UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NEW REACTORS

RELATED TO AMENDMENT NOS. 147 AND 146

TO THE COMBINED LICENSE NOS. NPF-91 AND NPF-92, RESPECTIVELY

SOUTHERN NUCLEAR OPERATING COMPANY, INC.

GEORGIA POWER COMPANY

OGLETHORPE POWER CORPORATION

MEAG POWER SPVM, LLC

MEAG POWER SPVJ, LLC

MEAG POWER SPVP, LLC

CITY OF DALTON, GEORGIA

VOGTLE ELECTRIC GENERATING PLANT UNITS 3 AND 4

DOCKET NOS. 52-025 AND 52-026

1.0 INTRODUCTION

By letter dated December 21, 2017 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML18029A243), and supplemented by letter dated September 28, 2018, (ADAMS Accession No. ML18271A187), the Southern Nuclear Operating Company (SNC) requested that the U.S. Nuclear Regulatory Commission (NRC or the Commission) amend Vogtle Electric Generating Plant (VEGP) Units 3 and 4, Combined License (COL) Numbers NPF-91 and NPF-92, respectively. The License Amendment Request (LAR) 17-043 requested changes to the COL in the form of departures from the incorporated plant-specific Design Control Document (DCD) Tier 1 and Tier 2 information. As part of this LAR, SNC proposed to change the Updated Final Safety Analysis Report (UFSAR) in the form of an update to Westinghouse Topical Report containment design basis accident analysis, "WGOTHIC Application to the AP600 and AP1000" (WCAP-15846) in addition to departures from the incorporated plant-specific DCD Tier 1 and Tier 2 information. These changes serve to reconcile a number of detailed design changes and modeling methodology changes made in calculations for the containment pressure following a transient. Changes accumulated over the course of detailed design have been incorporated into a revised evaluation model, and various errors have been corrected and some methodology changes have occurred as part of this submittal.

Specifically, LAR 17-043 requests changes to the VEGP Units 3 and 4 COL Appendix A, Technical Specifications (TS), Appendix C, Inspections, Tests, Analyses, and Acceptance

Criteria (ITAAC), and the UFSAR to reflect an updated plant-specific containment integrity analyses supported by Westinghouse Electric Company's technical documents and included calculations/analyses for heat sinks, WGOTHIC evaluation, model, mass and energy releases, steam line break containment integrity, and loss of coolant accident containment integrity. The changes that reflect the updated containment analysis include COL information mentioned previously in the form of departures from the incorporated PS-DCD Tier 2* and Tier 2 information in the plant-specific UFSAR and related changes to the COL Appendix A and COL Appendix C (and corresponding plant-specific DCD Tier 1) information, and TS Bases information. These changes were necessitated by multiple design changes within containment. Additional changes to Appendix C are related to flow rate testing of the passive containment cooling system (PCS) as a result of lessons learned from pre-operational tests at other AP1000 nuclear plants.

Pursuant to Section 52.63(b)(1) of Title 10 of the *Code of Federal Regulations* (10 CFR), SNC also requested an exemption from the provisions of 10 CFR Part 52, Appendix D, "Design Certification Rule for the AP1000 Design," Section III.B, "Scope and Contents." The requested exemption would allow a departure from the corresponding portions of the certified information in Tier 1 of the generic DCD.[1] In order to modify the UFSAR (the PS-DCD) Tier 1 information, the NRC must find SNC's exemption request included in its submittal for the LAR to be acceptable. The staff's review of the exemption request, as well as the LAR, is included in this safety evaluation.

The supplement dated September 28, 2018, provided additional information that clarified the application, did not expand the scope of the application as originally noticed, and did not change the NRC staff's original proposed no significant hazards consideration determination as published in the *Federal Register* on May 8, 2018 (83 FR 20866).

2.0 <u>REGULATORY EVALUATION</u>

The VEGP Units 3 and 4 COL Appendix A, Section 5.5.8, "Containment Leakage Rate Program," item (b) currently reads:

> b. The calculated peak containment internal pressure for the design basis loss of coolant accident, Pa, is 58.3 psig. The containment design pressure is 59 psig.

Item (b) was proposed to be revised to read as follows:

> b. The calculated peak containment internal pressure for the design basis loss of coolant accident, Pa, is 58.1 psig. The containment design pressure is 59 psig.

The staff considered the following regulatory requirements in reviewing the LAR that included the proposed changes:

Appendix D, Section VIII.A.4 to 10 CFR Part 52 states that exemptions from Tier 1 information are governed by the requirements in 10 CFR 52.63(b)(1) and 10 CFR 52.98(f). It also states

---

[1] While the licensee describes the requested exemption as being from Section III.B of 10 CFR Part 52, Appendix D, the entirety of the exemption pertains to proposed departures from Tier 1 information in the PS-DCD. In the remainder of this evaluation, the NRC will refer to the exemption as an exemption from Tier 1 information to match the language of Section VIII.A.4 of 10 CFR Part 52, Appendix D, which specifically governs the granting of exemptions from Tier 1 information.

that the Commission will deny such a request if it finds that the design change will result in a significant decrease in the level of safety otherwise provided by the design.

Appendix D, Section VIII.B.5.a allows an applicant or licensee who references this appendix to depart from Tier 2 information, without prior NRC approval, unless the proposed departure involves a change to or departure from Tier 1 information, Tier 2* information, or the Technical Specifications, or requires a license amendment under paragraphs B.5.b or B.5.c of the section.

10 CFR 52, Appendix D, Section VIII.B.5.b.(8) states, in part, that after issuance of a license, "A proposed departure from Tier 2, other than one affecting resolution of a severe accident issue identified in the plant-specific DCD requires a license amendment if it would: (8) Result in a departure from a method of evaluation described in the plant-specific DCD used in establishing the design bases or in the safety analyses." As discussed above, a change to the method of evaluation is requested and thus requires prior NRC approval.

10 CFR Part 52, Appendix D, VIII.C.6 states that after issuance of a license, "Changes to the plant-specific TS will be treated as license amendments under 10 CFR 50.90." 10 CFR 50.90 addresses the application for amendment of license, construction permit, or early site permit. The proposed LAR requires changes in the TS, and therefore an LAR is required to be submitted for NRC approval.

10 CFR 52.63(b)(1) allows the licensee who references a design certification rule to request NRC approval for an exemption from one or more elements of the certification information. The Commission may only grant such a request if it determines that the exemption will comply with the requirements of 10 CFR 52.7, which, in turn, points to the requirements listed in 10 CFR 50.12 for specific exemptions. In addition to the factors listed in 10 CFR 52.7, the Commission shall consider whether the special circumstances outweigh any decrease in safety that may result from the reduction in standardization caused by the exemption. Therefore, any exemption from the Tier 1 information certified by Appendix D to 10 CFR Part 52 must meet the requirements of 10 CFR 50.12, 52.7, and 52.63(b)(1).

10 CFR 52.98(f) requires NRC approval for any modification to, addition to, or deletion from the terms and conditions of a COL. These activities involve a change to COL Appendix C ITAAC information, with corresponding changes to the associated PS-DCD Tier 1 information. Therefore, NRC approval is required prior to making the plant specific proposed changes in this LAR.

10 CFR 50.36, TS impose limits, operating conditions, and other requirements upon reactor facility operation for the public health and safety. The TS are derived from the analyses and evaluations in the safety analysis report. In general, TS must contain: (1) safety limits and limiting safety system settings; (2) limiting conditions for operation; (3) surveillance requirements; (4) design features; and (5) administrative controls.

The specific NRC technical requirements applicable to LAR 17-043 are the general design criteria (GDC) in Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities." In particular, these technical requirements include the following GDC:

GDC 16—Containment design, requires in part that a reactor containment be provided to establish an essentially leak-tight barrier against the uncontrolled release of radioactivity to the environment and to assure that the containment design conditions important to safety are not exceeded for as long as postulated accident conditions require. The licensee's revised analyses submitted as part of this LAR are intended to demonstrate containment integrity for the limiting spectrum of design basis accidents for the duration of the accident.

GDC 38—Containment heat removal, requires in part that a system to remove heat from the reactor containment be provided, such that the containment pressure and temperature following any loss-of-coolant accident and maintain them at acceptably low levels. The licensee's revised analyses submitted as part of this LAR are intended to demonstrate the calculated containment pressure remains below the design pressure and continues to be reduced to less than half the peak pressure at 24 hours.

GDC 50—Containment design basis, requires in part that the reactor containment structure, including the containment heat removal system be designed so that the containment structure and its internal compartments can accommodate, without exceeding the design leakage rate and with sufficient margin, the calculated pressure and temperature conditions resulting from any loss-of-coolant accident. This margin shall reflect consideration of (1) the effects of potential energy sources which have not been included in the determination of the peak conditions, (2) the limited experience and experimental data available for defining accident phenomena and containment responses, and (3) the conservatism of the calculational model and input parameters. As part of this LAR, SNC has revised the calculational model and sources of mass and energy input into the model in order to demonstrate that for the limiting design basis accidents, the containment conditions remain acceptable including sufficient margin.

3.0 TECHNICAL EVALUATION

3.1 TECHNICAL EVALUATION OF THE REQUESTED CHANGES

LAR 17-043 requests to update the containment integrity analyses documented in UFSAR Section 6.2. The update was predicated by design changes, more detailed available information about containment components and geometry resulting from construction, and correction of errors that were discovered during review. The total scope of the proposed changes include a full update of the containment analysis methodology, recalculated mass and energy release values for both the loss-of-coolant accident (LOCA) and main steam line break (MSLB) transients, associated changes to descriptions in the UFSAR to account for the above, and changes to ITAAC related to PCS testing and containment coatings discussion. These changes are discussed in further detail below.

Updates to the containment evaluation model

As part of the LAR, SNC proposed substantial changes to the WGOTHIC evaluation model, used as part of the containment response methodology. The methodology is detailed in WCAP-15846, which is incorporated by reference in the UFSAR. SNC proposed to revise WCAP-15846 from Revision 1 to Revision 5, and the technically relevant attendant changes involved in that update are evaluated below.

One change common throughout WCAP-15846 is the consolidation of the material related to AP600 specific discussions of design, methodology and test applicability. The staff reviewed these changes and determined they were appropriate and not technically relevant to the LAR, except where discussed specifically below.

As part of WCAP-15846 Section 3.2, SNC provided information regarding the validity of the heat and mass transfer correlations to the enhanced shield building design. Discrepancies in the correlations as applied to the shield building are documented in Table 3-3 of the WCAP.

SNC updated the version of the WGOTHIC code used for calculating the peak pressure from version 4.2a to 4.3.1. The validation cases in WCAP-15846 continue to be performed with version 4.1, but DCD analyses for Revision 19 were performed using version 4.2a. In moving from version 4.2a to 4.3.1, a number of changes to the code result in changes to the analyses. The version change to 4.2b corrected an error in the mass balance; this error was found to cause issues that built up over time and did not generally have a perceptible impact during early portions of a transient. Relevant changes in the update to version 4.3 included adding the option to the code to automate a process previously performed as part of a spreadsheet calculation, discussed further below with the other changes in Section 7 of WCAP-15846. As part of the update to version 4.3.1, errors introduced in previous updates were corrected, and a two-dimensional conduction multiplier option was added; this change is discussed further below with the other changes in Section 7 of WCAP-15846.

Section 3.2 of WCAP-15846 states that, "subsequent code version updates will be made to address changes in computing platforms, correction of errors, and updates to enhance the user experience without it being a change in methodology. Therefore, updates will not be made to this document unless a methodology-changing code change is made." Staff requested SNC provide additional information regarding the language in WCAP-15846 as it it was not clear to the staff that, "correction of errors" would always fall within the constraints of existing regulatory change processes. In their response (ADAMS Accession No. ML18271A187), SNC clarified what the extent of a methodology change would entail.

Section 3.3 of WCAP-15846 describes the clime model in WGOTHIC. In this case, climes are horizontal slices of the containment structure that couple the heat and mass terms on either side of the containment shell that allow the conductors that comprise the structures in and around the shell to fully participate in heat transfer through the clime region. The clime model has been approved for use by the staff as part of the certified design; the updates to WCAP-15846 modify the clime model such that the wet and dry climes are paired for evaporation-limited conditions, allowing for the surface area that was designated as a wet clime to become a dry clime, and vice versa. In the code, this is a change from the calculation performed for the certified design, where user specified values are used for wetting on the outside of the containment, to the new version of WGOTHIC, which is capable of automatically calculating PCS flow based on the provided flow rate and coverage for the top two climes. The impacts of this change are evaluated below in the discussion pertaining to the film coverage model (Section 7.5 of WCAP-15846).

The WCAP provides an expanded discussion of the new automated evaporation-limited PCS flow coverage option. For this option in WGOTHIC, the code calculates a mass and energy balance for the fluid flowing down the containment shell for each clime region, taking into account convective heat transfer and conduction through the shell. The calculation is based on an assumed mass flow rate and mass flux into the clime, and then directly calculated from the conditions that exist in the clime region. Stacks of clime regions pass input and output conditions to one another.

As described in WCAP-15846, the code utilizes a 1D conduction model with a conduction heat transfer multiplier for the majority of the transient, but a 2D conduction model can also be used. This 2D conduction option is available as an option in the new version of WGOTHIC, and the effect is not credited until the water coverage of the external surface has been reduced below a defined threshold consistent with previously approved methodology. The 1D model is more conservative, but both the 1D and 2D models have been justified by SNC. Further discussion of the impact of this effect can be found below in the evaluation of Section 7.5 of WCAP-15846.

Changes to Section 5 of WCAP-15846 ("Initial and Boundary Conditions") entail additional clarification regarding the initial conditions and how they were varied for the sensitivity analyses. No changes to the values themselves were made. Additional context regarding the site parameters was added, and further detail on the initial conditions used in the sensitivity analyses was provided. Given the bounding conservatism of the parameters is maintained and corresponds to limiting values, either as set forth in the technical specifications for the certified design or for the site itself, the staff finds these proposed clarifications acceptable.

Substantial changes were made to WCAP-15846 Section 7, "Basis and Method for Calculating the PCS Water Evaporation Rate for the AP600 and AP1000 Containment DBA Evaluation Models." For the revised AP1000 model, the film coverage calculation is now an integral part of the code rather than calculated separately and then input and iterated. For the steady state portion of the transient, which is achieved following opening of the valves and fill of all the components leading to the shell proper (the lines, distribution bucket and weirs), the film coverage model is based on a constant water flow rate. SNC calculated an average time to achieve steady state coverage of the shell based on scaled test performance data from the PCS flow distribution test. This calculated time is an input into the containment analysis model, and represents the delay before PCS water is credited in the model. Although the steady state coverage time is calculated based on average fluid conditions (given the difference in fluid temperature and velocity at the top of the containment shell versus the bottom), staff finds this as appropriate to capture a realistic time for full flow coverage. The modeling choice as a whole is sufficiently conservative given that heat removal from the shell will start before the shell coverage delay and asymptotically approach the steady state value until the shell is fully wetted. Staff finds this modeling assumption as acceptably conservative.

Additional detail regarding the revised assumptions for flow over the baffle supports was also added to Section 7. Based on the testing performed for condensate return inside containment, SNC concluded that the baffle supports and welds on the outside of the containment shell was comparable to that over attachments on the inner surface of the shell. Although conditions inside containment differ somewhat from those outside containment, similar phenomena are likely to occur. In order to suitably account for any differences, SNC conservatively chose to assume that all film flow that interacts with the baffle supports on the vertical portion of the containment shell is lost. These assumptions are based on flow testing performed to support condensate return design changes made as part of Amendment No. 72 (ADAMS Accession No. ML17024A317). SNC's request for additional information (RAI) response (ADAMS Accession No. ML18271A187) provided a summary of the test conditions and resulting insights from the test program.

In effect, each time the film on the shell reaches a baffle support elevation, film equivalent to the fraction of shell (on a linear coverage basis) with a baffle support attached is removed. For supports not on the vertical portion of the containment (the dome region), no losses are assumed as losses are assumed to be recaptured as the portion that splashes off rejoins the flow when it hits at a lower elevation. Staff reviewed the methodology employed by SNC, and found that it is appropriately conservative in representing the effect of flow over the baffle supports. SNC documented a summary of the qualitative observations used to justify the recaptured film flow as part of the aforementioned RAI response.

The implementation of the rainout model results in transient losses that change both over the duration of the transient and as the flow travels down the shell. The WGOTHIC model accounts for the film with the base film tracking model modified further by the attachment losses over the baffle supports as rainout. As implemented, this results in the rainout stripping occurring at the top of each clime stack. This has the effect of slightly reducing the film flow rate for the full length of the shell compared to the expected flow rate, and therefore conservatively reduces the heat transfer from the containment.

Conduction through the containment shell is discussed in Section 7.4 of WCAP-15846. This LAR proposes changes to the calculational approach. The default model, as implemented in WGOTHIC, only credits conduction in the radial direction (through the shell). Because of the nature of the heat transfer and fluid flow on the containment shell, conduction in the circumferential direction (perpendicular to the radius of the containment) will also occur due to the variance in water coverage, especially where wet and dry regions are close to one another. Testing and modeling showed that crediting conduction in only one dimension could result in an overprediction of dry area temperature. Because of this, SNC implemented a corrective multiplier in the WGOTHIC evaporation film coverage model. This multiplication factor approximates the effect of two dimensional conduction, is not credited until the water coverage of the external surface has been reduced, and has been previously reviewed and approved by the staff as part of the certified design.

As part of the updates to the evaluation model, including the direct calculation of what was previously part of a separate spreadsheet calculation (discussed further below), two dimensional heat conduction can now be calculated more directly using the evaporation-limited flow coverage option. These multipliers are conservatively not employed until the water coverage of the external surface has been reduced below a defined threshold. This does not happen until well into the transient, and therefore has little to no impact on the calculated licensing basis values for the first 24 hours.

The newly implemented PCS film coverage model is described in Section 7.5 of WCAP-15846. Film coverage is a function of both total mass flow of the film and the linear coverage width of the film, which are modeled as being a function of vertical distance below the sidewall. As the film travels down the side of the containment shell, the volume of film decreases due to evaporation, and WGOTHIC explicitly captures the heat transfer effect of the film.

The film traveling down the shell is assumed to travel in stripes of constant width (with corresponding areas of dry shell) while the flow rate is greater than the minimum width normalized flow rate. Once that point is reached, SNC assumes the stripes narrow while the film width remains constant. Evaporative losses drive the reduction in film and stripe width as the flow travels down the shell. These assumptions are largely based on the PCS Large-Scale Test facility observations, and neither of these assumptions differs from the implementation previously reviewed by the staff in the certified design, as documented in Chapters 6 and 21 of NUREG-1793, “Final Safety Evaluation Report Related to Certification of the AP1000 Standard Design,” Supplement 1. As part of this LAR, the staff reviewed the specific implementation of these assumptions in WGOTHIC.

In the certified design, a spreadsheet calculation is employed in an iterative fashion to determine the evaporation rate based on the calculated heat transfer through the containment shell. The spreadsheet calculation involves an initial run of WGOTHIC using an assumed PCS flow rate, the code calculates an evaporation rate, and that rate is used in the spreadsheet to calculate a new PCS flow rate, which is then passed back to WGOTHIC and the process is repeated until sufficient convergence is achieved. The spreadsheet solves the equations for film coverage detailed in Section 7.5.1 of WCAP-15846 for the full height of the containment shell, determining film thickness, width and run-off flow at the bottom of the shell (when applicable), and passes values to and from the WGOTHIC calculation via manal iteration. This calculation is iterated on until the spreadsheet evaporation flowrate is greater than or equal to the PCS flow rate credited in WGOTHIC (note that this does not ensure a fully accurate accounting of the evaporated film on the outside of the containment shell, merely one that is close enough).

The newly available automated evaporation-limited flow model directly calculates the equations described above for each divided clime region and passes the results between each region, in effect performing the process that is iterated using the spreadsheet directly in each timestep. This results in a much more accurate calculation as there is no longer a need to “hunt” for the proper flow and heat transfer margin via iteration. Although the manual spreadsheet calculation could be considered more “conservative” in the sense that it produced higher containment pressure and temperature values, the conservatism in the spreadsheet method partially due to the unrealistic behavior imposed as a result of the calculation method. Although both models are conservative with respect to real expected conditions, the new model is more accurate. Because it was performed manually, the iterative process did not converge completely, and acceptable convergence was considered to be achieved when water evaporation exceeded minimum expectations. Additionally, the spreadsheet calculation resulted in average heat and mass fluxes being applied to each clime in the iterations, while utilizing WGOTHIC to implement the evaporation-limited PCS flow model allows for a higher fidelity calculation with unique calculations for each wet-dry clime pairing. The automation of the PCS film coverage model in WGOTHIC still incorporates conservatism, in that it calculates film flow rates for each clime and applies that flow rate on a transient basis for each clime region, reduced by rainout at the top of each “stack” of climes. This results in a slightly lower film flow rate than would be expected, and is discussed in further detail above.

Staff’s review consisted of reviewing the requested WCAP updates and evaluating their significance as well as reviewing the implementation of the changes during a staff audit. As part of the audit (ADAMS Accession No. ML18267A370) staff reviewed the impact of the code updates to WGOTHIC. For peak pressure, the impact is negligible (substantially less than 0.1 psia), and although the impacts of the error corrections tend to become somewhat more pronounced as time progresses in the transient, the changes documented in WCAP-15846 are either corrections of errors that are non-physical and have little impact on the transient, or enable further options to the user (and can be turned on or off). The implementation of these options in this model is discussed further below, and their use should be evaluated on a model-specific basis for any other future use. Based on the information above, staff finds the code updates to WGOTHIC appropriate for this application and therefore concludes that version 4.3.1 is appropriate for use for the AP1000 containment evaluation methodology.

Based on the above, the staff finds the new implementation of the film coverage model in WGOTHIC acceptable as it accurately models the expected behavior of the film based on testing, and does not constitute a change in methodology (merely a refinement in the application of that methodology) when compared with the previously approved implementation used in the certified design.

LOCA and MSLB mass and energy release changes

Section 3.1.2 of the LAR details the proposed updates to the mass and energy release values for both LOCA and MSLB events. For the LOCA transients, the new calculation incorporates revisions to a number of input values and model characteristics (detailed below), but continues to utilize the approved methodology.

The changes for the LOCA methodology are described at a very high level in the LAR, and UFSAR Table 6.2.1.3-8 reflects the most impactful input parameters in the analysis, some of which SNC proposes to change in this LAR. The new analysis results are reflected in UFSAR Table 6.2.1.3-9 and 6.2.1.3-10 and Figures 6.2.1.3-1 through 6.2.1.3-4. The staff audited the detailed changes, and some of the notable changes are listed below:

- New steam generator (SG) conditions and thermal characteristics are utilized based on the revised expected steam pressure
- Further detailed design work allowed for adjustments to the secondary side thermal mass in the model to more accurately reflect the expected as-built metal inventory
- Flow properties for lines leading to the pressurizer and the passive safety systems were modified to match those expected in the as-built design
- The SATAN code was discovered to be incorrectly calculating the power shape based on the provided inputs; the core power was further modified through updates to the core stored energy and thermal mass modeled in the core region
- Various setpoints in the model were updated based on known uncertainties

Staff's review consisted of reviewing the requested WCAP updates and evaluating their significance as well as reviewing the implementation of the changes during the audit. These changes were reviewed for applicability to the updated AP1000 model. The proposed changes either corrected errors in the initial model that were identified later, or updated detailed design assumptions that have been refined with construction experience and a more detailed state of knowledge about operational conditions. With the exception related to the heat transfer correlation discussed and evaluated below, the aforementioned changes are either conservative and increase the resulting mass and energy release, or have a well-founded basis for change based on newly available, detailed design information (they are appropriately representative and conservative for the expected as-built design).

Staff reviewed the newly revised heat transfer coefficient used in the SATAN-VI code for heat transfer between reactor coolant system (RCS) coolant and RCS piping material used to calculate the mass and energy release. The default assumed heat transfer coefficient of 375 Btu/hr-ft^2-°F is suited for the forced flow of liquid, and has been accepted by the staff for use in this context (as documented in the staff's evaluation of WCAP-8471). The use of such a value as a heat transfer coefficient for a predominately natural convection steam flow could be considered unrealistically conservative. Section 3.1.2 of the LAR describes the proposed change to the overall heat transfer used in the model, which is detailed in revised UFSAR Subsection 6.2.1.3.2.2. SNC proposed to change the overall heat transfer used in the code from 375 Btu/hr-ft^2-°F to a reduced value for natural convection (37 Btu/hr-ft2-°F).

As part of the audit (ADAMS Accession No. ML18267A370), staff reviewed SNC's calculation justifying the use of 37 Btu/hr-ft^2-°F. Conditions following blowdown are assumed to consist of nearly all steam, convective flow from the RCS. SNC assumes a reasonably conservative primary coolant to metal heat transfer coefficient, then applies the characteristics of the RCS metal to calculate an overall heat transfer coefficient (used in SATAN-VI). Both the assumed coolant to metal heat transfer coefficient and the input values used to characterize the RCS metal incorporate an appropriate amount of conservatism. For the implementation, SNC runs SATAN until the quality of the steam mixture exceeds 99 percent, then restarts the code with the new heat transfer coefficient. Staff finds the use of 99 percent quality as reasonably representative of practically all steam for the transition from the blowdown period, as this condition constitutes nearly all steam with very little liquid carryover (reaching 100 percent quality is not feasible, as some carryover will always be present) and the plant conditions are appropriately representative of this condition. The real heat transfer conditions will transition more gradually from approximately 375 to approximately 37 Btu/hr-ft^2-°F (values in the analyses are expected to be conservatively representative of real heat transfer conditions, used here for example). Staff finds that the values assumed in the calculation should bound the plant conditions and the restart time denotes an acceptable transition point for use of the new heat transfer coefficient.

Based on the information discussed above, staff finds the use of the new heat transfer coefficient in SATAN-VI for calculating mass and energy releases from AP1000 primary side breaks to be acceptable. Staff notes that the implemented heat transfer coefficient in SATAN-VI, while appropriate and well justified for the specific circumstances present in this transient, is not a "generally approved" modification for the code and should be justified and calculated individually on a case-by-case basis, as blowdown times and RCS characteristics will differ based on the plant design and transient of interest.

The net effect of the changes in the LOCA mass and energy release calculation is generally a slight increase in long term mass and energy releases, with assorted changes in the blowdown and post-blowdown period resulting from the changes above. Staff reviewed the inputs and assumptions for the LOCA mass and energy release, and finds them and the associated changes to UFSAR Subsection 6.2.1.3, Tables 6.2.1.3-8 through 6.2.1.3-10 and Figures 6.2.1.3-1 through 6.2.1.3-4 to be acceptable considering the changes made to the model, given the calculated results remain conservatively bounding.

For the MSLB mass and energy releases, high level changes are described in Section 3.1.2.b of the LAR. UFSAR changes reflecting the revised analyses inputs are documented in Subsection 6.2.1.4.1.7 and Table 6.2.1.4-3, while the resulting mass and energy release values are located in Tables 6.2.1.4-2 and 6.2.1.4-4.

The staffs review consisted of reviewing the requested WCAP updates and evaluating their significance as well as reviewing the implementation of the changes during the audit. Staff audited (ADAMS Accession No. ML18267A370) the documents detailing the specific changes, and notable specific changes are listed below:

- The startup feedwater system, which is non-safety-related, was not originally modeled in the analysis. Although it isolates on low RCS temperature, there is a period where main feedwater is no longer running before this isolation.
- Leakage through the feedwater flow control valve is added to the model. This represents a small mass input that adds up during the course of a long transient and conservatively increases the resultant containment pressure and temperature.
- The main feedwater control function was modified to be a function of SG pressure, rather than a function of time. As the existing LOFTRAN SG model is relatively simple, the new model conservatively bounds the expected feedwater conditions by adding a bias to the

calculated LOFTRAN SG pressure for the table determining main feedwater conditions based on SG pressure.

- A number of modification techniques were investigated and imposed by SNC on the 30 percent and 0 percent power models to increase stability. These techniques included, but were not limited to, limiting the flow rate in the upper head region of the reactor vessel to mitigate issues with flashing and increasing the volume of the pressurizer surge line to accommodate modeling of the pressurizer fluid during the transient.
- Heat transfer from secondary side metal (that is not in contact with the RCS) in the steam generators is added to the model.
- Pump heat for the reactor coolant pumps is now modeled as nominal, rather than conservatively high. Due to the fact that the AP1000 pumps trip relatively early in the transient and the method for specifying total reactor heat in LOFTRAN includes pump heat, this results in slightly higher long term power in exchange for a short period of lower power initially.
- Various input parameter changes for each of the power levels are made in order to refine the timing of the release.
- The temperature of the IRWST is increased and the volume of water credited in the tank is conservatively reduced so that the heat transfer through the PRHR is sufficiently conservatively low.

Although the modifications used to increase stability represent an element of artificiality introduced into the transient, staff finds that the parameters of interest change in the conservative direction. Additionally, the modeling options chosen result in transient sequences that are more representative than adhering to the previously utilized modeling options. Staff finds the changes implemented as appropriate for the purposes of calculating a conservative mass and energy release.

Because LOFTRAN does not track the startup feedwater signals with sufficient fidelity to determine the exact start time of startup feedwater input, SNC conservatively chose to assume that startup feedwater begins input to the feedwater system upon main feedwater termination. This conservatively bounds the expected plant condition for mass and energy input from the feedwater system for a steam line break, and is therefore an acceptable modeling choice.

These changes were also reviewed for applicability to the updated AP1000 model. In general, the changes corrected errors in the initial model that were discovered later, revised detailed design assumptions that have been refined with construction experience, or added to the model in order to more accurately reflect the expected system behavior. In the few cases where individual changes were made that resulted in parameters of interest changing in the less conservative direction, staff determined that either the change had a negligible impact on the calculation as a whole or that the initial model was unrealistically bounding, and the new model remains conservative with respect to the expected plant condition. Staff evaluated SNC's full set of changes documented above as described in the supporting documentation, and found SNC's justifications for the changes to be appropriate, as the changes either conservatively add to the mass and energy release, or, in the case of the stability model and flow control changes, reflect a more complete knowledge of the expected plant conditions.

The net effect of the changes in the MSLB LOCA mass and energy release calculation is a small increase in both the mass and energy releases, with associated changes in the timing of the transient (generally delayed slightly) resulting from the changes above. Staff has reviewed the inputs and assumptions for the MSLB mass and energy release, and based on the above discussion, and considering the revised model more accurately reflects the expected system behavior based on more accurate design information and continues to incorporate biases and inputs such that the calculated results are conservative, finds the associated changes to UFSAR Subsection 6.2.1.4.1.7 and Tables 6.2.1.4-2 through 6.2.1.4-4 to be acceptable.

During the course of the audit, staff discovered that the equipment qualification profiles for submerged equipment throughout the later portion of the LOCA transient were exceeded by relatively small amounts. This conflicted with the statement in the LAR that "the updated containment pressure and temperature does not result in a change to the limiting profiles assumed in the equipment qualification testing program." As a result, staff requested additional information to confirm that submerged equipment remains qualified as a result of the proposed changes.

In their response (ADAMS Accession No. ML18271A187), SNC expanded upon their dispositions of areas falling outside the equipment qualification envelope as stated in a supporting calculation which was made available for staff audit (ADAMS Accession No. ML18267A370). The exceedance referenced by the staff was not included in that disposition and so SNC completed an engineering change report evaluating the impact of, and implementing, the new submerged liquid temperature profiles. SNC stated structure, system, and component (SSCs) required to operate following a LOCA event have undergone testing that demonstrates they will remain qualified with sufficient margin, and the conclusions of the testing remain valid for these components. The staff reviewed the associated documentation and based on the previous discussion finds SNC's RAI response acceptable.

<u>Updates to containment heat sinks</u>

As part of LAR 17-043, changes were proposed to updated the passive heat sinks (or thermal conductors) used in the WGOTHIC evaluation model. During the course of detailed design and construction, assumptions made regarding the nature of the heat sinks have been refined as construction proceeds, as stated in the LAR. SNC revised the heat sinks used in the WGOTHIC model to more closely match those expected in the as-built design. The relevant parameters of the revised heat sinks are reflected in UFSAR Tables 6.2.1.1-8 through 6.2.1.1-11. This is a change from the certified design, where the heat sinks are detailed in WCAP-15846. As part of the LAR, SNC proposed to remove the heat sinks from the WCAP to refine the focus of the report to only the methodology, but recognizes that these characteristics need to be represented in the licensing basis and therefore added them to the aforementioned UFSAR tables. Staff finds this as an appropriate means of capturing the heat sink parameters and finds this change acceptable.

Another change made as part of this update to the properties of the thermal conductors within the containment included changing the assumed thermal conductivity value for inorganic zinc. The thermal conductivity for inorganic zinc coatings are reduced by a factor of two, rather than a factor of four as documented in previous sensitivity analyses. Subsequent analyses performed by SNC have indicated there is no strong technical basis for reducing the thermal conductivity by a factor of four, and known degradation mechanisms for the coating material are unlikely to have a substantial impact on the thermal conductivity. A further discussion on this topic can be found in the staff's safety evaluation of VEGP Units 3 and 4 Amendment No. 31, related to inorganic zinc (IOZ) thermal conductivity (ADAMS Accession No. ML15028A358). For the purposes of this analysis, SNC has, to conservatively account for variations in composition and measurement, chosen to reduce the thermal conductivity for the inorganic zinc by a factor of two (from the minimum test requirement). The staff finds this change as conservative for this containment analysis, as it should serve to bind the expected thermal conductivity value for the life of the plant.

Staff requested SNC provide additional information on the relative impacts of the conservatism in the heat sink parameters to better understand the model and to support a determination of whether the assumptions regarding the heat sinks were sufficiently conservative, specifically, based on the changes to the heat sink inventory and how those heat sinks that were turned off in the model differ from the model used in the certified design, staff requested SNC provide a sensitivity adjusting parameters that have quantifiable impact on the conservatism in the analysis, specifically regarding the volume of heat sinks credited in the analysis.

In their response (ADAMS Accession No. ML18271A187), SNC identifies a number of conservatisms already existing in the treatment of thermal structures inside the containment in the model, including:

- Heat sinks in containment exist at the technical specification limiting temperature for containment; those that are above the containment temperature (metal in contact with RCS components, for instance) are not credited.
- Coatings inhibit heat transfer and are assumed at limiting conservative thickness and thermal conductivity values.
- An air gap is assumed between the steel liner and the concrete on applicable heat sinks.
- Heat transfer on heat sinks in the dead-ended compartments, below the operating deck, are not credited after the blowdown period.
- Heat transfer to horizontal, upward-facing surfaces that may become covered by condensation is not credited.

SNC performed two sensitivity case runs in an attempt to better quantify the conservatism. One study showed the impact of the heat sinks that are turned off (going from the conservative set used in the design basis analysis to effectively nominal), and the second highlighted the impact of some (but not all) of the aforementioned conservatisms. The first sensitivity case results in an approximately 1 psi impact on the peak containment pressure, while the second shows an approximately 8 psi impact on the peak containment pressure for the limiting LOCA case and approximately 5 psi for the limiting MSLB case. Given that SNC has a more detailed accounting of the heat sinks within the containment and the relative impact of turning off a fraction of the heat sinks within the containment, in concert with the other conservatisms applied to the thermal conductors inside the containment the staff finds SNC is appropriately conservative in assessing the heat sink inventory.

The staff reviewed the revised heat sink inventory. SNC chose to increase the heat sink volume from the current licensing basis model by approximately 30 percent, corresponding roughly to the expected actual total volume of metal inside the containment. As a further conservatism, a fraction of the heat sinks are then “turned off” in the evaluation model, as discussed in further detail above in the context of SNC’s RAI response. The model incorporates some conservatisms, consistent with the previously approved model, including an assumed air gap between steel and concrete heat sinks where applicable (reducing the heat transfer rate to the heat sinks), not crediting heat transfer to horizontal upward facing surfaces, and not crediting heat sinks in dead-end compartments below the operating deck following the blowdown phase (less than a minute after the transient begins, depending on the specific break). A further refinement of material properties is also proposed as part of this LAR – three steel groups are added (so there are now six from the previous three), and the thermal properties are assumed to correspond to the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (BPVC) Section 2 properties, reduced by 10 percent (for both thermal conductivity and heat capacity) to conservatively account for uncertainty from "typical" values. These values are also now input as a function of temperature, rather than constant. The new material properties are more accurate than those used in the previous evaluation model, and based on the available information about the heat sinks, more accurately defined, especially given the added temperature dependence. Although in some cases that results in less conservative heat sink properties, that conservatism was unrealistic when applied to the actual expected steel properties, and the 10 percent reduction in thermal properties represents an adequate conservative bias. These new properties are presented in the changes to UFSAR Table 6.2.1.1-8. For the reasons set forth above, staff finds the changes acceptable.

As these proposed changes to heat sinks reflect physical changes from the design assumptions previously used, and incorporate conservatisms that serve to ensure the heat transfer to the heat sinks in the as-built design will bound that assumed in the containment evaluation. Based on the information above, staff finds the proposed changes to the heat sink inventory and properties acceptable. Additionally, based on the previous discussion, staff finds the removal of the area term from UFSAR Tier 2* Table 6.2.1.1-10, combined with the additional information provided (moved from WCAP-15846) as part of UFSAR Table 6.2.1.1-11 and the corresponding discussion in UFSAR Subsection 6.2.1.1.3 to document the changes to heat sink properties acceptable.

<u>Updates to control volumes and flow paths</u>

As part of LAR 17-043, SNC updated the control volumes used in the containment model to better align with known design data. The WGOTHIC model was originally based on the model used for the AP600, and the nodalization scheme used remains similar in the divisions between control volumes. Changes were made to accommodate elevation and geometry differences and more detailed design information available during the construction, SNC evaluated the need for a model change. For the purposes of the review of this LAR, the primary differences between the evaluation model used in the certified AP1000 design and the revised evaluation model used in the LAR are refined nodalization into quadrants for portions of the model and modifications to some compartments inside the containment, including the pressurizer compartment.

As noted in the LAR, SNC made a small change to the total containment volume, resulting in an increase to the volume as modeled by 270 ft^3. This is due to SNC recalculating more precise volumes based on more accurate information for the actual components (such as heat sinks) and performing more thorough geometrical comparisons (between the control volumes and the real containment volume) of some regions of the containment. Although an increased containment volume results in a lower calculated peak pressure, the increase is very small (approximately 0.01 percent) and would likely be within the measurement uncertainty if the containment volume was measured exactly. SNC elected not to change the value reported in the FSAR (which remains correct at the accuracy level denoted in the table). Because the change has a negligible impact and there is a basis for the new value based on actual construction and design data, the staff finds SNC's proposed justification for the changes with respect to the new control volumetric values to be acceptable.

SNC added a statement in WCAP-15846 that the containment free volume is calculated based on nominal cold dimensions. This is appropriate, considering that the shell will thermally expand slightly at the elevated temperatures present during an accident. This does not represent a change in the previously calculated containment volume, and is merely noted here in order to highlight another element of conservatism in the analysis.

In the revised evaluation model, the pressurizer compartment was sub-divided into two new control volumes (from one in the previous analysis) in order to allow for a model that better reflected the actual design and to more accurately reflect component locations. The new pressurizer compartment consists of a lower compartment volume, an upper compartment volume, and the top portion of the compartment which remains part of the larger volume above the pressurizer compartment. The staff reviewed the revised implementation of the pressurizer compartment and concludes that because the changes represent a more accurate categorization of the compartment volume, staff finds the changes acceptable.

Control volumes outside the containment have been refined into quadrants to accommodate the divided WGOTHIC clime regions. This change divides the larger lumped exterior region into smaller portions and does not have an adverse effect on the analysis. The divisions in large part are of “virtual” control volumes (those without physically defined separation barriers). These virtual control volumes can be modeled according to the user’s choice as long as a consistent methodology is applied so that the “virtual” flow paths connecting the control volumes do not exhibit non-physical behavior. In this case, the staff concludes that SNC appropriately modeled the control volumes to preclude that, and therefore staff finds the revised control volume implementation acceptable.

Revisions to the control volumes, in concert with other implemented design changes, necessitated changes to the flow paths in the WGOTHIC model. These changes included changes for model consistency as well as some changes that had small impacts on the model. As a result, a few of the in-containment flow paths were modified to match the revised control volumes or altered to better reflect the expected internal arrangement and on that basis finds the changes acceptable.

As part of the update process incorporated into the LAR, a number of modifications were made to the outside containment flow paths defined by the shield building and annulus region. As noted above, one portion of this update involved re-portioning the area into quarters. Further modifications to the region were made to recalculate some of the annulus loss regions based on test facility data. The calculated value was then further increased to conservatively account for uncertainty. Although this results in slightly lower loss coefficients than previously used, the staff evaluated the basis for the change and concluded the new value represents a sufficiently conservative expectation for the loss coefficient in the annulus region and therefore finds the changes acceptable.

SNC made further changes in the annulus region to better account for leakage through the baffle that divides the annulus in two. Of note, existing flow paths in the certified design analysis assumed a very small, but artificially defined leakage area; the new analysis assumes a very small fraction of the total baffle area to accommodate some leakage through the baffle (throughout the baffle, not just in one defined area). This concludes that these changes are conservative in that it has the effect of nominally reducing airflow and can be reasonably expected to more realistically represent the conditions in the annulus region with respect to baffle leakage. Further changes were made to the bottom flow paths in the annulus region, as the flow guide and turning vane have been changed such that loss coefficients needed to be updated to reflect the new configuration. Based on this review the staff finds these changes to be acceptable.

Updated containment peak pressure and temperature analyses

Ultimately, combining all the changes discussed above, SNC used the revised analysis methodology and refined analysis assumptions to recalculate the containment integrity analyses for both LOCA and MSLB cases. This resulted in changes to the mass and energy values input into WGOTHIC tabulated in UFSAR Tables 6.2.1.3-9, 6.2.1.3-10, 6.2.1.4-2, 6.2.1.4-3, and 6.2.1.4-4, and displayed in Figures 6.2.1.3-1, 6.2.1.3-2, 6.2.1.4-1 and 6.2.1.4-2, the calculated results in UFSAR Tables 6.2.1.1-1 and 6.2.1.1-3, as well as revisions to the calculated containment response in Figures 6.2.1.1-1, 6.2.1.1-2, and 6.2.1.1-5 through 6.2.1.1-10.

The net effect of the changes on the containment analysis is a decrease in peak pressure from 58.3 psig to 58.1 psig for the limiting double-ended cold leg guillotine (DECLG) break, and a decrease in peak vapor temperature from 411.3 °F to 385.8 °F for the double-ended hot leg guillotine (DEHLG) break. Further, SNC demonstrated that the pressure for the DECLG remains reduced to below half the peak pressure at 24 hours, satisfying the GDC 38 requirement to rapidly reduce pressure and maintain it at acceptably low levels. The DECLG bounds the DEHLG in the long-term, as the two breaks release similar RCS inventories but a hot leg break effectively isolates a steam generator following the blowdown, which has the effect of reducing the total heat input into containment.

The individual effects on the peak pressure resulting from a LOCA as a result of the changes described above in this safety evaluation are as follows: updates to the WGOTHIC code version results in a very small increase in peak containment pressure; adding the evaporation limited model as described above results in a small decrease in peak containment pressure; updating all of the changes documented in the LAR to the evaluation model, including heat sinks, control volumes, and flow paths, results in an approximately 5 percent decrease in the peak containment pressure; and including the new mass and energy release values results in an approximately 3 percent increase in the peak containment pressure. These single change files were part of sensitivity cases, and so the exact impact of each change does not translate directly into a precise psi value in the final analysis. The net, as noted above, is a small reduction in calculated peak containment pressure. Staff has reviewed the individual changes documented above and found them adequately justified as well as the provided values for their impact on the analysis, all of which is in the expected direction and within the expected order of magnitude for the impact of the change and on this basis finds these changes to be acceptable.

For the spectrum of MSLB cases, the systematic effects from the changes result in a decrease in the peak pressure from 58.2 psig to 57.2 psig for the MSLB from 30 percent power, and an increase in peak vapor temperature from 374.7 °F to 383.6 °F for the MSLB from 101 percent power. The MSLB spectrum analyses, which SNC stated show peak pressure for an MSLB results from a steam line break from 30 percent power and peak temperature results from an MSLB from 101 percent power, have not changed from the certified design and those spectrum analyses were not re-reviewed as part of this LAR.

The individual effects on the peak pressure resulting from a MSLB as a result of the changes are similar to those in the LOCA for each of the changes evaluated in sensitivity analyses (e.g., WGOTHIC code version, implementation of the evaporation limited model, full accounting of evaluation model changes and revised mass and energy release) but slightly lower in magnitude than the LOCA cases. This results in a slightly larger final reduction in peak containment pressure for the MSLB compared to the LOCA. As stated above, the staff reviewed the individual changes documented above which are the same for the LOCA and the

MSLB except for the mass and energy release values, and based on this review, found them sufficiently justified and therefore acceptable.

The LOCA peak vapor temperatures show a very brief spike above the equipment envelope design temperatures, this does not by itself indicate the analysis results are unacceptable. SNC states the temperature limit within containment the temperature to which the SSCs within the containment, including the containment itself, are subjected. The containment atmosphere temperature informs this value and is not limited by the temperature value itself, but a combination of time and temperature. Because the exceedance in this case is of short duration and relatively small in magnitude with respect to the SSC limits, the design specifications are not exceeded. This behavior is relatively common in containment temperature analyses, especially in MSLB cases for previously licensed designs, and these brief small exceedances have been reviewed by the staff and found to not challenge the SSC design limits.

As a result of the analysis update, which changed the peak containment pressure, SNC also updated the accident pressure (Pa) specified in TS Section 5.5.8. The change appropriately reflects the new analysis and the staff finds the change acceptable.

The revised note in UFSAR Table 6.2.1.1-3 states the analysis until 24 hours does not credit heat conduction between the hotter dry portions of the containment shell and the wet portion of the shell. This is appropriately conservative and discussed in further detail above in the context of the 2D conduction model used in WGOTHIC.

As part of the review, the staff conducted a confirmatory analysis of the containment pressure and temperature for the conditions provided in the updated LAR using MELCOR. The values calculated by the staff slightly exceed those calculated by SNC. The staff attributes this to be largely due to differences in the codes used and available boundary conditions, but the two calculations are consistent with one another and display the same behavior out to 24 hours for the design basis LOCA.

Staff reviewed the analyses that generated the UFSAR figures and tables mentioned above, and audited (ADAMS Accession No. ML18267A370) the underlying documentation that details the implementation for the analyses. Review by the staff indicated SNC appropriately utilized the methodology and inputs as discussed above in this report. The new values for containment peak pressure and temperature remain under the design limits and continue to meet the acceptance criteria for the analyses. Accordingly, the staff finds the changes to the calculated containment integrity analyses acceptable and determined SNC continues to meet GDCs 16, 38, and 59, as the containment will withstand the effects of a limiting design basis loss of coolant accident, the design conditions including margin are not exceeded for the duration of the accident, and sufficient heat removal from the containment such that containment pressure and temperature are maintained at acceptably low levels in the long term.

Updates to LOCA minimum calculated backpressure

SNC also elected to update the LOCA minimum containment backpressure model using the revised containment evaluation model. The minimum containment backpressure analysis is used for the purposes of analyses in Chapter 15 to minimize the amount of RCS inventory remaining in the RCS which results in maximizing cladding temperatures.

One aspect of the update proposed as part of the LAR involved reducing the initial temperature inside containment to 50 °F, rather than the previously used 90 °F. Based on the limiting conditions for operation in the technical specifications, the minimum possible in-containment temperature is based on the minimum site temperature -40 °F plus the 90 °F differential between the in-containment temperature and outside temperature. Because a lower temperature is more conservative for this calculation, the staff finds this change appropriate. Similarly, initial pressure was decreased from 14.7 to 14.5 psia; this change contributes to minimizing pressure and is also appropriate.

Heat sinks for the minimum pressure model are conservatively increased rather than decreased, when compared with the peak containment pressure model. Using the proposed updated nominal inventory of heat sinks, SNC applied a factor of 1.35 to increase the surface area of all in-containment heat sinks. Staff audited (ADAMS Accession No. ML18267A370) the calculation associated with the justification for the factor of 1.35. Based on the level of detailed information available for the new heat sink inventory, the factor of 1.35 represents a reasonable estimate for the maximum inventory of heat sinks within the containment and includes a further increase from the calculated value for conservatism. The staff finds this an appropriate approach, and the basis for the factor of increase to be sufficiently justified.

The proposed analysis incorporates new material properties for thermal conductors and heat sinks, akin to those discussed above for the peak pressure analysis, using typical ASME BPVC Section 2 properties. Instead of being reduced by 10 percent as in the peak pressure analysis, SNC chose to increase the properties by 10 percent from typical to bias the calculation in the conservative direction for this scenario, in which a lower containment pressure is more conservative. SNC notes that this is contrary to the guidance in Branch Technical Position 6-2, which suggests thermal properties for use in minimum containment pressure models. Some of the properties suggested by staff guidance would be less conservative compared with the values proposed for use by SNC. In general, the staff prefers properties from the guidance be used unless the applicant or licensee proposes either a more conservative set of properties or provides adequate justification for a different set of properties. In this case, the staff finds that the use of ASME BPVC Section 2 properties with an appropriate conservative bias is appropriately justified, based on the more accurate design information provided by SNC.

Using the updated WGOTHIC peak pressure containment evaluation model, SNC recalculated the minimum containment backpressure transients for small break LOCAs (SBLOCA) and large break LOCAs (LBLOCA). This resulted in an increase in the peak cladding temperature (PCT) penalties in the post-Core Reference Report (WCAP-17524-P-A). The LBLOCA rebaseline evaluation resulted in a PCT penalty of +54 °F, which brings the current licensing basis PCT to 2024 °F. The SBLOCA rebaseline evaluation resulted in a penalty of 243.5 °F for a current licensing basis PCT of 1096 °F. The staff finds the PCT for both LBLOCA and SBLOCA rebaseline acceptable because they remain below the allowed maximum cladding temperature of 2200 °F of 10 CFR 50.46.

<u>Additional changes</u>

Section 3.1.5 of the LAR requests a revision to an ITAAC criterion (2.2.2-7), that would allow for a supplemental analysis showing that as-tested performance of the PCS is greater than that assumed in the limiting containment analyses. In the event the ITAAC flow criteria were not satisfied, it was not readily apparent what would constitute an acceptable analysis when applied to the flow criteria. Staff requested additional information to clarify the acceptance criteria and ensure the proposed ITAAC remains inspectable.

In their response (ADAMS Accession No. ML18271A187), SNC summarized the acceptance criteria for the proposed analyses, which would include ensuring the peak containment pressures and temperatures as well as calculated transient equipment qualification profiles remain bounded by the limits in the UFSAR. Further, SNC revised the language in the acceptance criteria for ITAAC 2.2.2-7a to state that either the measured flow rate must exceed the analysis flow rate, or a report exists and concludes the measured flow rate provides sufficient heat removal capability such that limits are not affected. In effect, that the actual effective heat removal resulting from the PCS flow exceeds the assumed heat removal from the PCS flow in the analysis, even if the PCS flow rates are not always greater than those assumed in the analysis. The staff finds SNC's approach acceptable, as containment heat removal is the primary figure of merit for the PCS. In the event the measured flow rate does not exceed the analytical flow rate (and the revised portion of the ITAAC acceptance criteria is utilized), the staff expects the calculated containment pressure must remain below the value reported in the UFSAR for the duration of the transient (at least 72 hours). Satisfying the new proposed acceptance criteria via analysis for the full duration of the transient maintains provides the staff with the basis for the conclusion that the as-built design satisfies the minimum assumptions in the analysis, and is therefore acceptable.

Additionally, as part of the LAR, SNC proposed revisions to the language describing the containment vessel surface and its use as the primary heat transfer vehicle from the containment. Design commitments in Tier 1 and associated language in the UFSAR refer to the heat transfer surface as it exists 7 feet above the operating deck. As stated in the LAR, SNC recognizes this could be interpreted to imply that the surface below 7 feet above the operating deck is not credited for heat transfer. This is not the case, and the entirety of the containment vessel surface that is exposed to both the inside and outside environment is credited for heat transfer. The changes to the ITAAC, specifically, make reference to the requirement to coat the inside surface with inorganic zinc coating; the coating is applied to the entire interior surface above the operating deck, not only 7 feet above the operating deck. Staff has reviewed the analysis model and concluded that this does not represent a change in methodology with respect to either the current or the revised analysis submitted as part of this LAR. The revisions to ITAAC 2.2.02.07b.ii, ITAAC 3.3.00 item 2.g, and Tier 1 Section 3.3 to remove the reference to the 7 feet (and the proposed language "above the operating deck") as well as the associated changes to UFSAR Subsections 6.1.2.1.1 and 6.1.2.1.5 and Tier 2 Tables 6.1-2 and 14.3-2, and based on the previous discussion, the staff finds the changes are acceptable.

Further, SNC proposed a number of "clarifications/consistency/editorial changes" as part of Section 3.1.8 of the LAR. With the exceptions noted below, where the staff provides additional context as to the acceptability of the proposed changes, staff finds that the changes are editorial in nature and therefore, are acceptable.

The LAR proposes to revise the UFSAR Subsection 6.2.1.1.3 by simplifying the description regarding the IOZ coatings. The proposed UFSAR states that a factor of two reduction is applied to the thermal conductivity of the coatings; as discussed above, this is a change from the previous evaluation model, based on the conditions referenced in the UFSAR. Staff reviewed the proposed revision and based on the discussion on this topic in the staff's safety evaluation of VEGP Units 3 and 4 Amendment No. 31, related to inorganic zinc (IOZ) thermal conductivity (ADAMS Accession No. ML15028A358), staff finds the implementation of the change acceptable.

A new paragraph is added in UFSAR Subsection 6.2.1.1.3 describing UFSAR Table 6.2.1.1-10, which was changed to specify the minimum and maximum heat sink volume at various locations within the containment (rather than the heat sinks added to containment). The staff evaluation of the heat sink changes is discussed above; the added paragraph is appropriate in describing the new purpose of Table 6.2.1.1-10. Staff reviewed the proposed revision and based on the discussion above, staff finds it to be acceptable because the table itself conforms to the heat sink changes discussed above.

The proposed changes in UFSAR Subsection 6.2.1.5.1 provide additional clarity regarding the revised Table 6.2.1.5-1, which now presents a complete mass and energy release for the minimum containment pressure analysis case, rather than just the blowdown portion of the analysis. Staff reviewed the proposed revision and based on the discussion above documented under the section "Updates to LOCA minimum calculated backpressure," staff finds it to be acceptable.

The LAR proposes to clarify the design basis section of UFSAR Subsection 6.2.1.1.1 regarding the single failure assumption as stated. The stated failure is a single valve controlling the PCS flow to the containment shell, but the analysis assumes (and this assumption has not changed as part of the LAR) only a single flow path is available. The proposed changes make this condition clear, and the updated text further states that only a single flow path is required for successful containment cooling. This change describes a more conservative analysis assumption and does not change anything from the current licensing basis analysis results and therefore staff finds it acceptable.

As part of the review for the LAR, SNC discovered a discrepancy between the stated value in the UFSAR and the reported containment pressure analysis for wetted coverage of the shell at 72 hours (41.6 versus 41.7 percent). The LAR notes that the actual value for wetted coverage is 41.65 percent. SNC proposes to change the value in UFSAR Table 6.2.2-1 to 41.7 percent to reconcile the difference. Although this represents a change in the licensing basis value, the staff reviewed the provided information and there is no change in the reported analysis, merely in the value reported in the UFSAR. Additionally, the discrepancy is small enough that it would have an insignificant impact on the analysis. Staff has reviewed the change and based on the previous discussion, finds the proposed change acceptable.

TS Bases changes

The staff notes that SNC provided descriptions of changes to the TS Bases in its LAR 17-043 Enclosure 4. The staff reviewed the changes and found that they do not conflict with the proposed TS changes.

SUMMARY OF THE TECHNICAL EVALUATION

Based on the technical evaluations above, the staff finds that the proposed changes to the plant specific UFSAR Tier 2 information, to revise the containment peak pressure and temperature analysis methodology, to revise the minimum containment pressure analysis, to update the mass and energy release values for both the LOCA and MSLB analyses, and update the heat sinks and thermal properties for in-containment materials, as well as the associated UFSAR changes, continue to conform to GDCs 16, 38 and 50. Specifically, the staff finds that SNC's changes to the containment analysis methodology do not adversely affect the performance of the containment system as described in the UFSAR, and the changes more accurately represent the expected as-built design. The staff finds the licensing basis analyses continue to remain below the design basis limits. The changes to ITAAC 2.2.02.07 continue to meet the intent of the performance testing; that is, to demonstrate that the PCS is capable of adequate heat removal. The change to ITAAC 3.3.00.02g, as discussed above, is primarily for clarity and is not necessitated by an analysis change. Table 3-1 of the LAR documents the extent of the changes to the licensing basis proposed, and the LAR and updated UFSAR changes document SNC's review for other relevant design changes. The staff have reviewed the changes and made conclusions on the technical impacts in this safety evaluation. Therefore, based on the conclusions stated in this safety evaluation, the staff finds the proposed changes in this LAR to be acceptable.

3.2 EVALUATION OF EXEMPTION

The regulations in Section III.B of Appendix D to 10 CFR Part 52 require a holder of a COL referencing Appendix D to 10 CFR Part 52 to incorporate by reference and comply with the requirements of Appendix D, including certified information in Tier 1 of the generic AP1000 DCD. Exemptions from Tier 1 information are governed by the change process in Section VIII.A.4 of Appendix D of 10 CFR Part 52. Because SNC has identified changes to plant-specific Tier 1 information, with corresponding changes to the associated COL Appendix C information resulting in the need for a departure, an exemption from the certified design information within plant-specific Tier 1 material is required to implement the LAR.

The Tier 1 information for which a plant-specific departure and exemption was requested is described above. The result of this exemption would be that SNC could implement modifications to plant-specific Tier 1 information to the UFSAR as well as COL Appendix A and Appendix C and associated plant-specific DCD Tier 1 information. Pursuant to the provisions of 10 CFR 52.63(b)(1), an exemption from elements of the design as certified in the 10 CFR Part 52, Appendix D, design certification rule is requested for the involved Tier 1 information described and justified in LAR 17-043. This exemption is a permanent exemption limited in scope to the particular Tier 1 information specified.

As stated in Section VIII.A.4 of Appendix D to 10 CFR Part 52, an exemption from Tier 1 information is governed by the requirements of 10 CFR 52.63(b)(1) and 52.98(f). Additionally, Section VIII.A.4 of Appendix D to 10 CFR Part 52 provides that the Commission will deny a request for an exemption from Tier 1 if it finds that the requested change will result in a significant decrease in the level of safety otherwise provided by the design. Pursuant to 10 CFR 52.63(b)(1), the Commission may grant exemptions from one or more elements of the certification information, so long as the criteria given in 10 CFR 52.7, which, in turn, references 10 CFR 50.12, are met and that the special circumstances, which are defined by 10 CFR 50.12(a)(2), outweigh any potential decrease in safety due to reduced standardization.

Pursuant to 10 CFR 52.7, the Commission may, upon application by any interested person or upon its own initiative, grant exemptions from the requirements of 10 CFR Part 52. As 10 CFR 52.7 further states, the Commission's consideration will be governed by 10 CFR 50.12, "Specific exemptions," which states that an exemption may be granted when: (1) the exemptions are authorized by law, will not present an undue risk to the public health and safety, and are consistent with the common defense and security; and (2) special circumstances are present. Specifically, 10 CFR 50.12(a)(2) lists six circumstances for which an exemption may be granted. It is necessary for one of these bases to be present in order for the NRC to consider granting an exemption request. SNC stated that the requested exemption meets the special circumstances of 10 CFR 50.12(a)(2)(ii). That subparagraph defines special circumstances as when "[a]pplication of the regulation in the particular circumstances would not serve the underlying purpose of the rule or is not necessary to achieve the underlying purpose of the rule." The staff's analysis of these findings is presented below:

3.2.1 AUTHORIZED BY LAW

The requested exemption would allow SNC to implement the amendment described above. This exemption is a permanent exemption limited in scope to particular Tier 1 information. Subsequent changes to this plant-specific Tier 1 information, and corresponding changes to Appendix C, or any other Tier 1 information would be subject to the exemption process specified in Section VIII.A.4 of Appendix D to 10 CFR Part 52 and the requirements of 10 CFR 52.63(b)(1). As stated above, 10 CFR Part 52, Appendix D, Section VIII.A.4 allows the NRC to grant exemptions from one or more elements of the Tier 1 information. The NRC staff has determined that granting of SNC's proposed exemption will not result in a violation of the Atomic Energy Act of 1954, as amended, or the Commission's regulations. Therefore, as required by 10 CFR 50.12(a)(1), the exemption is authorized by law.

3.2.2 NO UNDUE RISK TO PUBLIC HEALTH AND SAFETY

As discussed above in the technical evaluation, the proposed changes comply with the NRC's substantive safety regulations. Therefore there is no undue risk to the public health and safety.

3.2.3 CONSISTENT WITH COMMON DEFENSE AND SECURITY

The proposed exemption would allow changes as described above in the technical evaluation, thereby departing from the AP1000 certified (Tier 1) design information. The change does not alter or impede the design, function, or operation of any plant structures, systems, or components associated with the facility's physical or cyber security and, therefore, does not affect any plant equipment that is necessary to maintain a safe and secure plant status. In addition, the changes have no impact on plant security or safeguards. Therefore, as required by 10 CFR 50.12(a)(1), the staff finds that the common defense and security is not impacted by this exemption.

3.2.4 SPECIAL CIRCUMSTANCES

Special circumstances, in accordance with 10 CFR 50.12(a)(2), are present, in part, whenever application of the regulation in the particular circumstances would not serve the underlying purpose of the rule or is not necessary to achieve the underlying purpose of the rule. The underlying purpose of the Tier 1 information is to ensure that a licensee will safely construct and operate a plant based on the certified information found in the AP1000 DCD, which was incorporated by reference into the VEGP Units 3 and 4 licensing basis. The proposed changes described in the above technical evaluation do not impact the ability of any SSCs to perform their functions or negatively impact safety.

Special circumstances are present in the particular circumstances discussed in LAR 17-043 because the application of the specified Tier 1 information is not necessary to achieve the underlying purpose of the rule. The proposed changes are equal or provide additional clarity to the existing requirement. The proposed changes do not affect any function or feature used for the prevention and mitigation of accidents or their safety analyses, and no safety-related SSC or function is involved. The proposed changes neither adversely impact the ability to meet the design functions of the SSCs nor involve a significant decrease in the level of safety provided by the SSCs. Because the proposed editorial changes are consistent with plant-specific DCD Tier 2 information and the underlying plant design, the changes do not physically affect an SSC. The proposed changes to information in plant-specific DCD Tier 1 continue to provide the detail necessary to implement the corresponding ITAAC. This exemption request and associated revisions to the Tier 1 information and corresponding changes to Appendix C demonstrate that the applicable regulatory requirements will continue to be met. Therefore, for the above reasons, the staff finds that the special circumstances required by 10 CFR 50.12(a)(2)(ii) for the granting of an exemption from the Tier 1 information exist.

3.2.5 SPECIAL CIRCUMSTANCES OUTWEIGH REDUCED STANDARDIZATION

This exemption would allow the implementation of changes to Tier 1 information in the plant-specific DCD and corresponding changes to information to the UFSAR as well as COL Appendix A and Appendix C that are being proposed in the LAR. The justification provided in LAR 17-043, the exemption request, and the associated licensing basis mark-ups demonstrate that there is a limited change from the standard information provided in the generic AP1000 DCD. The design functions of the system associated with this request will continue to be maintained because the associated revisions to the Tier 1 information support the design function of the AP1000 containment building. Consequently, the safety impact that may result from any reduction in standardization is minimized, because the proposed design change does not result in a reduction in the level of safety. In addition, the proposed changes reflect the actual detailed and finalized design of the containment building. Based on the foregoing reasons, as required by 10 CFR Part 52.63(b)(1), the staff finds that the special circumstances outweigh any decrease in safety that may result from the reduction of standardization of the AP1000 design.

3.2.6 NO SIGNIFICANT REDUCTION IN SAFETY

This exemption would allow the implementation of changes discussed above. The exemption request proposes to depart from the certified design by allowing changes discussed above in the technical evaluation. The changes for consistency will not impact the functional capabilities of this system. The proposed changes will not adversely affect the ability of the containment building to perform its design functions, and the level of safety provided by the current systems and equipment therein is unchanged. Therefore, based on the foregoing reasons and as required by 10 CFR 52.7, 10 CFR 52.98(f), and 10 CFR Part 52, Appendix D, Section VIII.A.4, the staff finds that granting the exemption would not result in a significant decrease in the level of safety otherwise provided by the design.

6.0 STATE CONSULTATION

In accordance with the Commission's regulations, the Georgia State official was notified of the proposed issuance of the amendment on October 16, 2018. The State official had no comment.

7.0 ENVIRONMENTAL CONSIDERATION

The amendment changes a requirement with respect to installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20. The NRC staff has determined that the amendment involves no significant increase in the amounts, and no significant change in the types, of any effluents that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendment involves no significant hazards consideration, and there has been no public comment on such finding (*Federal Register* 83 FR 20866 dated May 8, 2018). Accordingly, the amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendment.

Because the exemption is necessary to allow the changes proposed in the license amendment, and because the exemption does not authorize any activities other than those proposed in the license amendment, the environmental consideration for the exemption is identical to that of the license amendment. Accordingly, the exemption meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Therefore, pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment needs to be prepared in connection with the issuance of the exemption.

8.0 CONCLUSION

The staff has determined that pursuant to Section VIII.A.4 of Appendix D to 10 CFR Part 52, the exemption (1) is authorized by law, (2) presents no undue risk to the public health and safety, (3) is consistent with the common defense and security, (4) presents special circumstances, and (5) does not reduce the level of safety at SNC's facility. Therefore, the staff grants SNC an exemption from the Tier 1 information requested by SNC.

The staff has concluded, based on the considerations discussed in Section 3.1 that there is reasonable assurance that: (1) the health and safety of the public will not be endangered by operation in the proposed manner, (2) there is reasonable assurance that such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public. Therefore, the staff finds the changes proposed in this license amendment acceptable.

9.0 REFERENCES

1. Vogtle Electric Generating Plant, Request for License Amendment and Exemption Regarding "Containment Pressure Analysis (LAR-17-043)," letter from SNC, dated December 21, 2018, (ADAMS Accession No. ML18029A243).

2. Vogtle Electric Generating Plant, Request for License Amendment and Exemption Regarding "Containment Pressure Analysis (LAR-17-043), Supplement 1," letter from SNC, dated September 28, 2018, (ADAMS Accession No. ML18271A187).

3. U.S. NRC Final Request for Additional Information No. 1 for VEGP Units 3 and 4 LAR-17-043, ADAMS Accession No. ML18197A105, dated July 13, 2018.

4. U.S. NRC Final Request for Additional Information No. 2 for VEGP Units 3 and 4 LAR-17-043, ADAMS Accession No. ML18248A161, dated September 5, 2018.

5. U.S. NRC Final Audit Plan for VEGP Units 3 and 4 LAR-17-043, ADAMS Accession No. ML18115A124, dated April 25, 2018.

6. AP1000 Design Certification Nuclear Regulatory Commission Final Rule, Federal Register/Volume 71, No.18, dated January 27, 2006, Pages 4464-4482.

7. Final Safety Evaluation Report Related to Certification of the AP1000 Standard Plant Design, NUREG-1793, Supplement 2, dated August 5, 2011 (ADAMS Accession No. ML112061231).

8. Vogtle Electric Generating Plant, Final Safety Evaluation Report dated August 5, 2011 (ADAMS Accession No. ML111950510 - letter, ADAMS Accession No. ML110450302 - FSER package).

9. Westinghouse Electric Company, APP-GW-GLR-801, Revision 0, "WGOTHIC Application to AP600 and AP1000" (WCAP-15846) Revisions 1 through 5, March 2004 to September 2016 (Proprietary).

10. Westinghouse Electric Company, APP-GW-GLR-802, Revision 0, "WGOTHIC Application to AP600 and AP1000" (WCAP-15846) Revisions 1 through 5, December 2017 (Non-Proprietary).

11. Westinghouse Electric Company, APP-SSAR-GSC-588 Rev. 5, "WGOTHIC Application to AP600 and AP1000" (WCAP-15862) Revision 5 (Non-Proprietary).