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SOUTHERN COMPANY
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November 26, 2002

LCV-1617-A

Docket Nos. 50-424
50-425

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

VOGTLE ELECTRIC GENERATING PLANT
REQUEST TO REVISE TECHNICAL SPECIFICATIONS
REACTOR TRIP SYSTEM INSTRUMENTATION OVER TEMPERATURE DELTA TEMPERATURE (OTΔT) AND OVER POWER DELTA TEMPERATURE (OPΔT) REACTOR TRIP FUNCTIONS
REQUEST FOR ADDITIONAL INFORMATION

Ladies and Gentlemen:

By way of letter LCV-1617 dated May 8, 2002, Southern Nuclear Operating Company (SNC) requested to amend Vogtle Electric Generating Plant (VEGP) Unit 1 and Unit 2 Technical Specifications (TS) Figure 2.1.1-1, "Reactor Core Safety Limits;" Table 3.3.1-1, "Reactor Trip System Instrumentation;" and the associated Bases B2.1.1 and B 3.3.1. The amendment to the Technical Specifications and associated Bases is to revise the Over Temperature Delta Temperature (OTΔT) and the Over Power Delta Temperature (OPΔT) setpoints to increase operating margin.

This letter provides SNC's response to the request for additional information (RAI) dated July 12, 2002, and additional clarifications to the RAI requested on August 19, 2002, and September 5, 2002.

In the amendment request (letter LCV-1617 dated May 8, 2002), SNC provided a proposed implementation schedule. SNC has revised its proposed implementation schedule. The changes are planned to be implemented prior to startup following the Unit 1 Fall 2003 refueling outage and prior to startup following the Unit 2 Spring 2004 refueling outage.

The responses to the RAI do not contain any information proprietary to Westinghouse Electric Corporation.

A001

Enclosure 1 of this letter contains the responses to the RAI.

SNC has reviewed the previously submitted 10 CFR 50.92 evaluation and has determined that the conclusion that no significant hazards will result from the proposed license amendment remains valid.

Mr. J. T. Gasser states that he is a Vice President of Southern Nuclear Operating Company and is authorized to execute this oath on behalf of Southern Nuclear Operating Company and that, to the best of his knowledge and belief, the facts set forth in this letter are true.

Respectfully submitted,

JT Gasser

J. T. Gasser

Sworn to and subscribed before me this 26th day of November 2002.

Notary Public

My commission expires: 11/10/06

JTG/RJF

Enclosure

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U. S. Nuclear Regulatory Commission
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ENCLOSURE 1

RESPONSES TO RAI

<u>Question 1:</u> Westinghouse WCAP-8745-P-A, "Design Bases for the Thermal Overpower Delta T and Thermal Overtemperature Delta T Trip Functions," provides the methodology for calculating these setpoints. This WCAP established the following limits and restrictions on the use of this method:

a. Applies to Westinghouse plants that reference RESAR-3S and operate under Constant Axial Offset Control (CAOC) without part-length control rods.

<u>Response:</u>

When the methodology for generating the Overtemperature and Overpower DT reactor trip setpoints, as presented in WCAP-8745, was issued in 1977, the axial offset control strategy in place at the time was the CAOC control strategy. Since that time, Westinghouse has developed the "Relaxation of Constant Axial Offset Control / Fq Surveillance Technical Specification" (WCAP-10216-P-A), which allows plants more operational flexibility. It is noted in WCAP-10216-P-A that "...to obtain appropriate setpoints for core protection systems which assure the validity of the design basis ..... will be accomplished by such means as redefining the f(ΔI) penalty function in the Overtemperature ΔT setpoint equation (OTΔT)" (see page A-17). In addition, on top of page 3 of the SER to this WCAP, it is noted that "If required the overtemperature-delta temperature (OTΔT) or overpower-delta temperature (OPΔT) trips may be altered to provide protection by changing the F(ΔI) penalty function in the trips." Furthermore, it is noted in Section 3.2 "Scope and Applicability" of the SER to WCAP-8745-P-A that "..Westinghouse has stated that new methods and technology developed after the submittal of WCAP-8745 are described in separate topical reports, and do not invalidate the conclusions of WCAP-8745. As examples of such new methods .....and plant operating procedure (Relaxed Axial Offset Control)." Thus, it has been acknowledged by the NRC that the conclusions of WCAP-8745, which is based on CAOC control, are not invalidated by RAOC control. The WCAP also provides the following qualification statement ".. the application of this methodology must account for changes in system design and operation. The adequacy of the standard power shapes in establishing the core DNB protection system must be evaluated whenever changes are introduced that could potentially effect the core power distribution." This is discussed in the response to part "b." Finally, Vogtle references both WCAPs and considers them to be part of the plant's licensing basis.

b. The application of this methodology must account for changes in system design and operation. The adequacy of standard power shapes in establishing the core DNB protection system must be evaluated whenever changes are introduced that could potentially effect the core power distribution.

<u>Response:</u>

It is assumed that "changes in system design and operation" is referring to changes in the plant rated power, RCS flow rate, nominal pressure, and vessel average temperature. In the calculation of the Overtemperature and Overpower ΔT setpoints, plant-specific numbers are used for these parameters. In addition, plant-specific values for the high and low pressurizer reactor trip setpoints and for the main steam safety valves are assumed. These limit the range of conditions (ΔT versus Tavg) that the OTDT and OPDT setpoints must provide protection for. Changes in the axial offset control strategy (CAOC versus RAOC) are also directly accounted for in the OTDT f(ΔI) penalty function, as described above, and are based on plant-specific information. A change to any or all of the plant-specific values for the above parameters can potentially affect the Overtemperature and/or Overpower ΔT setpoints.

With respect to the adequacy of standard power shapes in establishing the core DNB protection system, Westinghouse has and continues to use the 1.55 chopped cosine axial power shape as the reference power shape to define the core DNB protection limits which define the Overtemperature ΔT K1, K2, and K3 gains and the Overpower ΔT K4 and K6 gains. This process is described in Appendix B of WCAP-8745-P-A, and is examined on a plant-specific basis for any change in axial offset control strategy since this can affect the OTDT f(ΔI) penalty function. Skewed axial power shapes are calculated based upon either the CAOC or RAOC control strategy, which defines an initial condition for the Condition II events. A DNB comparison of each resulting axial power shape to the 1.55 chopped cosine axial power shape is then performed. This information is used to define a locus of conditions in power versus axial offset space (or T-inlet versus axial offset space), as shown in Figure 4.2 in WCAP-8745-P-A. This information in this figure is used to define how the core thermal limits are to be adjusted, as described in Appendix C of WCAP-8745-P-A. For Vogtle, a T-inlet reduction, rather than a power reduction, is used, and the axial power shapes are analyzed at the power level at which they were generated instead of grouping them into two bins (118% and 80% power).

WCAP-8745 describes a process to adjust the Overtemperature-ΔT setpoints to account for the DNB effect of adverse axial power shapes resulting from different Condition I and II events, such as boron dilutions, borations, rod (bank) withdrawals, and cooldowns. The power shapes that were examined for WCAP-8745 were generated based on plant operation under constant axial offset control (CAOC). To assess the DNB impact of the axial power shapes on the OTΔT setpoints, the accident axial power shapes were compared to the reference axial power shape (historically the 1.55 chopped cosine shape) at two power levels (118% and 80% of full power) to form the Power versus Axial Offset (AO) limit curves as shown in Figure 4.2 of WCAP-8745. The resulting Power versus AO curves were used to define a penalty as a function of ΔI which is applied to the DNB-limited portion of the core thermal limits to reduce the core thermal limits for adverse axial power shapes. The revised core thermal limits for each ΔI examined were then used to calculate a reduction in K1 that insures that the revised core thermal limits are protected. Thus, for each ΔI there is a set of core thermal limits and a corresponding revised K1. The changes in K1 versus ΔI are used to define f(ΔI) function (see Figure C-3 in WCAP-8745).

In 1991, it was determined that the application of the Power versus AO curves at 118% and 80% power were non-conservatively being applied to power levels greater than 118%. The application of the Power versus AO curves to powers greater than 118% was necessary to define the reduced core thermal limits over the full range of power covered by the OTΔT setpoints. In other words, to generate the reduced core thermal limits up to the maximum power level (118%) for a specific ΔI, the reference core thermal limits lines were extrapolated to power levels in excess of 118% power and then reduced by the ΔI DNB power penalty obtained from the Power versus AO curves. For the W-3-based correlations, the Power versus AO approach was conservative for the extrapolation. However, for the WRB-1 and WRB-2 correlations, the Power versus AO approach was non-conservative. To address this non-conservatism, Westinghouse redefined the adverse axial power shape DNB penalty to be based on T_{inlet} versus AO at 118% and 80% power. The T_{inlet} versus AO DNB penalty curves were used to adjust the reference core thermal limits without any extrapolation of the core thermal limits to powers greater than 118%. The NRC was made aware of this issue via plant-specific submittals (e.g., the NRC's SER for the Catawba Unit 2 Amendment No. 87 to the Facility Operating License dated December 17, 1991) which were required to revise the Overtemperature f(ΔI) function. A revision to the WCAP-8745 was not issued, as the approach to determine the Overtemperature f(ΔI) function remains essentially the same as described in Appendix C. That approach is to adjust the core thermal limits for adverse axial power shapes such that the DNB design basis is maintained. The change from the original Power versus AO DNB penalty in WCAP-8745 to the T_{inlet} versus AO DNB penalty eliminated the non-conservative extrapolation in the calculation to determine the Overtemperature f(ΔI) function that was inherent in the original approach.

The approach of 'binning' the axial power shapes at two power levels (118% and 80% of full power) came under further review in the mid-1990s to avoid concerns with intermediate power levels between 80% and 118% and at power levels below 80% power. Binning the power shapes assumes a linear relationship, which may or may not be conservative for future DNB correlations. Also, the binning process, which was developed based on plant operation under CAOC, may have limitations for use with the Relaxed Axial Offset Control (RAOC) operating strategy (WCAP-10216-P-A, Revision 1A). The RAOC operating strategy allows more adverse Condition I axial power shapes at reduced power levels (down to 50% of full power) that are used as initial conditions for the Condition II events. To explicitly determine the effect of adverse Condition II RAOC axial power shapes at power levels other than 118% and 80% power, the DNB analysis of each power shape was performed at the power level at which the shape was generated. For a given shape and its associated power level, the reduction in the core limit inlet temperature at that power level is calculated such that the DNB design basis is maintained. Using the tens of thousands of Condition II shapes generated as part of the RAOC analyses, this process allows for the explicit determination of the adverse axial power shape penalty on the DNB-limited portion of the core thermal limits in terms of ΔT_{inlet} versus ΔI for direct use in the determination of the f(ΔI) function. This approach was not viable for the CAOC strategy because the number of axial power shapes generated with CAOC is significantly less than with RAOC and the power levels associated with the shapes generated for CAOC are mostly at or near 100% power. Once the adverse axial power shape penalty in terms of ΔT_{inlet} versus ΔI is determined, the approach to determine the Overtemperature f(ΔI) function remains essentially the same as described in Appendix C of WCAP-8745. Again, since the approach to the generation of the Overtemperature f(ΔI) function remains essentially the same, a revision to the WCAP-8745 was not issued. The use of an adverse axial power shape penalty (in terms of ΔT_{inlet} versus ΔI instead of Power versus AO or T_{inlet} versus AO) eliminated the assumed power shape behavior at power levels other than 80% and 118% that was inherent in the original approach to determine the Overtemperature f(ΔI) function and replaced that process with an explicit calculation of the power shape behavior.

c. Please discuss how all restrictions and limitations in WCAP-8745-P-A were evaluated in order to ensure that the methodology is applicable for Vogtle Units 1 and 2.

See response presented above to part "b".

<u>Question 2</u>: In addition to revising the OTDT and OPDT setpoints and constants, the licensee proposes to change the setpoint allowable values and the core safety limits

curve. Please provide a references to the NRC approved methodology used to calculate these revised values.

<u>Response:</u>

The methodology used to determine the OTDT and OPDT setpoint allowable values is identical to that used for Millstone Unit 3 (allowing for plant specific parameter variation). The Millstone Unit 3 allowable values for OTDT and OPDT are exhibited in Note 2, Table 2.2-1, page 2-10 of the Millstone Unit 3 Technical Specifications and were approved as Amendment 159, 5/26/1998.

Utilization of the calibration tolerance as the determinant of the difference between the Allowable Value and the Nominal Trip Setpoint has been concluded to be an acceptable approach for evaluating protection channel operability. This is documented in the last paragraph of page 1 of the NRC's SER for the Millstone 3 Amendment No. 159 to the Facility Operating License. The same approach has been utilized at Vogtle for Overtemperature ΔT and Overpower ΔT. Vogtle has the same Westinghouse 7300 process racks as Millstone 3; therefore, this is considered to be an acceptable approach for Vogtle since Westinghouse is performing uncertainty calculations for both plants.

The core safety limits curve (as presented in the Vogtle Technical Specifications) is calculated as described in WCAP-8745-P-A (see Figure B-3), except that Tavg is used as the y-axis rather than inlet temperature since the plant is controlled to Tavg. Again, as noted in response to Question "1.b", plant-specific information is used to generate this figure.

<u>**Question 3:**</u> **The licensee states that approval of the proposed changes to the OTDT and OPDT setpoints is contingent upon approval of the previous SNC amendment request for the revised RAOC band and clamp on the compensated temperature difference term in the OTDT trip setpoint. Please discuss how these previously proposed changes are incorporated into the analyses performed for the OTDT and OPDT setpoint changes being requested in the current amendment request.**

<u>Response:</u>

As discussed in SNC letter LCV-1617 (dated May 8, 2002) to address the temperature effects on operating margin, SNC proposed to increase the OTΔT and OPΔT setpoints. The program to increase the setpoints is referred to as the setpoint Margin Recovery Program (or MRP for short).

During the course of performing the analyses to support the setpoint MRP changes, design issues related to fuel rod design under transient conditions were discovered. As discussed in first amendment request in SNC letter LCV-1563 (dated October 30, 2001), the specific issue is related to clad stress margin. As discussed in this letter, as supplemented by letters LCV-1563-A (dated February 11, 2002) and LCV-1563-B (dated May 27, 2002), the proposed resolution of this issue was to revise the relaxed axial offset control (RAOC) operating band, revise the OTΔT reactor trip function axial flux difference modifier f1(AFD), and the implementation of the clamp on the compensated temperature difference term in the OTΔT trip setpoint.

The proposed changes in the previous paragraph could be implemented independently of the changes to the OTΔT and OPΔT setpoints to provide additional clad stress margin. At the time these proposed changes were submitted (letter LCV-1563), SNC originally planned on implementing the changes during the Unit 1 refueling outage in Spring 2002. The work to support the remainder of the setpoint MRP changes was not complete at that time. The remainder of the setpoint MRP changes are the subject of the second amendment request (letter LCV-1617).

Question 4: **As part of the MRP, the licensee is reducing margin in the VANTAGE+ safety analysis DNBR limits to obtain additional operating flexibility. What is the new safety analysis DNBR limit? Demonstrate that adequate DNBR margin will remain to offset any DNBR penalties (i.e., rod bow, transition core) such that the DNBR design limits will be met.**

Response:

As discussed in Section 3.1.2.1, the RTDP design basis limit DNBR values are unchanged for the Margin Recovery Program (1.24 and 1.23 for the typical and thimble cells, respectively, for VANTAGE+ fuel, and 1.23 and 1.22 for the typical and thimble cells, respectively, for LOPAR fuel). These values represent the DNB design basis limits for the fuel cladding fission product barrier.

Additional DNBR margin was maintained in the MRP DNB analyses by performing the safety analyses to DNBR limits higher than the design basis limit DNBR values. Sufficient DNBR margin was included in the safety analysis DNBR limits to offset the known DNBR penalties. The net remaining DNBR margin, after consideration of the DNBR penalties, is available for operating and design flexibility (e.g., VANTAGE+ transition core DNBR penalty associated with the limited insertion of LOPAR fuel), as discussed in Vogtle FSAR Section 4.4.1.1.2.

The amount of margin which was included in the MRP analyses for the VANTAGE+ fuel was greater than 15%. Prior to the MRP analyses, approximately 17% had been included. The known DNBR penalties that had to be addressed for the MRP analyses were less than 5% (not including any transition core DNBR penalty). Therefore, approximately 10% margin is available for operating and design flexibility to offset any cycle-specific DNBR penalties.

Question 5: **The licensee states that the fuel assembly lift force analysis is not affected by the MRP changes because the VEGP fuel assembly lift forces that were evaluated in support of the power uprate bounded operation with or without the use of thimble plugging devices. Please discuss the technical basis for this conclusion.**

Response:

The lift force calculations that were performed for the VANTAGE+ fuel were based on conservative assumptions regarding thimble plugging devices. The flow used in the lift force calculation was based on the assumption of no thimble plugging devices. The fuel assembly hydraulic resistance used in the lift force calculation was based on the assumption of thimble plugs in place. Therefore, the results bounded both configurations. The lift force analysis was not affected by the MRP assumptions.

Question 6: **The licensee proposes to revise the core thermal limits by reducing margins, one of which is an overpower limit increase from 118% to 120%. Please discuss the technical basis for the proposed overpower limit increase. WCAP 8745-P-A, which provides the design basis and calculation methodology for the OTDT and OPDT trip setpoints, is based on a value of 118%. Also, please discuss how this proposed change impacts the VEGP 22.4 kW/ft fuel melt limit, which is based on a 118% overpower limit.**

Response:

As noted in WCAP-8745-P-A, the overpower limit of 118% is a typical number (i.e., "typically 118% of nominal"). This is also noted in the WCAP-8745-P-A SER (see second paragraph of page 3 where it is stated "typically at 118% nominal power level"). It should be noted that the "118% of nominal" value is a historical number and is not the true limit. The true limit is the kw/ft that results in fuel centerline melting which is 22.4 kw/ft. The kw/ft is based on the plant-specific nominal kw/ft (which varies from plant to plant), the transient Fq, and the overpower limit. For Vogtle, even considering the 120% overpower limit, there is margin to the limit of 22.4 kw/ft. Furthermore, it should be noted that the margin for Vogtle is more than for other plants which continue to use the historical 118% overpower value. The more important consideration is the transient Fq from the Condition II events.

Question 7: **The licensee includes an allowance for 6.1°F of uncertainty on the RCS average temperature (Tavg) measurement. Please provide the technical basis for this value, including calculation methodology and a discussion of how this value is applied in the analysis.**

Response

The Vogtle safety analyses assume 6.0°F for the temperature uncertainty, which accounts for the difference between the actual temperature and the indicated temperature. The 6.1°F is completely separate from the 6.0°F temperature uncertainty and is intended to account for differences between the reference Tavgs for the OTDT (T') and OPDT (T") setpoints and the indicated Tavgs in each loop. It is also intended to account for the loop-to-loop differences in Tavg and any burndown effects on Tavg. That is, as the core burns, the indicated temperature can change. Temperature data from several operating cycles were reviewed. Based on this review, it was determined that the individual loop Tavg could differ from the loop reference Tavg (T' and T") by as much as 6.1°F. From a protection system point of view, the direction of non-conservatism that needs to be addressed is that of decreasing indicated Tavg during the cycle. During a heatup transient, the OTDT and OPDT setpoints are reduced to provide protection when the indicated loop Tavg increases above the loop reference Tavg (T' and T"). With the initial indicated Tavg less than the reference Tavg (T' and T"), a reactor trip on the OTDT setpoint will be delayed compared to the situation where the indicated loop Tavg is equal to the loop reference Tavg (T' and T"). This effect has been accounted for in the analysis, in addition to the 6.0°F temperature uncertainty which covers the actual versus indicated temperature.

To ensure that the OTDT and OPDT setpoints remain valid, as they are based upon some reference temperature condition which for Vogtle is fixed at 588.4°F, it is necessary to account for any differences between the OTDT and OPDT reference temperatures and the indicated temperatures. This 6.1°F allowance has been included in the Vogtle safety analyses by increasing the safety analysis values for the OTDT K1 gain and for the OPDT K4 gain.

<u>Question 8:</u> The licensee listed five UFSAR Chapter 15 transients which rely on OTDT and OPDT for primary protection and stated that they were reanalyzed or evaluated to consider the proposed MRP revisions.

a. Please discuss which of these events were reanalyzed and which were evaluated. For those that were evaluated, provide the technical basis for the conclusion that all acceptance criteria for the event will remain satisfied. For the reanalyzed events, please provide values for the calculated results which demonstrate that all acceptance criteria are satisfied.

<u>Response:</u>

The Uncontrolled Boron Dilution event was evaluated for the MRP program. The purpose of analyzing this event is to identify the minimum amount of time available to terminate an inadvertent boron dilution prior to complete loss of shutdown margin. Although the transient is analyzed at various operational modes, only the Mode 1 analysis could potentially be affected by changes in the OTDT trip function. The Mode 1 event is analyzed with the reactor in either manual or automatic mode. If the reactor is in automatic rod control, the operator would be alerted to a boron dilution occurrence by the rod insertion limit alarms. Since the time of occurrence of these alarms does not change due to the modifications associated with the MRP, the conclusions presented in the FSAR remain valid. If the reactor is in manual rod control, the first indication is expected to be a reactor trip on either OTDT or High Neutron Flux signal. The time of reactor trip, for operator cue, is based on an equivalent minimum reactivity insertion case of the Uncontrolled RCCA Withdrawal at Power (RWAP) analysis since this would provide the slowest, most conservative indication of the dilution event. For the Vogtle RWAP analysis, the minimum reactivity insertion case initiated from full power generates a reactor trip via the OTDT function. The revised setpoint and dynamic compensation modifications result in a rod motion at 80.6 seconds. Using this as the initial cue to the operator for diagnosing the occurrence of an uncontrolled boron dilution gives the operator 30.5 minutes to terminate the event. This is well in excess of the minimum acceptable time of 15 minutes.

The four events that were reanalyzed to incorporate the MRP features are:

- Uncontrolled Rod Cluster Assembly Bank Withdrawal at Power
- Loss of External Electrical Load and/or Turbine Trip
- Accidental Depressurization of the Reactor Coolant System
- Steam System Piping Failure

The results of the reanalysis of each of these events showed that the respective safety analysis acceptance criteria are satisfied.

For these events, the acceptance criteria are: the critical heat flux should not be exceeded (the DNB design basis is satisfied), the pressure in the reactor coolant and main steam systems should be maintained below 110% of the design pressures, and the peak linear heat generation rate should not exceed a value which would cause fuel centerline melt.

The contents of the licensing amendment submittal for the proposed MRP program is consistent with the contents provided in similar submittals to the NRC.

As noted in the response to Question "8.c", LOFTRAN is used to determine the minimum DNBR based upon a conservative representation (partial derivatives) of the core thermal limits (calculated with the THINC computer code). The core thermal limits are the locus of conditions where the DNBR is at the Safety Analysis Limit DNBR. The Safety Analysis Limit DNBR is greater than the licensing basis Design Limit DNBR, which for Vogtle is 1.23 for the thimble cell and 1.24 for the typical cell for VANTAGE 5 fuel, as explained in response to Question 4. The difference between the Design Limit DNBR and the Safety Limit DNBR is the DNB margin to offset DNB penalties such as those due to rod bow and transition core penalties, and after consideration of all penalties, is available for operating and design flexibility, as described in Section 4.4.1.1.2 of the Vogtle UFSAR.

The safety analyses demonstrate that the Safety Analysis Limit DNBR is satisfied by showing that the LOFTRAN calculated DNBR is greater than the safety analysis limit. In some cases, a more detailed DNBR calculation is performed, such as for the Steam System Piping Failure where the LOFTRAN DNBR calculations would not apply due to peaking, asymmetric inlet temperatures, and other asymmetric effects. The following is a summary of the limiting calculated DNBRs for the events analyzed.

Event	**Code**	**Calculated DNBR**	**DNBR Limit Typical/Thimble**
Uncontrolled RCCA Bank Withdrawal at Power	LOFTRAN	1.51*	1.24/1.23
Loss of External Electrical Load and/or Turbine Trip	LOFTRAN	1.53	1.24/1.23
Accidental Depressurization of the Reactor Coolant System	LOFTRAN	1.54	1.24/1.23
Steam System Piping Failure	LOFTRAN	1.83*	1.24/1.23

* confirmed with THINC code

Again, note that the Design Limit DNBRs and not the calculated DNBRs are the licensing basis limits.

b. Were the OPDT and OTDT setpoint changes the only changes considered? Were any other assumptions for these events revised? If so, provide the technical basis for the revised assumptions.

Response:

The OPDT and OTDT setpoints, including the associated dynamic compensation (lags, lead/lags, delays, and RTD response time), were the primary changes that were considered in the analyses performed for the Margin Recovery Program. In addition, slight changes were made to the dynamic compensation associated with the rod control system. These changes were made to desensitize the rod control system and the OPDT and OPDT setpoints to spurious temperature spiking in the indicated hot and cold leg temperatures. The technical basis for these revised assumptions is provided by the associated safety analyses which demonstrate that all of the applicable acceptance criteria continue to be met.

c. The licensee used the LOFTRAN computer code to calculate DNBR values. The use of LOFTRAN DNBR model requires user-input values of the minimum DNBR with respect to changes from nominal in the core average power, average coolant temperature, flow and pressure. Please discuss how this user-specified input was determined for the MRP reanalysis.

Response:

For transients in which the RCS flow remains unchanged and there are no radial peaking effects such as that occurring from the dropped rod event, it is possible to use the core thermal safety limits figure as an indication of how the DNBR is changing based on changes in the core power, average coolant temperature, and pressure. This approach is valid since the core thermal safety limits are linear with changes in these parameters, as shown by the sloped lines on the right of Vogtle Technical Specification Figure 2.1.1-1. The LOFTRAN code models the core thermal limits as a set of partial derivatives which cover any temperature, pressure (from the low pressurizer pressure safety analysis setpoint to the high pressurizer pressure setpoint), and power condition up to a power level of 120%. These partial derivatives are set up so that they predict being at the safety limit DNBR at the same condition or before the actual core thermal safety limits; the partial derivatives are exactly parallel; whereas, the core thermal safety limits are very slightly non-linear. In defining the LOFTRAN partial derivatives, it is ensured that they are equal to or lower than the core thermal safety limits for all possible temperature, pressure, and power conditions. The partial derivatives are most accurate at the safety limit DNBR. The partial derivatives are used along with the DNBR at nominal conditions to define how close the plant is to the safety limit DNBR, based on changes in the core power, average coolant temperature, and RCS pressure.

The partial derivatives are used in the analysis of selected AOO events. The initial condition for an AOO event would be at a nominal full power condition. This nominal point could be plotted on the Tech Spec Figure and it would have a corresponding DNBR equal to the DNBR at nominal conditions (typically greater than 2.0). If an AOO were to occur, the DNBR would change based on how the plant condition changed relative to the core thermal limits (the core thermal limits representing the conditions where the plant is at the safety limit DNBR). If the transient resulted in an increase in power, for instance, the DNBR would drop from the nominal value and would approach the safety limit DNBR (i.e., the core safety limits) up until just beyond the time of reactor trip. The amount that the DNBR changed for a given change in power, temperature, and/or pressure is defined by the partial derivatives and the difference between the nominal DNBR and the safety limit DNBR.

Provided that RCS flow remains unchanged, the relationship between T_{inlet}, reactor coolant system pressure, and power (thermal power) is fairly linear for a constant DNBR, as exhibited by the core thermal DNB limits, which are based on THINC calculations at the DNBR safety limit. Since the RCS flow remains constant and there is no asymmetric effects for the Loss of External Load/Turbine Trip and Accidental Depressurization transients, the LOFTRAN partial derivatives of the core thermal DNB limits can be used to determine the DNBR trend for transient changes in the reactor coolant temperature and pressure and core power. This approach of using the LOFTRAN partial derivatives has been employed since the 1970s for all Westinghouse designed PWRs and is used in the current licensing basis analyses for the Vogtle plants.

d. **For the Uncontrolled RCCA Withdrawal at Power event, NUREG-0800, "Standard Review Plan," includes fuel centerline temperature not exceeding the melt temperature as an acceptance criteria for this event. Please provide results which demonstrate that this acceptance criteria is satisfied.**

Response:

The peak fuel temperature is not directly calculated in the transient analysis of the Uncontrolled RCCA Withdrawal at Power event. Instead, specific values for the fractional core power (heat flux) are calculated for each of the transient analyses of the Condition II events (including the Uncontrolled RCCA Withdrawal at Power event) to ensure that the peak fractional core power remains less than 120% power. Separate from the transient analyses, detailed core design analyses of Condition II events (including the Uncontrolled RCCA Withdrawal at Power event) determine the transient Fq on a cycle-specific basis from different power levels and times in core life. The peak fractional core power limit of 120% power is used in conjunction with the nominal linear heat rate and the transient calculated Fq to determine a peak kw/ft, which is then compared to the limit of 22.4 kw/ft that would cause fuel centerline melting. Ensuring that the peak kw/ft is less than 22.4 kw/ft ensures that fuel centerline melting design basis is satisfied. The transient Fq is determined by a detailed core analysis of RCCA (bank) withdrawals from different power levels and times in life.

e. **For the Uncontrolled Boron Dilution event, NUREG-0800, "Standard Review Plan," includes RCS pressure and DNBR limits as acceptance criteria for this event. Please provide results which demonstrate that this acceptance criteria is satisfied.**

Response:

The uncontrolled RCCA bank withdrawal at power event is analyzed for a very wide range of reactivity insertion rates, with both minimum and maximum reactivity feedback for full power, 60% power, and 10% power. The event analyzes a large range of constant reactivity insertion rates which result in an increase in the core power, temperature, and pressure with a subsequent reactor trip on either the high neutron flux or Overtemperature DT reactor trip function. In general, the lower reactivity insertion rates trip on the Overtemperature DT reactor trip function, and the higher reactivity insertion rates trip on the high neutron flux reactor trip function. It is demonstrated for this event that the DNB design basis is satisfied. The analysis of the uncontrolled RCCA bank withdrawal at power bounds the uncontrolled boron dilution with respect to demonstrating that the DNB design basis is satisfied, as explained below.

An uncontrolled boron dilution event results in a positive reactivity insertion, essentially equivalent to what would be observed for the uncontrolled RCCA bank withdrawal at power event, with subsequent reactor trip on an Overtemperature DT, high neutron flux, or other reactor trip function. An equivalent reactivity insertion rate is calculated for the uncontrolled boron dilution event based on the dilution flow rate and the active RCS volume. This reactivity insertion rate is compared against the assumed reactivity insertion rates assumed in the uncontrolled RCCA bank withdrawal at power event. Provided that reactivity insertion rate is encompassed by the reactivity insertion rates assumed for the uncontrolled RCCA bank withdrawal at power event, the uncontrolled boron dilution event is bounded. Thus, a specific analysis of the system transient response for the uncontrolled boron dilution event is not specifically performed since it is encompassed/bounded by the analysis of the uncontrolled RCCA bank withdrawal at power event.

<u>Question 9</u>: Please provide the technical basis for the proposed revisions to the RTD response time, and time constants in the OPDT and OTDT setpoint equations.

<u>Response:</u>

The RTD time constant was revised to provide additional margin to the value assumed in the safety analysis. The current margin between the safety analysis value and the "as measured" values in the plant is minimal. It was felt that any small perturbation to the time constant of any of the RTDs could result in the channel response time exceeding the time assumed in the safety analyses. It was for this reason that the RTD time constant assumed in the safety analyses was increased from 4.0 to 5.5 seconds. In addition, a 6-second filter was added to the measured Tavg of the OTDT and OPDT reactor trip setpoints, and the lead/lag on the measured ΔT was reduced from 8/3 to 0/0. Spurious steady-state temperature spiking in the indicated hot and cold leg temperatures reduces the operating margin to the OTDT/OPDT trip setpoints. These changes will provide additional operating margin to the OTDT/OPDT trip setpoints. These changes were incorporated into the safety analyses. The technical basis for these revised assumptions is provided by the associated safety analyses which demonstrate that all of the applicable acceptance criteria continue to be met.