

February 21, 2008

MEMORANDUM TO: Charles A. Casto, Director
Division of Reactor Projects
Region II

FROM: Michael J. Case, Director **/RA by HNieh for/**
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

SUBJECT: FINAL RESPONSE TO VOGTLE ELECTRIC GENERATING PLANT -
TASK INTERFACE AGREEMENT 2007-01 RELATED TO THE
DEVELOPMENT OF THE REACTOR CORE POWER DISTRIBUTION
LIMITS (TAC NO. MD4963)

By your memorandum dated March 9, 2007, Region II, Division of Reactor Projects, submitted a request for a Task Interface Agreement (TIA) to the Office of Nuclear Reactor Regulation (NRR) to evaluate whether the Southern Nuclear Operating Company, Inc. (the licensee for Vogtle Electric Generating Plant, Unit 1 (VEGP-1 or Vogtle)), appropriately developed reactor core power distribution limits for Cycle 14. Specifically, Region II requested that NRR provide answers to the following questions:

1. Are there two separate Heat Flux Hot Channel Factor limits (transient and steady state) which must be met in order to validate the thermal limits, or are they both parts of one single limit?
2. Is the licensee's use of different $W(z)$ curves depending on core burnup inconsistent with WCAP-10216-P-A as required by the Vogtle technical specifications? Is the interpolation between two $W(z)$ curves inconsistent with technical specifications?
3. Is the licensee's use of less than the full range of axial offset allowed by Unit 1 Cycle 14 Core Operating Limits Report, figure 5, (AO doghouse) in the development of the $W(z)$ curves inconsistent with WCAP-10216-P-A as required by the Vogtle technical specifications? Is the methodology described in the AO Validity Criteria document consistent with the methodology described in WCAP-10216-P-A?
4. Is the use of an operability determination to show that the core can be operated with AO outside of the analyzed range a violation of NRC requirements?
5. Was the use of the guidance contained in RIS 2005-20 appropriate to justify the use of the Westinghouse AO Validity Criteria?

The draft TIA response was issued for Region II comments on November 20, 2007. Region II provided comments on the draft TIA during a teleconference held on January 25, 2008. These comments were incorporated into this final response. These changes clarified the NRC staff conclusions contained in the draft response.

Docket No.: 50-424

Enclosure: As stated

CONTACTS: J. Thompson
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S. Peters
301-415-1842

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ADAMS ACCESSION NO: ML080350270 *No significant changes from the Draft Staff Assessment.

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STAFF ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION
FOR TASK INTERFACE AGREEMENT (TIA) 2007-01
RELATED TO THE DEVELOPMENT OF THE REACTOR CORE POWER DISTRIBUTION
LIMITS FOR VOGTLE ELECTRIC GENERATING PLANT, UNIT 1 (VEGP-1)
DOCKET NO. 50-424

1.0 INTRODUCTION

On March 9, 2007, the U.S. Nuclear Regulatory Commission (NRC) staff in Region II submitted "Task Interface Agreement (TIA) 2007-01, Related to the Development of the Reactor Core Power Distribution Limits – Vogtle Electric Generating Plant" (Reference 1). The TIA requested assistance from the Office of Nuclear Reactor Regulation (NRR) in determining the answer to five questions regarding the development by Southern Nuclear Operations Company, Inc. (the licensee) of reactor core power distribution limits for VEGP-1 and its determination and application of those limits.

2.0 BACKGROUND

On December 4, 2006, the licensee performed a routine monthly flux map to verify that the reactor core met the power distribution limits contained in the VEGP-1 technical specifications (TSs) (Reference 2). The licensee identified that the steady state Axial Offset (AO) measured during the flux map was +5 percent. The licensee's reactor engineers noted that this measurement was outside of the AO band of -1 percent to +1.9 percent specified in the VEGP-1 Cycle 14 Core Reload Assessment, the Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.59 evaluation of the Core Operating Limits Report (COLR), for the development of the non-equilibrium factor, $W(z)$, for the beginning-of-cycle. This measurement indicated that the measured core parameters were outside of the analyzed range for the $W(z)$ factors used in determining the transient Heat Flux Hot Channel Factor at core height z ($F_Q(Z)$).

The licensee justified continuing reactor startup by applying a penalty to the transient $F_Q(Z)$ margin using a methodology described in the Westinghouse Electric Company (Westinghouse) report PCT-05-529, Revision 3, "Axial Offset Validity Criteria for Westinghouse Reload Safety Analysis Methodology, Nuclear Design Plant Operating Data Predictions, and Power Distribution Measurements including $W(z)$ Factors and $F_{xy}(z)$ Limits" (AO Validity Criteria) (Reference 3). This raised a concern with the NRC staff as the VEGP-1 TSs require that reactor core distribution limits be calculated using the pre-approved methodologies contained in the Technical Specifications Administrative Controls Program for the COLR (Section 5.6.5 of the VEGP-1 TSs) and the AO Validity Criteria, Revision 3, was not listed as a pre-approved methodology. Further, the $W(z)$ values used by the licensee to determine the transient $F_Q(Z)$ were based on an interpolation between pre-selected curves for discrete reactor core burnup values rather than using a single curve, a calculation that is only briefly alluded to in Topical

ENCLOSURE

Report (TR) WCAP-10216-P-A, Revision 1, "Relaxation of Constant Axial Offset Control FQ Surveillance Technical Specification" (Reference 4), the TR which describes the licensee's approach to developing reactor core power distribution limits.

The NRC resident inspectors raised questions about the use of a limited analysis band for AO, the use of the AO Validity Criteria, and the interpolation between burnup-dependent $W(z)$ curves. The five questions listed in this TIA were developed to help the NRC staff: (1) determine whether the TS requirements in question are being met, (2) understand the current licensing basis for VEGP-1 as it relates to the Heat Flux Hot Channel Factor, F_Q , (3) determine whether the methodology in TR WCAP-10216-P-A, Revision 1, has been appropriately applied by the licensee, and (4) determine whether the licensee appropriately used the operability determination process guidance in the development of reactor core power distribution limits for Cycle 14.

The technical basis for the licensee's approach to developing reactor core power distribution limits with respect to AO is provided in TR WCAP-10216-P-A, Revision 1, which is comprised of two parts. Part A describes a method for determining an acceptable Axial Flux Differential (AFD) profile referred to as the relaxation of constant axial offset control (RAOC). AFD is defined in NUREG-1431, "Standard Technical Specifications Westinghouse Plant," Revision 3 (Reference 5), as 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 flux/power differential between the top and bottom halves of the core. If flux is shifted too much in either direction, then it can exacerbate local peaking, resulting in challenges to fuel integrity. The RAOC method generates a range of AFD shapes at different power levels. Those shapes are used in the loss-of-coolant accident analysis, loss-of-flow accident analysis, and anticipated operational occurrence analysis. Unacceptable flux shapes are eliminated during the process. The remaining AFD shapes constitute a power-dependent AFD profile which is then used to operate the reactor.

Part B of TR WCAP-10216-P-A, Revision 1, describes an alternate means for monitoring F_Q . F_Q is defined in NUREG-1431 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 is a measure of the peak fuel pellet power within the reactor core. The method contained in TR WCAP-10216-P-A, Revision 1, measures $F_Q(Z)$ directly, under equilibrium conditions. The method takes into account power level, $F_Q(Z)$ normalization with respect to core height ($K(z)$), and manufacturing tolerance and measurement uncertainties. These factors are then combined with the F_Q used in the safety analysis to define an equilibrium relationship that must be met. If this relationship is not met, then a reduction in reactor power is required. To account for non-equilibrium conditions, another factor is included which defines a non-equilibrium relationship that must be met. If this relationship is not met, then a reduction in allowed AFD profile is required. The non-equilibrium factor is $W(z)$. $K(z)$ and $W(z)$ are to be specified in the COLR.

Westinghouse defines AO as the difference between the power in the top and bottom halves of the core divided by the sum of the power in the top and bottom halves of the core. Since power is directly proportional to flux, the terms AO and AFD are equivalent. If the flux/power is evenly balanced between the two halves, then the AO or AFD is zero. If the top half of the core is producing 51 percent of the flux/power, then the AO is 2 percent (51 percent - 49 percent). If the bottom half of the core is producing 51 percent of the flux/power, then the AO is -2 percent (49 percent - 51 percent).

3.0 EVALUATION

By this TIA, Region II requested answers to five questions:

Question 1:

Are there two separate Heat Flux Hot Channel Factor limits (transient and steady state) which must be met in order to validate the thermal limits, or are they both parts of one single limit?

Question 1 Response Summary:

The current licensing basis for VEGP-1 is for separate steady state and transient F_Q limits. TR WCAP-10216-P-A, Revision 1, and the original licensing activity for VEGP-1 address only one F_Q limit. However, in the most recent licensing activity, the licensee chose to explicitly create separate steady state and transient F_Q limits. The explicitly separate steady state and transient limits are documented in the licensee's most recent License Amendment Request (LAR), the NRC staff's Safety Evaluation Report (SER) for this LAR, and the licensee's TSs. Therefore, the current licensing basis for VEGP-1 is for separate steady state and transient $F_Q(Z)$ limits. Furthermore, the licensee must know $W(z)$ explicitly in order to set the F_Q Transient Limit. The licensee can not use an unapproved methodology to determine the acceptability or penalties on the pre-determined $W(z)$ function, because in doing so they are adjusting the F_Q Transient Limit.

Question 1 Response Discussion:

There have been discussions between the NRC staff, the licensee, and Westinghouse regarding whether there are two separate F_Q limits (transient and steady state) for VEGP-1 or whether there is only one. The licensee and Westinghouse have interpreted the licensing basis of VEGP-1 such that there is only one overall F_Q limit. Assuming this is so, if AO values are outside of the range used for the development of $W(z)$ in a VEGP-1 Core Reload Assessment, the 10 CFR 50.59 evaluation of the COLR, then the licensee may be able to meet an overall F_Q limit, even if they do not meet an F_Q transient limit. However, if VEGP-1 has a separate F_Q transient limit, then the licensee may not have a clear path to addressing the requirements of its TSs with respect to F_Q .

Subsequent to the events of December 4, 2006, the licensee justified continuing operation by applying the AO Validity Criteria to address an overall F_Q limit. When questioned as to the validity of that approach, the licensee considered using an operability determination to address an overall F_Q limit. The question of whether it is appropriate to apply an operability determination in the context of these is addressed in the NRC staff response to Question 4 of this TIA. Certain aspects of the question regarding the application of an operability determination to the development of reactor core power distribution limits, however, are closely related to the issue of whether there are one or two F_Q limits.

The question of whether there are one or two F_Q limits arose in part due to efforts to understand the wording in NRC Inspection Manual Part 9900: Technical Guidance, "Operability Determinations & Functionality Assessments for Resolution of Degraded or Nonconforming Conditions Adverse to Quality or Safety," Appendix C, Paragraph C.4.a, which states:

Occasionally, a regulation or license condition may specify the name of the analytic method for a particular application. In such instances, the application of the alternative analysis must be consistent with the TSs, license condition, or regulation. For example, the methods used to determine limits placed in the core operating limits report (COLR) may be specified in TSs. An evaluation of a SSC [structure, system, or component] performance capability may be determined with a non-COLR method, but the limits in the COLR must continue to comply with the technical specification.

If there is a separate transient F_Q limit, then the $W(z)$ function would need to be explicitly known to set the transient F_Q limit. The use of an unapproved methodology is prohibited from being used to set TS limits. The licensee has stated that they have one overall F_Q limit and not separate steady state and transient F_Q limits. The licensee has stated that it may be acceptable to use an unapproved methodology, through the operability determination process, to adjust the $W(z)$ function and thereby meet the surveillance requirements (see the response to Question 4 of this TIA regarding application of the operability determination process).

There are several citations which are pertinent to the question of whether there are two separate F_Q limits or whether they are both parts of one single limit:

VEGP-1 TS 3.2.1, "Heat Flux Hot Channel Factor ($F_Q(z)$) (F_Q Methodology)" LCO states:

$F_Q(Z)$ shall be within the steady state and transient limits specified in the COLR.

VEGP-1 TS 3.2.1, Actions, Condition A, states:

$F_Q(Z)$ not within steady state limit.

VEGP-1 TS 3.2.1, Actions, Condition B states:

$F_Q(Z)$ not within transient limit.

VEGP-1 Surveillance Requirement (SR) 3.2.1.1 states:

Verify $F_Q(Z)$ is within steady state limit.

VEGP-1 SR 3.2.1.2 states:

Verify $F_Q(Z)$ is within transient state limit.

The words 'steady state,' 'transient,' or 'limit' are not used in the VEGP-1 COLR with respect to TS 3.2.1. Therefore, the VEGP-1 TSs indicate that VEGP-1 has two separate limits. However, the licensee has stated that VEGP-1 has only one overall F_Q limit based on the fact that in TR WCAP-10216-P-A, Revision 1, there is only one overall F_Q limit. The NRC staff does not agree with this position. The following discussion evaluates the recent licensing activity associated with VEGP TS 3.2.1

The licensee's statement that WCAP-10216-P-A, Revision 1, only has one F_Q limit is supported by the following excerpts from that document:

The second paragraph of WCAP-10216-P-A, Revision 1, Part B, Section II, states:

$F_Q(z)$ surveillance is then accomplished by comparing the product of the measured $F_Q^M(z)$ and the analytically determined $W(z)$ to the $F_Q(z)$ limit.

TR WCAP-10216-P-A, Revision 1, Part B, Section III.A (first paragraph, first sentence), states:

During normal operation $F_Q(z)$ is shown to be within its limit by comparing the result of a measured $F_Q(z)$ multiplied by a $W(z)$ transient function to the measured $F_Q(z)$ limit.

The modifications to Section 3/4.2.2 Heat Flux Hot Channel Factor Limits LCO state:

$F_Q(z)$ shall be limited by the following relationships:

The relationships shown immediately thereafter are the steady state power-dependent relationships, wherein a non-axially dependent F_Q limit is depicted. In a similar manner, in SR 4.2.2.2 c., where $F_Q(Z)$ must "Satisfy the following relationship:," the relationships shown immediately thereafter are essentially identical to the steady state power-dependent relationships, except for the inclusion of the $W(z)$ function.

VEGP-1 adopted WCAP-10216-P-A, Revision 1, at the same time it implemented the VANTAGE 5 fuel assembly design (Reference 6). The TSs for F_Q in that license amendment are very similar to those listed in WCAP-10216-P-A, Revision 1. With respect to whether there is one F_Q limit or two, it is clear that in this license amendment there is only one F_Q limit.

If the VEGP-1 TSs adopted after the license amendment to adopt TR WCAP-10216-P-A, Revision 1, for determination of F_Q clearly indicated that there is only one F_Q limit, then how did the current TSs come to indicate that there are two? The most recent change to the VEGP-1 F_Q TS was Amendment Number 96 (Reference 7). Amendment 96 occurred when VEGP-1 converted to the Standard Technical Specifications (STS) for Westinghouse Plants, NUREG-1431, Revision 1. The VEGP-2 F_Q TS has not changed since its implementation of the STS, and the current wording is a direct result of Amendment 96.

The SER accompanying the license amendment approving VEGP's improved TS (Reference 7) was reviewed. In paragraph 3.4.3.2 of the STS Differences section it states, in part:

The Required Actions for Condition A are applicable to the case where $F_Q(Z)$ exceeds the steady state limit, so Condition A and the appropriate Required Actions are revised to refer to the steady state limits. Similarly, the Required Actions for Condition B are applicable to the case where $F_Q(Z)$ does not meet the transient limit. Therefore, Condition B has been revised appropriately.

The fact that this discussion is in the STS Differences section indicates that the NRC staff considered the separate steady state and transient limits to be neither more restrictive nor less restrictive than the STS, and that it was not merely a plant-specific administrative change, thus indicating the NRC staff's concurrence with there being two separate limits.

The VEGP's TS Bases document for incorporating NUREG-1431, Revision 1, clearly indicates there are separate steady state and transient limits. The LCO section starts with:

To ensure that the Heat Flux Hot Channel Factor, $F_Q(Z)$, will remain within limits during steady state operation, $F_Q(Z)$ shall be limited by the following relationships which define the steady state limits:

The relationships which follow are identical to those in NUREG-1431, Revision 1, Basis, except for some minor nomenclature. Later in the LCO section the VEGP TS Bases state:

To ensure that $F_Q(Z)$ will not become excessively high if a normal operational transient occurs, $F_Q(Z)$ shall be limited by the following relationships which define the transient limits:

The relationships which follow are identical to those in NUREG-1431, Revision 1, Basis, except for some minor nomenclature, and the addition of the $W(z)$ function in the denominator on the right side of the relationship.

Question 2:

Is the licensee's use of different $W(z)$ curves depending on core burnup inconsistent with WCAP-10216-P-A as required by the Vogtle technical specifications? Is the interpolation between two $W(z)$ curves inconsistent with technical specifications?

Question 2 Response Summary:

There is reasonable assurance that the use of different $W(z)$ curves depending on core burnup is consistent with TR WCAP-10216-P-A, Revision 1, as required by the VEGP-1 TSs, despite the lack of specificity in the TR regarding the development, control, and use of burnup dependent $W(z)$ curves. The interpolation between two $W(z)$ curves based on different burnups appears to be consistent with the VEGP-1 TSs. Based on discussions with Westinghouse and regulatory precedent (described below), a second order, or higher, polynomial interpolation between the curves should be considered consistent with TR WCAP-10216-P-A, Revision 1. The licensee's use of burnup-dependent $W(z)$ curves should be considered consistent with TR WCAP-10216-P-A, provided it uses a second order, or higher, polynomial interpolation between the curves.

Question 2 Response Discussion:

The licensee and Westinghouse have stated that the practice of having different $W(z)$ functions for different periods of core life is consistent with TR WCAP-10216-P-A, Revision 1. The basis for that statement is the last sentence of the second paragraph in Part B, Section IV.A of TR WCAP-10216-P-A, Revision 1, which states:

In most reload cores, operating flexibility can be maximized by making the $W(z)$ function burnup dependent.

That is the extent of the discussion about making the $W(z)$ function burnup-dependent found in TR WCAP-10216-P-A, Revision 1. Within TR WCAP-10216-P-A, Revision 1, there is no discussion about how to make the $W(z)$ function burnup dependent, or about any concerns, limitations, and restraints on this practice.

In the cover letter approving TR WCAP-10216-P-A, Revision 1, the last sentence of the fourth paragraph states: "Our acceptance applies only to the features described in the reports." The technical evaluation section of the SE enclosed with this cover letter is silent with respect to establishing a burnup-dependency for the $W(z)$ function. Therefore, the NRC staff's acceptance of the burnup-dependency of the $W(z)$ function is not explicit.

The position of Westinghouse, however, is that NRC staff acceptance of the burnup-dependency of the $W(z)$ function was implicit at the time SE was issued. Westinghouse holds that burnup-dependency of the $W(z)$ function was always intended and that the NRC staff was cognizant of this dependency at the time the original SE was issued. To support this position, Westinghouse provided a copy of the Peaking Factor Limit Report (PFLR) for Sequoyah Nuclear Plant (Sequoyah), Unit 1, Cycle 2 (U1C2) dated September 21, 1982. This PFLR predates the NRC staff's SE for TR WCAP-10216-P-A, Revision 1, by five months and Westinghouse's issuance of the approved TR WCAP-10216-P-A, Revision 1, by nine months. The Sequoyah U1C2 PFLR provides five $W(z)$ curves, each applicable over a specified burnup range. Westinghouse also provided a copy of the PFLR for Sequoyah, Unit 2, Cycle 4, (U2C4) dated March 1989. The Sequoyah U2C4 PFLR shows four $W(z)$ curves, each determined at a specific burnup. The Sequoyah U2C4 PFLR calls for three point interpolation between the curves to determine specific $W(z)$ values.

The Sequoyah PFLRs supplied by Westinghouse clearly show that burnup-dependency has been part of Westinghouse implementation of TR WCAP-10216-P-A, Revision 1, since its inception. While the PFLRs do not prove that the NRC staff knew how the burnup-dependency was being performed, they do indicate that it was a routine practice by Westinghouse and lends plausibility to the claim that the NRC staff implicitly accepted the practice. Therefore, based on the best information available, $W(z)$ burnup-dependency may be considered part of the approved methodology.

With respect to the question of whether the licensee's specific use of burnup-dependent $W(z)$ curves is consistent with TR WCAP-10216-P-A, Revision 1, there is limited information available to the NRC staff upon which to evaluate the licensee's implementation of burnup-dependent $W(z)$ curves. By inspection of the $W(z)$ functions provided in recent VEGP COLRs, the $W(z)$ functions do not vary linearly with burnup. The VEGP burnup steps are too large for a $W(z)$ function to be considered appropriate from one step to the next, as was done for the Sequoyah U1C2 PFLR. Westinghouse has stated that licensees are directed to use three point interpolation between the curves to determine specific $W(z)$ values, as was done for the Sequoyah U2C4 PFLR. A three-point interpolation method fits the three $W(z)$ curves closest to the burnup of interest with a second order polynomial. This method addresses the non-linearity of the changes in the $W(z)$ curves moving from one burnup to the next. While it would be possible to choose the burnup data such that a linear interpolation would be reasonable, there is no evidence that burnup points are chosen with that consideration. Absent that consideration, a linear interpolation may be conservative at some points during the cycle, while non-conservative at others. Due to the possibility of non-conservative results, a linear interpolation should not be considered consistent with TR WCAP-10216-P-A, Revision 1. An evaluation of the VEGP $W(z)$

functions indicates that a three-point interpolation between the curves would be reasonable. Therefore, the licensee's implementation of the burnup-dependency could be considered consistent with TR WCAP-10216-P-A, Revision 1, provided it is using at least a three-point interpolation.

Question 3:

Is the licensee's use of less than the full range of axial offset allowed by Unit 1 Cycle 14 Core Operating Limits Report, figure 5, (AO doghouse) in the development of the $W(z)$ curves inconsistent with WCAP-10216-P-A as required by the Vogtle technical specifications? Is the methodology described in the AO Validity Criteria document consistent with the methodology described in WCAP-10216-P-A?

Question 3 Response Summary:

The NRC staff has determined that the use of less than the full range of AO allowed by the VEGP-1, Cycle 14, COLR, figure 5, (AO doghouse) in the development of the $W(z)$ curves is consistent with TR WCAP-10216-P-A, Revision 1. The use of a single AO to determine the $F_Q(z)$ in the denominator of the $W(z)$ equation can also be considered consistent with TR WCAP-10216-P-A, Revision 1, even though it is not specifically described in the TR and not explicitly acknowledged in the SE approving its implementation at VEGP-1. Based on review by the NRC staff, the methodology described in the AO Validity Criteria is not consistent with the methodology described in TR WCAP-10216-P-A, Revision 1. Therefore, it is not part of an approved methodology. Although the NRC staff has not performed a thorough review of the AO Validity Criteria and its basis, the NRC staff does not perceive a significant safety issue based on the information provided.

Question 3 Response Discussion:

The first part of this question speaks to the licensee's practice of using less than the full range of AFD allowed by the COLR to determine the $W(z)$ function. To answer this question we must go to TR WCAP-10216-P-A, Revision 1, to find out how the $W(z)$ function is defined.

The first paragraph of TR WCAP-10216-P-A, Revision 1, Part B, Section II, reads:

$F_Q(z)$ surveillance is accomplished in the following manner. A full core flux map is taken under equilibrium conditions to determine $F_Q(z)$. This measured $F_Q(z)$ is increased by appropriate uncertainties to account for manufacturing tolerances and measurement uncertainty. The resulting $F_Q(z)$ including uncertainties is called $F_Q^M(z)$. Since $F_Q^M(z)$ was measured under equilibrium conditions, potential increases in $F_Q(z)$ that might arise from changes in the equilibrium power distribution caused by power level changes and control rod movement must also be accounted for. A $W(z)$ function that represents the maximum likely increase in the equilibrium measured $F_Q(z)$ that might arise during power distribution transients will account for non-equilibrium operation.

According to TR WCAP-10216-P-A, Revision 1, Part B, Section IV. A.:

The $W(z)$ factor represents the largest expected increase in an equilibrium $F_Q(z)$ that can result from changes in ΔI (change in flux shape) and power level which are allowed in plant operation.

$W(z)$ is defined as:

$$W(z) = (F_Q(z) \times P)^{\text{maximum, simulated transient}} / (F_Q(z) \times P)^{\text{equilibrium}}$$

It appears clear from these definitions that the non-equilibrium $F_Q(z)$ is the result of a transient induced from the equilibrium $F_Q(z)$ initial conditions.

TR WCAP-10216-P-A, Revision 1, Part B, Section IV. A. also states:

For a plant with RAOC Technical Specification, $W(z)$ is determined based on the transient $F_Q(z)$ resulting from the normal operation analysis of the final ΔI -Power operating space. The methodology for determining the ΔI -Power operating space is discussed in "Relaxation of Constant Axial Offset Control" (Part A of NS-EPR-2649).

Note: Part A of NS-EPR-2649 is Part A of TR WCAP-10216-P-A.

TR WCAP-10216-P-A, Revision 1, Part A, Section II.C, "Normal Operation Analysis," is where the final allowed ΔI -Power operating space is determined. According to TR WCAP-10216-P-A, Revision 1, Part A, Section II.C.1:

In the standard CAOC (Constant Axial Offset Control) analysis the generation of the normal operation power distributions is constrained by the rod insertion limits (RIL) and ΔI band limits. The purpose of RAOC is to find the widest permissible ΔI -Power operating space by analyzing a wide range of ΔI . Therefore, the generation of normal operation power distributions is constrained only by the RIL.

Section II.C then describes how the wide range of ΔI is created. Section II.C.2 states:

Each power shape generated in Section C.1, above, is analyzed to determine if LOCA constraints are met or exceeded.

Those power shapes that exceed LOCA constraints are removed from the total. In TR WCAP-10216-P-A, Revision 1, Part A, Section II.C.3., a similar analysis is made for the loss-of-flow-accident. The results from each analysis are compared and the most restrictive limits determined. The product is a range of ΔI -Power operating space or AO doghouse that is used for operation of the reactor.

It would appear from this description that $W(z)$ is determined by first establishing $F_Q(z)^{\text{equilibrium}}$ for a specific set of equilibrium conditions (i) and then inducing transients from that set of equilibrium conditions to determine the $F_Q(z)^{\text{maximum, simulated transient}}$ values that can be reached from those equilibrium conditions. These $F_Q(z)^{\text{maximum, simulated transient}}$ values are then used to calculate $W(z)$ for those initial conditions. The process is repeated until the entire range of ΔI -Power operating space has been covered and the limiting $W(z)$ value at each core height is

established. This would represent the largest expected increase in an equilibrium $F_Q(z)$ that can result from changes in ΔI and power level which are allowed in plant operation. The use of the fraction of rated thermal power (P) in both the numerator and denominator recognizes that the equilibrium and transient conditions may be at different power levels. The use of P also tends to normalize $W(z)$ with respect to power level such that $W(z)$ functions determined from low power conditions do not contribute excessively to the final $W(z)$ function.

Based on information submitted by with the licensee, the practice at VEGP-1 is to determine a $F_Q(z)$ ^{maximum, simulated transient} for the entire RAOC-determined range of ΔI -Power operating space, but the $F_Q(z)$ ^{equilibrium} which is used to determine the $W(z)$ function is based on a much narrower range of ΔI -Power operating space, or even a single axial flux shape (Reference 8). The licensee described the determination of $W(z)$:

$W(z)$ is defined as the ratio of peak transient $F_Q(z)$ divided by steady state $F_Q(z)$. The numerator is based on the most limiting of thousands of core power shapes, which are generated in a manner independent of the path taken to achieve each shape. The numerator is a robust quantity that represents the most limiting credible shape or shapes that can be attained by operation anywhere within the allowed operating axial flux difference (AFD) band. The denominator however, is based on a single steady state core power shape. As such, $W(z)$ factors are sensitive to the steady state core power shape, and it is implicitly assumed when generating $W(z)$ surveillance factors that the measured steady state AO will match the predicted steady state AO within the historical measured to predicted range of AO differences.

In the licensee's description of how to determine $W(z)$, the numerator represents the largest expected $F_Q(z)$ that can result from operation in the full ΔI -Power operating space. As TR WCAP-10216-P-A, Revision 1, does not permit operation exceeding the ΔI -Power operating space, even in transients, it is probable that the numerator contains all the maximum expected $F_Q(z)$ for transients initiated from steady state conditions. However, the denominator does not include the full ΔI -Power operating space, but rather a narrow AFD range. As long as the plant remains at that single steady state core power shape, the $W(z)$ function would appear to be valid, although the licensee's description makes no mention of how P is used to determine $W(z)$. As soon as the plant deviates from that single steady state core power shape, the $W(z)$ function becomes indeterminate, as the $F_Q(z)$ from the new steady state conditions was not used to determine the $W(z)$ function.

This description would appear to be different from the one described in TR WCAP-10216-P-A, Revision 1. However, Westinghouse has stated that the licensee's description of how TR WCAP-10216-P-A, Revision 1, is used is how the TR has always been implemented and that the NRC staff was cognizant of this process at the time of the original SE accepting this TR. To support this position, Westinghouse provided portions of the analysis used to determine the $W(z)$ functions in the PFLR for Sequoyah U1C2 and U2C4. While the information provided does not prove that the original $W(z)$ determinations used a single AO, this information does make such a position plausible. Similar to the use of burnup-dependency when developing $W(z)$ curves, it appears to have been common practice to use less than the full range of AO allowed by the AO doghouse when developing $W(z)$ curves, despite the lack of explicit acknowledgement of this practice in TR WCAP-10216-P-A or the associated SE. In

consideration of all these factors, therefore, it has been determined that the use of a single AO to determine the $F_Q(Z)$ in the denominator of the $W(z)$ equation can be considered consistent with TR WCAP-10216-P-A, Revision 1.

The second part of this question addresses how the licensee uses the AO Validity Criteria, a document used by the licensee to respond to occasions when the plant is outside of the narrow range of AFD space used to determine $W(z)$. There is no description in TR WCAP-10216-P-A, Revision 1, of how the single AO used to determine the $F_Q(Z)$ in the denominator of the $W(z)$ equation is chosen. Therefore, there is no description of the procedure to follow when a plant deviates from that single AO. When the licensee finds itself in that situation, the licensee relies on the AO Validity Criteria. However, unlike the use burnup-dependency or the use of a single AO, there is no evidence that the AO Validity Criteria existed at the time of the original SE. Westinghouse has confirmed that the AO Validity Criteria were not in place at the time of the original SE and that it has not been reviewed and approved by the NRC staff, either explicitly or implicitly. Therefore, approval of the AO Validity Criteria cannot be considered implicit in the use of the approved TR WCAP-10216-P-A, Revision 1.

The NRC staff obtained a copy of the AO Validity Criteria from the licensee. Upon reading the AO Validity Criteria, the NRC staff believes that it constitutes a change in methodology from that described in TR WCAP-10216-P-A, Revision 1. The NRC staff does not have sufficient information to have performed a thorough review of the AO Validity Criteria and its basis. However, based on the information available, the NRC staff does not believe that the use of the AO Validity Criteria poses a significant safety concern.

Question 4:

Is the use of an operability determination to show that the core can be operated with AO outside of the analyzed range a violation of NRC requirements?

Question 4 Response Summary:

No. Using an operability determination for the stated purpose is not a violation of NRC requirements. However, it is a misapplication of the operability determination process.

Question 4 Response Discussion:

The question pertains to whether VEGP-1 appropriately used the operability determination process guidance in the development of reactor core power distribution limits for Cycle 14. The operability determination process guidance was published on September 26, 2005, as an attachment to Regulatory Issue Summary 2005-20, "Revision to Guidance Formerly Contained in Generic Letter 91-18, "Information to Licensees Regarding Two NRC Inspection Manual Sections on Resolution of Degraded and Nonconforming Conditions and on Operability." Using an operability determination for the stated purpose is not a violation of NRC requirements, but it is a misapplication of the operability determination process. The operability determination process is inspection guidance that establishes expectations, not requirements, for assessing operability.

NRC Inspection Manual Part 9900, Technical Guidance, "Operability Determinations & Functionality Assessments for Resolution of Degraded and Nonconforming Conditions Adverse to Quality and Safety," describes the circumstance warranting operability determinations as:

Licenseses should enter the operability determination process on discovering any of the following circumstances when the operability of any structures, systems or components (SSCs) described in TSs is called into question:

- a. Degraded conditions
- b. Nonconforming conditions
- c. Discovery of an unanalyzed condition

If information calls into question the ability of SSCs to perform specified safety functions then:

The operability determination process is used to assess operability of SSCs and support functions for compliance with TSs when a degraded or nonconforming condition is identified for a specific SSC described in TSs, or when a degraded or nonconforming condition is identified for a necessary and related support function.

In a clarification, the guidance adds:

If an SSC is clearly inoperable (e.g., loss of motive power or failed TS surveillance), it must be declared inoperable and the operability determination process, per the Part 9900 technical guidance, need not be entered.

TS 5.6.5, Core Operating Limits Report, establishes limits for cycle-specific parameters referenced in TSs; however, COLR parameters are not LCO-specified SSCs. Discovery of failure to meet a COLR-specified limit is governed by LCO 3.0.2. LCO 3.0.2 states that when an LCO is not met (emphasis added) the required actions of the associated conditions must be met. Thus, for COLR-specified parameters, the LCO is not met when the parameter is not met and the operability determination process, per the Part 9900 technical guidance, need not be entered.

VEGP-1 showed that the core can be operated with an AO outside of the analyzed range by making a change to the facility through application of an unapproved methodology for the unanalyzed startup conditions. Changes to facilities can be in accordance with 10 CFR 50.59; not through application of the Part 9900 Operability Determination Process.

Question 5:

Was the use of the guidance contained in RIS 2005-20 appropriate to justify the use of the Westinghouse AO Validity Criteria?

Question 5 Response Summary:

No. The licensee incorrectly applied the Part 9900 operability determination process inspection guidance in Appendix C, "Specific Operability Issues," Section C.4, "Use of Alternative Methods in Operability Determinations" to justify continued reactor startup.

Question 5 Response Discussion:

VEGP-1 incorrectly applied the Part 9900 operability determination process inspection guidance in Appendix C, "Specific Operability Issues," Section C.4, "Use of Alternative Methods in Operability Determinations," to justify continued reactor startup.

Section C.4 relates the use of analytical methods or computer codes different from those originally used in the calculations supporting the plant design (emphasis added). The guidance states:

Although the use of alternative and normally more recent methods or computer codes may raise complex plant-specific issues, their use may be useful and acceptable in operability determinations.

However, this statement should not be a point of confusion regarding alternative methods applied to the COLR methods since Paragraph C.4.a uses an example to clarify the intent of the guidance in this regard:

For example, the methods used to determine limits placed in the core operating limits report (COLR) may be specified in TSs. An evaluation of an SSC performance capability may be determined with a non-COLR method, but the limits in the COLR must continue to comply with the technical specification (emphasis added).

Clearly, non-COLR methods may assist in establishing SSC performance capability as it relates to supporting plant design basis, but the calculated reactor core distribution limits, and therefore the analytical methods used to calculate these limits, must comply with TSs.

4.0 REFERENCES

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2. Southern Nuclear Operating Company, Inc. "Vogtle Electric Generating Plant, Facility Operating License, Appendix A, Technical Specifications" March 16, 1987 (ADAMS Accession No. ML052840233).
3. Westinghouse Electric Company, "Axial Offset Validity Criteria for Westinghouse Reload Safety Analysis Methodology, Nuclear Plant Operating Data Predictions, and Power Distribution Measurements including W(z) Factors and Fxy(z) Limits," PCT-05-529, Revision 3, July 20, 2005.
4. TR WCAP-10216-P-A, "Relaxation of Constant Axial Offset Control FQ Surveillance Technical Specification," Revision 1, February 1994.
5. NUREG-1431, "Standard Technical Specifications Westinghouse Plants," Revision 3.

6. D. S. Hood, US NRC, letter to W. G. Hariston, III, Georgia Power Company, "Issuance of Amendment Nos. 43 and 44 to Facility Operating License NPF-68 and Amendment Nos. 23 and 24 to Facility Operating License NPF-81, Vogtle Electric Generating Plant, Units 1 and 2 (TACS 79303/79304 and 81240/81241)," September 19, 1991 (ADAMS Accession No. ML012290256).
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8. D. E. Grissette, Southern Nuclear Operating Company, Inc., letter to U.S. Nuclear Regulatory Commission ATTN: Document Control Desk, "Vogtle Electric Generating Plant Followup Questions from Staff from Teleconference Held on May 11, 2006, Regarding the Use of W(z) Factors in the Unit 1 Core Operating Limits Report," dated May 22, 2006 (ADAMS Accession No. ML061420523).

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