to THERMAL POWER exceeding 75% RTP"] will be changed to state that $F_Q^W(Z)$ must be verified to be within its limit following each refueling within 24 hours after achieving equilibrium conditions after thermal power exceeds 75% RTP… This change is justified since initial startups following a refueling are slow and tightly controlled due to startup ramp rate limitations and fuel conditioning requirements. Consequently, the initial startup following a refueling will not result in non-equilibrium power shapes that could challenge the $F_Q^W(Z)$ limit. Also, core power distribution measurements taken at low powers (< 50% RTP) to confirm that the core is loaded properly will provide ample indication that the core is operating consistent with expectations. The new Frequency will ensure that verification of $F_Q^W(Z)$ is performed within a reasonable time period and prior to extended non-equilibrium operation at power levels where the maximum permitted peak linear heat rate could potentially be challenged.

Page B-1 provides a BASES[1] definition of equilibrium conditions: "being at a stable reactor power (i.e., within plus or minus (±) 1% RTP) and at stable axial flux conditions (i.e., with an axial flux difference variability of ± 1% over the previous 24 hours."

Issue and Request

It is not clear that the "new Frequency will ensure that verification of $F_Q^W(Z)$ is performed… *prior to extended non-equilibrium* [emphasis added] operation at power levels where the maximum permitted peak linear heat rate could potentially be challenged," because the new surveillance requirement would permit operation above 75% RTP, *prior to achieving equilibrium conditions*, without performing an initial surveillance. Therefore, as acknowledged in the proposed BASES, "In the absence of these Frequency conditions (discussed above) it is possible to operate for 31 EFPD without verification of $F_Q^W(Z)$."

The current version of the SR establishes an unambiguous requirement to verify $F_Q^W(Z)$ prior to exceeding 75% RTP and generally every 31 EFPD thereafter (or in accordance with the Surveillance Frequency Control Program). The improved TS should also establish an unambiguous requirement to perform an initial surveillance, followed by periodic surveillances on an appropriately justified frequency.

a. Provide analyses of past data of initial surveillance of $F_Q^W(Z)$ prior to exceeding 75% RTP following a refueling to demonstrate that surveillance at low power levels can be challenging with respect to obtaining an accurate transient $F_Q$ margin assessment.

b. Justify the 24 hours for completing the surveillance after achieving the equilibrium condition, particularly since 24 hours has elapsed to establish an equilibrium condition.

**RAI No. 4: Treatment of uncertainties in $F_Q^C(Z)$ and $F_Q^W(Z)$ determination and in defining the requirements**

Background

One of the multiplicative factors that determines $F_Q^C(Z)$ and $F_Q^W(Z)$ is the uncertainty $U_F$ which accounts for measurement and manufacturing uncertainties. It is typically 1.0815 (Page 3-2), which is the result of multiplying a measurement uncertainty of 1.05 by a manufacturing uncertainty of 1.03. The sample COLR input given in Appendices C and F do not refer to $U_F$ but do use 1.0815 as one the factors determining the above $F_Q(Z)$ quantities. It is not stated if these uncertainties represent 1-sigma or a 95/95 uncertainty. The use of a measurement uncertainty is obvious but the use of an uncertainty to account for manufacturing tolerances is less clear.

[1] NRC staff reviews the proposed BASES for information only and issues requests to obtain clarification and improve the interpretability of the proposed TS; however, plant-specific BASES are administratively controlled and the NRC staff does not intend to extend approval to the BASES provided in WCAP-17661-P Appendices, or to any plant proposing to implement WCAP-17661-P.

Another factor defining $F_Q^W(Z)$ is the T(z) function. According to the statement made with respect to Equations 2-23 and 2-24, the T(z) functions are derived with "appropriate uncertainties."

Issue and Request

A better discussion of the treatment of uncertainties in the methodology, in the calculated parameters, and how they are addressed in defining the requirements is appropriate.

a. Explain how uncertainties are taken into account in defining the $F_Q^C(Z)$ and $F_Q^W(Z)$ that are monitored.

b. It is understood that part of the uncertainty is the result of the surveillance measurement of planar radial peaking factor ($F_{XY}(Z)$) and part the result of the analysis to obtain T(z). The T(z) uncertainty is expected to be incorporated into the tabulation of these functions but the measurement uncertainty would be explicitly given in the COLR if it is a function of the particular reactor and fuel cycle or explicitly given and explained in the topical report if it is a generic number. Explain which of these options is being recommended and why.

**RAI No. 5: New Required Action B.1 requiring implementation of a RAOC/CAOC operating space**

Background

Under the proposed change, Required Action B.1 states:

> Implement a RAOC/CAOC operating space specified in the COLR that restores $F_Q^W(Z)$ to within its limits.

As stated on Page 3-14 of WCAP-17661-P,

> Pre-analyzed RAOC operating spaces, representing different levels of transient $F_Q$ margin, will be included in the COLR and characterized by transient (T(z) functions) which, in conjunction with measured radial peaking factors, may be used to quantify margin and ensure compliance with the LCO for future non-equilibrium operation. Analogous to the CAOC operating space concept..., a RAOC operating space is a unique combination of AFD [axial flux difference] operating space envelope and control rod bank insertion limits. In the unlikely event that none of the allowed RAOC operating spaces included in the COLR provides sufficient $F_Q$ margin, maximum power level and AFD reductions will be required along with setpoint reductions. The magnitude of the required reductions will be included in the COLR.

In addition, as part of the change for both RAOC and CAOC plants, the NOTE in Condition B stating that Required Action B.4 shall be completed whenever this Condition is entered is deleted. A NOTE in the Required Action column under Required Action B.2.1 is entered stating that Required Action B.2.4 shall be completed whenever Required Action B.2.1 is performed.

(Both B.4 in the previous version and B.2.4 in the revised version are the same Required Action, "Perform SR 3.2.1.1 and SR 3.2.1.2)." In effect, SRs will no longer be applicable when Required Action B.1 is implemented.

Issue and Request

Based on the analysis presented, the use of a different operating space is generally an appropriate approach to gain margin improvement. However, if changing the rod insertion limits (RILs) is part of the new operating space AND that requires movement of control rods to comply, then this approach puts the reactor into a new operating condition.

In addition, in order to understand if the new operating space will provide the needed margin, it is necessary for the reactor engineer to evaluate $F_Q^W(Z)$ using the T(z) for different operating spaces. This must be done within four hours, the TS completion time.

If movement of control rods was required, a reevaluation of $F_Q^C(Z)$ and $F_Q^W(Z)$ will be required to assure that TS requirements are being met. In other words, the NOTE may apply to B.1 for such situations.

Explain the use of Required Action B.1 incorporating the response to the following:

a. Explain what would be done if Required Action B.1 is carried out and requires movement of control rods.

b. Explain if in addition to the T(z) tables there will be tables to show the margin improvement as a function of axial position or some other scheme in the COLR to make it easier for the reactor engineer to determine if Required Action B.1 is sufficient or Required Actions B.2 are necessary.

c. Explain the deletion of the NOTE to perform SR 3.2.1.1 and SR 3.2.1.2 under required Action B.1

d. Discuss clearly the specific actions (e.g., how are the rod insertion limits imposed) that will be undertaken by the operator in implementing the new operating space and consequently what would constitute a violation of this required action.

**RAI No. 6: Effect of Crud Induced Power Shift**

Background

Currently, any downward trend in margin (as defined by the minimum margin over all axial locations) is accounted for by applying a penalty factor and requiring additional surveillance. This is specified in a note modifying SR 3.2.1.2, which is proposed to be eliminated. This NOTE monitored increases in $F_Q^W(Z)$ from the previous surveillance and required additional surveillances if measurements indicated that the maximum over z of $F_Q^C(Z)/K(Z)$ has increased since the previous evaluation of $F_Q^C(Z)$.

In lieu of this approach, it is proposed that a penalty factor be applied that takes account of the *expected* change in margin during the next effective full power minutes as a result of normal changes in burnup. This approach eliminates any action due to the concern over crud induced power shift (CIPS). Reasons are given for this (Page 4-18).

One of the arguments presented is that past trends of $F_Q^C(Z)/K(Z)$ may or may not be indicative of future trends. It is justified to remove monitoring of $F_Q^C(Z)/K(Z)$ for indication of future margin trends if it does not provide the required indication.

Request

It is stated (Page 4-18):

> …given that CIPS develops slowly and characteristically, it is proposed that its effects on peaking factor be evaluated in a timely fashion following its observed onset.

Although the TS is designed to monitor power peaking, it appears that the licensee will now have full discretion as to how monthly trends due to any anomalous behavior are taken into account.

a. Explain how this would actually take place.

b. Provide data from past experience and additional discussion supporting the statement "past measurement trends of $F_Q^C(Z)/K(Z)$ may or may not be indicative of future margin trends."

**RAI No. 7: Change of Required Action B.2.1 and limitation of THERMAL POWER to < 50% RTP**

Background

The improved TS define a new Required Action B.2. When $F_Q^W(Z)$ exceeds its limits, Required Actions B.2.1, B.2.2, B.2.3, and B.2.4 can be implemented instead of Required Action B.1. Required Action B.2.1 limits thermal power to less than RTP by the amount specified in the COLR. If the RAOC operating spaces specified in the COLR are insufficient to ensure margin to the $F_Q^W(Z)$ limits, then the Required Action B.2.1 must be entered and THERMAL POWER must be reduced to less than the thermal power specified in the COLR. Also, AFD limits must be reduced by the amount specified in the COLR.

It is also noted that as a practical matter, the number of discrete reduced power level evaluations included in the COLR will be limited to three or less (an individual utility may opt for additional evaluation levels). Also stated in WCAP-17661-P, if the required margin improvement exceeds the level of any pre-analyzed thermal power limits, the COLR will specify that the thermal power is limited to <50 percent RTP. WCAP-17661-P also states that other TS, such as the Nuclear Enthalpy Rise Hot Channel Factor TS, would also require a power level reduction in the presence of such a large anomaly.

Issue and Request

For situations where necessary margin improvement exceeds the level of any pre-analyzed thermal power limits, the requirement to reduce the thermal power to less than 50 percent RTP is not noted in the Technical Specifications (TS) or in the Bases. Since this type of situation means that a very large and unusual core anomaly is present, clear guidance and justification for the actions should be presented.

a. Explain how the required actions in the COLR for Required Action B.2.1 will be sufficient if $F_Q^W(Z)$ is not within limits. For example, will some limit of power to 50% RTP always be imposed and if so, at what point (vis-a-vis margin needed) would that be required.

b. Since the reduction of thermal power to < 50% RTP is a defined parameter applicable to all Westinghouse plants, explain why this requirement should not be included in the TS and/or Bases.

**RAI No. 8: Implementation of 24-Hour Frequency in TS SR 3.2.1.1 and 3.2.1.2**

Background

Section 3.2.4 states (Pages. 3-14 and 3-15):

> In the improved $F_Q$ TS, the second Frequency will be revised to require verification of $F_Q^C(Z)$ within 24 hours (instead of 12 hours) after achieving equilibrium conditions after exceeding, by ≥ 10% RTP , the THERMAL POWER at which $F_Q^C(Z)$ was last verified. This Frequency of 24 hours is contained in some plant Technical Specifications. (for a few plants, no Frequency is specified) and is a reasonable time period in which to perform this verification given the extremely small likelihood of limiting power shapes or limiting design basis events occurring prior to completion of the surveillance.

The information is repeated in Sections 5.4 and 8.4 and a similar change is proposed for SR 3.2.1.2, related to surveillance of $F_Q^W(Z)$.

The purpose of bracketed information in Standard Technical Specifications is to denote site-specific information, which must be in conformance with the final safety analysis report as updated. Refer to Chapter 16.0, “Technical Specifications,” of NUREG-0800, *Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition*, for further details.

Issue and Request

Since Pressurized Water Reactor Owners Group (PWROG) proposes to use WCAP-17661 as a basis to reduce the frequency requirement for these surveillance test intervals, a more thorough technical justification for the change should be provided. The justification should either follow a clearly risk-informed or deterministic approach, rather than provide a qualitative assessment of the likelihood of limiting initial conditions or initiating events.

If risk-informed, the appropriate regulatory guidance should be followed. This would include NRC Regulatory Guide (RG) 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," and RG 1.177, "An Approach for Plant-Specific, Risk-Informed Decision Making: Technical Specifications."

If deterministic, the justification could include consideration of the consequences of a postulated event occurring in a condition in which the extended surveillance interval prevented assurance that operation was within specified limiting conditions, and of additional mitigating features that would ensure that continued operation in such a condition remains otherwise acceptable. Finally, consider whether plant-specific submittal items should be identified, which would justify any facility licensing basis changes required to implement the proposed TS change.

**RAI No. 9: Equilibrium vs Stable Conditions**

Background

The SR for $F_Q^C(Z)$ requires a measurement "Once after each refueling prior to THERMAL POWER exceeding 75% RTP." According to the BASES (Page B-1), equilibrium conditions are not required for this measurement but rather stable conditions are required. Both equilibrium and stable conditions require that the power be within ± 1% but for equilibrium, this condition must exist for 24 hours. Equilibrium conditions also require that the AFD be within ± 1% for that 24-hour period but stable conditions just require that the AFD be within ± 0.5% during the period of interest (when the measurement is being done).

Issue and Request

All surveillance requirements except for those done prior to exceeding 75% RTP are done at equilibrium conditions whereas for the power ascension surveillance, it is only necessary to have stable conditions.

a. Explain why there is a need for equilibrium conditions during most surveillance; why can't stable conditions suffice?

b. Is there a benefit to defining the same conditions (equilibrium or stable) for conducting all $F_Q^C(Z)$ and $F_Q^W(Z)$ surveillance?

**RAI No. 10: Required Actions**

Background

In Required Action A (and Required Action B.2) there is a Note that states that Required Action A.4 (Required Action B.2.4) "*shall be* [emphasis added] completed whenever the Condition is entered." However, the completion time for Required Action A.4 (or B.2.4) is "prior to increasing THERMAL POWER above the limit of Required Action A.1 (B.2.1)."

Issue and Request

The Required Actions A.4 and B.2.4 are surveillance requirements. Because of the NOTE accompanying these actions, it is not clear if they must be carried out along with the other Required Actions or whether they can wait until a decision is made to increase THERMAL POWER.

Discuss and clarify the timing of the surveillance to be performed to satisfy both the NOTE and the Required Action B.2.4.

**RAI No. 11: Interface of WCAP-17661-P changes with TS 3.2.1A, Heat Flux Hot Channel Factor ($F_Q(Z)$) (CAOC-$F_{xy}$ Methodology)**

Background

In addition to TS 3.2.1B and TS 3.2.1C, TS 3.2.1A is included for some CAOC plants. No change is proposed for TS 3.2.1A. It is our understanding that some CAOC plants confirm $F_Q(Z)$ indirectly by measuring $F_{xy}^M(Z)$ and then comparing this measurement to an $F_{xy}(Z)$ limit. In the new formulation, the key factor being measured is also $F_{xy}(Z)$.

Issue and Request

In both TS 3.2.1 A and TS 3.2.1C, the key factor being measured is $F_{xy}(Z)$. However, the TS requirements are different. Some of the concept used in TS 3.2.1C is not used in TS 3.2.1A: namely, TS 3.2.1A is not modified to use a different operating space and avoid reduction in THERMAL POWER.

a. Delineate the difference between CAOC- $F_{xy}$ Methodology and CAOC-T(z) Methodology to explain why the changes similar to that considered for TS 3.2.1C are not applicable for TS 3.2.1A.

b. For CAOC plants, when $F_Q(Z)$ is not within limit, $F_Q^C(Z)$ will also be outside the limit. Under the proposed changes, Required Actions for TS 3.2.1A and TS 3.2.1C are different. Explain and justify the merits of the differences in the TS.

**RAI No. 12: Impact of the proposed changes on TS 3.2.4, Quadrant Power Tilt Ratio (QPTR)**

Background

TS 3.2.4, "Quadrant Power Tilt Ratio (QPTR)," provides limits and conditions and associated surveillance requirements for QPTR. As stated in the Bases for Section 3.2.4, the QPTR limits ensure that nuclear enthalpy rise hot channel factor ($F^N_{\Delta H}$) and $F_Q(Z)$ remain below their limiting values by preventing an undetected change in the gross radial power distribution. The QPTR limit of 1.02, at which corrective action is required, provides a margin of protection for both the departure from nucleate boiling ratio and linear heat generation rate contributing to

excessive power peaks resulting from X-Y plane power tilts. A limiting QPTR of 1.02 can be tolerated before the margin for uncertainty in $F_Q(Z)$ and $F^N_{\Delta H}$ is possibly challenged.

Issue and Request

Under the proposed changes, when a different operating space is implemented, QPTR may be affected. Since QPTR provides a margin of protection, assurance is needed that the margin of protection is not being lost or that adequate margin of protection will still be maintained.

a. Discuss the impact of the proposed changes on the QPTR and how the changes may impact the current LCO and SR in TS 3.2.4.

b. If changes are non-negligible, discuss that adequate margin of protection is being maintained.

**RAI No. 13: Additional discussion of methodology**

Background

The RAOC-T(Z) methodology is presented in different sections in WCAP-17661-P for the reader to understand the methodological issues. Details and example results are given; however, some aspects of the discussion of the methodology to obtain $F_Q^W(Z)$ can be considered lacking.

Issues and Request

Additional discussion on the following aspects is requested in order to fully understand the methodology:

a. Provide the specific assumptions, limitations, implementing procedures, and related guidance associated with the methodology and explain how they have been addressed in defining the new requirements.

b. Discuss the attributes/results of the methodology and relate them to the changes proposed in the Specifications. Discuss each of the changes in the Specifications and their relation to the improved methodology if one exists.

c. Discuss any differences from the results presented for a Westinghouse 4-loop plant that might be expected for different designs.

**RAI No. 14: Adjustment factor for the radial peaking factor ($A_{XY}(z)$)**

Background

Appendix C, "Sample COLR Input for a RAOC Plant," indicates in limit C.2.2.6 that "$A_{XY}(z)$ may be assumed equal to 1.0 or may be determined for specific surveillance conditions using the approved methods listed in TS 5.6.5." This follows discussion contained in Sections 4.3 and 6.4 of the main topical report.

Issue and Request

Regarding Method 2 as described in Licensing Topical Report (LTR) Section 4.3:

a. Provide a comprehensive list of all approved methods that may be used to calculate $A_{XY}(z)$, according to Method 2.

b. Since $A_{XY}(z)$ is a factor used to scale a surveillance value that is used to confirm adherence to a cycle-specific parameter operating limit, its reciprocal could, if applied to the operating limit, be considered a cycle (or, more specifically, situation)-specific scaling factor for a parameter operating limit. The core physics methodology, or computer code, used to calculate this value would need to be referenced in the TS COLR References list, for consistency with Generic Letter 1988-16 guidance.

c. Explain whether $A_{XY}(z)$ is calculated on-site by an implementing licensee, or whether Westinghouse or the PWROG, as supporting vendors, calculate these values.

d. Provide the procedures or engineering guidelines for calculating these values for NRC staff review.

Regarding Methods 3 and 4 as described in LTR Section 4.3:

e. Various passages of text in the LTR appear to acknowledge many shortcomings associated with these methods. For example, Page 6-3 states, "Obviously, this method is somewhat awkward given the large number of values that must be pre-calculated and the need to determine appropriate values for intermediate power levels and rod positions." Explain what benefit offering these methods provide to any implementing licensee: why make this option available?

Regarding $A_{XY}(z)$ in general:

f. The text in Section 4.3 suggests that incorporating an $A_{XY}(z)$ term in the surveillance formulation is optional. For example, Page 4-9 states, "…use of these factors should be an option…" Explain how $A_{XY}(z)$ is applied if its value is greater than 1.

g. Section 6.4 described $A_{XY}(z)$ values for initial power ascension. If the $F_Q^W(z)$ surveillance is not intended to be performed until after a period of equilibrium operation after exceeding a threshold power level, explain why the $A_{XY}(z)$ factors are necessary or desired for initial power ascension.